vcssmentor.com

capsule

GENERAL SCIENCE

PREPARATION BOOSTER for

CSS, PMS, PCS, NTS
& All other competitive examination

Complied By Aamir Mahar

GENERAL SCIENCE CAPSULE

This page intentionally left blank.

Aamir Mahar
Email: aamirmahar321@gmail.com

Author is not responsible for any fact/information mentioned in this booklet. This is a complied work. All contents had taken from different Internet sources.

SCIENCE CAPSULE

CONTENTS:

SCIENCE: The word science comes from the Latin word *scientia* which implies knowledge. The science as subject has come to mean the systematic, consistent and excellent study of the physical world including everything than can be seen, observed or detected in nature by the man and society and the knowledge that grows out of such study. Usually the science is characterized by the methodologies and approaches of the hypothesises, postulates, assumptions, theories and laws based experimental observations and mathematical conclusions. The science is broadly categorized into two groups- Natural Science and Social Science. Natural science deals with the nature or physical world.
Natural science is broadly divided into:

1. Physical science (studies concerned with non-living matter)
2. Life science or Biological science (studies concerned with living matter)

IMPACT OF SCIENCE ON SOCIETY

Science is the organisation of knowledge in such a way that it commands the hidden potential in nature. This hidden potential is surfaced out by the subject of science through the process of understanding Science has proved to be of enormous beneficial nature. It has made lasting impact on regarding each and every field of human existence. Whether it is concerned with our day to day lives or whether it is related with the various modern developments which have resulted in elevating the living standards of the individuals.

The significant contributions which the study of this subject has made are enumerated below.

Science and Human Attitude: The various noteworthy scientific advances have helped the individuals in raising up of their self confidence .This subject has enabled the human beings to control and modify their needs and requirements. With greater understanding of the scientific phenomena human beings have now become more confident about the environmental issues as compared to the people in the past. In fact science has promoted and paved the way for the independent and logical thinking.

Science and Human Health: Before the development of modern medicinal factors, a large number of people used to loose their precious lives because of the unavailability of the sources and medicines for a proper health care. With the advancements of science now the human life expectancy rate has increased as the various modern developments in the field of health care has helped in warding off the dangerous diseases.

The revolutions in surgery and medicine the infectious diseases like small pox, malaria, typhoid etc. have been eradicated. Thus science has improved the health standards of the people.

Science and Travel: People used to travel on foot before the inventions of automobiles, aeroplanes and steam engines. They also used animal carts and camels for the purpose of moving from one place to another. However, the modern scientific inventions have proved to be of great significance as it has added speed to the area of travel. The quick means of transportation have decreased the distances and is a source of saving time. In fact it would not be wrong to regard that these inventions have added much peace to the lives of the modern men.

Science and Communication: Science has also played a significant part in the development of the modern communication technology. Earlier people were living in isolation because of the slow means of communication. Now the well developed, efficient media have made it possible to communicate with each other more rapidly and quickly. The impact of mass media is enormous. The use of computers and televisions has made the world a global village where an event in one part of the world leaves an influence on the other.

Demerits of Science: Every invention of science has got its own merits and demerits. The most serious invention that science has contributed to is the development of the weapons of mass destruction like the atom and nuclear bombs. The recent wars have greatly showed that how much destruction can be brought about with the use of these lethal weapons. In fact these modern inventions of science have resulted in the elevation of the anxiety and unrest in the modern societies.

Another notable demerit which the study of this subject has lead to the rise in the environmental deterioration. Day by day the pollution factor is increasing which has proved to be very toxic and harmful for the human health. Not only the human health it is also proving fatal for the animals as well as the existing plants.

The rapid developments of science and industrialization have also been divided the world: The developed and the undeveloped. This division has lead to a widening gap between the status and the living standards of people. There is economic disparity which has also given rise to class distinction.

GENERAL SCIENCE:

1. The temperature at which all substances have zero thermal energy - **273 degree celcious.**
2. Any substance which when added to a reaction, alters the rate of the reaction but remains chemically unchanged at the end of the process is called - **Catalyst**.
3. The study of the inter-relations of animals and plants with their environment is called- **Ecology.**
4. Study of insects is called-Entomology.
5. A unit used to express the focal power of optical lenses- **Dioptre.**
6. The velocity that a body with less mass must achieve in order to escape from the gravitational attraction of a more massive body is called- **Escape Velocity.**
7. Laughing gas is chemically known as: **Nitrous Oxide.**
8. The blood vessels carrying blood from the heart to various parts of the body is called- **Artery.**
9. The distance travelled by light in one year is called - **Light year.**
10. An organism which derives its nourishment from another living organism is called- **Parasite.**
11. Newton's which law states that the rate of change of momentum of a body is directly proportional to the force applied and takes place in the direction in which the force act - **Newton's second law of motion.**
12. Which is the world's first man-made satellite- **Sputnik-I. (4 Oct, 1957)**
13. Which planet is the brightest of all the planets- **Venus.**
14. Small pieces of solid matter which are found scattered in the inter-planetary space of the solar system are known as- **Meteoroids.**
15. The largest gland in the body which is dark red in colour is- **Liver.**
16. Inadequate secretion of Insulin hormone causes which disease -**Diabetes.**
17. **Common cold, Influenza, Chickenpox** and Measles are caused due to the attack of Virus or Bacteria - **Virus.**
18. In which atmospheric layer are the communication satellite located- **Ionosphere.**
19. The scientific principle behind 'Fibre Optics' is – **Total internal reflection of light.**
20. Ginger is a stem and not a root, True or False - **True (because it has nodes and Internodes).**
21. When we wind a watch which energy is stored - **Potential Energy.**
22. On which phenomena the process of Dialysis used on patient with affected kidneys is Based - **Osmosis.**
23. When a piece of ice floating in a beaker of water melts, the level of water will rise or fall- **Remains the same.**
24. Energy stored in a dry cell is - **Chemical energy.**
25. When a cricketer lowers his hand while catching the ball, it saves him from injury due to - **Conservation of momentum.**
26. Full form of AIDS is - **Acquired Immune Deficiency Syndrome.**
27. Chemical technology dealing with the conversion of base metals into gold is - **Alchemy.**
28. Subtances produced by micro-organism that kill or prevent growth of other micro-organism is called - **Antibiotics.**
29. Substances which react with acids to form salts is called - **Base.**
30. The ancient oriental art of growing trees in dwarf form is called - Bonsai.
31. What is the unit of heat - **Calorie.**
32. The ability of a body to resist tension or compression and to recover its original shape and size when the stress is removed is called - **Elasticity.**
33. The negatively charged particles which revolve around the nucleus of the atom in certain orbits is called - **Electron.**
34. The branch of biology dealing with study of Heredity is - **Genetics.**
35. Kwashiorkor is caused due to the deficiency of - **Protein.**
36. The branch of science which deals with study of nature and properties of light is called- **Optics.**
37. The scale used to measure the magnitudes of earthquakes is called - **Richter scale.**
38. The heat required to raise the temperature of 1 kg of a substance through one degree celcius is called - Specific heat.
39. The speed greater than the speed of sound is called- **Supersonic speed.**
40. Volatile substance that incapacitates for a time by powerfully irritating the eyes, provoking tears is called - **Tear gas.**
41. Who is the inventor of Dynamite - **Alfred B. Nobel.**
42. The unit used to measure loudness of sound is - **Decibel.**
43. The smallest part of an element that can take part in a chemical reaction is called - **Atom.**
44. Substances used for destroying or stopping growth of micro-organisms in living tissue is Called -**Antiseptic.**
45. Water that does not form lather with soap easily is called - **Hard water.**
46. The lines drawn on maps joining the places having same barometric pressure is called -

Isobars.
47. Lymph differs from blood in not having - **Red Blood Corpuscles.**
48. Universal receivers can receive blood from - **Groups O, A, B and AB**
49. Study of Grass is called - **Agrostology.**
50. Study of Tumor is called - **Oncology.**
51. Which physical property will be unaffected with increase in quantity - **Density.**
52. Oil spreads over the surface of water because - **Oil has less surface tension than water.**
53. In high mountaneous regions bleeding through nose occurs because - **The pressure of the blood in the capillaries is higher than the outside air pressure.**
54. Why does a man weigh more at the poles than at the equator - **Gravitational pull is more at the poles.**
55. A gas will behave as an ideal gas at - **At very low pressure and high temperature.**
56. Oology is the branch of science dealing with the study of -**Birds egg.**
57. Why does a drop of liquid assume a spherical shape - **Because a sphere has the least surface tension**
58. When cream is separated from milk the density of milk increases or decreases- **Increases**
59. Diamond is harder than Graphite due to difference of -**Crystalline structure.**
60. Which combination of colours is the most convenient during day and night time-- **Red and Green**
61. An element which does not react with oxygen is - **Helium**
62. An instrument that measures and records the relative humidity of air is - **Hygrometer**
63. The different colours of different stars are due to the variation of- **Temperature**
64. Which is left when an hydrogen atom loses its electron - **A proton**
65. The fundamental scientific principle in the operation of a battery is - **Oxidation-reduction**
66. Which metal is used to galvanise iron - **Zinc**
67. The instrument used to measure the force and velocity of the wind is- **Anemometer**
68. Edward Jenner is associated with - **Small Pox**
69. The scientist who explained about blood circulation for the first time was - **William Harvey**
70. Nitroglycerine is used as - **An explosive**
71. Solar Energy is due to the process of - **Fusion reactions**
72. In a dry cell battery which are used as electrolytes - **Ammonium Chloride and Zinc Chloride**
73. Which types of waves are used in a night vision apparatus - **Infrared waves**
74. In order to stay over the same spot on the earth, a geostationary satellite has to be directly Above - **The Equator**
75. Water is used to cool the engines of cars, buses, trucks, etc. It is because water has- **High specific heat**
76. Due to contract of eyeball, a long-sighted eye can only see farther objects which is corrected by using - **Convex lens**
77. Rainwater collected after 30 to 40 minutes of raining is not suitable for drinking because it is - **Acidic**
78. The refining of petroleum is done by the process of - **Fractional Distillation** Physical quantities which are completely described by a magnitude (size) alone are known as - **Scalar quantities**
79. Study of the abundance and reactions of chemical elements and molecules in the universe, and their interaction with radiation is called - **Astrochemistry**
80. Organelles which is known as the power house of the cells - **Mitochondria**
81. Photosynthesis takes place maximum in red colour and minimum in - **Violet colour**
82. Other name of White Blood Cells is - **Leukocytes**
83. Other name of Red Blood Cells is - **Erythrocytes**
84. Which antiseptic compound is present in Dettol – **Chloroxylenol**
85. What is a compound that is a white solid which absorbs water vapour from the air – **Calcium chloride**
86. To which product of equivalent weight and valency of an element is equal – **Atomic weight**
87. Which element forms the highest number of compounds in the periodic table – **Silicon**
88. How does addition of ethylene dibromide help to petrol – **Elimination of lead oxide**
89. What do we call the process of separation of pure water from impurities – **Distillation**
90. What is the name of gas which is present in both the natural gas and the biogas – **Methane**
91. Of which alloy the commonly used safety fuse-wire is made – **Alloy of Tin and Lead**
92. What is alcohol obtained in the saponification process – **Glycerol**
93. Which is used to dilute oxygen in the gas cylinders used by divers – **Helium**
94. What do cathode rays case when obstructed by metal –**emission of X-rays**
95. With which liquid is anomalous expansion

associated – **Water**

96. What is a tick paste of cement, sand and water called – **Mortar**
97. Ethanol containing 5% water by which name is it known – **Rectified spirit**
98. Of which Container radioactive materials should be kept – **Pb**
99. Which is not an anesthetic agent in surgical operations – **Acetone**
100. What is the percentage of Nitrogen, present in ammonium sulphate – **21%**
101. Which is the nuclear particle having no mass and no charge, but only spin – **Neutrino**
102. The pH of fresh milk is 6. When it turns sour, what will be the pH – **Less than 6**
103. How must have metals used to make wires for safety fuses– **Low resistivity and low melting point**
104. Sodium stearate is a salt and how is it used – **To make soap**
105. Which are the two main constituents of granite– **Iron and silica**
106. Which method of water purification does not kill microorganism – **Filtration**
107. Which gase is supporter of combustion – **Oxygen**
108. By which was the presence of Cobalt. in Vitamin B-12 established for the first time – **Borax-Bead test**
109. Which metal can deposit copper from copper sulphate solution – **Iron**
110. Which group of gases contribute to the "Green House effect" – **Carbon dioxide and Methane**
111. On heating, Gypsum loses certain percentage of its water content and what does it become – **Plaster of Paris**
112. A liquid initially contracts when cooled down to 4 degree Celsius but on further cooling down to zero degree Celsius, it expands. What is the name of liquid – **Water**
113. Under which category Magnetic, electrostatic and gravitational forces come – **Non-contact forces**
114. No matter how far you stand from a mirror, your image appears erect, How is the mirror likely to be – **Either plane or convex**
115. Due to which Phenomenon are advanced sunrise and delayed sunset found in the sky – **Refraction of sunlight**
116. Due to which Phenomenon is the formation of colours in soap bubbles – **Interference of light**
117. On which principle a pressure cooker works –**Elevation of boiling point of water by application of pressure**
118. Why does pressure of a gas increases due to increase of its temperature– **Kinetic energies of die gas molecules are higher**
119. By which Newton's may the weight of an object be assigned– **Laws of gravitation**
120. With which field is a current carrying conductor associated – **A magnetic field**
121. Which doesn't have any effect on velocity of sound – **Pressure**
122. Why does white light into its components – **Due to dispersion**
123. What type of lenses are used in movie projectors – **Convex**
124. During which radioactivity radiation is not emitted – **Cathode rays**
125. An object is undergoing a non-**accelerated motion.**
126. What is its rate of change in momentum – **Zero**
127. A particle is moving freely. Then its– **kinetic energy is always greater than zero**
128. If an object undergoes a uniform circular motion, then What will be– **Its velocity changes**
129. A motor vehicle is moving in a circle with a uniform speed. Where will be the net acceleration of the vehicle – **towards the centre of circle**
130. Which property of a proton may change while it moves freely in a magnetic field – **Velocity**
131. During sunrise and sunset, why does sun appears reddish-orange – **Reddish-orange light is least scattered by the atmosphere**
132. Why are ball bearings used in bicycles, cars, etc – **The effective area of contact** between the wheel and axle is reduced
133. By which Signal a television channel is characterised – **Frequency of transmitted signal**
134. What is a good conductor while carrying current – **Electrically neutral**
135. **What is the device used for** measuring the wavelength of X-rays – **Bragg Spectrometer**
136. Which is responsible for the working of Newton's colour disc experiment – **Persistence of vision**
137. Who is the founder, of quantum theory of radiation – **Plank**
138. What is Photon – **The fundamental unit/quantum of Light**
139. When does a liquid disturbed by stirring come to rest – **Due to Viscosity**
140. Study of Heavenly bodies is called –**Astronomy**
141. Study of bacteria and the diseases caused by them is called - **Bacteriology**
142. Science dealing with the origin and development of mankind is called - **Anthropology**

143. Study of cells is called - **Cytology**
144. Science dealing with the functions and the diseases of heart is called - **Cardiology**
145. Study of skin is called - **Dermatology**
146. Study of Blood Vascular System is called - **Angiology**
147. Study of Fungi and fungus diseases is called- **Mycology**
148. Study of Tumors is called -**Oncology**
149. Study of Liver and its diseases is called - **Hepatology**
150. Study of the Nervous system, its functions and its disorders is called - **Neurology**
151. Branch of Biology dealing with the phenomena of Heredity is called - **Genetics**
152. Study of causes of Diseases is called - Etiology
153. Study of Ears and their diseases is called - **Otology**
154. Study of Condition and Structure of Earth is called - **Geology**
155. Study of Kidneys and its function is called - **Nephrology**
156. Study of Birds is called - **Ornithology**
157. Study of Fossils is called - **Palaeontology**
158. Study of Bones is called - **Osteology**
159. Study of Soils is called - **Pedology**
160. Branch of science dealing with Urinary system is called - **Urology**
161. Study of Viruses is called - **Virology**
162. Study of resistance of body against infection (immunity) is called -**Immunology**
163. Study of Muscles is called - **Myology**
164. Study of development of Embryos is called - **Embryology**
165. Study of Insects is called - **Entomology**
166. Study of Female Reproductive System is called - **Gynaecology**
167. Study of production of Three Dimensional Image using Laser is called – **Holography**
168. Study of Snakes is called - **Serpentology**
Production of Raw Silk by rearing of Silk Worms is called - **Sericulture**
169. Study of Algae is called -**Phycology**
170. Study of diseases, symptoms, cause and remedy is called - **Pathology**
171. Study of Serum is called - **Serology**
172. The Breeding, Rearing, and Transplantation of Fish is called - **Pisciculture**
173. The slope low lying area of ocean near highland: **Costal Plane**
174. Galileo discovered that falling bodies have same: **Acceleration**
175. The relative motion between observer and frequency is called: **Doppler's effect**
176. The source of energy for brain is: **Glucose**
177. The ready source of energy for athletes is: **Carbohydrates**
178. Arthritis is: **Inflammation of joints**
179. Dengue is caused by**: Aedes (Female Mosquito)**
180. The solid and liquid can be separated by the process of: **Filtration**
181. The composition of sun is 90 % Hydrogen and Helium and Heavy metals ratio is: **7.8 %**
182. Accessory gland close of digestive system close to duodenum is: **Pancreas**
183. Fat soluble vitamins are: **A,D,E,K**
184. Protein content of edible part of egg: **Yolk**
185. What is disease: **A disease is a particular abnormal condition, a disorder of a structure or function that affects part or all of an organism.**
186. How Asthma is provoked: **Allergy**
187. Which material conduct heat and electricity: **Solid**
188. The fuel used in rockets is: **Liquid oxygen, nitrogen tetroxide, and hydrogen peroxide**
189. Chemical name of Table salt is: **Sodium Chloride**
190. Milk is pasteurized because : **To kill bacteria**
191. Gall bladder is part of which system: **Digestive System**
192. Genes in higher organism are located in: **Genome (DNA)**
193. Which finest filament grow from skin: **Hair**
194. The thinking part of brain is: **Cerebrum**
195. The Shape of the Earth is: **Spherical**
196. Horticulture is the study of: **Producing, improving, marketing, and using fruits, vegetables, flowers, and ornamental plants**
197. Entomology is the study of: **Study of insects**
198. Vitamin C prevent which disease: **Scurvy**
199. Substance use for coloring dye: **Pigment**
200. Soft drink contains which gas? **CO_2**
201. Serial pin has how many minimum ports: **9**
202. Cyclone is? **Circular moving tornado**
203. X-rays were discovered in 1895 by: **Wilhelm Conrad Roentgen**
204. Jelly fish looks like: **Umbrella.**
205. In how much time Earth rotates around its axis: **A Day**
206. In how much time Earth complete its round to sun: **A year**
207. Which colored eye doesn't have pigment? **Blue**
208. A person who write computer program called: **Programmer**
209. To say in the sunlight while circling the globe at the equator, o ne has to move with a speed of **1670 km/hour.**
210. **Infrared waves** have more wavelengths than the red colour.
211. **Liver** produces bile which is involved in the

breakdown of fats.

212. A **secondary cell** can be charged again.
213. The study of human population is called **Demography.**
214. Human being belongs to species called **Sapiens**.
215. Defect of eye due to which nearly located objects are not clearly visible is called **Hyperopia/Hypermetropia.**
216. About **60-70%** of the human body consists of water.
217. All of the oxygen that we breathe has been produces by the splitting of water during **Photosynthesis.**
218. The important ore of Chromium is **Chromite**.
219. The measurement of rainfall is made by an instrument known as **Rain gauge.**
220. **Oxidation** means loss of electron.
221. Poplar is woody raw material which is used for the **manufacture of paper pulp**.
222. Rectified spirit contains alcohol about **95%.**
223. The Famous book; Al-Qanoon was written by the Muslim scientist **Abu Ail Sina**
224. Basic metals can be converted into gold by **artificial nuclear radioactivity**.
225. One of the main functions of the earth‘s ozone layer is to filter out **ultraviolet rays**.
226. Blood is formed in bone marrow in **human body.**
227. **Quark** is the smallest part of the matter discovered by the scientists.
228. **Trachoma** is a disease o f the eye.
229. The heart of a normal adult human being weighs about 300 grams and that of woman **200 grams.**
230. Heart pumps **5 litre blood per minute** in a normal human adult (at resting position).

ABBREVIATIONS (SCIENTIFIC & OTHERS)

1. LPG: Liquefied Petroleum Gas
2. TNT: Tri Nitro Toluen
3. RNA: Ribonucleic Acid
4. CNG: Compressed Natural Gas
5. ATP: Adenosine Tri Phosphate
6. RBC: Red Blood Cells/Corpuscles
7. ECG: Electro Cardio Gram
8. PVC: Poly vinyl Chloride
9. RAM: Random Access Memory
10. CFC: Chloro Fluoro Carbon
11. LASER: Light Amplification by Stimulated emission of Radiation
12. RADAR: Radio Detection and Ranging
13. AIDS: Acquired Immune Deficiency Syndrome
14. ROM: Read Only Memory
15. LAN: Local Area Network
16. WWW: World Wide Web
17. DNA: Deoxyribonucleic Acid
18. SONAR: Sound Navigation and Ranging
19. SARS: Severe Acute Respiratory Syndrome
20. NTP: Network Time Protocol/ Normal Temperature and Pressure
21. RQ: Respiratory Quotient
22. NPN: Negative Positive Negative
23. PNP: Purine Nucleoside Phosphorylase
24. WAN: Wide Area Network
25. CPU: Central Processing Unit
26. BCG: Bacillus Calmette Guerin
27. STP: Standard Temperature And Pressure/Shielded Twisted Pair/Sodium Tripolyphosphate/Spanning Tree Protocol
28. ATP: Adenosine Triphosphate
29. KWh: Kilo Watt Hour
30. BTU: British thermal Unit
31. LDL: Low Density Lipoprotein
32. MAF: Million Acre Feet
33. HDL: Hardware Description Language
34. MCV: Mean Corpuscular Volume
35. UHF: Ultra High Frequency
36. LED: Light emitting Diode
37. LCD: Liquid Crystal Display
38. BASIC: Beginner's All-Purpose Symbolic Instruction Code
39. MASER: Microwave Amplification by Stimulated Emission of Radiation
40. ETT: Educational Telecommunications and Technology/ European Transaction on Telecommunication
41. HST: High Speed Technology/ High Speed Train (in UK)/Hubble Space Telescope
42. DBS: Data Base Server/ Direct Broadcast Satellite
43. CRO: Cathode Ray Oscilloscope
44. BOT: Build, Operate and Transfer/Botulinum Toxin
45. AMU: Atomic Mass Unit
46. EMF: Electro Motive force
47. ADH: Anti-diuretic Hormone
48. GeV: Giga Electro Volt
49. CRT: Cathode Ray Tube
50. CNS: Central Nervous System
51. PTFE: Poly Tetra Fluoro Ethylene
52. GUT: Grand Unified Theory
53. LONAR: Long Range Navigation
54. MeV: Mega Electron Volt/ Million Electron Volt/ Multi-experiment Viewer
55. AWACS: Airborne Warning and Control System 56. CCTV: Closed-Circuit Television
56. ABM: Anti-Ballistic Missile
57. AC: Alternating Current/Air Conditioning
58 AEC: Atomic Energy Commission
59. Alt: Altitude
60. AM: Ante Maridiem (Before Noon/Midday)
61. Amp: Ampere

62. APTEC: All Pakistan Technology Engineers Council
63. ATM: Automated Teller Machine (Banking)
64. AW: Atomic Weight/ Asia Watch
65. BIOS: Basic Input Output System
66. BDS: Bachelor Of Dental Surgery/ Bomb Disposal Squad
67. BP: Blood Pressure/ Boiling Point/ Blue Print 13. C/A: Current Account
68. CAA: Civil Aviation Authority
69. CABB: Centre Of Agricultural Biochemistry And Biotechnology 16. CAD: Computer-Aided Design
70. Cal: Calorie
71. CD: Compact Disc/ Civil Defence/ Community Development
72. CD-ROM: Compact Disc Read-Only Memory
73. CECP: Cotton Export Corporation Of Pakistan
74. CHASNUPP: Chashma Nuclear Power Plant
75. CMCC: China Mobile Communications Corporation
76. COM: Computer Aided Manufacturing
77. COMSAT: Communications Satellite Corporation
78. COMSTECH: Council of Scientific And Technology Cooperation Of Islamic Conference
79. CSIRO: Commonwealth Scientific and Industrial Research Organisation
80. CTBT: Comprehensive Test Ban Treaty
81. CT-Scan: Computerised Axial Tomography Scanning
82. DVD: Dynamic Versatile Disc
83. ECAT: Engineering Colleges Admission Test
84. EDB: Engineering Development Board
85. EEG: Electroencephalogram
86. ENERCON: Energy Conservation Centre
87. EPA: Energy Protection Agency
88. EPD: Energy Protection Department
89. ESA: European Space Agency
90. ESRO: European Space Research Organisation
91. FAT: File Allocation Table
92. FCPS: Fellow of The Royal College Of Physicians And Surgeons
93. FM: Frequency Modulation
94. FMCT: Fissile Material Cut-Off Treaty
95. FRCS: Fellow of The Royal College Of Surgeons
96. GHz. Gigahertz
97. GMT: Greenwich Mean Tim
98. HIV: Human Immune Deficiency Virus
99. HTML: Hypertext Mark-Up Language
100. HTTP: Hypertext Transfer Protocol
101. IAEA: International Atomic Energy Agency (UN)
102. IBM: International Business Machine
103. IC: Integrated Circuit/ Intelligence Corps
104. ICBM: Inter-Continental Ballistic Missile
105. ICU: Intensive Care Unit
106. IEA: International Energy Agency
107. INSTRAW: International Research and Training Institute for the Advancement of Women
108. INTELSAC: International Telecommunications Satellite Consortium
109. Intelsat: International Telecommunications Satellite Organisation
110. IRBM: Intermediate Range ballistic Missile
111. ISP: Internet Service Provider
112. IT: Information Technology
113. ITB: Information Technology Board
114. JAXA: Japan Aerospace Exploration Agency
115. KANUPP: Karachi Nuclear Power Plant
116. KAPCO: Kot Adu Power Company
117. kHz: Kilohertz
118. KV: Kilo Volt
119. kW: Kilowatt
120. MCAT: Medical Colleges Admission Test
121. MDS: Master In Dental Surgery
122. MNP: Mobile Number Probability
123. MRBM: Medium Range Ballistic Missile
124. MRCP: Member of Royal College Of Physicians
125. MRCS: Member of Royal College Of Surgeons
126. MRI: Magnetic Resonance Imaging
127. MS: Medical Superintendent
128. MSN: Microsoft Network
129. MW: Megawatt
130. NADRA: National Database and Registration Authority
131. NEPRA: National Electric Power Regulatory Authority
132. NM: Nautical Mile
133. NMD: National Missile Defence
134. NPT: Non-Nuclear Proliferation Treaty
135. NRA: Nuclear Regulatory Authority
136. OGRA: Oil And Gas Regulatory Authority
137. NWD: Nation Wide Dialling
138. OGDC: Oil And Gas Development Corporation
139. pm: Post Meridiem
140. PEMRA: Pakistan Electronic Media Regulatory Authority
141. PTA: Pakistan Telecommunication Authority
142. RADAR: Radio Detection and Ranging
143. SALT: Strategic Arms Limitation Talks
144. SLV: Satellite Launch Vehicle
145. SMS: Short Message Service
146. SNGPL: Sui Northern Gas Pipelines Limited
147. SONAR: Sound Navigation And Ranging
148. SSGPL: Sui Southern Gas Pipeline Limited
149. STD: Subscriber's Trunk Dialling
150. STM: Subscriber Identification
151. SUPARCO: Space and Upper Atmosphere Research Committee (Pakistan)
152. TB: Tubercle Bacillus/ Tuberculosis
153. UHF: Ultra High Frequency
154. UNAEC: United Nations Atomic Energy Commission
155. UNESCO: United Nations Education, Scientific and Cultural Organisation
156. VCD: Video Compact Disc

157. VHF: Very High Frequency
158. WAN: Wide Area Network
159. WAP: Wireless Application Protocol
160. WAPDA: Water and Power Development Authority
161. WHO: World Health Organisation
162. WMD: Weapons of Mass Destruction
163. WWF: World Wildlife Fund
164. ZPG: Zero Population Growth

LIST OF SCIENTIFIC INSTRUMENT

1. An instrument used in aircrafts for measuring altitudes is called - **Altimeter**
2. An instrument used to measure the strength of an electric current is called - **Ammeter**
3. An instrument to measure the speed, direction and pressure of the wind is called- **Anemometer**
4. An intrument used to measure difference in hearing is called - **Audiometer**
5. An instrument to measure atmospheric pressure and conditions is called - **Barometer** 6. An intrument used to measure potential difference between two points is called - **Voltmeter**
7. An optical instrument used for magnified view of distant objects is called-**Binoculars**
8. An instrument used to measure the diameters of wire, tube or rod is called-**Callipers**
9. An instrument used to measure quantities of Heat is called - **Calorimeter**
10. An apparatus used for charging air with petrol vapours in an internal combustion engine is called – **Carburettor**
11. An instrument used for measuring the temperature of the human body is called- **Thermometer**
12. A device which converts mechanical energy into electrical energy is called- **Dynamo**
13. An instrument used for measuring electrical potential differences is called- **Electrometer**
14. An instrument used for detecting the presence of electric charge is called- **Electroscope**
15. An instrument used for measuring Electric Current is called - **Galvanometer**
16. An instrument used for measuring depth of the ocean is called - **Fathometer**
17. An instrument used for relative density of liquids is called - **Hydrometer**
18. An instrument used for relative density of milk is called - **Lactometer**
19. An instrument used for magnified view of very small objects is called - **Microscope**
20. An apparatus used in submarines for viewing objects lying above the eye level of the observer is called - **Periscope**
21. An instrument used for comparing the luminous intensity of two sources of light is Called – **Photometer**
22. An instrument used to measure high temperature is called - **Pyrometer**
23. An instrument used to measure Rainfall is called - **Rain Gauge**
24. An instrument used for recording the intensity and origin of earthquakes shocks is called – **Siesmograph**
25. An instrument used for measuring angular distance between two objects is called - **Sextant**
26. An instrument used for measuring speed of the vehicle is called - **Speedometer**
27. An apparatus used for converting high voltage to low and vice-versa is called- **Transformer**
28. An instrument that continuously records a barometer's reading of atmospheric pressure. - **Barograph**
29. An instrument used to measure infrared, or heat, radiation. - **Bolometer**
30. An instrument used for measuring growth in plants. **Crescograph**
31. An instrument used for tracing movement of heart. **Cardiograph**
32. A clock that keeps very accurate time and determines longitude of a vessel at sea. - **Chronometer**
33. An instrument used to examine internal parts of the body. - **Endoscope**
34. A glass tube for measuring volumes changes in the chemical reactions between gases -**Eudiometer**
35. A machine for reproducing recorded sound. - **Gramophone**
36. An instrument used to measure the moisture content or the humidity of air or any gas. - **Hygrometer**
37. A microphone designed to be used underwater for recording or listening to underwater sound. **Hydrophone**
38. A device used to measure atmospheric pressure - **Manometer**
39. A device which converts sound waves into electrical signals. - **Microphone**
40. An instrument attached to the wheel of a vehicle, to measure the distance traversed. - **Odometer**
41. An instrument used for reproducing sound. **Phonograph**
42. An instrument used for measuring Solar radiation is called - **Pyrheliometer**
43. An instrument used for taking angular measurements of altitude in astronomy and navigation is called - **Quadrant**
44. An instrument for measuring a Refractive Index

of a substance is called - **Refractometer**
45. An instrument used for Spectrum analysis is called- **Spectroscope**
46. An instrument for measuring blood pressure is called - **Sphygmomanometer**
47. An instrument for measuring and indicating temperature is called - **Thermometer**
48. A medical instrument used for hearing and analysing the sound of Heart is called - **Stethoscope**
49. An apparatus for recording the readings of an instrument and transmitting them by radio is called - **Telemeter**
50. An instrument used for magnified view of distant objects is called- **Telescope**
51. A device that automatically regulates constant temperatures is called - **Thermostat**
52. An instrument used for measuring Viscosity is called - **Viscometer**
53. A small scale calibrated to indicate fractional divisions of the main scale is called- **Vernier Scale**
54. An instrument for testing the refractive power of the eye is called - **Optometer**
55. An instrument designed for visual examination of the eardrum is called -**Otoscope**
56. A device that measures low temperature is called - **Cryometer**
57. An instrument used in an aircraft indicating airspeed is called – **Machmeter**

SI UNITS

1. **Force:** Newton/ Dyne
2. **Temperature:** Kelvin/ Celsius/ Degree
3. **Current:** Ampere
4. **Heat:** Joule/ Calorie/ BTU
5. **Pressure:** Pascal/Torr
6. **Radioactivity:** Becquerel/Curie/Rutherford
7. **Atomic energy**: Rydberg/Joule
8. **Voltage:** Volt
9. **Electric Potential Difference:** Volt
10. **Electric Charge:** Coulomb
11. **Power:** Watt
12. **Resistance:** Ohm
13. **Conductivity:** Mho
14. **Energy**: Joule/ Erg
15. **Distance between Stars and Planets**: Light Year
16. **Wavelength:** Angstrom
17. **Volume:** Acre-Foot/Litre
18. **Frequency:** Hertz
19. **Rate of flow of water:** Cusec
20. **Length:** Meter/Fermi/Parsec
21. **Optical Power of a Lens:** Dioptre
22. **Plane Angle:** Radian
23. **Luminous Intensity:** Candela
24. **Amount of Substance**: Mole
25. **Rate of Decay of Radioactive Material:** Rutherford
26. **Sedimentation Rate:** SVEDBERG Unit
27. **Induction:** Henry
28. **Magnetic flux:** Maxwell/ Weber
29. **Magnetic Flux Density/Magnetic Inductivity:** Telsa/ Gauss
30. **Electric Conductance**: Siemens
31. **Angle:** Degree
32. **Solid Angle:** Steradian
33. **Torque:** Foot-Pound
34. **Mass:** Slug
35. **Volume of Water Reservoirs**: Acre-foot
36. **Mechanical work/Energy:** Erg
37. **Magneto Motive Force:** Gilbert
38. **Newton:** Force
39. **Dyne:** Force
40. **Kelvin:** Temperature
41. **Celsius:** Temperature
42. **Degree:** Temperature
43. **Ampere:** Current
44. **Joule:** Heat/Atomic Energy/Energy
45. **Calorie:** Heat
46. **BTU:** Heat
47. **Pascal:** Pressure
48. **Torr:** Pressure
49. **Becquerel:** Radioactivity
50. **Curie:** Radioactivity
51. **Rutherford:** Rate of Decay of Radioactive Material/Radioactivity
52. **Rydberg:** Atomic Energy
53. **Volt:** Voltage/Electron Potential difference: Coulomb: Electric Charge
55. **Watt:** Power
56. **Ohm:** Resistance
57. **Mho:** Conductivity
58. **Erg:** Energy
59. **Light Year:** Distance Between Star
60. **Angstrom:** Wavelength 61. **Litre:** Volume
62. **Acre Foot:** Volume
63. **Hertz:** Frequency
64. **Cusec:** Rate of Flow of Water
65. **Meter:** Length
66. **Fermi:** Length
67. **Parsec:** Length
68. **Dioptre:** Optical Power of Lens
69. **Radian:** Plane Angle
70. **Candela:** Luminous Intensity
71. **SVEDBERG:** Sedimentation Rate
72. **Henry:** inductance
73. **Maxwell:** Magnetic Flux

74. **Weber:** Magnetic Flux
75. **Tesla:** Magnetic Flux Density/Magnetic Inductivity
76. **Gauss:** Magnetic Flux Density/Magnetic Inductivity
77. **Siemens:** Electric Conductance
78. **Degree:** Angle
79. **Steradian:** Solid Angle
80. **Foot Pound:** torque
81. **Slug:** Mass

SCIENTIFIC REASONS

1) **The Earth bulges out at equator. Why?**
Ans: This is due to the shape of the earth. The earth is not a true sphere but it is an ellipsoid. The equatorial diameter of the earth is 12756.27 kms. While its polar diameter is 12713.505 km. the difference between its equatorial and polar diameter is about 43 kilometres. The rotation of the earth on its axis produces a centrifugal force which increases its equatorial diameter. That is why earth bulges at the equator.

2) **The Sun appears red at sunset and sunrise. Why?**
Ans: The sun appears red at the time of sunset and sunrise due to the scattering of light by small particles of dust or smoke near the surface of the earth. The light travels relatively without hindrance that is why the sun appears red at the time of sunset and sunrise.

3) **The ozone layer in the atmosphere is necessary for our survival. Why?**
Ans: Ozone layer in the atmosphere is very necessary for plant and animal survival because it is the absorber of ultraviolet rays which are very dangerous for animal health. Ultraviolet rays cause cancer of skin, spotting of plants etc. that is why the ozone layer is necessary and essential for animal as well as plant survival.

4) **The sky from moon appears black. Why?**
Ans: As the moon has no atmosphere, so the sky looks completely black when viewed from the moon.

5) **Roads are bent inwards on curves. Why?**
Ans: The roads are bent inwards on the curves and at the turns because the bents avoid falling outside and prevent the accidents. OR When an object turns in a circle it is influenced by a centrifugal force which pushes it away from the centre of the circle. When vehicles turn on a road they fall outside under the influence of centrifugal force. In this way there is danger of falling or slipping out of road at a turn. Roads are made in a way that these bent inward at the turns to avoid falling outside and to prevent accidents.

6) **Australian continent has winter season when we have summer season in Pakistan.**
Ans: The earth on its axis is not at a vertical angle to its orbit. It is inclined at an angle of about. In this way when the northern hemisphere of the earth is inclined to the sun and getting direct sun rays, southern hemisphere is inclined away from the sun and getting less direct rays. Thus the northern hemisphere has summer season and southern hemisphere has winter season. Pakistan is in the northern hemisphere while Australia is in the southern hemisphere. So when there is winter in Australia there is summer season in Pakistan.

7) **Meat takes longer to cook on mountains.**
Ans: The meat takes longer time to cook on the mountains because the atmospheric pressure decreases with attitude and the boiling point of a liquid is directly proportional to the atmospheric pressure.

8) **Water remains cool in earthen pitcher.**
Ans: This occurs due to the process of evaporation. Water gets cooled on evaporation. As the earthenware pitcher is concerned, they have small pores. Water tends to come out of pores and evaporates which results in cooling effect on the earthenware and water. While in the metal pots there are no pores and evaporation does not take place. Besides metal has tendency to absorb heat that why water does not get cooled in a metal pot.

9) **Ice and salt mixture is used as a freezing agent by manual ice-cream makers.**
Ans: In manual ice-cream making a mixture of salt and ice is always used because salt has capacity to reduce the temperature of ice by decreasing its freezing point. That's why ice and salt mixture is used as freezing agent in manual ice cream making.

10) **It is not advisable to sleep under trees during the night.**
Ans: During night the plants release carbon dioxide (CO_2) which is a poisonous gas and injurious to health. That is why it is not advisable to sleep under trees during night.

11) **Why the green house operators paint their glass roofs white in summer?**
Ans: White colour is the reflector of light and it absorbs less heat as compared to other colours. As in summer there is already very hot season and heat is not required to that level. That is why the green-house operators paint glass roofs white in summer season.

12) **Water boils quicker on mountains.**
Ans: On Mountains the pressure of the air is low

due to height, as the air pressure decreases with altitude. In this way, water boils quicker on mountains at temperature less than 100 degree centigrade, which is the boiling point of water at ground level.

13) **Rainbow is produced in the sky after rainfall and sunlight.**
Ans: After rain, many droplet of water travel in the atmosphere. When sun rays fall on these droplets, dispersion of water occurs and droplets act as prism and produce a spectrum of seven colours. That's why a rainbow is seen in the sky after rain.

14) **Milk is considered as an ideal food.**
Ans: Milk is considered as an ideal food due to following reasons: a) It contains all constitute of balanced diet. b) Milk contains fat. c) Milk has high nutritional value because it contains proteins as well as minerals.

15) **Lunar eclipse last much longer than solar eclipse.**
Ans: Lunar eclipse last longer than the solar eclipse because the length of the earth's umbral shadow cone is more than three times the average distance between the moon and the earth, so the shadow is relatively wide at the point where the moon crosses it.

16) **Goitre is common in hilly areas.**
Ans: Goitre is common in hilly areas because there is deficiency of Iodine in the water.

17) **Detergents are better cleaning agents.**
Ans: A detergent consists of hydrophilic and hydrophobic ends. In case of dirt the detergent pushes the dirt off the wet surface of the fabric. The washing machine provides the agitation.

18) **Decomposers are important for life.**
Ans: Decomposers break down animal waste and dead organisms in order to get energy and release free nutrients back into the ecosystem. OR Decomposers break down organics into nutrients, which can be used by living organisms to create new life.

19) **Places near sea are cooler in summer.**
Ans: Sea water keeps the temperature moderate. In the summer season the places located near sea are cooler due to the lower temperature of water.

20) **Colour blindness is more common in men than women.**
Ans: Women have the sex chromosomes XX, while men have the chromosomes XY. The gene for normal colour vision is found on the X-chromosome. If a woman has one X-chromosome with the gene and one without it, she will not be colour blind. On the other hand, a man with an X chromosome that is missing the gene has no 'backup'. He will definitely be colour blind. Colour blind women have both X- chromosomes missing the colour vision gene. This is less probable mathematically than having just one X-chromosome missing the gene.

21) **Light colours absorb less heat therefore these are not heated as much as the black colour.**
Ans: Dark colours do not exactly absorb more heat, but they do convert a higher percentage of light into heat. In the sun with a dark coloured shirt it gets hot, where a lighter coloured shirt would not get nearly as hot. This is due to the amount of light being absorbed by the colour. The lighter the colour the smaller is the range of visible light being absorbed and converted into heat. White objects reflect all visible light, where black objects absorb all visible light.

22) **Rain water is more fertile than water from tube well.**
Ans: Rain water is more fertile because it contains many salts and nitrogen dissolved from the atmosphere.

23) **The manhole covers are generally round.**
Ans: Manholes, which interconnect underground sewerage pipes, and serve as a point of entry for cleaning the pipes, are located at every major sewer pipe junction, and are capped with round manhole covers. The reason for the circular construction of these covers is, quite simply, that covers of any other shape would fall through the manholes by virtue of their varying diameters. Circular manhole covers do not vary in width, or in diameter, as is the case with these other shapes, thus remaining in place despite the street traffic running roughshod over them.

24) **Clothes of a moving dancer bulge.**
Ans: The clothes of a moving dancer bulge outside due to the centrifugal force which tends to move away from the centre.

25) **People are advised not to stand near fast moving train.**
Ans: One should not stand beside a fast moving train because of the strong pressure of air which carries along. A man can fall in this pressure.

26) **The image of a tree is inverted on the bank of a lake.**
Ans: The water of lake acts as a mirror. According to the laws of light, mirror forms inverted images.

27) **Polar star is always seen in the north.**
Ans: It is because the Polar Star (North Star) is closest to the location of the celestial North Pole.

28) **We never see birds urinating.**
Ans: The birds do not have a urinary system like other living beings which possess urinary excretory organs. In the birds the urine is

excreted from body without special organs.

29) **Pasteurized milk has more nourishment than the ordinary boiled milk.**
Ans: Pasteurized milk is obtained by heating milk at a temperature of 60 degree Celsius for 30 minutes. In this way the TB bacteria are killed without damaging the milk protein. Thus pasteurized milk has more nourishment than ordinary boiled milk.

30) **Bees die when they sting human being.**
Ans: Their stingers are actually ovipositors, tubular structures extending from the abdomen that sometimes contain eggs. When the barbed stinger is left inside the victim, the honeybee mortally tears her abdomen in t he process. They leave their stingers in the wound with a tiny venom sac attached. Fortunately, only about one out of a hundred people are allergic to bee sting, but allergic reactions can be very serious.

31) **Cloudy nights are usually warmer than the clear ones.**
Ans: The clouds serve as a barrier and prevent the loss of heat. Thus the warm temperature is maintained.

32) **Why do some people snore?**
Ans: Some people snore during their sleep because the breathing action produces sound. This is so because the pharynx or the windpipe offers resistance to the air taken in or expelled.

33) **Why do we sometimes sleep walk?**
Ans: Sleep walk is a sort of disorder of sleep in which a person starts walking during his sleep. The sleeper walks and performs complex activities automatically without regaining consciousness.

34) **Climbers bend forward while climbing mountain.**
Ans: While climbing a mountain, a climber bends his body forward in order to keep the centre of gravity of his body within two thirds portion. According to this principle the Pisa Tower is not falling.

35) **Why climbers get their food by climbing on other trees?**
Ans: The climbers are mostly parasites and they cannot manufacture their food. Therefore, they climb on other trees and get food from them.

36) **Mars is called red planet.**
Ans: Mars is called the red planet because its colour is red due to the desert like surface.

37) **Vitamin D is the essential component of the body.**
Ans: Vitamin D is necessary for body because it is essential for bone formation and retention of calcium in the human body. Vitamin D also protects the teeth.

38) **The weight of the object is less at the equator than at the poles.**
Ans: The weight of an object is the product of mass and force of gravity. The equatorial diameter is more than the polar diameter. Thus, the force of gravity is more at the poles and the weight is more there.

39) **Why do the stars twinkle?**
Ans: The light from the stars travels through different layers of space of varying densities. Therefore, the light rays deviate from their original path. Further, these layers are not stationary but keep on moving. This leads to the twinkling of stars.

40) **On what days do we have equal days and nights all over the world? And why?**
Ans: On 23 September and 21 March we have equal days and nights all over the world. This is so because on these days, the rays of the sun fall vertically on the equator at noon. Both the poles receive equal rays of the sun. As a result, exactly one- half of each hemisphere receives the sun's rays. This makes day and night equal.

41) **Every fourth year has 366 days. Explain.**
Ans: One revolution of the earth around the sun takes 356 days and 6 hours. But we consider a year as consisting of only 365 days and ignore 6 hours. In four years the difference becomes as much as 24 hours or one day. Hence, to every fourth year we add one day. That year of 366 days is known as leap year.

42) **Why are igneous rocks called primary or parent rocks?**
Ans: Igneous rocks are formed when the molten material from volcanoes gets solidified. This material is liquid, hot and sticky which moves towards the surface through cracks and joints. All other rocks derived from these rocks. Hence, they are called primary or parent rocks.

43) **Why are the areas lying between the Arctic Circle and the North Pole in the Northern Hemisphere and the Antarctic Circle and the South Pole in the Southern Hemisphere very cold?**
Ans: These areas are very cold because the sun does not rise much above the horizon. Therefore, its rays are always very slanting which emit minimum heat. These areas being very cold are called Frigid Zones.

44) **Why are the three hot regions of the world-equatorial forests, savannah lands and hot deserts-not found in Europe?**
Ans: The three hot regions of the world-equatorial forests, savannah lands and hot deserts-are not found in Europe because Europe is the only inhabited continent situated entirely

outside the tropics.

45) **Why is the lowest layer of the atmosphere in contact with the earth's surface, the warmest?**
Ans: The lowest layer of the atmosphere in contact with the earth's surface is the warmest because the atmosphere is heated mainly from the below.

46) **Why does the temperature above the ocean and land masses vary even on the same latitude?**
Ans: Temperature above the oceans and land masses varies even on the same latitude because of the differential heating of land and water, i.e., land mass is heated and cooled more rapidly and to a greater degree than water.

47) **Why are marine animals able to live at great depths than marine plants?**
Ans: As marine animals do not depend upon sunlight for their survival, they are able to live at great depths where there is permanent darkness.

48) **Why do trees of coniferous forests possess needle-like leaves?**
Ans: The needle-like leaves limit transpiration and thus enable conifers to grow in the drier areas.

49) **Why is petroleum often called black gold?**
Ans: Petroleum is often called black gold because of its great demand in the modern industry and for domestic use. It provides fuel for heat and lighting, lubricant for machinery and raw material for a number of industries.

50) **Why are the kangaroos called marsupials?**
Ans: Marsupial means broad-pouch. Since kangaroos have a pouch-like fold of skin near the stomach in which they carry their young ones, they are called marsupials.

51) **Why is platypus considered a strange animal?**
Ans: Platypus is a strange animal because it is an animal-bird that survives under water, walks on the ground and digs tunnel under the ground. It is a four-legged animal that lays eggs like a bird. It is found in Australia.

52) **Why is a person in moving vehicle thrown forward when the vehicle stops suddenly?**
Ans: A person in a moving vehicle is in a state of motion. When the vehicle suddenly stops his body tends to remain in a state of motion due to inertia and he is thrown forward.

53) **Earth is continuously pulling moon towards its centre. Why does not the moon fall on to the earth?**
Ans: it is so because the gravitational attraction of the earth provides the necessary centripetal force to the moon for its orbital motion around the earth due to which the moon is revolving around the earth.

54) **Which of the two-glass or rubber is more elastic and why?**
Ans: Glass is more elastic than rubber because for a given applied force per unit area, the strain produced in glass is much more than that produced in rubber.

55) **Animal like camel can easily walk in the desert sand while other animals like donkeys, dogs and horses cannot. Explain.**
Ans: The camel has very broad and large feet. As a result of the large surface area in contact with the ground, it exerts less pressure on the sand and sinks only slightly in it. Other animals have smaller feet which exert more pressure on the sand. As a result, they sink more in the sand and cannot walk easily in desert.

56) **Why do equatorial forests appear evergreen?**
Ans: In equatorial forests trees often shed a few leaves or shed their leaves seasonally, but most of the trees retain their leaves for most of the time so that the forests appear evergreen.

57) **Why does a small quantity of liquid assume spherical form?**
Ans: A small quantity of liquid assumes a spherical form due to surface tension which tends to reduce the surface area. A given mass will acquire minimum surface area if it assumes a spherical shape.

58) **Why does an iron needle float on clean water but sink when some detergent is added to this water?**
Ans: Due to surface tension, the free surface of liquid at rest behaves like a stretched membrane. When an iron needle floats on the surface of clean water, its weight is supported by the stretched membrane. When some detergent is added to this water, its surface tension decreases. As a result of it, the stretched membrane on the surface of water is weakened and is not able to support the weight of needle. Hence the needle sinks in such water.

59) **Why is cooking quicker in a pressure cooker?**
Ans: The boiling point of water depends upon the pressure on its surface. Steam produced inside the cooker builds up pressure thereby raising the boiling point of water, which results in quick cooking.

60) **Why does steam cause more severe burns than boiling water?**
Ans: The amount of heat (latent heat) possessed by steam is much greater than the amount of heat possessed by water at the same temperature. Therefore, steam causes more severe burns than boiling water.

61) **Why does ice not melt readily when salt is sprinkled over it?**

Ans: When salt is sprinkled over ice, some of it dissolves. As dissolution of the salt is accompanied by absorption oh heat. The temperature of the system falls below 0 degree Celsius. Hence, ice does not melt readily.

62) **It is difficult for firemen to hold a hose, which ejects large amount of water at a high velocity. Why?**
Ans: The water which comes out of the fireman's hose carries large momentum as its velocity is very high. The equal and opposite reaction force pushes the fireman backwards with a great speed satisfying the law of conservation of momentum. As a result, it is difficult for t he fireman to hold the hose.

63) **In the outer space astronauts talk to each other through radios. Why?**
Ans: Sound waves need a material medium for its propagation. There is no air in space and hence, sound waves cannot travel. However, radio waves can travel through space. The astronauts can see each other because light, like radio waves, can travel through vacuum.

64) **Sonar scanners are used by doctors. Explain.**
Ans: Sonar scanners send out ultrasonic waves, which are reflected by body tissue and organs. From the pattern of reflections, a computer can build up an image of the internal structure which is vital for diagnosis.

65) **Why the flash of lightning is seen before the sound of thunder is heard?**
Ans: The velocity of light is much greater than that of the sound. Therefore, flash of lightning is seen before the sound of thunder is heard.

66) **Bats have poor eyesight but are able to home their prey with great accuracy. Also, dolphins can avoid fishing nets and can detect fish at night. Explain**
Ans: Bats emit high frequency (1, 20,000 Hz) sound waves and listen with their sensitive ears for any echoes. From the time taken to hear the echo and from the nature of sound received. Bats are able to estimate the distance and the type of surroundings. This process is known as echolocation. Same process is used by the dolphins.

67) **When low flying aircraft passes overhead, we sometimes notice a slight disturbance on our TV screen. Why is it so?**
Ans: a low flying aircraft reflects TV signal. Due to the interference between the direct signal and the reflected signal, there is disturbance on the TV screen.

68) **In automobiles, why are convex mirrors used to see the traffic from behind?**
Ans: Convex mirrors are used in automobiles because they form erect and diminished images of the object. Thus, it helps the drivers to get a wider field of view of the traffic coming from behind.

69) **Why is mirage formed in the deserts?**
Ans: A mirage is formed owing to total internal reflection. To the observer at a distance, the reflected image of the object appears behind the reflecting surface, as if the object were in front of it, but actually it is just an illusion.

70) **What will be the colour of grass in blue light?**
Ans: Grass will appear blackish in colour in blue light because it has the property of absorbing all other colours except its own colour. The blue rays falling on grass will be absorbed by it, and it will appear dark coloured.

71) **A bird perches on a bare high power line and nothing happens to it. A man standing on the ground touches the same line and gets a fatal shock. Why?**
Ans: When bird perches on a live high power line, no current passes through the body of bird because there is no potential difference between live wire and the body of bird as the potential of bird's body is the same as that of wire. When a man standing on the ground touches the same wire then due to a large potential difference between his hands and feet, a large current flows through his body to the earth.

72) **During lightning it is safest to be inside a car rather than under a tree or in the open. Give reason.**
Ans: When a person is in the open or under the tree, the lightning passes through his body to the earth. On the other hand, for a person inside a car, the car provider shielding and the electric field inside the car is zero, thus lightning does not affect the person inside it. The lightning actually passes through the metallic body of the car to the earth without affecting the person sitting inside it.

73) **Why is earthing desirable for electric appliances?**
Ans: Earthing helps the current move into the earth in the event of short-circuit, without giving a shock to the user.

74) **Why does a perspiring man feel relief when air flows by his side?**
Ans: The air flowing by the side of a perspiring man quickens the pace of evaporation of perspiration from the body of that person, and the resultant loss of heat from his body causes the cooling sensation which provides relief to him.

75) **Why is magnet always made of soft iron?** Ans: Magnet is always made of soft iron because

magnetization & demagnetization both are possible in soft iron.

76) **Why are telephone wires between two poles kept loose?**
Ans: Telephone wires are kept loose between two poles so that they are protected from being broken due to expansion and contraction caused by the change of temperature in summers and winters.

77) **X-rays penetrate through the flesh but not through bones. Why?**
Ans: The penetrating power of X-rays depends upon the potential difference between the cathode and the anode of X-ray tube. The X-rays produced can penetrate through light element like flesh of human body but they are unable to penetrate through heavier elements like bones.

78) **What is a black hole? Why is it called so?** Ans: A black hole is a super dense planetary material formed due to the death of a star of mass more than five solar masses. It is called black hole because any particle or photon approaching its surface is just swallowed by it. It appears black, as radiation is neither emitted nor reflected by it.

79) **Why do water pipes burst in severe cold winters?**
Ans: Water freezes in pipes during winters, when the temperature goes below 0 degree Celsius (i.e., freezing point of water). It expands and in the process exerts pressure on the water pipes, thereby sometimes bursting them.

80) **Most aircrafts and ships have their front shape pointed. Why**
Ans: The shape of many objects, viz. aeroplanes, rockets, ships, etc. moving through air or water, are designed in such a way that friction can be reduced between the objects and air/water. Such type of body is known as streamlined and the process is known as streamlining.

81) **An athlete runs some distance before taking jump, why?**
Ans: An athlete runs a certain distance before actually jumping in order to increase his speed, and thereby, his inertia of motion. This increased inertia of motion enables him to jump a longer distance.

82) **It is difficult to drown in the Dead Sea. Why?**
Ans: The water of Dead Sea has a salt content of 27%. Therefore, its density is much greater than that of ordinary sea water and it also offers a greater upthrust. Hence, the body weighs less than an equal volume of Dead Sea water and is thus, able to float.

83) **Why aquatic animals have soft skeleton unlike those of the terrestrial animals?**
Ans: The density of animals and fish living in water is almost the same as the density of water. Therefore, their weight is almost completely balanced by buoyancy. That is why they do not need massive skeleton like those of terrestrial animals.

84) **Why does a swimming pool appear less deep than it really is?**
Ans: When rays of light start from the bottom of a pool and travel from water to air, they are refracted away from the normal because they travel from a denser medium to a rarer medium. As a result, a virtual image of bottom is formed above the bottom. Hence, a swimming pool appears less deep than it really is.

85) **Why is electrical wiring in parallel better?**
Ans: electrical wiring in parallel is better because all the lines will have the same potential difference and if one line gets fused the other lines remain unaffected.

86) **It is easier to swim in sea water than in river water. Explain.**
Ans: The density of sea water is more than that of the river water. Therefore, the weight of sea water displaced by the swimmer is more. Thus, buoyant force of upthrust on the swimmer increases, making it easier to swim in sea water.

87) **A cold compress is applied on the forehead of a person suffering from high fever. Why?**
Ans: Evaporation causes cooling. As the water evaporates, it absorbs heat from the forehead and helps in reducing the temperature.

88) **A man with a load his head jumps from a high building. What will be the load experienced by him.**
Ans: Zero, because the acceleration of his fall is equal to the acceleration due to gravity of the earth.

89) **Why is spring made of steel and not copper?**
Ans: The elasticity of steel is greater than that of copper.

90) **Why is it easier to spray water to which soap is added?**
Ans: Addition of soap decreases the surface tension of water. The energy for spray is directly proportional to surface tension.

91) **A piece of chalk when immersed in water, emits bubbles. Why?**
Ans: Chalk consists of pores forming capillaries. When it is immersed in water, the water begins to rise in the capillaries and air present there is expelled in the form of bubbles.

92) **Why does a liquid remain hot or cold for a long time inside a thermo flask?**
Ans: Because of the presence of air, which is poor conductor of heat, in between the double glass walls of a thermos flask.

93) **Why is the boiling point of sea water more than that of pure water?**
Ans: Sea water contains salts and other impurities with different points which jointly raise its boiling point.

94) **Why is it recommended to add salt in water while boiling grams?**
Ans: By addition of salt the boiling point of water gets which helps in cooking.

95) **Why is soft iron used as an electromagnet?**
Ans: Because it remains magnetic only till the current passes through the coil and loses its magnetism when the current is switched off (principle of electric bells)

96) **Why does ink leak out of a partially filled pen when taken to a high altitude?**
Ans: As we go up the pressure and the density of air go on decreasing. Partially filled pen leaks when taken to a higher altitude because the pressure of air acting on the ink inside the tube of the pen is greater than the pressure of air outside.

97) **Why do some liquids burn while others do not?**
Ans: A liquid burns if its molecules can combine with oxygen of the air with the production of heat. Hence, oil burns but water does not.

98) **Oil and water do not mix. Why?**
Ans:
i) Molecules of oil are not bigger than that of water and therefore do not mix easily.
ii) Molecules of water are polars, i.e. they have opposite charges at two ends whereas oil molecules do not; as a consequence they tend to stay away from water molecule.

99) **Man, dogs, cats, horses have lungs through which they breathe. How do smaller animals like fish, earthworm, etc obtain their requirement of oxygen?**
Ans: Earthworms also respire. They use their moist skin to exchange carbon dioxide for oxygen. The fishes use their gills to respire. Even frogs in the tadpole stage use their skin for respiring. Reptiles such as snakes and turtles and even birds breathe through lungs.

DISCOVERIES & INVENTIONS

Vitamin F.G.Hopkins, Cosimir Funk
Vitamin-A Mc. Collum
Vitamin-B Mc.Collum
Vitamin-C Holst
Vitamin-D Mc. Collum
Streptomycin Selman Waksmann
Heart Transplantation Christian Bernard
Malaria parasite and treatment Ronald Ross
First test tube baby Edwards and stepto
Antigen Karl Landsteiner
RNA James Watson and ArtherArg
DNA James Watson and Crick
Insulin Banting
Vaccine of chicken pox Edward Jenner
T. B. bacteria Robert Koch
Diabetes Banting
Penicillin Alexander Flemming
Polio vaccine Johan E.Salk
BCG Guerin Calmatte
Bacteria Luvenhauk –Leeuwenhock
Blood transfer Karl Landsteiner
X-rays Roentgen
Structure of DNA: Watson & Crick
Rabies Vaccination: Louis Pasteur
Genetic Laws of Heredity: Mendel
Vaccination against Small Pox: Edward Jenner
Solar System: Copernicus
Current Electricity: Volta
Telephone: Graham Bell
Gramophone: Thomas Edison
Atomic Number: Mosley
Mercury Thermometer: Fahrenheit
Dynamite: Alfred Noble
Cell: Robert Hooke
Television: John Baird

CONTRIBUTIONS OF MUSLIM SCIENTISTS

MUHAMMAD-BIN-MUSA AL KHWARZIMI:

LIFE:
- ✓ Place of birth: Khwarzim
- ✓ Year of birth: 780 A.D.
- ✓ Year of death: 847 A.D.

FIELDS:
- ✓ Geography
- ✓ Music
- ✓ Mathematics
- ✓ Astronomy
- ✓ History

ACHIEVEMENTS:
- ✓ First to use Zero
- ✓ Compiled the oldest Astronomical Table
- ✓ Composed oldest works on Arithmetic and Algebra
- ✓ Gave analytical solution of linear and quadratic equations

WORKS:
- ✓ Hisab al-Jabr wal Muqabla
- ✓ Kiab Surat-ul-Ard
- ✓ Kitab al-Tareekh
- ✓ Zijj - his own Astronomical table

He made lasting contributions in the fields of Mathematics, Astronomy, Music, Geography and History. He composed the oldest works on Arithmetic and on Algebra. The oldest Mathematic book composed by him is "Kitab ul Jama wat Tafriq". He is the first person who used zero and wrote “Hisabul Jabr Wal Muqabla” which is conceived to be an outstanding work on the subject which included analytical solutions of linear and quadratic equations. In the field of Astronomy he compiled his own tables which formed the basis of later astronomical pursuits in both East and West. He also contributed in the field of geographical science by writing a noteworthy book KItab ul Surat al Ard. In Arabic. His book — “Kitab al Tarik” is also a memorable work regarding history.

ABU REHAN AL BERUNI:

LIFE:
- ✓ Place of birth: Khwarzim
- ✓ Year of birth: 973 A.D.
- ✓ Year of death: 1048 A.D

FIELDS:
- ✓ Metaphysics
- ✓ Geography
- ✓ Mathematics
- ✓ History
- ✓ Philosophy
- ✓ Physics

ACHIEVEMENTS:
- ✓ Explained problems of advanced trignometry
- ✓ His theory - Light travels faster than air
- ✓ Concept of longitude and latitude
- ✓ His idea - Earth is not stationary

WORKS:
- ✓ Kitab al-Hind - Travels through India
- ✓ Qanun-e-Masudi - Astronomy
- ✓ Al-Athar al-Baqia - Latitude and Longitude
- ✓ Kitab al-Saidana - Various medicines
- ✓ Kitab al-Jawahir - Properties of precious stones

He was born in Afghanistan Beruni made original important contributions to science. He is conceived to be the most prominent scientists of the Islamic world who wrote around 150 books on various significant subjects concerning human existence. These subjects include Mathematics, History, Archeology, Biology, Geology, Chemistry, Religion etc. He discussed the behavior of earth, moon, and planets in his book "Qanoon Almasudi" which is also considered as an outstanding astronomical encyclopedia. He also discovered seven different ways of finding the directions of north and south and discovered mathematical techniques to determine exactly the beginning of the seasons. Another notable discovery he made was that the speed of light is faster than sound. His wide range of scientific knowledge is also revealed through his books “Kitab al Saidana” and "Kitab al Jawahar" dealing with medicine and the types of gems their gravity respectively. He was a prolific writer whose works showed his versatility as a scientist.

ZAKARIYA AL RAZI:

LIFE:
- ✓ Place of Birth: Ray, Iran.
- ✓ Year of Birth: 864 A.D.
- ✓ Year of Death: 930 A.D.

FIELDS:
- ✓ Medicine
- ✓ Chemistry
- ✓ Mathematics
- ✓ Astronomy
- ✓ Philosophy

ACHIEVEMENTS:
- ✓ First to use opium for anesthesia
- ✓ First to use animal gut as ligature
- ✓ Recognized the reaction of pupil to the light
- ✓ Classfied chemical substances
- ✓ Preparation of alcohol

WORKS:
- ✓ Al-Hawi - Encyclopedia of medicine
- ✓ Diseases In Children - a monograph
- ✓ Al-Judari Wa'al-Husbah - Smallpox and Measles

- ✓ Kitab-ul-Asrar - Chemical substances
- ✓ Kitab-ul-Mansuri
- ✓ Barr-ul-Saat

The famous philosopher and a notable surgeon of the Muslim world, Zakriya Al Razi was born in Ray near modern Theran Iran. His eagerness for knowledge lead him to the study of Alchemy and Chemistry, philosophy, logic, Mathematics and Physics. He was a pioneer in many areas of medicine and treatment of health sciences in general, and in particular he worked a lot in the fields of pediatrics, obstetrics and ophthalmology. Al Razi was the first person to introduce the use of Alcohol for medical purposes and opium for the objective of giving anesthesia to his patients. In the field of ophthalmology too Al Razi gave an account of the operation for the extraction of the cataract and also the first scientist to discover the effect of the intensity of light on the eye. The modern studies confirm his understanding on the subject thus making him a great physician of all the times.

ABU ALI IBN E SINA:

LIFE:

- ✓ Place of birth: Bukhara.
- ✓ Year of birth: 980 A.D.
- ✓ Year of death: 1037 A.D.

FIELDS:

- ✓ Geology
- ✓ Physiology
- ✓ Mathematics
- ✓ Astronomy
- ✓ Philosophy

ACHIEVEMENTS:

- ✓ First to use cathaters made of the skins of animals
- ✓ Distribution of diseases by water and soil
- ✓ Recognised the nature of Tuberculosis
- ✓ Discussed interaction between Psychology and health
- ✓ Mentioned intra-vesical injections by means of silver syringe

WORKS:

- ✓ Al-Qanun Fil Tib - Human physiology and medicine
- ✓ Kitab al-Shifa - Philosophical encyclopedia
- ✓ Al-Najat - Philosophy
- ✓ Isharat - Philosophy

He endowed with great powers of absorbing and retaining knowledge this Muslim scholar also made valuable contributions to the field of science. He is considered to be the founders of Medicine and also added his great efforts to the fields of Mathematics, Astronomy, Medicinal Chemistry, Philosophy, Palaeontology and Music. His most famous book is "Al Qannun" which brings out the features of human physiology and medicine. Sina is also considered as a father of the science of Geology on account of his invaluable book on mountains in which he discussed matters relating to earth's crust and gave scientific reasons for earthquakes. He is the author of 238 books which are fine instances of his thoughts regarding various subjects in diverse ways.

ABU MUSA JABIR BIN HAYAN:

LIFE:

- ✓ Place of birth: Tous, Iran
- ✓ Year of birth: 721 A.D.
- ✓ Year of death: 815 A.D.

FIELDS:

- ✓ Chemistry
- ✓ Astronomy
- ✓ Engineering
- ✓ Astrology
- ✓ Geology
- ✓ Philosophy
- ✓ Physics
- ✓ Pharmacy
- ✓ Physiology

ACHIEVEMENTS:

- ✓ Invented over 20 types of chemical laboratory equipment
- ✓ Invented new chemical processes
  Distillation: Calcinations
  Sublimation
  Evaporation
  Crystallization
- ✓ He also discovered:
  Sulphuric Acid
  Hydrochloric Acid
  Nitric Acid
  Citric Acid
  Acetic Acid
  Aqua Regia
- ✓ The first to classify Sulphur and Mercury among the metals
- ✓ Preventing rust
- ✓ Engraving gold
- ✓ Tannong leather
- ✓ Invented a paper that resisted fire
- ✓ Invented ink that could be read at night

WORKS:

- ✓ The Great Book of Mercy
- ✓ One Hundred And Twelve Books
- ✓ The Book of the Seventy
- ✓ Books of Balances
- ✓ Five Hundred Books
- ✓ Composition of Alchemy

He introduced experimental research in chemical science which immensely added its rapid development and made him the Father of Chemistry. He devised methods for preparation of important chemicals like hydrochloric acid, nitric acid, and white lead.

Jabir's work also deal with the refinement of metals ,preparation of steel, dyeing of cloth and leather, use of manganese dioxide in glass making, distillation of vinegar to concentrate acetic acid. Jabir also explained scientifically two principle functions of chemistry, i.e., calcinations, and reduction and registered a marked improvement in the methods of evaporation, sublimation, distillation and crystallization. He wrote more than 100 books which are one of the most outstanding contributions in the field of science especially the chemical science.

ABDUL HASSAN IBN AL HAITHAM:

LIFE:

- ✓ Place of birth: Basra
- ✓ Year of birth: 965 A.D.
- ✓ Year of death: 1040 A.D.

FIELDS:

- ✓ Medicine
- ✓ Astronomy
- ✓ Mathematics
- ✓ Physics

ACHIEVEMENTS:

- ✓ Described nature of light
- ✓ Described the phenomenon of vision
- ✓ First to elaborate 2 laws of reflection of light
- ✓ First to declare that light is the form of energy
- ✓ Discovered magnifying glasses
- ✓ Opined that Retina is responsible for vision
- ✓ Identified gravity as a force
- ✓ Discovered the laws of refraction

WORKS:

- ✓ Kitab al-Manazir - Optics
- ✓ Mizan al-Hikmah - Density of atmosphere

He was one of the most outstanding Mathematicians, Physiologists, and Opticians of Islam. He contributed to the realms of medicine and philosophy. He wrote more than 200 scientific works on diverse subjects. Haitham examined the refraction of light rays through transparent objects including air and water. Infact he was the first scientist to elaborate two laws of reflection of light He made a number of monumental discoveries in the field of optics ,including one which locates retina as the seat of vision. His book on optics "Kitab Al Manazir" vividly shows his grip on the subject. He constructed a pinhole camera and studied formation of images. Due to his noteworthy contributions he is regarded as one of the prolific Muslim scientists of all times.

OMAR AL KHAYAM:

LIFE:

- ✓ Place of birth: Khurasan
- ✓ Year of birth: 1044 A.D.
- ✓ Year of death: 1123 A.D.

FIELDS:

- ✓ Poetry
- ✓ Astronomy
- ✓ Mathematics
- ✓ Astrology
- ✓ Physics

ACHIEVEMENTS:

- ✓ First one to prove binomial theorem
- ✓ Classified algebric equations
- ✓ Introduced the Jalali Calendar
- ✓ Recognized 13 forms of cubic eqautions
- ✓ Developed accurate method for the determination of specific gravity

WORKS:

- ✓ De Aspectabus - Geometrical and physiological optics
- ✓ Al-Tareekh al-Jalali
- ✓ Risala-dar Wajud - Metaphysics
- ✓ Noroz-nama
- ✓ Rubaiyat - Poetry and figures of Sufism

He was an outstanding Mathematician and Astronomer. He was also known as a poet, philosopher and a physician. He travelled to the great centers of learning of the era i.e. Samrakund, Bukhara, and Ispahan. He classified many algebraic equations based on their complexity and recognized thirteen different forms of cubic equation. He also classified algebraic theories of parallel lines. On the invitation of Sultan Jalal-ud- Din, he introduced the Jilali calendar which has an error of one day in 3770 years. He also developed accurate methods for determination of gravity as a poet too, he is known for his Rubaiyat. He made great contributions in the development of mathematics and analytical geometry which benefitted Europe several years later.

NASIR UD DIN TUSI:

Al Tusi was one of the greatest scientists, Mathematicians, Astronomers, Philosophers, Theologians and physicians of his time. He was a prolific writer and wrote many treatises on varied subjects like Algebra, Arithmetic, Trignometry, Geometery, Logic, Metaphysics, medicine, ethics and Theology. He served as a minister of Halaku Khan and persuaded him to establish an observatory and library after the destruction of Baghdad. He worked at the observatory and prepared precise tables regarding the motion of the planets. These are also known as “Tables of Khan”.

SCIENTIFIC LAWS AND THEORIES

1. Archimede's principle - It states that a body when wholly or partially immersed in a liquid, experiences an upward thrust which is equal to the weight of the liquid displaced by it. Thus, the body appears to lose a part of its weight. This loss in weight is equal to the weight of the liquid displaced by the body.

2. Aufbau principle - It states that in an unexcited atom, electrons reside in the lowest energy orbitals available to them.

3. Avogadro's Law - It states that equal volumes of all gases under similar conditions of temperature and pressure contain equal number of molecules.

4. Brownian motion - It is a zigzag, irregular motion exhibited by small solid particles when suspended in a liquid or gas due to irregular bombardment by the liquid or gas molecules.

5. Bernoulli's principle - It states that as the speed of a moving fluid, liquid or gas, increases, the pressure within the fluid decreases. The aerodynamic lift on the wing of an aeroplane is also explained in part by this principle.

6. Boyles's Law - It states that temperature remaining constant, volume of a given mass of a gas varies inversely with the pressure of the gas. Thus, $PV = K$ (constant), where, P = Pressure and V = Volume.

7. Charles's Law - It states that pressure remaining constant, the volume of a given mass of gas increases or decreases by 1/273 part of its volume at 0 degree celsius for each degree celsius rise or fall of its temperature.

8. Coulomb's Law - It states that force of attraction or repulsion between two charges is proportional to the amount of charge on both charges and inversely proportional to the square of the distance between them.

9. Heisenberg principle (uncertainty principle) - It is impossible to determine with accuracy both the position and the momentum of a particle such as electron simultaneously.

10. Gay-Lussac's Law of combining volumes - Gases react together in volumes which bear simple whole number ratios to one another and also to the volumes of the products, if gaseous — all the volumes being measured under similar conditions of temperature and pressure.

11. Graham's Law of Diffusion - It states that the rates of diffusion of gases are inversely proportional to the square roots of their densities under similar conditions of temperature and pressure.

12. Kepler's Law - Each planet revolves round the Sun in an elliptical orbit with the Sun at one focus. The straight line joining the Sun and the planet sweeps out equal areas in equal intervals. The squares of the orbital periods of planets are proportional to the cubes of their mean distance from the Sun.

13. Law of Floatation - For a body to float, the following conditions must be fulfilled:
(1) The weight of the body should be equal to the weight of the water displaced.
(2) The centre of gravity of the body and that of the liquid displaced should be in the same straight line.

14. Law of conservation of energy - It states that energy can neither be created nor destroyed but it can be transformed from one form to another. Since energy cannot be created or destroyed, the amount of energy present in the universe is always remains constant.

15. Newton's First Law of Motion - An object at rest tends to stay at rest, and an object in motion tends to stay in motion, with the same direction and speed in a straight line unless acted upon by some external force.

16. Newton's Second Law of Motion - The rate of change of momentum of a body is directly proportional to the force applied and takes place in the direction in which the force acts.

17. Newton's Third Law of Motion - To every action there is an equal and opposite reaction.

18. Newton's Law of Gravitation - All particles of matter mutually attract each other by a force directly proportional to the product of their masses and inversely proportional to the square of the distance between them.

19. Ohm's Law - It states that the current passing through a conductor between two points is directly proportional to the potential difference across the two points provided the physical state and temperature etc. of the conductor does not change.

20. Pauli exclusion principle - It explains that no two electrons in the same atom or molecule can have the same set of quantum numbers.

21. Raman effect - It is the change in wavelength that occurs when light is scattered by the atoms or molecules in a transparent medium.

22. Tyndall effect - The scattering of light by very small particles suspended in a gas or liquid.

VITAMINS & MINERALS

BALANCE DIET: It means a diet which contains right amount and types of foods and drink to provide essential nutrients and energy required for proper development of the body cells, tissue and organs. Balance diet should contain right amount of vitamins and minerals for overall development of the body.

VITAMINS: Vitamins are organic compounds required in small quantities for optimal health. It enhances the metabolism of proteins, carbohydrates and fats. Vitamins are required for growth in children, formation of hormones, blood cells, tissues and bones. Vitamins cannot be synthesised/produced by the human body, thus, our diet must contain vitamins.

TYPES OF VITAMINS

Vitamin	Chemical Name	Food Sources	Deficiency Diseases
A	Retinol	Milk, eggs, fish, butter, cheese and liver.	Night blindness, Skin dryness.
B1	Thiamine	Legumes, whole grain, nuts.	Beri-beri.
B2	Riboflavin	Egg, milk, cheese, nuts, bread products.	Inflammation of tongue, sores in the corners of the mouth.
B3	Niacin or Nicotinic acid	Meat, fish, pea nuts, whole grain.	skin disease, diarrhoea, depression, dementia.
B5	Pantothenic acid	Eggs, liver, dairy products.	Fatigue, muscle cramp. Pellagra
B6	Pyridoxine	Organ meats, cereals, corn.	Anaemia, kidney stones, nausea, depression.
B12	Cyanocobalamin	Meat, fish.	pale skin, constipation, fatigue.
C	Ascorbic acid	Oranges, tomatoes, sweet and white potatoes.	Scurvy, anaemia, ability to fight infections decreases.
D	Calciferol	Direct sunlight, fish oils, eggs.	Rickets, osteomalacia.
E	Tocopherol	Vegetable oils, olives, tomatoes, almonds, meat, eggs.	Neurological problems, problems of reproductive system.
K	Phylloquinone or Naphthoquinone	Soyabeans, green leafy vegetables, dairy products, meat.	Failure to clot blood.

Vitamins are further divided into two groups-
(1) Fat soluble vitamins, and
(2) Water soluble vitamins.

Fat soluble vitamins - A, D, E and K.
Water soluble vitamins - Vitamin-B complex (B1, B2, B3, B5, B6, B12), C and Folic acid.

VITAMINS DEFICIENCY DISEASES

1. Anaemia	It is caused due to deficiency of mineral Iron.
2. Ariboflavinosis	It is caused due to deficiency of Vitamin B2.
3. BeriBeri	It is caused due to deficiency of Vitamin B.
4. Goitre	It is caused due to deficiency of Iodine.
5. Impaired clotting of the blood	It is caused due to deficiency of Vitamin K.
6. Kwashiorkor	It is caused due to deficiency of Protein.
7. Night Blindness	It is caused due to deficiency of Vitamin A.
8. Osteoporosis	It is caused due to deficiency of mineral Calcium.
9. Rickets	It is caused due to deficiency of Vitamin D.
10. Scurvy	It is caused due to deficiency of Vitamin C.

MINERALS

Minerals are also essential for proper development of the body. Minerals helps in building strong teeth and bones, skin, hair, proper function of nerves, muscle contraction, maintains heart functions, etc.

TYPES OF MINERALS

Minerals	Food Sources	Properties	Deficiency Diseases
Calcium	Milk, cheese and other diary products, nuts, green leafy vegetables.	Build and maintain bones and teeth, control heart beat and blood pressure.	Weak teeth and bones, poor development of body.
Iron	Meat, liver, egg yolk, nuts, cereals.	It is required for transportation of Oxygen in the blood. Maintains Haemoglobin level in the blood.	Anaemia, weak immunity.
Iodine	Iodine-enriched salt, milk, cheese.	Iodine is the main building block of thyroid hormone, T3 and T4. It is essential for proper development of the body.	Goitre.
Phosphorus	Meat, fish, poultry, cereals.	It is required in building strong bones and teeth. It also repair cells. It is a component of DNA and RNA.	Poor body growth, weak bones and teeth.
Sodium	Salt	Maintains water balance, blood pressure and nervous system.	Low blood pressure, muscle cramp.
Zinc	Meat, liver, fish, milk, cheese and other diary products.	It is important for the function for the enzymes in the body. It builds immunity and regulates cholesterol levels.	Retarded body growth
Potassium	Fish, milk, pulses, nuts, green vegetables, meat.	It maintains the pH balance of the blood. It controls the water balance of the body.	Low blood pressure, weak muscles.
Magnesium	Green vegetables, nuts, cereals.	Magnesium builds immunity. It is important for nerve cell function and muscle contraction.	It affects nervous system

Our Solar System

SOLAR SYSTEM : SOME FACTS

Biggest Planet	Jupiter
Smallest Planet	Mercury
Nearest Planet to Sun	Mercury
Farthest Planet from Sun	Neptune
Nearest Planet to Earth	Venus
Brightest Planet	Venus
Brightest star after Sun	Sirius
Planet with maximum satellites	Jupiter
Coldest Planet	Neptune
Hottest Planet	Venus
Heaviest Planet	Jupiter
Red Planet	Mars
Biggest Satellite	Gannymede
Smallest Satellite	Deimos
Blue Planet	Earth
Morning/Evening Star	Venus
Earth's Twin	Venus
Green Planet	Neptune
Planet with a big red spot	Jupiter
Lord of the Heavens	Jupiter
Greatest Diurnal Temperature	Mercury
Ratio of Gravitational Pull of Moon and Earth	1:6
Part of Moon not visible From Earth	41%
Revolution period of Moon around Earth	27 days, 7 hrs, 43 min and 11.47sec
Rotation period of Moon around Earth	27 days, 7 hrs, 43 min and 11.47 sec
Highest mountain of Moon	35,000 ft (Leibniz Mts.)
Time taken by moonlight to reach Earth	1.3 sec

MERCURY

- Rotation: 58.65 days.
- Revolution: 88 days (Fastest revolution in Solar System).
- Maximum diurnal range of temperature. Its days are scorching hot and nights are frigid.
- It has no atmosphere and no satellite.

VENUS

- Also called Earth's Twin, because it is slightly smaller than earth (500 km less in diameter).
- Popularly known as Evening star and Morning star.
- Brightest object after sun and moon (because of 70% albedo, the reflecting power).
- Closest planet to earth.
- It is the hottest planet in Solar System. It is because of the green house effect as its atmosphere contains 90-95% carbon dioxide. The night and day temperatures are also almost same. Rotates backward (clockwise) unlike others.
- It has no satellite.
- Slowest rotation in Solar System (257 days.) Almost equal rotation and revolution (224. 7 days).

EARTH

- Also called Blue Planet. It is the densest of all planets.
- Circumference: 40,232 km. Area: 510 million sq. km.
- Average distance from sun: 149 million-km.
- Spins on its imaginary axis from west to east in 23 hrs, 56 min and 40.91 sec.
- Takes 365 days, 5 hrs, 48 min and 45.51 sec in annual movement around the sun. Its results in one extra days every fourth year.

MARS

- Also called Red planet.
- Revolution: 687 days
- Rotation: 24.6 hrs (almost equal to Earth)
- It has a thin atmosphere comprising of nitrogen and argon.
- It is marked with dormant volcanoes and deep chasms where once water flowed. Recent explorations have thrown light on the possibilities of existence of life here.
- The highest mountain here is named 'Nix Olympia' which is three times higher than Mount Everest.
- It has 2 satellites-Phobos and Deimos.

JUPITER

- Largest of all planets (71% of the total mass of all planets). Called Lord the Heavens.
- Jupiter appears to have stopped halfway to becoming a star. It was too massive to solidify as a planet but not massive enough to develop 'nuclear fusion' and become a star.

- Its atmosphere contains hydrogen, helium, methane and ammonia. A great red spot is detected on it. It represents a huge storm-a super hurricane, existing for hundreds of years, without abating. This storm is probably powered by Jupiter's internal heat.
- It has the fastest rotation time (9.8 hr) in the Solar System.
- Revolution-12 years.
- It has 63 satellites (prominent are Europe, Gannymede & Callisto). Gannymede is the largest satellite of Solar System.

SATURN

- Second in size after Jupiter.
- Revolution: 29 yrs. Rotation: 10. 3 hrs
- Least density of all (30 times less dense than earth).
- Unique feature is its system of rings (3 well defined).
- These are separate particles that move independently in circular orbits.
- 60 satellites (Prominent is Titan).
- The space probe, Cassini, is on Saturn these days.

URANUS

- Identified as a planet in 1781 by William Hershel.
- Seems to rotate from north to south as it is inclined at an angle of 98^0 to its orbit.
- Revolution: 84 yrs. Rotation: 10.8 hrs.
- Surrounded by a system of 9 faint rings.
- Has 27 satellites (Prominent are Miranda, Ariel, etc).

NEPTUNE

- Appears as 'Greenish Star'.
- Revolution: 165 yrs. Rotation: 15.7 days.
- Has 5 faint rings.
- Discovered by J.G Galle of Berlin in 1846.
- 13 satellites.

PLUTO

- Pluto is much smaller than only of the official planet and now classified as a 'dwarf planet'.
- A heavenly body must fulfill certain conditions and then only it can be called a planet.
- There are three requirements defined by IAU.
  1. It needs to be in an orbit around the Sun.
  2. It needs to have enough gravity to pull itself into a spherical shape.
  3. It needs to have clear and separate orbit away from the orbits of its neeghbours.
- Pluto satisfied conditions (1), (2) but not (3). It's orbit cuts through the orbit of Neptune and it is so small that the satellites of many other plants are bigger than Pluto. Hence it was, declared a 'Dwarf Planet' in 2006.

ASTEROIDS

- Asteroid are a series of very small planets or fragments of planets lying between the orbits of Mars and Jupiter. Also called 'Planetoids or small planets'. They are thought to be the debris left over from the formation of inner planets.

COMETS

- It has a head and a tail. Its tail originates only when it gets closer to the sun. The tail can be 20-30 million km long. It always point away from the sun because of the force exerted by solar wind and radiation on the cemetery material.

METEORS (Shooting Stars)

- The meteors are probably the remains of comets which are scattered in the inter-planetary space of the Solar System. On contact with the earth's atmosphere, they burn due to friction.

Moon

- Circumference: 11,000 - km. Diameter: 3475 km.
- Gravitational pull: 1/6th of Earth.
- Its orbit around earth is elliptical. The maximum distance (Apogee) of the moon from the earth is 406,000 km. and the minimum distance (Perigee) is 364,000 km. the average distance is 3, 82,200 km. All other satellites (except Charon) have sizes below 1/8 th the size of mother planets. But moon is about 1/4th the size of earth.
- Takes 27 days, 7 hrs, 43 min and 11.47 sec to complete one revolution around earth.

  Rotates on its axis in exactly the same time as it takes to complete one revolution. That is why we see only one side of the moon (only 59% of its surface).

PLANETS AND THEIR SATELLITES

Planet	No. of satellites
Mercury	0
Venus	0
Earth	1
Mars	2
Jupiter	63
Saturn	60
Uranus	27
Neptune	13

EARTH

- Also called **Blue Planet.** It is the densest of all planets.
- Circumference: 40, 232 km. Area: 510 million sq. km. Average distance from sun: 149 million-km.
- **Perihelion:** Nearest position of earth to sun. The earth reaches its perihelion on January 3, every year at a distance of about 147 million km.
- **Aphelion:** Farthest position of earth from sun. The earth reaches its aphelion on July 4, when the earth is at a distance of 152 million km.
- The shape of the earth is oblate spheroid or oblate ellipsoid (i.e. almost spherical, flattened a little at the poles with a slight bulge at the centre).

EARTH MOVEMENTS

- There are two types of movements:

(i) Rotation or daily movement.

(ii) Revolution or annual movement.

ROTATION

- The earth spins on its imaginary axis from west to east in 23 hrs, 56 min and 40.91 sec.
- Rotational velocity at equator is 1667 km/h and it decreases towards the poles, where it is zero.
- Earth's rotation results in
  - (i) causation of days and-nights;
  - (ii) a difference of one hour between two meridians which are 15^0 apart;
  - (iii) change in the direction of wind and ocean currents;
  - (iv) rise and fall of tides every day.
- The longest day in North Hemisphere is June 21, while shortest day is on Dec 22 (Vice-versa in Southern. Hemisphere).
- Days and nights are almost equal at the equator.

REVOLUTION

- It is earth's motion in elliptical orbit around the sun. Earth's average orbital velocity is 29.79 km/s.
- The earth takes 365 days, 5 hrs, 48 min and 45.51 seconds to complete revolution. It results in one extra day every fourth year.
- Revolution of the earth results in
  - (i) change of seasons;
  - (ii) variation in the lengths of days and nights at different times of the year;
  - (iii) shifting of wind belts;
  - (iv) determination of latitudes.

- **Inclined Axis:** The axis is an imaginary line running from north to south and passing through the centre of the earth. It always remains inclined at an angle of $66\frac{1}{2}^0$ to the plane of the earth's orbit, and is tilted $23\frac{1}{2}^0$ from a line perpendicular to this plane. The two facts, i.e., a fixed angle of the earth's axis to the plane of the orbit and the axis always pointing in the same direction, when combined with the earth's movements, results in varying lengths of days and nights, seasonality and changes in the altitude of sun at different times of the year.
- **Seasons** are periods into which the year can be divided as a result of the climatic conditions, largely due to the changes in the duration and intensity of solar radiation. The 4 seasons are:

1. **Spring:** On March 21, the sun is directly overhead the equator. This is the season of spring in the northern hemisphere.
2. **Summer:** On June 21, the sun is directly overhead the Tropic of Cancer. Thus, the northern hemisphere experiences summer.
3. **Autumn:** On September 23, the sun returns to the equator, and the northern hemisphere experiences autumn.
4. **Winter:** On December 22, the sun is at the Tropic of Capricorn, and the northern hemisphere experiences winter.

EQUINOXES

- These are dates when days and nights are equal. During these days the sun shines directly over the equator.
- March 21: **Vernal equinox.**
- Sept 23: **Autumnal equinox.**

SOLSTICE

- The time of the year when the difference between the length of days and the length of nights is the largest.
- During these days the sun shines directly over the tropics.
- **June 21: Summer Solstice.**
- **Dec 22: Winter Solstice.**

MIDNIGHT SUN

- It is a phenomenon, seen in the latitudes $66\frac{1}{2}^0$ North and South (or the Arctic and Antarctic Circles) where the sun does not sink below the horizon during summer. This results due to the tilt of the earth's axis, each hemisphere being inclined towards the sun during its summer. The duration of the phenomenon increases towards the poles, where it may be observed for six months of each year.
- North Pole experiences day from 21^{rd} march to 23^{rd} September.
- South Pole experiences day from 23^{rd} September to 21^{st} March.

LATITUDE

- Imaginary lines drawn parallel to the equator. Measured as an angle whose apex is at the centre of the earth.
- The equator represents 0° latitude, while the North pole is 90° N and the South Pole is 90°S.
- $23\frac{1}{2}^0$ N represent Tropic of Cancer while $23\frac{1}{2}^0$ S represents Tropic of Capricorn.
- $66\frac{1}{2}^0$ N represents Arctic Circle while $66\frac{1}{2}^0$ S represents Antarctic Circle.
- There are total 181 latitude including the equator. Each Parallel of latitude is a circle, but they are not equal. The circle becomes smaller towards the poles. Equator is the 'Greatest Circle' that can be drawn on the earth's surface.
- The distance between any two Parallels of latitude is always equal.

LONGITUDE

- It is the angular distance measured from Prime meridian. On the globe the lines of longitude are drawn as a series of semicircles that extend from the North Pole to the South Pole through the equator. They are also called meridians.
- The distance between any two meridians is not equal. At the equator, 1 degree = 111 km. At 30° N or S, it is 96.5 km. It goes on decreasing in this way until it is zero at the poles.
- There are 360 meridians of longitude. The prime meridian is a longitude of 0°, passing through the Royal Observatory at Greenwich near London. This meridian is taken by geographers to divide the earth into the eastern and the western hemispheres.
- Each meridian of longitude is a semi-circle. 180° meridian (international Date Line) lies exactly opposite to 0° meridian. Such points are called **Antipodal Points.**
- The earth is divided into 24 longitudinal zones, each being 15° or 1 hour apart in time (4 minutes/degree).

LONGITUDE AND TIME

- Places that are on the same meridian have the same local (Sun) time. Since the earth makes one complete revolution of 360° in 24 hours, it passes through 15° in one hour or 1° in 4 minutes.
- The earth rotates from west to east; hence places east of Greenwich see the sun later and lose time.
- A suitable memory acronym can be East-Gain-Add (E.G.A.) and West- Lose- subtract (W.L.S). So, if it is noon in London ((near 0°), 15° east will be one hour ahead of London. This means here the time will be 1p.m. and Chennai of 80° E will be 5 hours 20 minutes ahead. This means here the time will be 5:20 pm.
- To avoid confusion about having many local times within one country, a particular meridian is chosen for the whole country whose time is known as 'standard time'.
- Generally, the standard meridians are chosen to differ from the Greenwich meridian by the multiples of fifteen degree or seven and a half degree, i.e., by exact number of hours or half hours. The world is thus divided into a number of time zones. Larger countries like Russia, Canada, USA etc., have greater east-west extension, so they adopt several time zones. Russia has 11time zones while USA and Canada have 5 time zones.
- India, whose longitudinal extent is approx. 30°, has adopted only one time zone, selecting the 82.5°E for the standard time which is 5 hours and 30 minutes ahead of GMT (Greenwich Mean Time).

INTERNATIONAL DATE LINE

- It is the 180° meridian running over the Pacific Ocean, deviating at Aleutian Islands, Fiji, Sanmoa and Gilbert Islands.
- Travellers crossing the Date Line from west to east (i.e., from Japan to USA) repeat a day. Travellers crossing it from east to west (i.e.. from USA to Japan) lose a day.

ECLIPSES

Lunar Eclipse

- Lunar Eclipse occur when earth comes between the sun and the moon.
- Occurs only on a full moon day. However, it does not occur on every full moon day because the moon is so small and the plane of its orbit is titled about 5° with respect to the plane of the earth's orbit. It is for this reason that eclipses do not occur every month.
- An eclipse can last up to one hour 40 minutes. The moon does not become completely dark during most lunar eclipses. In many cases, it becomes reddish. The earth's atmosphere bends part of the Sun's light around the earth and towards the moon. This light is red because the atmosphere scatters the other colors present in the sunlight in greater amounts than it does red.

Solar Eclipse

- Solar Eclipse is caused when moon comes between sun and earth.
- Can be partial or total.
- Occurs only on a new moon day when the moon is in line with the sun. However, due to the inclination of the moon's orbit, a solar eclipse doesn't occur on every new moon day.

TIDES

- Tides refer to the phenomenon of regular rise and fall of the sea water. Though both sun and moon exert gravitational force on earth, resulting in the production of tides, the moon, by nature of its closeness to the earth, has greater control over the timings of the tidal rises and falls.
- The interval between low tides is 12 hrs and 26 minutes.

Spring tide

- When the sun, moon and the earth are in a straight line, the gravitational force is at its greatest because tide producing forces of both sun and moon complement each other and they pull together. This produces tides of unusually great range, called the spring tide. These occur about twice a month: at new moon when the sun and the moon are in conjunction and at full moon when they are in opposition.

Neap tide

- Lowest magnitude as the tide producing forces of sun and moon act opposite to each other, as they form a triangle. This happens during phases of first and third quarter, i.e., at half moon, the sun's tide producing force tends to balance the tide producing force of the moon, resulting in tides of unusually small range known as neap tides.

INTERNAL STRUCTURE OF EARTH

THE CRUST

- It is the outermost and thinnest layer of the earth's surface, about 8 to 40 km thick. The crust varies greatly in thickness and composition-as small as 5 km thick at some places beneath the oceans, while under some mountain ranges it extends up to 70 km in depth.
- The crust is made up of two layers-an upper lighter layer called the **Sial** (Silicate + Aluminum) and a less denser layer called **Sima** (Silicate Magnesium).
- The average density of this layer is 3 gm/cc.

THE MANTLE

- This layer extends up to a depth of 2900 km.
- Mantle is made up of two parts: Upper mantle or Asthenosphere (up to about 500 km) and Lower Mantle. Asthenosphere is in a semi-molten plastic state, and it is thought that this enables the lithosphere to move about it. Within the asthenosphere the velocity of seismic waves is considerably reduced (Called 'Low Velocity Zone).
- The line of separation between the mantle and the crust is known as **Mohoviricic Discontinuity.**

THE CORE

- Beyond a depth of 2900 km lies the core of the earth.
- The outer core is 2100 km thick and is in molten form due to excessive heat out there. Inner core is 1370 km thick and is in plastic form due to the combined factors of excessive heat and pressure. It is made up of **iron and nickel (Nife)** and is responsible for earth's magnetism. This layer has the maximum specific gravity.
- The temperatures in the earth's core lie between 2200^{0}C and 2750^{0}C.
- The line of separation between the mantle and the core is called **Gutenberg-Wiechert Discontinuity.**

Temperature inside the Earth

. In the first 100 km, there is 12^0 increase per km. In the next 300 km, there is 2^0 increase in temperature per km. After that it is 1^0 increases per km.

COMPOSITION OF EARTH

- The Earth is made up of over 100 elements.
- The following 8 are important:

Element	Per cent
Oxygen	46.5%
Silicon	27.72%
Aluminums	8.13%
Iron	5.01%
Calcium	3.63%
Sodium	2.85%
Potassium	2.62%
Magnesium	2.09%

LITHOSPHERE

- It is the topmost crust of the earth.
- Thickness varies from 35-50 km in continents and 6-12 km at the ocean beds.

THE ROCKS

- Any aggregate of material particles that forms part of the earth's crust is called a rock.
- There are 3 major types of rock types:

IGNEOUS ROCKS

- Formed by the solidification of molten magma from the interior of the earth.
- Most abundant of the three types of rocks (95%).
- They do not occur in layers. Most of them are crystalline and do not contain fossils.
- All other types of rocks originate from these rocks. So Igneous rocks are called **primary rocks.**

SEDIMENTARY ROCKS

- Made up of weathered remains of igneous rocks. Also contains fossils of plants and animals.
- Comprise only about 5% of the earth's crust but cover about 75% of the total land surface.
- The layers of sedimentary rocks hold all reserve of coal, oil and natural gas.

METAMORPHIC ROCKS

- Sometimes igneous or sedimentary rocks metamorphize or change due to great pressure, intense temperature or the action of water and chemical activity.
- Examples of metamorphic rocks formed from different rocks are:

Metamorphic Rock	Made From
Slate	shale and mudstone
Quartzite	sandstone
Gneiss	granite
Marble	limestone, chalk
Schist	shale
Anthracite	coal

EARTHQUAKES

- Tremors or vibrations of earth's surface produced by internal forces.
- The point of origin of earthquake is called **seismic focus.** Most of the earthquakes originate at the depth of 50-100 km inside the earth.
- The point on the earth's surface vertically above the earth's surface is called **Epicentre.**
- The passage of earthquake waves is recorded by **Seismograph.**
- The magnitude of waves is measured on **Richter's scale**. For measurement of the intensity of the earthquake (damage caused), the **Modified Mercalli Intensity Scale** is used.

TYPES OF WAVES

1. **Primary Waves (P-Waves) :** Travel from the point of happening by the displacement of surrounding particles. They are transmitted through solids, liquids and gases. Travels fastest.
2. **Secondary Waves (S-Waves):** Travels through solids only. Thus they cannot pass through core.
3. **Surface Waves or Long Waves (L-Waves) :** Travels on earth's surface and causes maximum destruction. They are recorded after the P and S waves.

Distribution of Earthquakes

- 68 per cent of the volcanoes are experienced in the region around the Pacific Ocean along a belt of volcanoes which is known as the Ring of Fire.
- From the middle of Asia (Himalayas, Caspian Sea) through the Mediterranean Sea to West Indies experience 21 Per cent of the earthquakes.
- Mid-Atlantic ridge belt accounts for 11 per cent of the earthquakes.

VOLCANOES

- A volcano is a vent or opening usually circular in form through which heated materials consisting of gases, water, liquid lava and fragments of rocks are ejected from the highly heated interiors to the surface of the earth.

TYPES OF VOLCANOES

There are there types of volcano.

a. **Active Volcano:** Volcano which erupt periodically. E.g., Maona Loa in Hawaii, Etna in Sicily, Stromboli in Mediterranean Sea, etc.

b. **Dormant Volcano:** Volcano which has been inactive for a long time but in which there is a possibility of eruption. E.g., Fujiyama in Japan, Krakatora in Indonesia, Barren island volcano in Andamans, etc.

c. **Extinct Valcano :** Volcano which has not erupted during the whole historic time but retain the features of volcano. E.g, Popa (Myanmar) Deovand (Iran), etc.

Distribution of Volcanoes

- About 15% of world's active volcanoes are found along the constructive or divergent 'plate margins, whereas 80% volcanoes are associated with the 'destructive or convergent' plate boundaries.

a. **The Circum-Pacific belt or the 'Ring of Fire'** It extends across the Kamchatka Peninsula, Kurile Islands, the Islands of Japan, Philippines, New Guinea, New Zealand and the Soloman Islands. It also passes through the Antarctica and the western coast of America.

b. **The Mid-Continent belt** includes volcanoes of Alpine mountain chain, the Mediterranean Sea and the fault zone of eastern Africa. E.g., Stromboli, Vesuvius, Etna, Kilimanjaro, etc.

c. **The Mid-Atlantic belt** in which the volcanoes are fissure eruption type. E.g., Iceland, Canary Islands, Cape Verde, Azores, etc.

TPES OF MOUNTAINS

FOLD MOUNTAINS

- They were formed when the rocks of the crust of the earth folded under stress, mainly by forces of compression (as a result of series of earthquakes).
- E.g.- All big mountain systems : Himalayas, Alps, Andes, Rockies, Atlas, etc.
- On the basis of age, Fold Mountains are grouped into

Young/ New Fold Mountains

- Came into existence after the continental drift. E.g., Himalayas, Andes, Rockies, Alps. Himalayas are regarded the youngest mountains in the world.

BLOCK MOUNTAINS

- These are formed when great blocks of earth's crust are raised or lowered. During the uplift of structural mountains, sometimes magma flows upwards into the crust. On its cooling and hardening beneath the surface, it contracts and the overlying rock may crack into large blocks moving up or down. An intense folding of rocks is generally followed by faulting of strata due to horizontal forces of tension. The land between the two parallel faults either rises forming **Block mountains or Horsts**, or subsides into a depression termed as **Rift Valley or Graben.**
- E.g.: Narmada, Tapti and Damodar valley in India, the Vosges in France and Black forest in Germany (through which Rhine river flows).

VOLCANIC MOUNTAINS

- Formed as a result of volcanic eruption and the outflow of lava (through crater, the opening). Also called **Mountains of Accumulation.** Have a gentle slope.
- E.g.: Cotopaxi in Andes, Vesuvius and Etna in Italy, Fujiyama in Japan, Mauna Loa and Kilauea (Most active volcano) in Hawaii, Ojos del Salado in Argentina/Chile **(Highest active volcano)**, Popocatepetl in Mexico, Raineer of Washington, Stromboli in Mediterranean (called **Light house of the Mediterranean**), Mirapi and Krakatao in Indonesia, etc.

RELICT MOUNTAINS

- Sometimes, the mountains are carved out as a result of erosion of plateaus and high planes by various agents of erosion. E.g., Highlands of Scotland, Sierras of Spain, Catskill mountains of New York and Nilgiri, Parasnath, Girnar, Rajmahal of India.

ATMOSPHERE

- The atmosphere is a mixture of a layer of gases enveloping the earth, held to it by gravitational force. Almost all the atmosphere (97per cent) lies within 29 km of the earth's surface.
- Beyond approximately 100 km, recent data from satellites suggest that the lightest gases separate out, forming several concentric layers around the earth. The innermost of the atmosphere is the nitrogen layer (100-200 km); then comes oxygen (200-1100 km); helium (1100-3500) and then hydrogen only, to which there is really no clearly defined upper limit.
- Up to about 50 km the atmosphere is composed of:

Nitrogen	78.9%
Oxygen	20.95%
Argon	0.93%
Carbon dioxide	0.03%

(Others are Neon, Helium, Ozone, Hydrogen, etc.)

- Water vapors, besides being the immediate cause of condensation and precipitation, absorb the insulation coming from the sun, reducing the amount reaching the earth's surface.
- Carbon dioxide is important for absorption of heat from the sun as well as from the earth. A high concentration of carbon dioxide leads to **Greenhouse Effect.**
- Dust particles scatter and diffuse insulation and also act as hygroscopic nuclei for condensation (for the formation of clouds).

TROPOSPHERE

- Layer nearest to earth's surface. Thickness varies from 8 km at the poles to 16 km at the equator.
- All weather phenomenons' occur here.
- Densest of all. It contains water vapour, moisture and dust.
- Dust particles present in this layer hold the water vapour and contribute to the occurrence of twilight and the red colors of sunlight and sunset.
- In this with every 165 m of ascent there is a drop of 1°C (or 6.4° C per km). This is called **Normal Lapse Rate of Temperature.**
- **Tropopause** separates troposphere from stratosphere.

STRATOSPHERE

- Extends from 16 km to 50 km of height. The temperature ceases to fall with the increase of height in this layer.
- Little weather is generated here as there is very little water vapour and virtually no dust present.
- Stratosphere provides ideal conditions for flying large airplanes.
- Contains ozone at a height of 25-30 km from earth's surface. This region is called Ozonosphere. It absorbs the ultra- violet rays from the sun. This layer has a comparatively higher temperature due to the absorption of ultra-violet radiation from the sun (temperature increases as we go up).

MESOSPHERE

- Up to a height of about 80 km.
- In this, the temperature decreases with height and falls to about 100°C at a height of 80 km.

IONOSPHERE

- Extends up to about 500-600 km.
- It is called Ionosphere because it contains electrically charged particles (ions) that reflect the radio waves back to the earth thus making radio communication possible.
- Also protects earth from harmful radiation. This causes increase in temperature with height in this layer.
- It also protects earth from falling meteorites, as most of them burn out in this region.

EXOSPHERE

- Here the earth's gravity is extremely weak.
- Upper limit quite uncertain.
- The outer part is called **Magnetosphere.**
- The ionized particles increase in frequency with increasing heights. There are two belts in the upper atmosphere having a high concentration of ionized particles. They are known as **Van Allen's Radiation Belts.** The inner belt lies about 2600 km from the earth's surface, while the outer lies at about 13, 000 to 19,000 kms from it. These belts represent concentrations of highly charged particles, protons and electrons from the sun, trapped within lines of force of the earth's external magnetic field-the Magnetosphere.
- The final boundary between the earth and the outer space is called **'Magnetopause'**-

PRESSURE AND WINDS

- Air moving in a particular direction is called wind. The principal cause of winds is difference in pressure. Air always moves from areas of high pressure to those with low pressure. The slope of the pressure from high to low is known as **Pressure Gradient** and pressure decides the direction of winds.
- Wind velocity is directly related to the steepness of the pressure gradient.
- In addition, the direction of wind are affected by the **Coriolis force**, which is caused by the rotation of the earth. Under the influence of this effect, winds are deflected to their right in the Northern Hemisphere and to their left in the Southern Hemisphere. This is referred to as **Farrel's Law.** Coriolis force is absent at the equator and increases toward the poles. Due to this, the winds, which would blow at right angles to the isobars under the pressure gradient, blow obliquely to them.

GLOBAL PRESSURE BELTS

Equatorial Low-Pressure Belt (or Doldrums)

- From 5°N to 5°S.
- Tremendous heat, thus warm air rises creating low pressure. Also, the centrifugal force is very high at the equator, where the velocity of rotation is high. Hence, the air masses tend to be thrown out, resulting in low pressure.
- Here wind speed is low That's why this area is called **DOLDRUMS** (Belt of Calm).

Tropical High Pressure Belt (or Horse Latitudes)

- From 30° to 35° N and S.
- Apart from 2 months, usually high temperature is experienced here.
- Here the pressure is high, although there is high temperature, because here pressure depends on the rotation and movement of air (as winds from Doldrums belt rises up and accumulate here. Also winds from Sub-Polar Low Pressure Belt accumulate here).

Sub-Polar Low Pressure Belt

- From 60° to 65° N and S.
- Here the low pressure is created because of intense high pressure at the poles.

WINDS AND THEIR TYPES

- Winds are classified into three broad categories are:
  - **Regular Winds/ Prevailing Winds/ Planetary Winds:** (E.g.: Trade winds, Westerlies and Polar Easterlies).

- **Periodical Wind (which blow seasonally):** Monsoons.
- **Variable Winds:** Cyclones and other local winds

TRADE WINDS

- Trade in German means Track. 'To blow trade' means to 'blow steadily' in the same direction and in a constant course.
- These are steady currents of air blowing from the sub-tropical high pressure belts towards the equatorial low pressure areas (doldrums). Under the influence of the Coriolis force they blow from the north-east in the northern hemisphere and from the south-east in the southern hemisphere.

WESTERLIES

- Blows from subtropical high pressure to sub-polar low pressure belt.
- In the northern hemisphere, land masses cause considerable disruption in the westerly wind belt. But between 40°and 60° S lies the almost unbroken ocean belt. Westerlies are strong and persistent here, giving rise to mariner's expressions '**Roaring Forties**', '**Furious Fifties**' and '**Shrieking Sixties**'.

POLAR EASTERLIES

- Move from high pressure poles to sub-polar low pressure areas.
- **These** are deflected by the Earth's rotation to become east winds, or the polar easterlies.

CYCLONES

- It is a system of very low pressure at the center surrounded by increasingly high pressure outwards. In this, the winds blow in a circular manner in-
  1. Anticlockwise direction in Northern Hemisphere.
  2. Clockwise direction in Southern Hemisphere.
- In the temperate region, they occur due to the coming close and imperfect mixing of two masses of air of contrasting temperature and humidity conditions. Cycles of this type are also known as **Wave Cyclones or Temperate Cyclones.**
- On the other hand, in the tropical regions, they occur due to intense heating up of air in some regions causing very low pressure in these locations. Tropical seas and oceans are most conducive to the development of tropical cyclones.
- These are known as:

Cyclones	-	in the Indian Ocean.
Hurricanes	-	in the Caribbean Islands
Typhoons	-	in the China Sea.
Willy-Willies	-	in the North-West Australia.
Tornadoes	-	in coastal US.
Twisters	-	in Mississippi Valley, USA.

- Tornadoes are very strong tropical cyclones of a smaller size. They are especially feared in the Mississippi Valley in US and here they are called Twisters. They differ from cyclones in the way that they generally develop over land. They are more destructive than cyclones as the speed of winds is very high, exceeding 320 km per hour.

ANTICYCLONES

- They are opposite to cyclones in all respects. They are the centers of high pressure with gentle outward flow of air.
- The air circulation is clockwise in the northern hemisphere and anticlockwise in the southern hemisphere.
- Weather associated with an anticyclone is fair weather.

HUMIDITY

- Humidity refers to the amount of water vapour actually present in the air.
- The ratio between the amount of water vapour actually present in the air mass and the maximum amount that the air mass can hold at that temperature is called **relative humidity.** It is expressed in percentage. It varies inversely with temperature, given a fixed amount of water vapour.
- **Absolute humidity** denotes the actual quantity of water vapour present in the air and it is defined as the weight of water vapour (grams) in a given volume of air (cubic meter).
- The term specific humidity is applied to express the ratio of weight of water vapour to the weight of moist air (including water vapour). It is stated as grams of water vapour per kilogram of moist air.
- Humidity is measured by an instrument called **hygrometer**. Another instrument used for the same purpose is **sling psychrometer**.

CONDENSATION, DEW POINT AND RELATED TERMS:

- The physical process of transformation from the vapour to the liquid state is **condensation.** This is the basis of all types of **precipitation.** Precipitation is the fall of water from the atmosphere to the ground in any form.

- **Dew Point** is the temperature at which the air is fully saturated and below which condensation normally occurs.
- **Dew** is the deposition of water droplets on the ground. It occurs when the temperature of the ground surface falls and the air in contact with it is cooled below its dew point. Dew is likely to occur on clear and calm nights.
- **Frost** is a weather condition that occurs when the air temperature is at or below 0°C. Moisture on the ground surface and objects freezes to form an icy deposit.
- **Fog** is made of the droplets of water suspended in the lower layers of the atmosphere, resulting from the condensation of water vapour around nuclei of floating dust or smoke particles. A visibility of less than 1 km is the internationally recognized definition of fog. Fog is not considered as a form of precipitation.
- **Smog (Smoke + Fog)** is a form of fog that occurs in areas where the air contains a large amount of smoke.
- **Mist** is the term for reduction of visibility between 1-2 km, caused by condensation producing water droplets within the lower layers of atmosphere.
- **Haze** is formed by water particles that have condensed in the atmosphere and the visibility in this case is more than 1 km but less than 2 km. Haze may also be produced by presence of dust and smoke, which reduce visibility.

CLOUD

- Clouds are masses of minute water droplets and/or ice crystals formed by the condensation of water vapour and held in suspension in the atmosphere. Condensation, which results from cooling, usually takes place around nuclei such as dust, smoke particles and salt. Such particles are called condensation nuclei.
- Clouds are different types and they can be classified on the basis of their form and altitude. On the basis of form, there are two major groups:
  (i) Strati-form or layered types, and
  (ii) Cumuliform or massive types.

Stratiform Clouds

- These clouds, which are fairly thin and blanket like, are sub-divided into three main categories on the basis of altitude.

High Clouds (mean height 5-13 km)

1. **Cirrus:** Indicates fair weather.
2. **Cirrocumulus:** Forms the mackerel sky.
3. **Cirrostratus:** Produces a halo around sun and moon.

Middle Clouds (mean height 2-7 km)

1. **Altocumulus:** Indicate fine weather.
2. **Alto-stratus:** Associated with development of bad weather.

Low (mean height up to 2 km)

1. **Stratus:** Brings dull weather, usually accompanied with a drizzle.
2. **Nimbostratus:** If rain or snow is falling from a stratus cloud, it is called nimbostratus.
3. **Stratocumulus:** Indicators of fair or clear weather.

Cumulus Clouds

- They are massive clouds having a vertical extent from 1,500 to 9,000 m. They resemble the head of a cauliflower. When these clouds are sunlit, they are brilliantly white and are called 'wool-clouds'. They occur mainly in summer and are produced by convection.
- **Cumulonimbus:** Under different weather conditions, a cumulus cloud may develop into cumulonimbus, the thunderstorm cloud mass of enormous size which brings heavy rainfall, thunder and lightning and gusty winds.

PRECIPITATION

- It refers to falling of water, snow or hail from the clouds and results when condensation is occurring rapidly within a cloud.
- The most common form of precipitation is rain and it is formed when many cloud droplets coalesce into drops too large to remain suspended in the air. Rainfall occurs when the dew point of air is above the freezing point.
- Sometimes the raindrops freeze before reaching the ground and precipitation occurs in the form of ice pellets, called **sleet.**
- **Snow** is produced when condensation takes place at a temperature below freezing point, so that the minute crystals (spicules) of ice are formed directly from the water vapour.

- **Hail** consists of masses of ice with a layered structure. It occurs when there are very strong updrafts in the clouds carrying raindrops up to a high altitude, causing them to freeze. Hail stone is a rounded lump of ice having concentric layers.

Conditions for Precipitation

- There are three possible ways by which precipitation takes place-

CONVECTIONAL PRECIPITATION

- It is caused by heating of moist air in the lower layers of atmosphere which rises, expands, and is cooled adiabatically to its dew point. Convection rain is often accompanied by lightning and thunder. It occurs in regions near the equator in the afternoon as a result of the constant high temperature and high humidity.

OROGRAPHIC PRECIPITAION

- In this, precipitation is caused by moisture-laden air which is forced to rise over a relief barrier (mountain ranges). As the air rises in the windward side, it is cooled at adiabatic rate. If sufficiently cooled, precipitation results; when the air descends on the leeward side, it gets warmed and dry as it has no source from which it can draw up moisture. A belt of dry climate, often called a rain shadow, may exist on the leeward side.

CYCLONIC OR FRONTAL PRECIPITATION

- When the air is caused to rise upward due to cyclonic circulation, the resulting precipitation is said to be of the cyclonic type.

CLIMATE

- The average weather conditions over a large area is called the climate of a place. Weather conditions over a specific length of time, usually a period of 31 years, are taken into consideration.
- On a large scale, the climate of a particular region is determined by:

(i) Latitude and tilt of the earth's axis, which determines the amount of solar radiation received by the area;
(ii) The distribution of land and sea and proximity of ocean currents;
(iii) The altitude and topography of the area;
(iv) The location of the area in relation to the main circulation belts of the earth.

Climate can be classified on the basis of temperature, rainfall, evaporation, evapotraspiration and water balance.

IMPORTANT GRASSLANDS

Prairies	-	North America
Pampas	-	South America
Veldt	-	South Africa
Downs	-	Australia
Steppes	-	Eurasia
Canterbury	-	New Zealand
Postaz	-	Hungary
Manchurian	-	Russia

IMPORTANT DESERTS

1.	**Sahara**	North Africa (Includes the Libyan and the Nubian Desert)
2.	**Australian**	Australia (Includes Gibson, Simpson, Victorian, Great Sandy)
3.	**Arabian**	Arab Countries (Includes Rub'al Khali & An-Nafad of South Arabia and Dost-e-Lut & Dast-e Kavir of Iron)
4.	**Kalahari**	Africa (mainly in Botswana)
5.	**Gobi**	Mongolia
6.	**Atacama**	Central Chile
7.	**Patagonian**	Argentina
8.	**Nabib**	Namibia
9.	**Takla Makan**	Sinkiang, China
10.	**Karakum**	Turkmenistan
11.	**Sonoron**	Arizona and California (USA)
12.	**Thar**	India

THE HYDROSPHERE

- Hydrosphere is the name given to the mass of water that covers about 71% of the earth's surface.
- The average depth of oceans is about 4 km.

OCEAN FLOOR

- It is very irregular as the surface of the continents.
- Four major units of ocean floor are:

Continental Shelf

- It is the coastal part of the ocean which is not very deep and the slope of the bottom is very gentle.
- Extends to a depth of 100 fathoms (1 fathom = 1.8m).
- In regions where the mountains extend along the coast, the shelf is narrower.
- About 20% petrol and gas is found here. They also provide the richest fishing ground in the world. Marine life exists entirely here.
- They occupy about 7% of the total ocean area.

Continental slope

- Extends seawards from the continental Shelf. The continent blocks are supposed to end at the site of continental slope.
- The boundary between shelf and slope is known as Andesine Line, named after the andesine rock.
- Depth is up to 2000 fathoms.
- They cover about 8.5% of the total ocean area.

Continental Rise

- At the foot of slope is found an area slightly rising due to the accumulation of debris transported over the slope.
- Oil deposits occur here.

Abyssal or the Deep Sea Plains

- It is the deepest and the most extensive part of the ocean floor and accounts for about 40% of the total ocean floor.
- Parts of the abyssal plains are occupied by raised ridges or submarine mountains and by very deep trenches or canyons.
- Ridges are the raised areas in sea. E.g., Mid-Atlantic ridge (s-shaped), Indian Ocean ridge (inverted y-shaped).
- A ridge rising more than 1000m above the ocean floor is called **Seamount**. Flat topped seamounts are called **Guyots** (maximum in Pacific Ocean).
- Some parts of the ridge or volcanic peaks reach the surface of the oceans and form islands (E.g. Hawaii Islands).
- **Trenches** are narrow and have steep sided depressions. They occur where two plates of the earth's crust are moving together and one is being pushed down below the other. Deepest is **Challenger Deep**, a part of **Mariana Trench** in Pacific Ocean, near Philippines. It is more than 11km deep.
- **Submarine canyons** are the deep gorges on the ocean floor and are restricted to the continental shelves, slopes and rises.

SALINITY

- The proportion of dissolved salts to pure water is called salinity. The average salinity in the oceans and seas is 35%. i.e., 35 grams of salt in one liter of water.
- Salinity in decreasing order is: NaCl, MgCl, $MgSO_4$, $CaSO_4$, KSO_4, etc. Chlorine is the most abundant element.
- Maximum salinity: lake Van (Turkey)- 330%. Then Dead Sea-240%. Most saline sea is Red Sea.
- The main source of salinity is dissolution of the rocks of oceanic crust, which contains salts.
- It is maximum at the tropics, because here temperature is high . Equatorial regions come second because although they have high temperatures, they have high rainfall also. Poles have minimum salinity because of addition of fresh water in the form of icebergs and excessive snowfall.
- It causes vertical circulation of water.

WAVES

- They are caused due to the friction with the winds.
- There is no forward movement of water in a wave. When a wave enters shallow water, it breaks. The top of it is thrown forward and this is when water moves forward. Water from the breaking wave runs up the shore as swash and go back from the shore as backwash.
- The maximum height of waves in most oceans is about 12m but they may be as high as 15m. Seismic waves or tsunamis are the waves caused by earthquake in volcanic eruptions in the sea bottom. The tsunamis which hit the coasts in the S.E. Asia on Dec 26, 2004 caused havoc in that region.

OCEAN CURRENTS

- Actual transportation of water from one part of ocean to another.

  Ocean currents occur because of differences in density, salinity, temperature of ocean waters, rotation of earth, shape of coastline and the prevailing winds.
- Currents circulate in clockwise direction in Northern Hemisphere and in anti-clockwise direction in Southern Hemisphere.

ISOPLETH

- Lines drawn on map along which the value of a particular phenomenon is uniform. Some important isopleths are:

Isopleths	Phenomenon
Isobars	Equal pressure
Isobaths	Equal depth in sea
Isohaline	Equal salinity
Isohyets	Rainfall
Isohypse	Equal elevation above sea-level
Isotherms	Equal temperature
Isoneph	Cloudiness
Isocline	Equal slope

CURRENTS IN PACIFIC OCEAN

(a) North-Equatorial Current (Warm) : Flows across from east to west, i.e., from North America it reaches the Philippines.

(b) **Kuroshio Current (Warm):** North Equatorial current along the Philippines, Taiwan &Japan coast form this current.

From the S.E. Japan the current' under the influence of prevailing westerlies, flows right across the ocean. After reaching the west coast of North. America, it bifurcates into 2 branches:

(i) **Alasca Current (Warm):** It flows along the coast of British Columbia and Alasca.

(ii) **California Current (Cold):** It moves southward along the coast of California.

(c) **Oyashio Current (Cold) :** Flows along the east coast of Kamchatka Peninsula.

(d) **Okhotsk Current (Cold) :** Comes from the N. Pole and merges with the Oyashio current.

(e) **East Australian Current (Warm) :** It flows from east to west in South Pacific Ocean.

(f) **Peru Current (Cold) :** This is a cold current near the west coast of South America.

CURRENTS OF ATLANTIC OCEAN

(a) **Guinea Current (Warm) :** Flows off the West African coast.

(b) **Florida Current (Warm) :** Along the coast of US up to Cape Hatterus.

(c) **Gulf Stream (Warm):** Beyond the Cape Hatterus up to the Grand Banks of New Found Land, Florida current is known as Gulf Stream. From the Grand Banks the Gulf stream moves eastward across the Atlantic as the **Atlantic Drift.**

(d) Atlantic Drift is divided into 2 branches:

(i) **Norwagian Current :** The main current passes along the Norway coast and enters the Arctic Ocean.

(ii) **Canary Current:** The south branch of North Atlantic drift flows near Spain by this name.

(e) **2 Cold Currents:** The East Greenland Current & the Labrador Current flows from the Arctic Ocean into the Atlantic Ocean.

The Labrador Current meets the Gulf Stream. The influence of these 2 currents produces the famous fogs around New Found Land. [Most busy fishing ground of the world].

(f) **Brazil Current (Warm) :** Flows along the South American coast from North to South.

(g) **Benguela Current (Cold) :** Cold current from South to North near the 'Cape of Good Hope'.

(h) **Falkland Current (Cold) :** Cold flowing along the S.E.coast of South America from South to North (meets the Brazil current).

CURRENTS OF THE INDIAN OCEAN

- The currents in the North Indian Ocean differ entirely from the general pattern of circulation. They change their direction from season to season in response to the seasonal rhythm of the monsoons.
  - In winters the North Equatorial current & the South Equatorial current flows from East to West.
  - **Mozambique Current:** Warm current flowing through the Mozambique Channel.
  - **Agulhas Current:** Warm current at the south-East coast of Africa.

MAJOR SHIPPING CANALS

- **KIEL CANAL:** Between London and Baltic ports. 98 km long links North Sea with the Baltic Sea.
- **PANAMA CANAL:** Links the Atlantic Ocean and the Pacific Ocean. 58 km long, opened in 1914.
- **SUEZ CANAL:** Connects the Mediterranean Sea and the Red Sea. Built in 1869 by the French engineer, Ferdinand de Lesseps. 169 km long, one of the greatest canals of the world and was nationalized by Col. Nasser (Egypt) on July 26, 1956.

MAJOR SEAS

- In decreasing order: I South China Sea II. Caribbean Sea III. Mediterranean Sea.

MAJOR RIVERS

- Largest river is Amazon, although it is 222 km shorter than Nile (the longest river of the world). It is considered so because it is navigable by deep sea steamers and has the greatest flow of water.
- III is Mississippi Missouri in USA.

ISLANDS

Guinea, Borneo, Madagaskar, Baffin, etc.

- Largest river island is Majuli (Assam).
- Most populated island is Java (Indonesia).
- Largest island of India is Middle Andaman.

WILD FIRE AND URBAN FIRE

WILDFIRE

- A wildfire is an uncontrolled fire in an area of combustible vegetation that occurs in the countryside area.
- Other names such as brush fire, bush fire, forest fire, desert fire, grass fire, hill fire, peat fire, vegetation fire, and veldfire may be used to describe the same phenomenon depending on the type of vegetation being burned, and the regional variant of English being used.
- A wildfire differs from other fires by its extensive size, the speed at which it can spread out from its original source, its potential to change direction unexpectedly, and its ability to jump gaps such as roads, rivers and fire breaks.
- Wildfires are characterized in terms of the cause of ignition, their physical properties such as speed of propagation, the combustible material present, and the effect of weather on the fire.
- The name wildfire was once a synonym for Greek fire but now refers to any large or destructive conflagration.
- Wildfires differ from other fires in that they take place outdoors in areas of grassland, woodlands, bush land, scrubland, peat land, and other wooded areas that act as a source of fuel, or combustible material.
- While wildfires can be large, uncontrolled disasters that burn through 0.4 to 400 square kilometers (100 to 100,000 acres) or more, they can also be as small as 0.001 square kilometers (0.25 acres; 1,000 m2) or less.

Causes

Wildfires are 'quasi-natural' hazards, meaning that they are not entirely natural features (like volcanoes, earthquakes and tropical storms). This is because they are caused by human activity as well. The four major natural causes of wildfire ignitions are Lightning, volcanic eruption, sparks from rock falls, and Spontaneous combustion.

Effect of Weather

- Heat waves, droughts, cyclical climate changes such as El Niño, and regional weather patterns such as high-pressure ridges can increase the risk and alter the behavior of wildfires dramatically
- Intensity also increases during daytime hours.

Prevention

- Effective prevention techniques allow supervising agencies to manage air quality, maintain ecological balances, protect resources,and to limit the effects of future uncontrolled fires
- Sources of human-caused fire may include arson, accidental ignition, or the uncontrolled use of fire in land-clearing and agriculture such as the slash-and-burn farming in Southeast Asia.
- Vegetation may be burned periodically to maintain high species diversity, and frequent burning of surface fuels limits fuel accumulation, thereby reducing the risk of crown fires
- Building codes in fire-prone areas typically require that structures be built of flame-resistant materials and a defensible space be maintained by clearing flammable materials within a prescribed distance from the structure
- Electronic systems have gained popularity in recent years as a possible resolution to human operator error, Provision of Wildland firefighting safety measures.

URBAN FIRES

Urban Fires in cities or towns involve buildings with potential for spread to adjoining structures. Although the statistics show a decline in fire casualty rates in recent years, the U.S. rate remains much higher than the yearly reported fire death and damage rates for Australia, Japan and most of the Western European countries. The urban fire hazard involves areas where single family homes, multi-family occupancies and/or business facilities are clustered close together, increasing the possibility of rapid spread to another structure.

Causes

- Criminal acts (arson, illegal explosive devices, acts of terrorism)
- Residential accidents (improper use of electrical appliances, faulty connections, grease fires, smoking, heating appliances or improper disposal of wood ashes).
- Industrial accidents (hazardous material incidents, explosions, transportation accidents)
- Acts of nature (lightening strikes, earthquake byproduct)

Features:

- Those areas which have a high population density present a high risk for fire simply due to increased exposure and probability.
- Those same areas can also pose the threat of high casualty rates for the same reasons. Other areas include large residential areas near heavily wooded wild land, posing a wild land/urban interface situation.
- A large urban fire puts a tremendous strain on many of the operating departments of the community.
- The fire service needs all available firefighters to control the blaze and yet must continue to meet normal demands for service; law enforcement provides for evacuation activities, traffic and crowd control; public works is

tasked with supplying barricades and a continuous supply of critical utilities necessary to manage the incident.

- Zone resources may be asked for assistance in one form or another.
- The mass movement of citizens through evacuation or disaster migration will affect emergency forces. If people are removed from a residential area, emergency shelters may be required.

Arson fires have been on the increase for the past several years. The arson fire presents a unique and significant risk to everyone in the community because there is no way of knowing where, when, and how an arsonist may strike.

WATER POLLUTION

Types, sources, causes and effects of major water pollutants; Synthetic Organic Chemicals, Oxygen Demanding Wastes, Plant Nutrients

1) Introduction

a. Water pollution is the contamination of water bodies (e.g. lakes, rivers, oceans, aquifers and groundwater).

b. Water pollution is any chemical, physical or biological change in the quality of water that has a harmful effect on any living thing that drinks or uses or lives (in) it.

c. This form of environmental degradation occurs when pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove harmful compounds.

d. Water pollution affects the entire biosphere – plants and organisms living in these bodies of water

e. The effect is damaging not only to individual species and population, but also to the natural biological communities.

f. requires ongoing evaluation and revision of water resource policy at all levels

2) What are the major water pollutants?

a. Disease-causing agents:
Bacteria, viruses, protozoa and parasitic worms that enter sewage systems and untreated waste.

b. Oxygen-demanding wastes;

i. Wastes that can be decomposed by oxygen-requiring bacteria.

ii. When large populations of decomposing bacteria are converting these wastes it can deplete oxygen levels in the water.

iii. This causes other organisms in the water, such as fish, to die.

c. Water-soluble inorganic pollutants

i. Acids, salts and toxic metals

ii. Large quantities of these compounds will make water unfit to drink and will cause the death of aquatic life.

d. Nutrients

i. water-soluble nitrates and phosphates that cause excessive growth of algae and other water plants, which deplete the water's oxygen supply

ii. This kills fish and, when found in drinking water, can kill young children.

e. Organic compounds

i. Oil, plastics and pesticides

ii. Harmful to humans and all plants and animals in the water.

f. Suspended sediment

i. A very dangerous category

ii. It causes depletion in the water's light absorption and the particles spread dangerous compounds such as pesticides through the water.

g. Water-soluble radioactive compounds can cause cancer, birth defects and genetic damage and are thus very dangerous water pollutants.

3) Causes of water Pollutions

Human activities; Different human sources add to the pollution of water. There are two sorts of sources, point and nonpoint sources

i. Point sources discharge pollutants at specific locations through pipelines or sewers into the surface water e.g. factories, sewage treatment plants, underground mines, oil wells, oil tankers and agriculture.

ii. Nonpoint sources are sources that cannot be traced to a single site of discharge e.g. acid deposition from the air, traffic, pollutants that are spread through rivers and pollutants that enter the water through groundwater. (is hard to control)

4) How do we detect water pollution

a. Detected in laboratories, where small samples of water are analysed for different contaminants.

b. Living organisms such as fish can also be used for the detection of water pollution

c. Changes in their behaviour or growth show us

d. Laboratories also use computer models to determine what dangers there can be in certain waters.

e. Eutrophication means natural nutrient enrichment of streams and lakes. The enrichment is often increased by human activities, such as agriculture (manure addition).

5) Effects of Water Pollution

a. Death of aquatic (water) animals; Dead fish, crabs, birds and sea gulls, dolphins, and many other animals often wind up on beaches
b. Disruption of food-chains; Pollutants such as lead and cadmium are eaten by tiny animals. Later, these animals are consumed by fish and shellfish, and the food chain continues to be disrupted at all higher levels.
c. Diseases; hepatitis by eating seafood that has been poisoned; outbreak of cholera
d. Destruction of ecosystems: Ecosystems (the interaction of living things in a place, depending on each other for life)

SURVEILLANCE

1) **Introduction**

a. A close observation, especially of a suspected spy or criminal.
b. A French phrase for "watching over" ("sur" means "from above" and "veiller" means "to watch")
c. Surveillance is the monitoring of the behavior, activities, or other changing information, usually of people for the purpose of influencing, managing, directing, or protecting them.
d. This can include observation from a distance by means of electronic equipment (such as CCTV cameras); interception of electronically transmitted information (such as Internet traffic or phone calls); simple, relatively no- or low-technology methods such as human intelligence agents and postal interception.
e. Is used by governments for intelligence gathering, the prevention of crime, the protection of a process, person, group or object, or for the investigation of crime
f. Also used by criminal organizations to plan and commit crimes such as robbery and kidnapping, by businesses to gather intelligence, and by private investigators.
g. Is often a violation of privacy, and is opposed by various civil liberties groups and activists
h. Liberal democracies have laws which restrict domestic government and private use of surveillance
i. Authoritarian government seldom have any domestic restrictions; and international espionage is common among all types of countries.

2) **Types of Surveillance**

a. Computer: monitoring of data and traffic on the Internet
b. Telephones: tapping of telephone lines (US possess technology to activate the microphones in cell phones remotely)
c. Cameras: video cameras used for the purpose of observing an area
d. Social network analysis: create maps of social networks based on data from social networking sites
e. Biometric: measures and analyzes human physical and/or behavioral characteristics for authentication
f. Aerial: gathering of visual imagery or video, from an airborne vehicle
g. Corporate: monitoring of a person or group's behavior by a corporation.
h. Satellite imagery
i. RFID and geolocation devices: Radio Frequency Identification (RFID) tagging is the use of very small electronic devices (called "RFID tags") which are applied to or incorporated into a product, animal, or person for the purpose of identification and tracking using radio waves.
j. Global Positioning System

3) **Controversy**

a. These tools protect society from terrorists and criminals. It can reduce crime by three means: by deterrence, by observation, and by reconstruction.
b. can give human operatives a tactical advantage through improved situational awareness, or through the use of automated processes
c. availability of footage for forensics experts to prove guilt
d. can also influence subjective security
e. As Sun Microsystems CEO Scott McNealy said: "You have zero privacy anyway. Get over it."

4) Counter surveillance is the practice of avoiding surveillance or making surveillance difficult.

5) Inverse surveillance is the practice of the reversal of surveillance on other individuals or groups (e.g., citizens photographing police)

LITHOSPHERE

(Minerals and Rocks, Rock Types, Plate Tectonics)

1) **Introduction**

a. The lithosphere is the solid outer section of Earth, which includes Earth's crust (the "skin" of rock on the outer layer of planet Earth), as well as the underlying cool, dense, and rigid upper part of the upper mantle.

b. The rocks of the lithosphere are considered elastic, they are not viscous.

c. The lithosphere is also the coolest of Earth's layers.

d. The lithosphere has ability to conduct heat associated with the convection taking place in the plastic mantle below the lithosphere.

e. The lithosphere is far less ductile than the asthenosphere

f. There are two types of lithosphere:

- Oceanic lithosphere: oceanic crust, slightly denser than continental lithosphere; composed of dense (mafic) iron magnesium silicate rocks.
- Continental lithosphere: continental crust, much thicker stretching more than 200 kilometers (124 miles) below Earth's surface; composed of (felsic) sodium, potassium, aluminium, silicate rocks.

2) **Minerals and Rocks:** The crust's made from 3 different types of rock: Igneous; sedimentary; and, metamorphic.

- IGNEOUS ROCKS are formed through the cooling and solidification of magma or lava.
- SEDIMENTARY ROCKS are types of rock that are formed by the deposition of material at the Earth's surface and within bodies of water.
- METAMORPHIC ROCKS arise from the transformation of existing rock types, in a process called metamorphism, which means "change in form". The original rock (protolith) is subjected to heat (temperatures greater than 150 to 200 °C) and pressure (1500 bars), causing profound physical and/or chemical change.

3) **Plate Tectonics**

a. The most well-known feature associated with Earth's lithosphere is tectonic activity.

b. Tectonic activity describes the interaction of the huge slabs of lithosphere called tectonic plates.

c. The lithosphere is divided into 15 major tectonic plates: the North American, Caribbean, South American, Scotia, Antarctic, Eurasian, Arabian, African, Indian, Philippine, Australian, Pacific, Juan de Fuca, Cocos, and Nazca.

d. Most tectonic activity takes place at the boundaries of these plates, where they may collide, tear apart, or slide against each other.

e. The movement of tectonic plates is made possible by thermal energy (heat) from the mantle part of the lithosphere.

f. Thermal energy makes the rocks of the lithosphere more elastic

g. Tectonic activity is responsible for some of Earth's most dramatic geologic events: earthquakes, volcanoes, orogeny (mountain-building), and deep ocean trenches

h. Tectonic activity can shape the lithosphere itself; rift valleys and mid-ocean ridges.

LAND POLLUTION

(Solid Waste Management and Disposal)

1) **Introduction**

a. Waste management is a set of activities that include the following:

- collection, transport, treatment and disposal of waste;
- control, monitoring and regulation of the production, collection, transport, treatment and disposal of waste;
- and prevention of waste production through in-process modification, reuse and recycling.

b. Solid waste generation in Pakistan ranges between 0.283 to 0.612 kg/capita/day and the waste generation growth rate is 2.4% per year. Solid domestic waste is typically dumped on low-lying land.

2) **Types of Solid Waste**

a. Municipal solid waste
b. Industrial waste
c. Agricultural waste
d. Hazardous waste

3) **Main Composition**

a. Biodegradable waste i.e. could be decomposed naturally such as food and kitchen waste, green waste, paper, etc.

b. Recyclable material i.e. could be recycled again and again; such as paper, glass, bottles, cans, metals, certain plastics ,fabrics, clothes, batteries etc.

c. Inert waste i.e. not liable to decompose; such as construction and demolition waste, dirt, rocks, debris, etc.

d. Electrical and electronic waste (WEEE); such as electrical appliances, TVs, computers, screens, etc.

e. Composite wastes; such as waste clothing, Tetra Packs, waste plastic, etc.

f. Domestic hazardous waste & toxic waste medication; such as paints, chemicals, light bulbs, fluorescent tubes, spray cans, fertilizer and pesticide containers, shoe polish, etc.

4) **Effects of Improper Solid Waste Management**

Health Hazards

- Skin and eye infections are common
- Dust in the air at dumpsites can cause breathing problems in children and adults
- Flies breed on uncovered piles of rotting garbage and spread diseases like diarrhea, dysentery, typhoid, hepatitis, and cholera
- Mosquitoes transmit many types of diseases like malaria and yellow fever
- Dogs, cats and rats living around refuse carry a variety of diseases including plague and flea born fever
- Intestinal, parasitic and skin diseases are found in workers engaged in collecting refuse

Ground Water Pollution

- As water filters through any material, chemicals in the material may dissolve in the water, a process called leaching. The resulting mixture is called leachate.
- As water percolates through Muncipal Solid Waste, it makes a leachate that consists of decomposing organic matter combined with iron, mercury, lead, zinc, and other metals from rusting cans etc.

Air Pollution

5) **Methods of Waste Disposal**

- **Sanitary Landfill:** burying the waste in the land
- **Incineration/Combustion:** municipal solid wastes are burned at high temperatures so as to convert them into residue and gaseous products
- **Recovery and Recycling:** process of taking useful discarded items for a specific next use.
- **Plasma gasification:** a vessel uses characteristic plasma torches operating at +10,000 °F which is creating a gasification zone till 3,000 °F for the conversion of solid or liquid wastes into a syngas. the waste's molecular bonds are broken down as result of the intense heat in the vessels and the elemental components
- **Composting:** process that takes organic wastes i.e. remains of plants and turns into nutrient rich food for your plants. used for organic farming, occurs by allowing organic materials to sit in one place for months until microbes decompose it
- **Waste to Energy (Recover Energy) WtE:** converting of non-recyclable waste items into useable heat, electricity, or fuel through a variety of processes.
- **Avoidance/Waste Minimization**

GLOBAL WARMING CAUSES

1: Carbon dioxide emissions from fossil fuel burning power plants: Our ever increasing addiction to electricity from coal burning power plants releases enormous amounts of carbon dioxide into the atmosphere. 40% of U.S. CO_2 emissions come from electricity production, and burning coal accounts for 93% of emissions from the electric utility industry Every day, more electric gadgets flood the market, and without widespread alternative energy sources, we are highly dependent on burning coal for our personal and commercial electrical supply.

2: Global Warming Cause: Carbon dioxide emissions from burning gasoline for transportation: Our modern car culture and appetite for globally sourced goods is responsible for about 33% of emissions in the U.S. With our population growing at an alarming rate, the demand for more cars and consumer goods means that we are increasing the use of fossil fuels for transportation and manufacturing. Our consumption is outpacing our discoveries of ways to mitigate the effects, with no end in sight to our massive consumer culture. One of the first things scientists learned is that there are several greenhouse gases responsible for warming, and humans emit them in a variety of ways. Most come from the combustion of fossil fuels in cars, factories and electricity production. The gas responsible for the most warming is carbon dioxide, also called CO_2. Other contributors include methane released from landfills and agriculture (especially from the digestive systems of grazing animals), nitrous oxide from fertilizers, gases used for refrigeration and industrial processes, and the loss of forests that would otherwise store CO_2. Different greenhouse gases have very different heat-trapping abilities. Some of them can even trap more heat than CO_2. A molecule of methane produces more than 20 times the warming of a molecule of CO_2. Nitrous oxide is 300 times more powerful than CO_2. Other gases, such as chlorofluorocarbons (which have been banned in much of the world because they also degrade the ozone layer), have heat-trapping potential thousands of times greater than CO_2. But because their concentrations are much lower than CO_2, none of these gases adds as much warmth to the atmosphere as CO_2 does.

In order to understand the effects of all the gases together, scientists tend to talk about all greenhouse gases in terms of the equivalent amount of CO_2. Since 1990, yearly emissions have gone up by about 6 billion metric tons of "carbon dioxide equivalent" worldwide, more than a 20 percent increase.

3. Global Warming Cause: Methane emissions from animals, agriculture such as rice paddies, and from Arctic seabeds

Methane is another extremely potent greenhouse gas, ranking right behind CO_2. When organic matter is broken down by bacteria under oxygen-starved conditions as in rice paddies, methane is produced. The process also takes place in the intestines of herbivorous animals, and with the increase in the amount of concentrated livestock production, the levels of methane released into the atmosphere is increasing. Another source of **methane** is methane clathrate, a compound containing large amounts of methane trapped in the crystal structure of ice. As **methane escapes from the Arctic seabed**, the rate of global warming will increase significantly.

3. Global Warming Cause: Methane emissions from animals, agriculture such as rice paddies, and from Arctic seabeds

Methane is another extremely potent greenhouse gas, ranking right behind CO_2. When organic matter is broken down by bacteria under oxygen-starved conditions (anaerobic decomposition) as in rice paddies, methane is produced. The process also takes place in the intestines of herbivorous animals, and with the increase in the amount of concentrated livestock production, the levels of methane released into the atmosphere is increasing. Another source of **methane** is methane clathrate, a compound containing large amounts of methane trapped in the crystal structure of ice. As **methane escapes from the Arctic seabed**, the rate of global warming will increase significantly.

Animals, particularly sheep and cattle, produce large amounts of methane. Some fertilisers also release nitrous oxide, which is another greenhouse gas.

Waste breakdown: Carbon dioxide and methane are released during the decay of food, vegetation and paper dumped in landfills. The same thing occurs when sewage wastes break down.

4. Global Warming Cause: Deforestation, especially tropical forests for wood, pulp, and farmland

The use of forests for fuel (both wood and for charcoal) is one cause of deforestation, but in the first world, our appetite for wood and paper products, our consumption of livestock grazed on former forest land, and the use of tropical forest lands for commodities like palm oil plantations contributes to the mass deforestation of our world. Forests remove and store carbon dioxide from the atmosphere, and this deforestation releases large amounts of carbon, as well as reducing the amount of carbon capture on the planet

Deforestation: burning and removing vegetation

All plants take in carbon dioxide from the air and release oxygen, which is why they are sometimes referred to as carbon "sinks". This process is called photosynthesis. When land is cleared and trees or vegetation removed or burnt, the stored carbon is converted back into carbon dioxide. Before European settlement in 1788, forest and woodlands covered 54% of Australia. This has now been reduced to 42%, mainly through landclearing.

5. Global Warming Cause: Increase in usage of chemical fertilizers on croplands

In the last half of the 20th century, the use of **chemical fertilizers** (as opposed to the historical use of animal manure) has risen dramatically. The high rate of application of nitrogen-rich fertilizers has effects on the heat storage of cropland (nitrogen oxides have 300 times more heat-trapping capacity per unit of volume than carbon dioxide) and the run-off of excess fertilizers **creates 'dead-zones'** in our oceans. In addition to these effects, high nitrate levels in groundwater due to over-fertilization are cause for concern for human health.

6. Global Warming Effect: Rise in sea levels worldwide

Scientists predict an increase in sea levels worldwide due to the melting of two massive ice sheets in Antarctica and Greenland, especially on the East coast of the U.S. However, many nations around the world will experience the effects of **rising sea levels**, which could displace millions of people. One nation, **the Maldives, is already looking for a new home, thanks to rising sea levels**.

7. Global Warming Effect: More killer storms

The **severity of storms such as hurricanes and cyclones is increasing**,

"Scientists have come up with the firmest evidence so far that global warming will significantly increase the intensity of the most extreme storms worldwide. The maximum wind speeds of the strongest tropical cyclones have increased significantly since 1981, according to research published in Nature this week. And the upward trend, thought to be driven by rising ocean temperatures, is unlikely to stop at any time soon."

9. Global Warming Effect: Widespread extinction of species

By 2050, **rising temperatures could lead to the extinction of more than a million species**. And because we can't exist without a diverse population of species on Earth, this is scary news for humans. This **6th mass extinction** is really just a continuation of the holocene extinction which began at the end of the last ice age and has resulted in the extinction of nearly all of the Earth's megafauna animals, largely as a result of human-expansion.

Climate change now represents at least as great a threat to the number of species surviving on Earth as habitat-destruction and modification.

10. Global Warming Effect: Disappearance of coral reefs

A report on coral reefs from WWF says that in a worst case scenario, coral populations will collapse by 2100 due to increased temperatures and **ocean acidification**. The **'bleaching' of corals** from small but prolonged rises in sea temperature is a severe danger for ocean ecosystems, and many other species in the oceans rely on coral reefs for their survival.

"Despite the ocean's immensity — 71 per cent of the Earth's surface with an average depth of almost 4 km (21⁄▯m) — there are indications that it is approaching its tipping point. For reefs, warming waters and acidification are closing in like a pair of jaws that threaten to make them the first global ecosystem to disappear.

What You Can Do to Prevent Plant Extinctions

There are a handful of things you can clearly do to prevent plant extinctions (and prevent more plants from ending up on this humongous list), many of which we emphasize here on Planetsave every chance we get:

1. Grow your own food as much as possible, buy local as much as possible, and eat vegetarian to cut down on deforestation;
2. Help prevent global warming from escalating by greening your transport, greening your diet, and cutting the coal;
3. Urge leading supermarkets and restaurants to not buy products related to deforestation or habitat destruction (and don't buy products related to such things).

GLOBAL POSITIONING SYSTEM

1) **Introduction**

GPS, which stands for Global Positioning System, is a radio navigation system that allows land, sea, and airborne users to determine their exact location, velocity, and time 24 hours a day, in all weather conditions, anywhere in the world.

GPS is a space-based navigation system that provides location and time information in all weather conditions, anywhere on or near the Earth where there is an unobstructed line of sight to four or more GPS satellites.

It provides critical capabilities to military, civil, and commercial users around the world. The US began the GPS project in 1973 to overcome the limitations of previous navigation systems. It became fully operational in 1995.

Bradford Parkinson, Roger L. Easton, and Ivan A. Getting are credited with inventing it. The Total Satellites currently operational 32 (Dec, 2012), First Launch: February 1978

2) **Fundamentals of GPS**

GPS concept is based on time. The satellites carry very stable atomic clocks that are synchronized to each other and to ground clocks.

Any drift from true time maintained on the ground is corrected daily. Likewise, the satellite locations are monitored precisely. GPS receivers have clocks as well. GPS satellites continuously transmit their current time and position. A GPS receiver monitors multiple satellites and solves equations to determine the exact position of the receiver and its deviation from true time. At a minimum, four satellites must be in view of the receiver for it to compute four unknown quantities (three position coordinates and clock deviation from satellite time).

3) **Structure (3 Main Components)**

- **Space Segment:** is composed of the orbiting GPS satellites or Space Vehicles (SV) in GPS parlance.
- **Control segment** is composed of a master control station (MCS), an alternate master control station, four dedicated ground antennas, and six dedicated monitor stations.
- **User segment:** is composed of many U.S. and allied military users of the secure GPS Precise Positioning Service, and millions of civil, commercial and scientific users of the Standard Positioning Service

FIBER OPTICS SURVEILLANCE

INTRODUCTION: Fiber optic (or "optical fiber") refers to the medium and the technology associated with the transmission of information as light impulses along a glass or plastic wire or fiber. Optical surveillance systems are security set-ups that utilize cameras which are able to monitor surrounding areas in various lighted (or non-lighted) environments. The cameras are able to adjust to day or night conditions and allow clear imaging of an area. Many different locations are using optical surveillance systems to achieve security goals, such as Transportation such as airports, Manufacturing facilities, Military and Armed Services. Optical surveillance systems are able to transmit images by different means such as fiber optic technology.

HOW FIBRE OPTIC SURVEILLANCE SYSTEMS WORK

Digital images are transmitted through a camera via a fiber optic cable. Fiber optic cable consists of strands of pure glass that are thinner than human hair. The strands carry digital information (such as images) over distance and deliver the information to a receiver. The strands are arranged in bundles that have an outer jacket (covering). The light (image) is transferred along the fiber optic cable by bouncing along the mirror lined walls of the cable.

SYSTEM; A **fiber optic transmitter** is used to feed data into. The transmitter transforms the information into coded light. The optical fiber conducts the light signals over a distance. An optical booster may be used to amplify the light if it is traveling a long distance. An optical receiver decodes the light signal back into the original data format.

APPLICATIONS:

- Military communications on the battlefield.
- It is used by many people to protect and monitor their belongings and loved ones.
- Business surveillance systems for security in retail stores, industrial manufacturing facilities

CAUSES OF DISEASES

DISEASE CAUSED BY VIRUSES:

- **Chicken Pox**: It is caused by Varicella- zoster virus.
- **Small Pox**: It is caused by Variola virus.
- **Common Cold**: It is caused by Rhinovirus.
- **AIDS (Acquired Immunono Deficiency Syndrome):** It is caused by Human Immunodeficiency Virus (HIV).
- **Measles**: It is caused by Measles virus.
- **Mumps**: It is caused by Mumps virus.
- **Rabies**: It is caused by Rabies virus (Rhabdoviridae family).
- **Dengue fever**: It is caused by Dengue virus.
- **Viral Encephalitis:** It is an inflammation of the brain. It is caused by rabies virus, Herpes simplex, polio virus, measles virus, and JC virus.

DISEASE CAUSED BY BACTERIA:

- Diphtheria: It is caused by Corynebacterium diphtheriae.
- **Whooping Cough:** It is caused by a bacterium called Bordetella pertussis.
- **Cholera:** It is caused by Vibrio cholerae.
- **Leprosy:** It is caused by Mycobacterium leprae.
- **Pneumonia:** It is caused by Streptococcus pneumoniae.
- **Tetanus:** It is caused by Clostridium tetani.
- **Typhoid:** It is caused by Salmonella typhi.
- **Tuberculosis:** It is caused by Mycobacterium tuberculosis.
- **Plague**: It is caused by Yersinia pestis.

DISEASE CAUSED BY PROTOZOANS:

- **Amoebic dysentery:** It is caused by Entamoeba histolytica.
- **Malaria:** It is spread by Anopheles mosquitoes. The Plasmodium parasite that causes malaria is neither a virus nor a bacteria - it is a single-celled parasite that multiplies in red blood cells of humans.
- **Sleeping sickness:** It is caused by Trypanosoma brucei.
- **Kalaazar:** It is caused by Leishmania donovani.

DISEASE CAUSED BY WORMS:

- **Tapeworn:** They are intestinal parasites. It cannot live live on its own. It survives within the intestine of an animal including human.
- **Filariasis:** It is caused by thread-like filarial nematode worms. Most cases of filaria are caused by the parasite known as Wuchereria bancrofti.
- **Pinworm**: It is caused by small, thin, white roundworm called Enterobius vermicularis.

ATOM, MOLECULE AND STRUCTURE OF ATOMS

ATOM

Atom is the smallest particle of matter. It is postulated that if we go on dividing the matter we get the smallest particle called Parmanu/Atom. Atoms can't be seen with naked eyes. They can be observed with special instrument such as scanning tunneling microscope.

STRUCTURE OF ATOM

1. Matter is electrical in nature.
2. Atoms are made up of three fundamental particles – Electrons, Protons and Neutrons.
3. Protons and neutrons are present in a very small nucleus at the centre of the atom .Almost the entire mass of the atom is concentrated in the nucleus.
4. Protons are positively charged and are present in nucleus. Its mass is 1836 times that of electrons.
5. Electrons which have negligible mass are present around the nucleus.
6. Atom contains equal number of protons and electrons and is electrically neutral.
7. Electrons are negatively charged.
8. The electron in an atom revolves around the nucleus in definite energy levels or shell.
9. Neutron is a sub atomic particle which has no electric charge and mass slightly larger than proton. Its mass is 1839 times the mass of electron.

Electrons are arranged around the nucleus in an atom. The electrons are arranged according to their energy. These energy levels are described by number 1,2,3,4......... or by letters K, L, M, N etc. referred to as shells. Smaller values of the principal quantum number indicate that the electrons are in a low energy level. The n=1 energy level is lowest energy level.

This corresponds to K-shell. Similarly, the successive higher energy level n=2, n=3 and so on correspond to L, M, shell, etc.

- The first or the inner most shell (n=1) can take only two elements.
- The second shell (n=2) can take up to 8 electrons.

The next shell (n=3) can take maximum 18 electrons, but if it is the outermost, then it can take 8 electrons only.

Atomic Number

Atomic Number is equal to number of proton/electron. For example the number of proton/electron in hydrogen is 1. So the atomic number of hydrogen is 1. Similarly, the number of protons of helium is 2 so atomic number of helium is 2.

Number of Protons = Atomic Number

Atomic Mass

The number of protons/electrons and number of neutrons is equal to atomic mass. For example in hydrogen there is 1 proton/electron but no neutron so the atomic mass of hydrogen is 1. Similarly in helium there are two protons and two neutrons so the atomic mass of helium is 4. Hydrogen with atomic mass 1 is the lightest element.

No: of Protons + No: of Electrons = Atomic Mass

Valence Electrons

The electrons present in outer most shell are known as valence electrons and they are responsible for chemical properties of atoms. Also they ate mainly responsible for emission spectra of an element.

Example:

1. **Hydrogen**

In hydrogen there is just one electron and the chemical activity is dependent on this electrons.

2. **Oxygen**

Oxygen has 2 electrons in first shell and 6 electrons is second shell. The total number of electron in second shell can be 8. In forming compound oxygen atom can receive two electrons to completely fill it second shell. Therefore, 1 atom of oxygen combines with 2 atoms of hydrogen to form a water molecule.

3. **Noble Elements**

- The Atoms of noble element have complete outer shell such as helium (2 electrons in 1st shell) and neon (8 electrons in 2nd shell) so they are chemically non reactive.

Isotopes

Some elements have more than one atomic mass but have same electrical charge on their nucleus and same chemical properties. Such element variants are called isotopes.

Example of Isotopes are:

1. **Isotopes of Carbon**

Carbon-11, Carbon-12, carbon-13 and carbon-14 are three isotopes of the element carbon with mass numbers 12, 13 and 14 respectively. The atomic number in all isotopes remains same (6), however the number of neutrons in the isotopes are 6, 7 and 8 respectively.

^{12}C, ^{13}C, ^{14}C

Uses of Carbon Isotopes:

a. Carbon 11 is used in positron emission tomography scanning or PET scan.

b. Carbon 14 is used in dating fossil.

The relative concentration of isotope variants of carbon is nearly constant in living organism. However when the dead organism decay, the carbon 14 radioactive isotopes start disintegrating this phenomena can be used in dating fossils.

2. **Isotopes of Hydrogen**

Protium, Deuterium and tritium are the three isotopes of hydrogen.

A. Deuterium is also known as heavy water and is used in coolant in nuclear reactors.

B. While Protium is the fuel for nuclear fusion in sun cycle.

C. Tritium:

- It is a important component of nuclear weapon.
- In making self power lighting devices called beta lights. Which are used in night vision goggles and watches. This takes the place of radium which can cause bone cancer.

3. **Isotopes of Uranium**

Uranium 238 is abundant in nature and does not show fission properties. On the other hand uranium 239 is radioactive and is used as a fuel in first stage nuclear programme.

4. **Isotopes of Cobalt** are

Cobalt 59 and Cobalt 60.

Cobalt 60 is radioactive it convert into cobalt 59 (normal isotope) by emitting gamma rays. The gamma rays are very energetic and these are used to kill microorganism and cancerous cell.

Uses of cobalt 60 –

- Radiation processing for food preservation.

5. **Isotopes of Holmium** are

Holmium 164 and Holmium 166

Holmium 166 is used for treatment of arthritis.

6. **Isotopes of Samarium**

Samarium 150 and Samarium 153C

Radioactive Samarium 150 is used for treatment of arthritis.

7. **Isotopes of Cesium**

Cesium 132 and Cesium 137

Cesium 132 is used in brachytraphy (Radiotherapy in which the source of irradiation is placed close to the surface of the body or within a body cavity).

8. **Isotopes of Iodine**

Iodine 126, Iodine 125 and Iodine 131

Iodine used in nuclear imaging of thyroid gland.

Iodine 131 is used in treatment of hyperthyroidism (Graves's diseases).

ELEMENTARY PARTICLES

Elementary particles are particles which are not fundamentally divided into further smaller particles. Elementary particles of matter interact with one another through four different types of forces: gravitation, electromagnetism, the forces of strong interactions and the forces of weak interactions.

Two fundamental classes of particles are
1. FERMIONS
2. BOSONS

1. FERMIONS
Fermions are one of the two fundamental classes of particles. They include QUARKS and LEPTONES.

QUARKS
Quarks are the fundamental constituents of HADRONS (which make up protons and neutrons).Quarks combine in group of three (baryons) or group of two with antiquark (mesons). There are six quarks, three positively charged (up quarks) and three negatively charged (down quark).

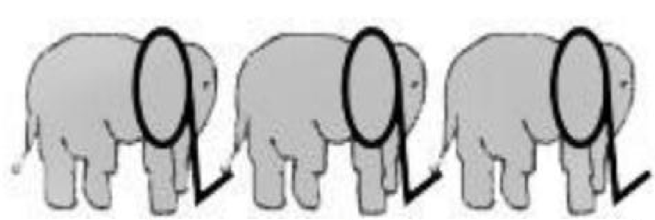
Three up type quarks are
- a) Up,
- b) Top,
- c) Strange.

Three down type quarks are
- a) Down,
- b) Bottom,
- c) Charm.

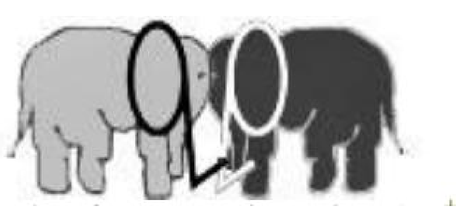
Like social elephants, quarks only exist in groups with other; quarks are never found alone. Although individual quarks have fractional electrical charges, they combine such that hadrons have a net integer electric charge.

There are two classes of hadrons
1. Baryons
2. Hadrons Mesons

Baryons: Baryons are any hadron which is made of three quarks (qqq) because they are made of two up quarks and one down quark. Protons and neutrons are baryons. It is strange that a very-very small part of mass of a hadron is due to quarks in it.



Hadrons Mesons: A meson is a fundamental particle which is 275 times heavier than electron. It is present in the nucleus, oscillating with the velocity of light and responsible for attraction between proton and neutron in the nucleus. Mesons contain one quark (q) and one antiquark ($\bar{q}$).



One example of a meson is a pion (π^+), which is made of an up quark and a down anti quark. The antiparticle of a meson is antipion (π^-).

LEPTONS
Leptons interact via weak interactions. There are total six leptons. Three charged leptons are called electron like leptons, while the three neutral leptons are called neutrinos.

NEUTRINO
A Neutrino is an electrically neutral, weakly interacting elementary subatomic particle. The neutrino is denoted by the Greek letter ν (nu). Neutrinos have mass but it is so less that it is unmeasureable.

Neutrinos do not carry electric charge, which means that they are not affected by the electromagnetic forces that act on charged particles such as electrons and protons. Neutrinos are affected only by the weak sub-atomic force, of much shorter range than electromagnetism, and gravity, therefore a typical neutrino passes through normal matter unimpeded.

Neutrinos are created as a result of certain types of radioactive decay, or nuclear reactions such as those that take place in the Sun, in nuclear reactors, or when cosmic rays hit atoms. There are three types of neutrinos: electron-neutrinos, muon-neutrinos and tau-neutrinos

Most neutrinos passing through the Earth emanate from the Sun. About 65 billion solar neutrinos per second pass through every square centimetre perpendicular to the direction of the Sun in the region of the Earth.

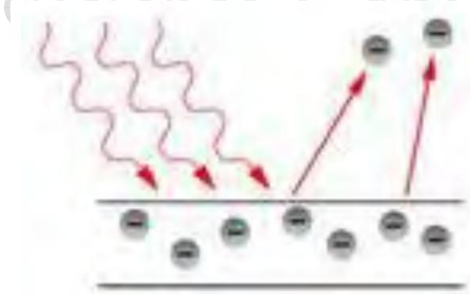
NEUTRINO DETECTION
Neutrinos cannot be detected directly, because they do not ionize the materials they are passing through it, requires a very large detector in order to detect a significant number of neutrinos. Neutrino detectors are often built underground in order to isolate the detector from cosmic rays and other background radiation.

Various neutrino detector observatories:
- Super Kamiokande detector of Japan uses a large volume of water surrounded by photomultiplier tubes that watch for the Cherenkov radiation emitted when an incoming neutrino creates an electron or muon in the water.
- The Sudbury Neutrino Observatory is similar, but uses heavy water as the detecting medium.

2. BOSONS
Bosons are one of the two classes of fundamental particles. Bosons may be either elementary, like photons and gluons, or composite, like mesons.

Photon
Photon is a discrete bundle (or quantum) of electromagnetic (or light). In vacuum the speed of light is $c = 3x10^8$ m/s.

Basic Properties of Photons
1. Photon has no mass.
2. Photon has the property of both wave and particle all the time.
3. Photon cannot decay on its own, although the energy of the photon can transfer (or be created) upon interaction with other particles such as electrons.
4. Wave properties of light is explained by the fact that photons have frequency, amplitude and wavelength.
5. Particle properties of photon is explained by photoelectric effect
6. Photoelectric effect
7. The photoelectric effect posed a significant challenge to the study of optics in the latter portion of the 1800s. It challenged the classical wave theory of light. It was documented by Heinrich Hertz (originally called hertz effect)
8. As shown in the diagram above when a light source is incident upon a metallic surface, the surface can emit electrons. Electrons emitted in this fashion are called photoelectrons (although they are still just electrons). It thus explains that photon act as particles and hit the metal surface of electrons.



9. Photons are electrically neutral and are one of the rare particles that are identical to their antiparticle, the anti-photon.

Einstein and Photoelectric Effect
Einstein proposed that light consisted of quanta, which we call photons. He suggested that the energy in each quantum of light was equal to the frequency multiplied by a constant (Planck's constant) and that a photon with a frequency over a certain threshold would have sufficient energy to eject a single electron, producing the photoelectric effect. It turns out that light does not need to be quantized in order to explain the photoelectric effect, but some textbooks persist in saying that the photoelectric effect demonstrates the particle nature of light.

ARTIFICIAL INTELLIGENCE

- It is the study and engineering of intelligent machines capable of performing the same kinds of functions that characterize human thought.
- Advent of digital computers in 20th century brought AI into realm of possibility.
- It was conceived as a field of computer science in mid 1950s.
- It has been applied to computer programs and systems capable of performing tasks more complex than straightforward programming.

USES AND CHALLENGES OF AI

- Used by financial institutions, scientists, psychologist, medical practitioners, design engineers, planning authorities and security services.
- Tends to be highly specialized for a specific task.
- can play games, predict stock values, interpret photographs, diagnose diseases, plan travel itineraries, translate languages, take dictation, draw analogies, help design complex machinery, teach logic make jokes, compose music, create drawings and learn to do tasks better. e.g, a supercomputer called Deep Blue beat world chess champion Garry Kasparov in 1997.

FINANCE AND E-COMMERCE:

- Predict stock prices
- Detect possible fraud.
- It can also mimic human behaviour.

INFORMATION PROCESSING AND DATA MINING:

- Most widely used AI applications involve information processing and pattern recognition.
- Data mining method is one by which it can find interesting patterns in extremely large databases.
- It is an application of machine learning in which specialized algorithms enable computers to "learn."

MEDICAL FIELD:

Programs are made that analyze the disease symptoms, medical history and lab test results of a patient and then suggest a diagnosis to the physician.

DEVELOPMENT OF ROBOTS:

- Important branch of AI is development of robots.
- WABOT-2, a robot developed by Wasefa University in Japan in the 1980s, utilized AI programs to play a keyboard instruments, red sheet music and converse rudimentarily with people.

- NASA is developing robust AI programs designed to enable the next generation of Mars rovers to make decisions for themselves, rather than relying on detailed instructions from teams of human controllers on Earth.
- To match everything that people can do, AI systems would need to model the richness and subtlety of human memory and common sense.

LIMITATIONS:
- Imperfect translations
- Dictation is reliable only if vocabulary is predictable.

TYPES OF AI:
Focused on two main areas,
a) Developing logic based systems that perform common sense and expert reasoning
b) Using cognitive and biological models to stimulate and explain the information processing capabilities of human brain.

These can be categorized into three research and development types.

1: SYMBOLIC AI:
- Based on logic
- Uses sequence of rules to tell the computer what to do next.
- Inflexible
- If part of expected input data is missing, they may give a bad answer.

2: CONNECTIONIST AI:
- Inspired by human brain.
- Related to computational neuroscience, which models actual brain cells and neural circuits.
- Uses artificial neural networks made of many units working in parallel.
- More flexible than symbolic AI.

3: EVOLUTIONARY AI:
- Draws on biology.
- Programs make random changes in their own rules and select best daughter programs to breed the next generation
- One focus of study in artificial life is on self organization.

THE FUTURE OF AI:
Nearly all industrial, governmental and consumer applications are likely to utilize AI capabilities in the future.

KYOTO PROTOCOL

INTRODUCTION:
Kyoto Protocol is considered as a milestone in the field of climate change negotiations. It came into existence in third Conference of Parties held in Japan in 1997. The Kyoto Protocol has completed its term and now world is moving forward to a more strong resolution in Paris Meet last year. Before discussing Paris meet let's have an analysis on few important meets of UNFCCC (CoP).

UNFCCC and CoP:
The first multilateral legal instrument on climate change was adopted, by consensus among 195 parties, in a UN Summit Conference on Environment and Development (UNCED). This instrument was named UNFCCC (The UN Framework Convention on Conference of the Parties). All institutions, particularly the Conference of the Parties (COP), the subsidiary bodies (advisor of the cop), and the COP bureau, engaged in the international climate charge negotiations are supported well by the UNFCCC secretariat. COP Bureau deals mainly with organizational and procedural issue emerging from the COP and also has some technical function. All the multilateral negotiation are based on the principle and objectives spelled art by the UNFCCC, which were to cooperatively consider what they could do to check average global temperature increase and the resulting climate charge.

KYOTO PROTOCOL: COP-3
On 11 December 1997, the Kyoto Protocol was adopted, in order to strengthen the global response to climate change in Kyoto, Japan. However, due to a complicated ratification process it entered into force on 16 February 2005.
The Kyoto Protocol commits industrialised nation to stabilise greenhouse gas emission based on the principles and objectives of the convention. Therefore, it can be said that the Kyoto Protocol "operationalized" the convention.
The major difference between the convention and the Protocol is -the convention encourages industrialized nations to stabilize GHG emission, the Protocol commits them to do it.

Targets of KP:
In its first commitment period, KP fixed binding targets for 37 industrialized countries and the European countries. It was acknowledged by KP that developed countries were mainly responsible for the current high level of GHG emissions in the atmosphere owing to their 150 years of industrial activities. so it only restricted the developed countries. Under its central principle of common but differentiates responsibility. KP placed a heavier burden on developed counties. These targets on the whole added up to an average five per cent emissions reduction compared to 1990 levels over the five-year

period from 2008 to 2012.

The Famework of Kyoto Protocol regime

The essential framework of the Kyoto Protocol has been constructed and shaped over almost two decoded of experience, political will and hard work. The most important features on which Kyoto Protocol was made up of:

Procedures of reporting and verification,

Flexible market-based mechanisms which had in turn their own procedures of governance and, a system of compliance. So it can be claimed that two things made KP function efficiently

Commitments to emission reduction

The restricted emission reduction commitments for developed parties, the first one, clearly indicated that space to pollute was limited. Carbon dioxide became new commodity as it was prevalent in greenhouse gas emissions. Kyoto Protocol then started to internalise what was then acknowledged as unpriced externalities.

Mechanism of flexible Markets

The mechanisms of flexible markets, the second one, of the KP were based on the trade of emissions permits. The countries bound to targets had to meet them mainly through domestic action-for example, in the developing countries.

Mechanisms of the Kyoto Flexible Market Protocol

JI (joint Implementation)
CDM (The clean Development Mechanism)
Emission Trading

The objectives of Kyoto mechanisms:

Its objective is to promote, facilitate and enforce compliance with commitment listed in the protocol. Its objectives are:

- To help parties to meet their targets by removing carbon from the atmosphere in other countries in a cost-effective way.
- To encourage sustainable development through investment and technology transfer.
- To urge the developing countries and the private sector to contribute to the efforts in emission reduction.

Joint Implementation:

This mechanism permitted a country under the Kyoto Protocol (Annex. B Party- develop nation) to earn emission reduction units (ERUs) from an emission removal project in another Annex B Party, each being equivalent to one tonne of CO_2 which could be counted towards meeting its Kyoto target.

In this mechanism the host party benefited from foreign investment and technology transfer. Although projects starting from the year 2000 might be eligible as JI projects, ERU issued from 2008.

Clean Development Mechanism

The clean Development Mechanism (CDM), being the first global, environmental investment and credit scheme of its kind, allowed a party under the Kyoto Protocol (Annex B Party) to implement an emission reduction project in developing countries.

This scheme provided standardized emission offset instrument – CERs. The projects under this scheme could earn certified emission reduction (CER) credits, each equivalent to one tonne of Carbon dioxide that could be counted in meeting Kyoto targets.

Carbon Trading:

The exchange of emission permits that – is carbon trading – may take place within the economy or may take the form of international transaction.
There are two types of carbon trading;
Emission trading, and
Offset trading

1. Emission trading/ 'Cap-and-trade'

Emission permit is another name for carbon credit. The protocol had assigned a fixed amount of carbon emission for each Annex 1 country in the agreement. This amount was in fact the amount of emission that was to be reduced by the concerned country, implying that the country was permitted to exit the remaining amount. This allowance was in fact kind of carbon credit.

The total amount of allowance was then subdivides into certain units which were expressed in terms of carbon equivalent. Each unit granted the owner the right to exit one metric tonne of greenhouse gods.

2. Offset trading/Carbon project/'Baseline-and-credit' trading:

A country can earn another variant of carbon credit by investing some amount of money in carbon projects which exit lesser amount of greenhouse gas in the atmosphere. The Word Bank's carbon finance unit estimated that the volume of carbon trade through emission trading route alone had indicated a 240 per cent increase in 2005 over the previous year.

Benefits of Flexible Market Mechanism

It has the analogous benefits or encouraging green investment in developing countries and embracing the private sector in this effort to cut and hold steady GHG emission at save level. It also makes "leap-frogging" more economical by creating the possibility to terminate older, dirtier technology for newer, cleaner infrastructure and systems to get long term benefits.

The Kyoto Protocol compliance mechanism was aimed to strengthen its environmental integrity, support the credibility of carbon market and ensure transparency of accounting by parties.

Non-Compliance of Kyoto Protocol and Penalties

- The country that does not fulfill the requirements for measurements and reporting loses the privilege of getting credit through joint implementation projects.

The country that crosses its emission cap, and does not try to bridge the difference by using any of the available mechanisms, must make up the difference plus and an additional thirty per cent during the next period. The country could also face a ban from participating in the "cap and trade" programme.

TELEPHONES

The telephone consists of coils of fine insulated wire that is wound around a permanent horse shoe magnet. A soft iron disc diaphragm is held near the end of the magnet. The magnet lines of force gather in this disc. When the disc is thrown into vibration by a human voice, the number of lines of force passing through the coil changes and a flutuating current is induced. At the receiving end the terminals over the coil wound over the holes of another horse shoe magnet produces the similar vibrations that are produced at the transmitting end and thus helps in producing the sound.

SEMI CONDUCTORS

Semi-conductors are materials with an electrical conductivity that increases with increasing temperature, a trend that is opposite to that of metals. Semi-conductors characteristically have a band gap between the valence and conduction bands that is smaller than that found in the insulators. The reason the conductivity increases is because as the temperature increases more electrons become thermally excited and are able to jump the band gap between the valence and conduction band. An example of this is silicon.

n-Type Conductivity: When a foreign atom with an excess of electrons is added to a pure semi-conductor, the result is a n-type semi-conductor, so named because the charge carriers are negative. This increases the conductivity because a donor band, which is filled with electrons, is introduced near to the conduction band in the band gap. This greatly decreases the band gap which the electrons must jump. Therefore, more electrons are able to get to the conduction band and hence a greater conductivity is the result. An example of an n-type semi-conductor is germanium doped with phosphorous.

p-Type Conductivity: When foreign atoms with less than 2N electrons are added, the result is a p-type semi-conductor, so called because the charge carrier is a positive hole. The foreign atoms create an acceptor band very close to the valence band that is empty. The result is that the band gap is deceased between a full and empty band. Electrons are then able to easily jump from the valence band into the acceptor bands where they are trapped creating positive holes in the valence band. These positive create a means for the electrons to move within the valence band, thus increasing the conductivity.

LASER

Laser light has several features that are significantly different from white light. To begin with, light from most sources spreads out as it travels, so that much less light hits a given area as the distance from the light source increases. Laser light travels as a parallel beam and spreads very little.

Furthermore, laser light is monochromatic and coherent. White light is a jumble of colored light waves. Each color has a different wavelength. If all the wavelengths but one are filtered out, the remaining light is monochromatic. If these waves are all parallel to one another, they are also coherent: the waves travel in a definite phase relationship with one another. In the case of laser light, the wave crests coincide and the troughs coincide. The waves all reinforce one another. It is the mono-chromaticity and coherency of laser light that makes it ideal for recording data on optical media such as a CD as well as use as a light source for long haul fiber-optic communications.

The laser uses a process called stimulated emission to amplify light waves. (One method of amplification of an electromagnetic beam is to produce additional waves that travel in step with that beam.) A substance normally gives off light by spontaneous emission. One of the electrons of an atom absorbs energy. While it possesses this energy, the atom is in an excited state. If the electron gives off this excess energy (in the form of electromagnetic radiation such as light) with no outside impetus, spontaneous emission has occurred.

If a wave emitted by one excited atom strikes another, it stimulates the second atom to emit energy in the form of a second wave that travels parallel to and in step with the first wave. This stimulated emission results in amplification of the first wave. If the two waves strike other excited atoms, a large coherent beam builds up. But if they strike unexcited atoms, they are simply absorbed, and the amplification is then lost. In the case of normal matter on Earth, the great majority of atoms are not excited. As more than the usual number of atoms become excited, the probability increases that stimulated emission rather than absorption will take place.

Physicist Gordon Gould invented the laser in 1958. The first working model was built in 1960 by T.H. Maiman. It contained a synthetic, cylindrical ruby with a completely reflecting silver layer on one end and a partially reflecting silver layer on the other. Ruby is composed of aluminum oxide with chromium impurities. The chromium atoms absorb blue light and become excited; they then drop first to a meta-stable level and finally to the ground (unexcited) state, giving off red light. Light from a flash lamp enters the ruby and excites most of the chromium atoms, many of which fall quickly to the meta-stable level. Some atoms then emit red light and return to the ground state. The light waves strike other excited chromium atoms, stimulating them to emit more red light. The beam bounces back and forth between the silvered ends until it gains enough energy to burst through the partially silvered end as laser light. When most of the chromium atoms are back in the ground state, they absorb light, and the lasing action stops. In continuous-wave lasers, such as the helium-neon laser, electrons emit light by jumping to a lower excited state, forming a new atomic population that does not absorb laser light, rather than to the ground state.

MICROSCOPE

Microscopes give us a large image of a tiny object. The microscopes we use in school and at home trace their history back almost 400 years.

The first useful microscope was developed in the Netherlands between 1590 and 1608. There is almost as much confusion about the inventor as about the dates. Three different eyeglass makers have been given credit for the invention. The possible inventors are Hans Lippershey (who also developed the first real telescope), Hans Janssen, and his son, Zacharias. Lens quality in early microscopes was often poor so the images were not very clear. But even these rather crude microscopes were a great help in learning more about animals and plants.

The microscope works a lot like a refracting telescope except that the object is very close to the objective lens. The clips on the microscope's flat stage hold the slide in place. A mirror at the bottom of the microscope reflects light rays up to the daphnia through a hole in the stage. Objective lenses magnify the image which is made even larger when we see it through the eyepiece lenses.

The objective lens is usually a compound lens, a combination of two lenses made from different kinds of glass. When only one lens is used, we often get distortion. This distortion (chromatic aberration) is caused because the colours making up light are not refracted (bent) the same amount when passing through a glass lens. When we use a compound lens, any distortion from the first lens is corrected by the second lens.

Different types of microscopes have been used to look at human cells, identify minerals, solve crimes. Microscopes are an essential tool in medicine too. They have been used to identify the causes of many deadly diseases like malaria and tuberculosis. Microscopes can also help to find out why a person or animal died. Scientists can even use a microscope to figure out where illegal drugs come from. For example, looking at opium crystals through a microscope reveals different shapes depending on where the poppies they came from were grown. This information can help pinpoint the source of illegal drugs.

Microscope, instrument used to obtain a magnified image of minute objects or minute details of objects.

OPTICAL MICROSCOPES

The most widely used microscopes are optical microscopes, which use visible light to create a magnified image of an object. The simplest optical microscope is the double-convex lens with a short focal length (see Optics). Double-convex lenses can magnify an object up to 15 times. The compound microscope uses two lenses, an objective lens and an ocular lens, mounted at opposite ends of a closed tube, to provide greater magnification than is possible with a single lens. The objective lens is composed of several lens elements that form an enlarged real image of the object being examined. The real image formed by the objective lens lies at the focal point of the ocular lens. Thus, the observer looking through the ocular lens sees an enlarged virtual image of the real image. The total magnification of a compound microscope is determined by the focal lengths of the two lens systems and can be more than 2000 times.

Optical microscopes have a firm stand with a flat stage to hold the material examined and some means for moving the microscope tube toward and away from the specimen to bring it into focus. Ordinarily, specimens are transparent and are mounted on slides—thin, rectangular pieces of clear glass that are placed on the stage for viewing. The stage has a small hole through which light can pass from a light source mounted underneath the stage—either a mirror that reflects natural light or a special electric light that directs light through the specimen.

In photomicrography, the process of taking photographs through a microscope, a camera is mounted directly above the microscope's eyepiece. Normally the camera does not contain a lens because the microscope itself acts as the lens system.

Microscopes used for research have a number of refinements to enable a complete study of the specimens. Because the image of a specimen is highly magnified and inverted, manipulating the specimen by hand is difficult. Therefore, the stages of high-powered research microscopes can by moved by micrometer screws, and in some microscopes, the stage can also be rotated. Research microscopes are also equipped with three or more objective lenses, mounted on a revolving head, so that the magnifying power of the microscope can be varied.

SPECIAL-PURPOSE OPTICAL MICROSCOPES

Different microscopes have been developed for specialized uses. The stereoscopic microscope, two low-powered microscopes arranged to converge on a single specimen, provides a three-dimensional image. The petrographic microscope is used to analyze igneous and metamorphic rock. A Nicol prism or other polarizing device polarizes the light that passes through the specimen. Another Nicol prism or analyzer determines the polarization of the light after it has passed through the specimen. Rotating the stage causes changes in the polarization of light that can be measured and used to identify and estimate the mineral components of the rock.

The dark-field microscope employs a hollow, extremely intense cone of light concentrated on the specimen. The field of view of the objective lens lies in the hollow, dark portion of the cone and picks up only scattered light from the object. The clear portions of the specimen appear as a dark background, and the minute objects under study glow brightly against the dark field. This form of illumination is useful for transparent, unstained biological material and for minute objects that cannot be seen in normal illumination under the microscope.

The phase microscope also illuminates the specimen with a hollow cone of light. However, the cone of light is narrower and enters the field of view of the objective lens. Within the objective lens is a ring-shaped device that reduces the intensity of the light and introduces a phase shift of a quarter of a wavelength. This illumination causes minute variations of refractive index in a transparent specimen to become visible. This type of microscope is particularly effective for studying living tissue.

A typical optical microscope cannot resolve images smaller than the wavelength of light used to illuminate the specimen. An ultraviolet microscope uses the shorter wavelengths of the ultraviolet region of the light spectrum to increase resolution or to emphasize details by selective absorption (see Ultraviolet Radiation). Glass does not transmit the shorter wavelengths of ultraviolet light, so the optics in an ultraviolet microscope are usually quartz, fluorite, or aluminized-mirror systems. Ultraviolet radiation is invisible to human eyes, so the image must be made visible through phosphorescence (see Luminescence), photography, or electronic scanning.

The near-field microscope is an advanced optical microscope that is able to resolve details slightly smaller than the wavelength of visible light. This high resolution is achieved by passing a light beam through a tiny hole at a distance from the specimen of only about half the diameter of the hole. The light is played across the specimen until an entire image is obtained.

The magnifying power of a typical optical microscope is limited by the wavelengths of visible light. Details cannot be resolved that are smaller than these wavelengths. To overcome this limitation, the scanning interferometric apertureless microscope (SIAM) was developed. SIAM uses a silicon probe with a tip one nanometer (1 billionth of a meter) wide. This probe vibrates 200,000 times a second and scatters a portion of the light passing through an observed sample. The scattered light is then recombined with the unscattered light to produce an interference pattern that reveals minute details of the sample. The SIAM can currently resolve images 6500 times smaller than conventional light microscopes.

ELECTRON MICROSCOPES

An electron microscope uses electrons to "illuminate" an object. Electrons have a much smaller wavelength than light, so they can resolve much smaller structures. The smallest wavelength of visible light is about 4000 angstroms (40 millionths of a meter). The wavelength of electrons used in electron microscopes is usually about half an angstrom (50 trillionths of a meter).

Electron microscopes have an electron gun that emits electrons, which then strike the specimen.

Conventional lenses used in optical microscopes to focus visible light do not work with electrons; instead, magnetic fields (see Magnetism) are used to create "lenses" that direct and focus the electrons. Since electrons are easily scattered by air molecules, the interior of an electron microscope must be sealed at a very high vacuum. Electron microscopes also have systems that record or display the images produced by the electrons.

There are two types of electron microscopes: the transmission electron microscope (TEM), and the scanning electron microscope (SEM). In a TEM, the electron beam is directed onto the object to be magnified. Some of the electrons are absorbed or bounce off the specimen, while others pass through and form a magnified image of the specimen. The sample must be cut very thin to be used in a TEM, usually no more than a few thousand angstroms thick. A photographic plate or fluorescent screen beyond the sample records the magnified image. Transmission electron microscopes can magnify an object up to one million times. In a scanning electron microscope, a tightly focused electron beam moves over the entire sample to create a magnified image of the surface of the object in much the same way an electron beam scans an image onto the screen of a television. Electrons in the tightly focused beam might scatter directly off the sample or cause secondary electrons to be emitted from the surface of the sample. These scattered or secondary electrons are collected and counted by an electronic device. Each scanned point on the sample corresponds to a pixel on a television monitor; the more electrons the counting device detects, the brighter the pixel on the monitor is. As the electron beam scans over the entire sample, a complete image of the sample is displayed on the monitor.

An SEM scans the surface of the sample bit by bit, in contrast to a TEM, which looks at a relatively large area of the sample all at once. Samples scanned by an SEM do not need to be thinly sliced, as do TEM specimens, but they must be dehydrated to prevent the secondary electrons emitted from the specimen from being scattered by water molecules in the sample. Scanning electron microscopes can magnify objects 100,000 times or more. SEMs are particularly useful because, unlike TEMs and powerful optical microscopes, they can produce detailed three-dimensional images of the surface of objects.

The scanning transmission electron microscope (STEM) combines elements of an SEM and a TEM and can resolve single atoms in a sample.

The electron probe microanalyzer, an electron microscope fitted with an X-ray spectrum analyzer, can examine the high-energy X-rays emitted by the sample when it is bombarded with electrons. The identity of different atoms or molecules can be determined from their X-ray emissions, so the electron probe analyzer not only provides a magnified image of the sample, but also information about the sample's chemical composition.

SCANNING PROBE MICROSCOPES

A scanning probe microscope uses a probe to scan the surface of a sample and provides a three-dimensional image of atoms or molecules on the surface of the object. The probe is an extremely sharp metal point that can be as narrow as a single atom at the tip.

An important type of scanning probe microscope is the scanning tunneling microscope (STM). Invented in 1981, the STM uses a quantum physics phenomenon called tunneling to provide detailed images of substances that can conduct electricity. The probe is brought to within a few angstroms of the surface of the material being viewed, and a small voltage is applied between the surface and the probe. Because the probe is so close to the surface, electrons leak, or tunnel, across the gap between the probe and surface, generating a current. The strength of the tunneling current depends on the distance between the surface and the probe. If the probe moves closer to the surface, the tunneling current increases, and if the probe moves away from the surface, the tunneling current decreases. As the scanning mechanism moves along the surface of the substance, the mechanism constantly adjusts the height of the probe to keep the tunneling current constant. By tracking these minute adjustments with many scans back and forth along the surface, a computer can create a three-dimensional representation of the surface.

Another type of scanning probe microscope is the atomic force microscope (AFM). The AFM does not use a tunneling current, so the sample does not need to conduct electricity. As the metal probe in an AFM moves along the surface of a sample, the electrons in the probe are repelled by the electrons of the atoms in the sample and the AFM adjusts the height of the probe to keep the force on it constant. A sensing mechanism records the up-and-down movements of the probe and feeds the data into a computer, which creates a three-dimensional image of the surface of the sample.

SATELLITES

Satellite technology has emerged tremendously over the last 50 years since Arthur C. Clarke first invented it. Today, satellite technology is all around us and has become a very useful, everyday application of modern telecommunications. Satellite systems can provide a variety of services including broadband communication systems, satellite-based video, audio, internet and data distribution networks, as well as worldwide customer service and support.

What is a satellite?

An artificial satellite is a man made object placed into orbit around the Earth for the purpose of scientific research, weather reports, or military reconnaissance. Scientific satellites are set into orbit to observe the space environment, the Earth, the Sun, stars and extra galactic objects. These satellites have retrieved a huge amount of information helpful to scientific research. Weather satellites are used every day for meteorological forecasts and in shipping. Also military satellites play an important role in today's modern military. Satellites are extremely important today. All artificial satellites have certain features in common. They all include radar systems, sensors like optical devices in observation satellites and receivers and transmitters in communication satellites. Solar cells are used to generate power for the satellites and in some cases , nuclear power is used. All satellites need altitude-control equipment to keep the satellite in the desired orbit.

Orbit of a Satellite

The orbit of the satellite is achieved when it is given a horizontal velocity of 17,500 mph at sea level causing the Earth's surface to curve away and as fast as it curves away gravity pulls the object downward and at this point the satellite achieved orbit. As the altitude of the satellite increases, its velocity decreases and its period increases. The period of satellite is the time the satellite takes to make on revolution around the Earth. Satellites in later orbit are called synchronous satellites. If the satellite orbits in a equatorial plane, it is called geostationary which means it is always over the same place on earth at all times. This form of orbit is used in weather for reports of a certain area at all times. The orbit of a satellite is very scientific but not hard to understand.

ANTIBIOTICS

A chemical substance derivable from a mold or bacterium that kills microorganisms and cures infections.

Antibiotics are drugs used to kill or harm specific bacteria. Since their discovery in the 1930s, antibiotics have made it possible to cure diseases caused by bacteria such as pneumonia, tuberculosis, and meningitis - saving the lives of millions of people around the world.

But antibiotics must be used wisely. Because bacteria are living organisms, they are always changing in an effort to resist the drugs that can kill them. When antibiotics are used incorrectly, bacteria can adapt and become resistant. Antibiotics are then no longer useful in fighting them. Antibiotic resistance is now a major public health issue. The correct use of these drugs is the best way to ensure that antibiotics remain useful in treating infections.

VACCINES

Immunogenic consisting of a suspension of weakened or dead pathogenic cells injected in order to stimulate the production of antibodies can be defined as vaccines.

Working: Disease causing organisms have at least two distinct effects on the body. The first effect is exhibiting symptoms such as fever, nausea, vomiting, diarrhea, rash, and many others. The second effect generally leads to eventual recovery from the infection: the disease causing organism induces an immune response in the infected host. As the response increases in strength over time, the infectious agents are slowly reduced in number until symptoms disappear and recovery is complete.

The disease causing organisms contain proteins called "antigens" which stimulate the immune response. The resulting immune response is multi-fold and includes the synthesis of proteins called "antibodies." These proteins bind to the disease causing organisms and lead to their eventual destruction. In addition, "memory cells" are produced in an immune response. These are cells which remain in the blood stream, sometimes for the life span of the host, ready to mount a quick protective immune response against subsequent infections with the particular disease causing agent which induced their production. If such an infection were to occur, the memory cells would respond so quickly that the resulting immune response could inactivate the disease causing agents, and symptoms would be prevented. This response is often so rapid that infection doesn't develop - and we get immune from infection.

Vaccines are effective in preventing disease not only in individuals, but also in communities. This type of protection is called "herd immunity." When a disease spreads from one human to another, it requires both an infected individual to spread it and a susceptible individual to catch it. Herd immunity works by decreasing the numbers of susceptible people. When the number of susceptible people drops low enough, the disease will disappear from the community because there are not enough people to carry on the catch-and-infect cycle. The greater the proportion of vaccinated members of the community, the more rapidly the disease will disappear.

FERTILIZERS

Any substance such as manure or a mixture of nitrates used to make soil more fertile are fertilizers.

Fertilizers are plant nutrients. Nutrients exist naturally in the earth's soil and atmosphere, and in animal manure. However, naturally occurring nutrients are not always available in the forms that plants can use. Therefore, man-made fertilizer is vital to food production. Man-made and natural fertilizers contain the same ingredients, but man-made fertilizers act more quickly and are less susceptible to weather changes. Farmers, ranchers and gardeners add these fertilizers directly to the soil, where they can be absorbed by plants for healthy growth. Incorporated into a program of best management practices, which includes soil testing, man-made fertilizer use leads to higher crop yields and greater environmental protection.

PESTICIDES

Types of Pesticides

A pesticide is any chemical which is used by man to control pests. The pests may be insects, plant diseases, fungi, weeds, nematodes, snails, slugs, etc. Therefore, insecticides, fungicides, herbicides, etc., are all types of pesticides. Some pesticides must only contact (touch) the pest to be deadly. Others must be swallowed to be effective. The way that each pesticide attacks a pest suggests the best way to apply it; to reach and expose all the pests. For example, a pesticide may be more effective and less costly as a bait, rather than as a surface spray.

Insecticides: Insecticides are chemicals used to control insects. Often the word "insecticide" is confused with the word "pesticide." It is, however, just one of many types of pesticides. An insecticide may kill the insect by touching it or it may have to be swallowed to be effective. Some insecticides kill both by touch and by swallowing. Insecticides called Systemics may be absorbed, injected, or fed into the plant or animal to be protected. When the insect feeds on this plant or animal, it ingests the systemic chemical and is killed.

Miticides or Acaricides:
Miticides (or Acaricides) are chemicals used to control mites (tiny Insecticides spider-like animals) and ticks. The chemicals usually must contact the mites or ticks to be effective. These animals are so numerous and small, that great care must be used to completely cover the area on which the mites live. Miticides are very similar in action to insecticides and often the same pesticide kills both insects and mites. The terms "broad spectrum," "short term," and "residual" are also used

Fungicides: Fungicides are chemicals used to control the fungi which cause molds, rots, and plant diseases. All fungicides work by coming in contact with the fungus, because fungi do not "swallow" in the normal sense. Therefore, most fungicides are applied over a large surface area to try to directly hit every fungus. Some fungicides may be systemic in that the plant to be protected may be fed or injected with the chemical. The chemical then moves throughout the plant, killing the fungi to describe miticides.

Herbicides: Herbicides are chemicals used to control unwanted plants. These chemicals are a bit different from other pesticides because they are used to kill or slow the growth of some plants, rather than to protect them. Some herbicides kill every plant they contact, while others kill only certain plants.

Rodenticides: Rodenticides are chemicals used to control rats, mice, bats and other rodents. Chemicals which control other mammals, birds, and fish are also grouped in this category by regulatory agencies. Most rodenticides are stomach poisons and are often applied as baits. Even rodenticides which act by contacting the pest are usually not applied over large surfaces because of the hazard to domestic animals or desirable wildlife. They are usually applied in limited areas such as runways, known feeding places, or as baits.

Nematicides: Nematicides are chemicals used to control nematodes. Nematodes are tiny hir-like worms, many of which live in the soil and feed on plant roots. Very few of these worms live above ground.

Usually, soil fumigants are used to control nematodes in the soil.

INTRODUCTION OF IMMUNIZATION

Immunization, also called vaccination or inoculation, a method of stimulating resistance in the human body to specific diseases using microorganisms—bacteria or viruses—that have been modified or killed. These treated microorganisms do not cause the disease, but rather trigger the body's immune system to build a defense mechanism that continuously guards against the disease. If a person immunized against a particular disease later comes into contact with the disease-causing agent, the immune system is immediately able to respond defensively.

Immunization has dramatically reduced the incidence of a number of deadly diseases. For example, a worldwide vaccination program resulted in the global eradication of smallpox in 1980, and in most developed countries immunization has essentially eliminated diphtheria, poliomyelitis, and neonatal tetanus. The number of cases of Haemophilus influenzae type b meningitis in the United States has dropped 95 percent among infants and children since 1988, when the vaccine for that disease was first introduced. In the United States, more than 90 percent of children receive all the recommended vaccinations by their second birthday. About 85 percent of Canadian children are immunized by age two.

TYPES OF IMMUNIZATION: Scientists have developed two approaches to immunization: active immunization, which provides long-lasting immunity, and passive immunization, which gives temporary immunity. In active immunization, all or part of a disease-causing microorganism or a modified product of that microorganism is injected into the body to make the immune system respond defensively. Passive immunity is accomplished by injecting blood from an actively immunized human being or animal.

A - Active Immunization

Vaccines that provide active immunization are made in a variety of ways, depending on the type of disease and the organism that causes it. The active components of the vaccinations are antigens, substances found in the disease-causing organism that the immune system recognizes as foreign. In response to the antigen, the immune system develops either antibodies or white blood cells called Tlymphocytes, which are special attacker cells. Immunization mimics real infection but presents little or no risk to the recipient. Some immunizing agents provide complete protection against a disease for life. Other agents provide partial protection, meaning that the immunized person can contract the disease, but in a less severe form. These vaccines are usually considered risky for people who have a damaged immune system, such as those infected with the virus that causes acquired immunodeficiency syndrome (AIDS) or those receiving chemotherapy for cancer or organ transplantation. Without a healthy defense system to fight infection, these people may develop the disease that the vaccine is trying to prevent. Some immunizing agents require repeated inoculations—or booster shots—at specific intervals. Tetanus shots, for example, are recommended every ten years throughout life.

In order to make a vaccine that confers active immunization, scientists use an organism or part of one that has been modified so that it has a low risk of causing illness but still triggers the body's immune defenses against disease. One type of vaccine contains live organisms that have been attenuated—that is, their virulence has been weakened. This procedure is used to protect against yellow fever, measles, smallpox, and many other viral diseases.

Immunization can also occur when a person receives an injection of killed or inactivated organisms that are relatively harmless but that still contain antigens. This type of vaccination is used to protect against bacterial diseases such as poliomyelitis, typhoid fever, and diphtheria. Some vaccines use only parts of an infectious organism that contain antigens, such as a protein cell wall or a flagellum. Known as acellular vaccines, they produce the desired immunity with a lower risk of producing potentially harmful immune reactions that may result from exposure to other parts of the organism. Acellular vaccines include the Haemophilus influenzae type B vaccine for meningitis and newer versions of the whooping cough vaccine. Scientists use genetic engineering techniques to refine this approach further by isolating a gene or genes within an infectious organism that code for a particular antigen. The subunit vaccines produced by this method cannot cause disease and are safe to use in people who have an impaired immune system. Subunit vaccines for hepatitis B and pneumococcus infection, which causes pneumonia, became available in the late 1990s.

Active immunization can also be carried out using bacterial toxins that have been treated with chemicals so that they are no longer toxic, even though their antigens remain intact. This procedure uses the toxins produced by genetically engineered bacteria rather than the organism itself and is used in vaccinating against tetanus, botulism, and similar toxic diseases.

B - Passive Immunization
Passive immunization is performed without injecting any antigen. In this method, vaccines contain antibodies obtained from the blood of an actively immunized human being or animal. The antibodies last for two to three weeks, and during that time the person is protected against the disease. Although short-lived, passive immunization provides immediate protection, unlike active immunization, which can take weeks to develop. Consequently, passive immunization can be lifesaving when a person has been infected with a deadly organism.

Occasionally there are complications associated with passive immunization. Diseases such as botulism and rabies once posed a particular problem. Immune globulin (antibody-containing plasma) for these diseases was once derived from the blood serum of horses. Although this animal material was specially treated before administration to humans, serious allergic reactions were common. Today, human-derived immune globulin is more widely available and the risk of side effects is reduced.

IMMUNIZATION RECOMMENDATIONS
More than 50 vaccines for preventable diseases are licensed in the United States. The American Academy of Pediatrics and the U.S. Public Health Service recommend a series of immunizations beginning at birth. The initial series for children is complete by the time they reach the age of two, but booster vaccines are required for certain diseases, such as diphtheria and tetanus, in order to maintain adequate protection. When new vaccines are introduced, it is uncertain how long full protection will last. Recently, for example, it was discovered that a single injection of measles vaccine, first licensed in 1963 and administered to children at the age of 15 months, did not confer protection through adolescence and young adulthood. As a result, in the 1980s a series of measles epidemics occurred on college campuses throughout the United States among students who had been vaccinated as infants. To forestall future epidemics, health authorities now recommend that a booster dose of the measles, mumps, and rubella (also known as German measles) vaccine be administered at the time a child first enters school.
Not only children but also adults can benefit from immunization. Many adults in the United States are not sufficiently protected against tetanus, diphtheria, measles, mumps, and German measles. Health authorities recommend that most adults 65 years of age and older, and those with respiratory illnesses, be immunized against influenza (yearly) and pneumococcus (once).

HISTORY OF IMMUNIZATION
The use of immunization to prevent disease predated the knowledge of both infection and immunology. In China in approximately 600 BC, smallpox material was inoculated through the nostrils. Inoculation of healthy people with a tiny amount of material from smallpox sores was first attempted in England in 1718and later in America. Those who survived the inoculation became immune to smallpox. American statesman Thomas Jefferson traveled from his home in Virginia to Philadelphia, Pennsylvania, to undergo this risky procedure.

A significant breakthrough came in 1796 when British physician Edward Jenner discovered that he could immunize patients against smallpox by inoculating them with material from cowpox sores. Cowpox is a far milder disease that, unlike smallpox, carries little risk of death or disfigurement. Jenner inserted matter from cowpox sores into cuts he made on the arm of a healthy eight-year-old boy. The boy caught cowpox. However, when Jenner exposed the boy to smallpox eight weeks later, the child did not contract the disease. The vaccination with cowpox had made him immune to the smallpox virus. Today we know that the cowpox virus antigens are so similar to those of the smallpox virus that they trigger the body's defenses against both diseases.

In 1885 Louis Pasteur created the first successful vaccine against rabies for a young boy who had been bitten 14 times by a rabid dog. Over the course of ten days, Pasteur injected progressively more virulent rabies organisms into the boy, causing the boy to develop immunity in time to avert death from this disease.

Another major milestone in the use of vaccination to prevent disease occurred with the efforts of two American physician-researchers. In 1954 Jonas Salk introduced an injectable vaccine containing an inactivated virus to counter the epidemic of poliomyelitis. Subsequently, Albert Sabin made great strides in the fight against this paralyzing disease by developing an oral vaccine containing a live weakened virus. Since the introduction of the polio vaccine, the disease has been nearly eliminated in many parts of the world.
As more vaccines are developed, a new generation of combined vaccines are becoming available that will allow physicians to administer a single shot for multiple diseases. Work is also under way to develop additional orally administered vaccines and vaccines

for sexually transmitted diseases.

Possible future vaccines may include, for example, one that would temporarily prevent pregnancy. Such a vaccine would still operate by stimulating the immune system to recognize and attack antigens, but in this case the antigens would be those of the hormones that are necessary for pregnancy.

FINGERPRINTING

Fingerprinting, method of identification using the impression made by the minute ridge formations or patterns found on the fingertips. No two persons have exactly the same arrangement of ridge patterns, and the patterns of any one individual remain unchanged through life. To obtain a set of fingerprints, the ends of the fingers are inked and then pressed or rolled one by one on some receiving surface. Fingerprints may be classified and filed on the basis of the ridge patterns, setting up an identification system that is almost infallible.

HISTORY: The first recorded use of fingerprints was by the ancient Assyrians and Chinese for the signing of legal documents. Probably the first modern study of fingerprints was made by the Czech physiologist Johannes Evengelista Purkinje, who in 1823 proposed a system of classification that attracted little attention. The use of fingerprints for identification purposes was proposed late in the 19th century by the British scientist Sir Francis Galton, who wrote a detailed study of fingerprints in which he presented a new classification system using prints of all ten fingers, which is the basis of identification systems still in use. In the 1890s the police in Bengal, India, under the British police official Sir Edward Richard Henry, began using fingerprints to identify criminals. As assistant commissioner of metropolitan police, Henry established the first British fingerprint files in London in 1901. Subsequently, the use of fingerprinting as a means for identifying criminals spread rapidly throughout Europe and the United States, superseding the old Bertillon system of identification by means of body measurements.

MODERN USE: As crime-detection methods improved, law enforcement officers found that any smooth, hard surface touched by a human hand would yield fingerprints made by the oily secretion present on the skin. When these so-called latent prints were dusted with powder or chemically treated, the identifying fingerprint pattern could be seen and photographed or otherwise preserved. Today, law enforcement agencies can also use computers to digitally record fingerprints and to transmit them electronically to other agencies for comparison. By comparing fingerprints at the scene of a crime with the fingerprint record of suspected persons, officials can establish absolute proof of the presence or identity of a person.

The confusion and inefficiency caused by the establishment of many separate fingerprint archives in the United States led the federal government to set up a central agency in 1924, the Identification Division of the Federal Bureau of Investigation (FBI). This division was absorbed in 1993 by the FBI's Criminal Justice Information Services Division, which now maintains the world's largest fingerprint collection. Currently the FBI has a library of more than 234 million civil and criminal fingerprint cards, representing 81 million people. In 1999 the FBI began full operation of the Integrated Automated Fingerprint Identification System (IAFIS), a computerized system that stores digital images of fingerprints for more than 36 million individuals, along with each individual's criminal history if one exists. Using IAFIS, authorities can conduct automated searches to identify people from their fingerprints and determine whether they have a criminal record. The system also gives state and local law enforcement agencies the ability to electronically transmit fingerprint information to the FBI. The implementation of IAFIS represented a breakthrough in crime fighting by reducing the time needed for fingerprint identification from weeks to minutes or hours.

INFRARED RADIATION

Infrared Radiation, emission of energy as electromagnetic waves in the portion of the spectrum just beyond the limit of the red portion of visible radiation (see Electromagnetic Radiation). The wavelengths of infrared radiation are shorter than those of radio waves and longer than those of light waves. They range between approximately 10-6 and 10-3 (about 0.0004 and 0.04 in). Infrared radiation may be detected as heat, and instruments such as bolometers are used to detect it. See Radiation; Spectrum. Infrared radiation is used to obtain pictures of distant objects obscured by atmospheric haze, because visible light is scattered by haze but infrared radiation is not. The detection of infrared radiation is used by astronomers to observe stars and nebulas that are invisible in ordinary light or that emit radiation in the infrared portion of the spectrum.

An opaque filter that admits only infrared radiation is used for very precise infrared photographs, but an ordinary orange or light-red filter, which will absorb blue and violet light, is usually sufficient for most infrared pictures. Developed about 1880, infrared photography has today become an important diagnostic tool in medical science as well as in agriculture and industry. Use of infrared techniques reveals pathogenic conditions that are not visible to the eye or recorded on X-ray plates. Remote sensing by means of aerial and orbital infrared photography has been used to monitor crop conditions and insect and disease damage to large agricultural areas, and to locate mineral deposits. See Aerial Survey; Satellite, Artificial. In industry, infrared spectroscopy forms an increasingly important part of metal and alloy research, and infrared photography is used to monitor the quality of products. See also Photography: Photographic Films.

Infrared devices such as those used during World War-II enable sharpshooters to see their targets in total visual darkness. These instruments consist essentially of an infrared lamp that sends out a beam of infrared radiation, often referred to as black light, and a telescope receiver that picks up returned radiation from the object and converts it to a visible image.

GREEN HOUSE EFFECT

Greenhouse Effect, the capacity of certain gases in the atmosphere to trap heat emitted from the Earth's surface, thereby insulating and warming the Earth. Without the thermal blanketing of the natural greenhouse effect, the Earth's climate would be about 33 Celsius degrees (about 59 Fahrenheit degrees) cooler—too cold for most living organisms to survive.

The greenhouse effect has warmed the Earth for over 4 billion years. Now scientists are growing increasingly concerned that human activities may be modifying this natural process, with potentially dangerous consequences. Since the advent of the Industrial Revolution in the 1700s, humans have devised many inventions that burn fossil fuels such as coal, oil, and natural gas. Burning these fossil fuels, as well as other activities such as clearing land for agriculture or urban settlements, releases some of the same gases that trap heat in the atmosphere, including carbon dioxide, methane, and nitrous oxide. These atmospheric gases have risen to levels higher than at any time in the last 420,000 years. As these gases build up in the atmosphere, they trap more heat near the Earth's surface, causing Earth's climate to become warmer than it would naturally.

Scientists call this unnatural heating effect global warming and blame it for an increase in the Earth's surface temperature of about 0.6 Celsius degrees (about 1 Fahrenheit degree) over the last nearly 100 years. Without remedial measures, many scientists fear that global temperatures will rise 1.4 to 5.8 Celsius degrees (2.5 to 10.4 Fahrenheit degrees) by 2100. These warmer temperatures could melt parts of polar ice caps and most mountain glaciers, causing a rise in sea level of up to 1 m (40 in) within a century or two, which would flood coastal regions. Global warming could also affect weather patterns causing, among other problems, prolonged drought or increased flooding in some of the world's leading agricultural regions.

HOW THE GREENHOUSE EFFECT WORKS?

The greenhouse effect results from the interaction between sunlight and the layer of greenhouse gases in the Earth's atmosphere that extends up to 100 km (60 mi) above Earth's surface. Sunlight is composed of a range of radiant energies known as the solar spectrum, which includes visible light, infrared light, gamma rays, X rays, and ultraviolet light. When the Sun's radiation reaches the Earth's atmosphere, some 25 percent of the energy is reflected back into space by clouds and other atmospheric particles. About 20 percent is absorbed in the atmosphere. For instance, gas molecules in the uppermost layers of the atmosphere absorb the Sun's gamma rays and X rays. The Sun's ultraviolet radiation is absorbed by the ozone layer, located 19 to 48 km (12 to 30 mi) above the Earth's surface.

About 50 percent of the Sun's energy, largely in the form of visible light, passes through the atmosphere to reach the Earth's surface. Soils, plants, and oceans on the Earth's surface absorb about 85 percent of this heat energy, while the rest is reflected back into the atmosphere—most effectively by reflective surfaces such as snow, ice, and sandy deserts. In addition, some of the Sun's radiation that is absorbed by the Earth's surface becomes heat energy in the form of long-wave infrared radiation, and this energy is released back into the atmosphere.

Certain gases in the atmosphere, including water vapor, carbon dioxide, methane, and nitrous oxide, absorb this infrared radiant heat, temporarily preventing it from dispersing into space. As these atmospheric gases warm, they in turn emit infrared radiation in all directions. Some of this heat returns back to Earth to further warm the surface in what is known as the greenhouse effect, and some of this heat is eventually released to space. This heat transfer creates equilibrium between the total amount of heat that reaches the Earth from the Sun and the amount of heat that the Earth radiates out into space. This equilibrium or energy balance—the exchange of energy between the Earth's surface, atmosphere, and space—is important to maintain a climate that can support a wide variety of life. The heat-trapping gases in the atmosphere behave like the glass of a greenhouse. They let much of the Sun's rays in, but keep most of that heat from directly escaping. Because of this, they are called greenhouse gases. Without these gases, heat energy absorbed and reflected from the Earth's surface would easily radiate back out to space, leaving the planet with an inhospitable temperature close to −19°C (2°F), instead of the present average surface temperature of 15°C (59°F).

To appreciate the importance of the greenhouse gases in creating a climate that helps sustain most forms of life, compare Earth to Mars and Venus. Mars has a thin atmosphere that contains low concentrations of heat-trapping gases. As a result, Mars has a weak greenhouse effect resulting in a largely frozen surface that shows no evidence of life. In contrast, Venus has an atmosphere containing high concentrations of carbon dioxide. This heat-trapping gas prevents heat radiated from the planet's surface from escaping into space, resulting in surface temperatures that average 462°C (864°F)—too hot to support life.

TYPES OF GREENHOUSE GASES

Earth's atmosphere is primarily composed of nitrogen (78 percent) and oxygen (21 percent). These two most common atmospheric gases have chemical structures that restrict absorption of infrared energy. Only the few greenhouse gases, which make up less than 1 percent of the atmosphere, offer the Earth any insulation. Greenhouse gases occur naturally or are manufactured. The most abundant naturally occurring greenhouse gas is water vapor, followed by carbon dioxide, methane, and nitrous oxide. Human-made chemicals that act as greenhouse gases include chlorofluorocarbons (CFCs), hydrochlorofluorocarbons (HCFCs), and hydrofluorocarbons (HFCs).

Since the 1700s, human activities have substantially increased the levels of greenhouse gases in the atmosphere. Scientists are concerned that expected increases in the concentrations of greenhouse gases will powerfully enhance the atmosphere's capacity to retain infrared radiation, leading to an artificial warming of the Earth's surface.

A -Water Vapor: Water vapor is the most common greenhouse gas in the atmosphere, accounting for about 60 to 70 percent of the natural greenhouse effect. Humans do not have a significant direct impact on water vapor levels in the atmosphere. However, as human activities increase the concentration of other greenhouse gases in the atmosphere (producing warmer temperatures on Earth), the evaporation of oceans, lakes, and rivers, as well as water evaporation from plants, increase and raise the amount of water vapor in the atmosphere.

B -Carbon Dioxide: Carbon dioxide constantly circulates in the environment through a variety of natural processes known as the carbon cycle. Volcanic eruptions and the decay of plant and animal matter both release carbon dioxide into the atmosphere. In respiration, animals break down food to release the energy required to build and maintain cellular activity. A byproduct of respiration is the formation of carbon dioxide, which is exhaled from animals into the environment. Oceans, lakes, and rivers absorb carbon dioxide from the atmosphere. Through photosynthesis, plants collect carbon dioxide and use it to make their own food, in the process incorporating carbon into new plant tissue and releasing oxygen to the environment as a byproduct.

In order to provide energy to heat buildings, power automobiles, and fuel electricity-producing power plants, humans burn objects that contain carbon, such as the fossil fuels oil, coal, and natural gas; wood or wood products; and some solid wastes. When these products are burned, they release carbon dioxide into the air. In addition, humans cut down huge tracts of trees for lumber or to clear land for farming or building. This process, known as deforestation, can both release the carbon stored in trees and significantly reduce the number of trees available to absorb carbon dioxide.

As a result of these human activities, carbon dioxide in the atmosphere is accumulating faster than the Earth's natural processes can absorb the gas. By analyzing air bubbles trapped in glacier ice that is many centuries old, scientists have determined that carbon dioxide levels in the atmosphere have risen by 31 percent since 1750. And since carbon dioxide increases can remain in the atmosphere for centuries, scientists expect these concentrations to double or triple in the next century if current trends continue.

C –Methane: Many natural processes produce methane, also known as natural gas. Decomposition of carbon-containing substances found in oxygen-free environments, such as wastes in landfills, release methane. Ruminating animals such as cattle and sheep belch methane into the air as a byproduct of digestion. Microorganisms that live in damp soils, such as rice fields, produce methane when they break down organic matter. Methane is also emitted during coal mining and the production and transport of other fossil fuels.

Methane has more than doubled in the atmosphere since 1750, and could double again in the next century. Atmospheric concentrations of methane are far less than carbon dioxide, and methane only stays in the atmosphere for a decade or so. But scientists consider methane an extremely effective heat-trapping gas—one molecule of methane is 20 times more efficient at trapping infrared radiation radiated from the Earth's surface than a molecule of carbon dioxide.

D -Nitrous Oxide: Nitrous oxide is released by the burning of fossil fuels, and automobile exhaust is a large source of this gas. In addition, many farmers use nitrogen-containing fertilizers to provide nutrients to their crops. When these fertilizers break down in the soil, they emit nitrous oxide into the air. Plowing fields also releases nitrous oxide.

Since 1750 nitrous oxide has risen by 17 percent in the atmosphere. Although this increase is smaller than for the other greenhouse gases, nitrous oxide traps heat about 300 times more effectively than carbon dioxide and can stay in the atmosphere for a century.

E -Fluorinated Compounds: Some of the most potent greenhouse gases emitted are produced solely by human activities. Fluorinated compounds, including CFCs, HCFCs, and HFCs, are used in a variety of manufacturing processes. For each of these synthetic compounds, one molecule is several thousand times more effective in trapping heat than a single molecule of carbon dioxide.

CFCs, first synthesized in 1928, were widely used in the manufacture of aerosol sprays, blowing agents for foams and packing materials, as solvents, and as refrigerants. Nontoxic and safe to use in most applications, CFCs are harmless in the lower atmosphere. However, in the upper atmosphere, ultraviolet radiation breaks down CFCs, releasing chlorine into the atmosphere. In the mid-1970s, scientists began observing that higher concentrations of chlorine were destroying the ozone layer in the upper atmosphere. Ozone protects the Earth from harmful ultraviolet radiation, which can cause cancer and other damage to plants and animals. Beginning in 1987 with the Montréal Protocol on Substances that Deplete the Ozone Layer, representatives from 47 countries established control measures that limited the consumption of CFCs. By 1992 the Montréal Protocol was amended to completely ban the manufacture and use of CFCs worldwide, except in certain developing countries and for use in special medical processes such as asthma inhalers.

Scientists devised substitutes for CFCs, developing HCFCs and HFCs. Since HCFCs still release ozone-destroying chlorine in the atmosphere, production of this chemical will be phased out by the year 2030, providing scientists some time to develop a new generation of safer, effective chemicals. HFCs, which do not contain chlorine and only remain in the atmosphere for a short time, are now considered the most effective and safest substitute for CFCs.

F -Other Synthetic Chemicals: Experts are concerned about other industrial chemicals that may have heat-trapping abilities. In 2000 scientists observed rising concentrations of a previously unreported compound called trifluoromethyl sulphur pentafluoride. Although present in extremely low concentrations in the environment, the gas still poses a significant threat because it traps heat more effectively than all other known greenhouse gases. The exact sources of the gas, undisputedly produced from industrial processes, still remain uncertain.

OTHER FACTORS AFFECTING THE GREENHOUSE EFFECT

Aerosols, also known as particulates, are airborne particles that absorb, scatter, and reflect radiation back into space. Clouds, windblown dust, and particles that can be traced to erupting volcanoes are examples of natural aerosols. Human activities, including the burning of fossil fuels and slash-and-burn farming techniques used to clear forestland, contribute additional aerosols to the atmosphere. Although aerosols are not considered a heat-trapping greenhouse gas, they do affect the transfer of heat energy radiated from the Earth to space. The effect of aerosols on climate change is still debated, but scientists believe that light-colored aerosols cool the Earth's surface, while dark aerosols like soot actually warm the atmosphere. The increase in global temperature in the last century is lower than many scientists predicted when only taking into account increasing levels of carbon dioxide, methane, nitrous oxide, and fluorinated compounds. Some scientists believe that aerosol cooling may be the cause of this unexpectedly reduced warming.

However, scientists do not expect that aerosols will ever play a significant role in offsetting global warming. As pollutants, aerosols typically pose a health threat, and the manufacturing or agricultural processes that produce them are subject to air-pollution control efforts. As a result, scientists do not expect aerosols to increase as fast as other greenhouse gases in the 21st century.

UNDERSTANDING THE GREENHOUSE EFFECT

Although concern over the effect of increasing greenhouse gases is a relatively recent development, scientists have been investigating the greenhouse effect since the early 1800s. French mathematician and physicist Jean Baptiste Joseph Fourier, while exploring how heat is conducted through different materials, was the first to compare the atmosphere to a glass vessel in 1827. Fourier recognized that the air around the planet lets in sunlight, much like a glass roof.

In the 1850s British physicist John Tyndall investigated the transmission of radiant heat through gases and vapors. Tyndall found that nitrogen and oxygen, the two most common gases in the atmosphere, had no heat-absorbing properties. He then went on to measure the absorption of infrared radiation by carbon dioxide and water vapor, publishing his findings in 1863 in a paper titled "On Radiation through the Earth's Atmosphere."

Swedish chemist Svante August Arrhenius, best known for his Nobel Prize-winning work in electrochemistry, also advanced understanding of the greenhouse effect. In 1896 he calculated that doubling the natural concentrations of carbon dioxide in the atmosphere would increase global temperatures by 4 to 6 Celsius degrees (7 to 11 Fahrenheit degrees), a calculation that is not too far from today's estimates using more sophisticated methods. Arrhenius correctly predicted that when Earth's temperature warms, water vapor evaporation from the oceans increases. The higher concentration of water vapor in the atmosphere would then contribute to the greenhouse effect and global warming.

The predictions about carbon dioxide and its role in global warming set forth by Arrhenius were virtually ignored for over half a century, until scientists began to detect a disturbing change in atmospheric levels of carbon dioxide. In 1957 researchers at the Scripps Institution of Oceanography, based in San Diego, California, began monitoring carbon dioxide levels in the atmosphere from Hawaii's remote Mauna Loa Observatory located 3,000 m (11,000 ft) above sea level. When the study began, carbon dioxide concentrations in the Earth's atmosphere were 315 molecules of gas per million molecules of air (abbreviated parts per million or ppm). Each year carbon dioxide concentrations increased—to 323 ppm by 1970 and 335 ppm by 1980. By 1988 atmospheric carbon dioxide had increased to 350 ppm, an 8 percent increase in only 31 years.

As other researchers confirmed these findings, scientific interest in the accumulation of greenhouse gases and their effect on the environment slowly began to grow. In 1988 the World Meteorological Organization and the United Nations Environment Programme established the Intergovernmental Panel on Climate Change (IPCC). The IPCC was the first international collaboration of scientists to assess the scientific, technical, and socioeconomic information related to the risk of human-induced climate change. The IPCC creates periodic assessment reports on advances in scientific understanding of the causes of climate change, its potential impacts, and strategies to control greenhouse gases. The IPCC played a critical role in establishing the United Nations Framework Convention on Climate Change (UNFCCC). The UNFCCC, which provides an international policy framework for addressing climate change issues, was adopted by the United Nations General Assembly in 1992.

Today scientists around the world monitor atmospheric greenhouse gas concentrations and create forecasts about their effects on global temperatures. Air samples from sites spread across the globe are analyzed in laboratories to determine levels of individual greenhouse gases. Sources of greenhouse gases, such as automobiles, factories, and power plants, are monitored directly to determine their emissions. Scientists gather information about climate systems and use this information to create and test computer models that simulate how climate could change in response to changing conditions on the Earth and in the atmosphere. These models act as high-tech crystal balls to project what may happen in the future as greenhouse gas levels rise. Models can only provide approximations, and some of the predictions based on these models often spark controversy within the science community. Nevertheless, the basic concept of global warming is widely accepted by most climate scientists.

EFFORTS TO CONTROL GREENHOUSE GASES

Due to overwhelming scientific evidence and growing political interest, global warming is currently recognized as an important national and international issue. Since 1992 representatives from over 160 countries have met regularly to discuss how to reduce worldwide greenhouse gas emissions. In 1997 representatives met in Kyôto, Japan, and produced an agreement, known as the Kyôto Protocol, which requires industrialized countries to reduce their emissions by 2012 to an average of 5 percent below 1990 levels. To help countries meet this agreement cost-effectively, negotiators are trying to develop a system in which nations that have no obligations or that have successfully met their reduced emissions obligations could profit by selling or trading their extra emissions quotas to other countries that are struggling to reduce their emissions. Negotiating such detailed emissions trading rules has been a contentious task for the world community since the signing of the Kyôto Protocol. A ratified agreement is still not yet in force, and ratification received a setback in 2001 when newly elected U.S. president George W. Bush renounced the treaty on the grounds that the required carbon-dioxide reductions in the United States would be too costly. He also objected that developing nations would not be bound by similar carbon-dioxide reducing obligations. However, many experts expect that as the scientific evidence about the dangers of global warming continues to mount, nations will be motivated to cooperate more effectively to reduce the risks of climate change.

ANTIMATTER

Antimatter, matter composed of elementary particles that are, in a special sense, mirror images of the particles that make up ordinary matter as it is known on earth. Antiparticles have the same mass as their corresponding particles but have opposite electric charges or other properties related to electromagnetism. For example, the antimatter electron, or positron, has opposite electric charge and magnetic moment (a property that determines how it behaves in a magnetic field), but is identical in all other respects to the electron. The antimatter equivalent of the charge-less neutron, on the other hand, differs in having a magnetic moment of opposite sign (magnetic moment is another electromagnetic property). In all of the other parameters involved in the dynamical properties of elementary particles, such as mass, spin, and partial decay, antiparticles are identical with their corresponding particles.

The existence of antiparticles was first proposed by the British physicist Paul Adrien Maurice Dirac, arising from his attempt to apply the techniques of relativistic mechanics to quantum theory. In 1928 he developed the concept of a positively charged electron but its actual existence was established experimentally in 1932. The existence of other antiparticles was presumed but not confirmed until 1955, when antiprotons and antineutrons were observed in particle accelerators. Since then, the full range of antiparticles has been observed or indicated. Antimatter atoms were created for the first time in September 1995 at the European Organization for Nuclear Research (CERN). Positrons were combined with antimatter protons to produce antimatter hydrogen atoms. These atoms of antimatter exist only for forty-billionths of a second, but physicists hope future experiments will determine what differences there are between normal hydrogen and its antimatter counterpart.

A profound problem for particle physics and for cosmology in general is the apparent scarcity of antiparticles in the universe. Their nonexistence, except momentarily, on earth is understandable, because particles and antiparticles are mutually annihilated with a great release of energy when they meet (see Annihilation). Distant galaxies could possibly be made of antimatter, but no direct method of confirmation exists. Most of what is known about the far universe arrives in the form of photons, which are identical with their antiparticles and thus reveal little about the nature of their sources. The prevailing opinion, however, is that the universe consists overwhelmingly of “ordinary” matter, and explanations for this have been proposed by recent cosmological theory (see Inflationary Theory).

In 1997 scientists studying data gathered by the Compton Gamma Ray Observatory (GRO) operated by the National Aeronautics and Space Administration (NASA) found that the earth’s home galaxy—the Milky Way—contains large clouds of antimatter particles. Astronomers suggest that these clouds form when high-energy events—such as the collision of neutron stars, exploding stars, or black holes—create radioactive elements that decay into matter and antimatter or heat matter enough to make it split into particles of matter and antimatter. When antimatter particles meet particles of matter, the two annihilate each other and produce a burst of gamma rays. It was these gamma rays that GRO detected.

MAGMA

Magma, molten or partially molten rock beneath the earth’s surface. Magma is generated when rock deep underground melts due to the high temperatures and pressures inside the earth. Because magma is lighter than the surrounding rock, it tends to rise. As it moves upward, the magma encounters colder rock and begins to cool. If the temperature of the magma drops low enough, the magma will crystallize underground to form rock; rock that forms in this way is called intrusive, or plutonic igneous rock, as the magma has formed by intruding the surrounding rocks. If the crust through which the magma passes is sufficiently shallow, warm, or fractured, and if the magma is sufficiently hot and fluid, the magma will erupt at the surface of the earth, possibly forming volcanoes. Magma that erupts is called lava.

COMPOSITION OF MAGMA

Magmas are liquids that contain a variety of melted minerals and dissolved gases. Because magmas form deep underground, however, geologists cannot directly observe and measure their original composition. This difficulty has led to controversy over the exact chemical composition of magmas. Geologists cannot simply assume it is the same as the composition of the rock in the source region. One reason for this is that the source rock may melt only partially, releasing only the minerals with the lowest melting points. For this reason, the composition of magma produced by melting 1 percent of a rock is different from the composition of magma produced by melting 20 percent of a rock. Experiments have shown that the temperature and pressure of the location within the earth, and the amount of water present at that location affect the amount of melting. Because temperature and pressure increase as depth within the earth increases, melting an identical source rock at different depths will produce magmas of different composition. Combining these considerations with the fact that the composition of the source rock may be different in different geographic regions, there is a considerable range of possible compositions for magma.

As magma moves toward the surface, the pressure and temperature decrease, which causes partial crystallization, or the formation of mineral crystals within the magma. The compositions of the minerals that crystallize are different from the initial composition of the magma because of changes in temperature and pressure, hence the composition of the remaining liquid changes. The resultant crystals may separate from the liquid either by sinking or by a process known as filter-pressing, in which pressure compresses the liquid and causes it to move toward regions of lower pressure while leaving the crystals behind. As a result, the composition of the remaining magma is different from that of the initial magma. This process is known as magmatic differentiation, and is the principal mechanism whereby a wide variety of magmas and rocks can be produced from a single primary magma (see Igneous Rock: Formation of Igneous Rocks).

The composition of magma can also be modified by chemical interactions with, and melting of, the rocks through which it passes on its way upward. This process is known as assimilation. Magma cannot usually supply enough heat to melt a large amount of the surrounding rock, so assimilation seldom produces a significant change in the composition of magma. Magmas also contain dissolved gases, because gases are especially soluble (easily dissolved) in liquids when the liquids are under pressure. Magma deep underground is under thousands of atmospheres (units of measure) of pressure due to the weight of the overlying rock. Gases commonly dissolved in magma are carbon dioxide, water vapor, and sulfur dioxide.

PHYSICAL PROPERTIES OF MAGMA

The density and viscosity, or thickness, of magma is key physical factors that affect its upward passage. Most rocks expand about 10 percent when they melt, and hence most magma has a density of about 90 percent of the equivalent solid rock. This density difference produces sufficient buoyancy in the magma to cause it to rise toward the surface.

The viscosity of a fluid is a measure of its resistance to flow. The viscosity of a magma affects how quickly the magma will rise, and it determines whether crystals of significantly different density will sink rapidly enough to change the bulk composition of the magma. Viscosity also influences the rate of release of gases from the magma when pressure is released. The viscosity of magma is closely related to the magma's chemical composition. Magma rich in silicon and poor in magnesium and iron, called felsic magma, is very viscous, or thick (see Igneous Rock: Felsic Rocks). Magma poor in silicon and rich in magnesium and iron, called mafic magma, is quite fluid.

GEOLOGICAL FEATURES FORMED BY MAGMA

Some magma reaches the surface of the earth and erupts from volcanoes or fissures before they solidify. Other magmas fail to reach the surface before they solidify. Magma that reaches the surface and is erupted, or extruded, forms extrusive igneous rocks. Magma that intrudes, or pushes its way into rocks deep underground and solidifies there forms intrusive igneous rock. Volcanoes are cone-shaped mountains formed by the eruption of lava. Magma collects in a reservoir surrounded by rock, called a magma chamber, about 10 to 20 km (6 to 12 mi) below the volcano. A conduit known as a volcanic pipe provides a passage for the magma from the magma chamber to the volcano. As the magma rises in the conduit, the pressure of the overlying rock drops. Gases expand and bubble out that were kept dissolved in the magma by the pressure. The rapidly expanding gases propel the magma up the volcanic pipe, forcing the magma to the surface and leading to an eruption. The same process occurs when a shaken bottle of soda is suddenly opened.

The viscosity and dissolved-gas content of the magma control the character of the eruption. Low-viscosity magmas often have a low gas content. They flow easily from volcanic conduits and result in relatively quiet eruptions. Once the magma reaches the surface, it rapidly spreads out and over the volcano. Such fluid lava creates broad, gently sloped volcanoes called shield volcanoes, so called because they resemble giant shields lying on the ground.

Low-viscosity lava can also flow from fissures (long cracks in the rock), forming huge lava lakes. Repeated eruptions result in formations called flood basalts. The Columbia Plateau, in the states of Washington, Oregon, and Idaho, is a flood basalt that covers nearly 200,000 sq km (about 80,000 sq mi) and is more than 4000 m (13,000 ft) thick in places. If a low-viscosity magma contains moderate amounts of dissolved gas, the released gases can eject the magma from the top of the volcano with enough force to form a lava fountain. The blobs of lava that are ejected into the air are called pyroclasts. They accumulate around the base of the fountain, forming a cinder cone.

Medium-viscosity magmas usually contain higher amounts of gases. They tend to form stratovolcanoes. The higher amounts of gases in the magma lead to very explosive eruptions that spew out large amounts of volcanic material. Stratovolcanoes have steeper sides than shield volcanoes. They are also known as composite volcanoes because they are made up of alternating layers of lava flows and deposits of pyroclasts.

High-viscosity magmas do not extrude easily though volcanic conduits. They often have a high gas content that can cause catastrophic eruptions. Both of these properties tend to promote explosive behavior, such as occurred on May 18, 1980 at Mount Saint Helens in Washington, when about 400 m (about 1300 ft) of rock was blasted off of its summit.

Intrusive bodies of rock formed from magma are classified by their size and shape. A batholith is an intrusive body that covers more than 100 sq km (nearly 40 sq mi). Lopoliths are saucer-shaped intrusions and may be up to 100 km (60 mi) in diameter and 8 km (5 mi) thick. Laccoliths have a flat base and a domed ceiling and are usually smaller than lopoliths. Sills and dikes are sheetlike intrusions that are very thin relative to their length. They can be less than one meter (about one yard) to several hundred meters thick but can be larger; the Palisades sill in the state of New York is 300 m (1000 ft) thick and 80 km (50 mi) long. Sills are formed when magma is forced between beds of layered rock; they run parallel to the layering of the surrounding rock. Dikes are formed when magma is forced into cracks in the surrounding rock; they tend to run perpendicular to the layering of the surrounding rock.

RAIN

Rain, precipitation of liquid drops of water. Raindrops generally have a diameter greater than 0.5 mm (0.02 in). They range in size up to about 3 mm (about 0.13 in) in diameter, and their rate of fall increases, up to 7.6 m (25 ft) per sec with their size. Larger drops tend to be flattened and broken into smaller drops by rapid fall through the air. The precipitation of smaller drops, called drizzle, often severely restricts visibility but usually does not produce significant accumulations of water.

Amount or volume of rainfall is expressed as the depth of water that collects on a flat surface, and is measured in a rain gauge to the nearest 0.25 mm (0.01 in). Rainfall is classified as light if not more than 2.5 mm (0.10 in) per hr, heavy if more than 7.50 mm (more than 0.30 in) per hr, and moderate if between these limits.

PROCESS OF PRECIPITATION

Air masses acquire moisture on passing over warm bodies of water, or over wet land surfaces. The moisture, or water vapor, is carried upward into the air mass by turbulence and convection (see Heat Transfer). The lifting required to cool and condense this water vapor results from several processes, and study of these processes provides a key for understanding the distribution of rainfall in various parts of the world.

The phenomenon of lifting, associated with the convergence of the trade winds (see Wind), results in a band of copious rains near the equator. This band, called the intertropical convergence zone (ITCZ), moves northward or southward with the seasons. In higher latitudes much of the lifting is associated with moving cyclones (see Cyclone), often taking the form of the ascent of warm moist air, over a mass of colder air, along an interface called a front. Lifting on a smaller scale is associated with convection in air that is heated by a warm underlying surface, giving rise to showers and thunderstorms. The heaviest rainfall over short periods of time usually comes from such storms. Air may also be lifted by being forced to rise over a land barrier, with the result that the exposed windward slopes have enhanced amounts of rain while the sheltered, or lee, slopes have little rain.

AVERAGE RAINFALL

In the U.S. the heaviest average rainfall amounts, up to 1778 mm (70 in), are experienced in the Southeast, where air masses from the tropical Atlantic and Gulf of Mexico are lifted frequently by cyclones and by convection. Moderate annual accumulations, from 762 to 1270 mm (30 to 50 in), occur throughout the eastern U.S., and are caused by cyclones in winter and convection in summer. The central plains, being farther from sources of moisture, have smaller annual accumulations, 381 to 1016 mm (15 to 40 in), mainly from summer convective storms. The southwestern U.S. is dominated by widespread descent of air in the subtropical Pacific anticyclone; rainfall is light, less than 254 mm (less than 10 in), except in the mountainous regions. The northwestern states are affected by cyclones from the Pacific Ocean, particularly during the winter; but rainfall is moderate, especially on the westward-facing slopes of mountain ranges.

The world's heaviest average rainfall, about 10,922 mm (about 430 in) per year, occurs at Cherrapunji, in northeastern India, where moisture-laden air from the Bay of Bengal is forced to rise over the Khāsi Hills of Assam State. As much as 26,466 mm (1042 in), or 26 m (87 ft), of rain have fallen there in one year. Other extreme rainfall records include nearly 1168 mm (nearly 46 in) of rain in one day during a typhoon at Baguio, Philippines; 304.8 mm (12 in) within one hour during a thunderstorm at Holt, Missouri; and 62.7 mm (2.48in) in over a 5-min period at Portobelo, Panama.

ARTIFICIAL PRECIPITATION

Despite the presence of moisture and lifting, clouds sometimes fail to precipitate rain. This circumstance has stimulated intensive study of precipitation processes, specifically of how single raindrops are produced out of a million or so minute droplets inside clouds. Two precipitation processes are recognized: (1) evaporation of water drops at subfreezing temperatures onto ice crystals that later fall into warmer layers and melt, and (2) the collection of smaller droplets upon larger drops that fall at a higher speed.

Efforts to effect or stimulate these processes artificially have led to extensive weather modification operations within the last 20 years (see Meteorology). These efforts have had only limited success, since most areas with deficient rainfall are dominated by air masses that have either inadequate moisture content or inadequate elevation, or both. Nevertheless, some promising results have been realized and much research is now being conducted in order to develop more effective methods of artificial precipitation.

ACID RAIN

Acid Rain, form of air pollution in which airborne acids produced by electric utility plants and other sources fall to Earth in distant regions. The corrosive nature of acid rain causes widespread damage to the environment. The problem begins with the production of sulfur dioxide and nitrogen oxides from the burning of fossil fuels, such as coal, natural gas, and oil, and from certain kinds of manufacturing. Sulfur dioxide and nitrogen oxides react with water and other chemicals in the air to form sulfuric acid, nitric acid, and other pollutants. These acid pollutants reach high into the atmosphere, travel with the wind for hundreds of miles, and eventually return to the ground by way of rain, snow, or fog, and as invisible “dry” forms.

Damage from acid rain has been widespread in eastern North America and throughout Europe, and in Japan, China, and Southeast Asia. Acid rain leaches nutrients from soils, slows the growth of trees, and makes lakes uninhabitable for fish and other wildlife. In cities, acid pollutants corrode almost everything they touch, accelerating natural wear and tear on structures such as buildings and statues. Acids combine with other chemicals to form urban smog, which attacks the lungs, causing illness and premature deaths.

FORMATION OF ACID RAIN

The process that leads to acid rain begins with the burning of fossil fuels. Burning, or combustion, is a chemical reaction in which oxygen from the air combines with carbon, nitrogen, sulfur, and other elements in the substance being burned. The new compounds formed are gases called oxides. When sulfur and nitrogen are present in the fuel, their reaction with oxygen yields sulfur dioxide and various nitrogen oxide compounds. In the United States, 70 percent of sulfur dioxide pollution comes from power plants, especially those that burn coal. In Canada, industrial activities, including oil refining and metal smelting, account for 61 percent of sulfur dioxide pollution. Nitrogen oxides enter the atmosphere from

many sources, with motor vehicles emitting the largest share—43 percent in the United States and 60 percent in Canada.
Once in the atmosphere, sulfur dioxide and nitrogen oxides undergo complex reactions with water vapor and other chemicals to yield sulfuric acid, nitric acid, and other pollutants called nitrates and sulfates. The acid compounds are carried by air currents and the wind, sometimes over long distances. When clouds or fog form in acid-laden air, they too are acidic, and so is the rain or snow that falls from them.

Acid pollutants also occur as dry particles and as gases, which may reach the ground without the help of water. When these "dry" acids are washed from ground surfaces by rain, they add to the acids in the rain itself to produce a still more corrosive solution. The combination of acid rain and dry acids is known as acid deposition.

EFFECTS OF ACID RAIN

The acids in acid rain react chemically with any object they contact. Acids are corrosive chemicals that react with other chemicals by giving up hydrogen atoms. The acidity of a substance comes from the abundance of free hydrogen atoms when the substance is dissolved in water. Acidity is measured using a pH scale with units from 0 to 14. Acidic substances have pH numbers from 1 to 6—the lower the pH number, the stronger, or more corrosive, the substance. Some non-acidic substances, called bases or alkalis, are like acids in reverse—they readily accept the hydrogen atoms that the acids offer. Bases have pH numbers from 8 to 14, with the higher values indicating increased alkalinity. Pure water has a neutral pH of 7—it is not acidic or basic. Rain, snow, or fog with a pH below 5.6 is considered acid rain.
When bases mix with acids, the bases lessen the strength of an acid (see Acids and Bases). This buffering action regularly occurs in nature. Rain, snow, and fog formed in regions free of acid pollutants are slightly acidic, having a pH near 5.6. Alkaline chemicals in the environment, found in rocks, soils, lakes, and streams, regularly neutralize this precipitation. But when precipitation is highly acidic, with a pH below 5.6, naturally occurring acid buffers become depleted over time, and nature's ability to neutralize the acids is impaired. Acid rain has been linked to widespread environmental damage, including soil and plant degradation, depleted life in lakes and streams, and erosion of human-made structures.

A –Soil: In soil, acid rain dissolves and washes away nutrients needed by plants. It can also dissolve toxic substances, such as aluminum and mercury, which are naturally present in some soils, freeing these toxins to pollute water or to poison plants that absorb them. Some soils are quite alkaline and can neutralize acid deposition indefinitely; others, especially thin mountain soils derived from granite or gneiss, buffer acid only briefly.

B –Trees: By removing useful nutrients from the soil, acid rain slows the growth of plants, especially trees. It also attacks trees more directly by eating holes in the waxy coating of leaves and needles, causing brown dead spots. If many such spots form, a tree loses some of its ability to make food through photosynthesis. Also, organisms that cause disease can infect the tree through its injured leaves. Once weakened, trees are more vulnerable to other stresses, such as insect infestations, drought, and cold temperatures.
Spruce and fir forests at higher elevations, where the trees literally touch the acid clouds, seem to be most at risk. Acid rain has been blamed for the decline of spruce forests on the highest ridges of the Appalachian Mountains in the eastern United States. In the Black Forest of southwestern Germany, half of the trees are damaged from acid rain and other forms of pollution.

C –Agriculture: Most farm crops are less affected by acid rain than are forests. The deep soils of many farm regions, such as those in the Midwestern United States, can absorb and neutralize large amounts of acid. Mountain farms are more at risk—the thin soils in these higher elevations cannot neutralize so much acid. Farmers can prevent acid rain damage by monitoring the condition of the soil and, when necessary, adding crushed limestone to the soil to neutralize acid. If excessive amounts of nutrients have been leached out of the soil, farmers can replace them by adding nutrient-rich fertilizer.

D -Surface Waters: Acid rain falls into and drains into streams, lakes, and marshes. Where there is snow cover in winter, local waters grow suddenly more acidic when the snow melts in the spring. Most natural waters are close to chemically neutral, neither acidic nor alkaline: their pH is between 6 and 8. In the northeastern United States and southeastern Canada, the water in some lakes now has a pH value of less than 5 as a result of acid rain. This means they are at least ten times more acidic than they should be. In the Adirondack Mountains of New York State, a quarter of the lakes and ponds are acidic, and many have lost their brook trout and other fish. In the middle Appalachian Mountains, over 1,300 streams are afflicted. All of Norway's major rivers have been damaged by acid rain, severely reducing salmon and trout populations.

E -Plants and Animals: The effects of acid rain on wildlife can be far-reaching. If a population of one plant or animal is adversely affected by acid rain, animals that feed on that organism may also suffer. Ultimately, an entire ecosystem may become endangered. Some species that live in water are very sensitive to acidity, some less so. Freshwater clams and mayfly young, for instance, begin dying when the water pH reaches 6.0. Frogs can generally survive more acidic water, but if their supply of mayflies is destroyed by acid rain, frog populations may also decline. Fish eggs of most species stop hatching at a pH of 5.0. Below a pH of 4.5, water is nearly sterile, unable to support any wildlife.

Land animals dependent on aquatic organisms are also affected. Scientists have found that populations of snails living in or near water polluted by acid rain are declining in some regions. In The Netherlands songbirds are finding fewer snails to eat. The eggs these birds lay have weakened shells because the birds are receiving less calcium from snail shells.

F -Human-Made Structures: Acid rain and the dry deposition of acidic particles damage buildings, statues, automobiles, and other structures made of stone, metal, or any other material exposed to weather for long periods. The corrosive damage can be expensive and, in cities with very historic buildings, tragic. Both the Parthenon in Athens, Greece, and the Taj Mahal in Agra, India, are deteriorating due to acid pollution.

G -Human Health: The acidification of surface waters causes little direct harm to people. It is safe to swim in even the most acidified lakes. However, toxic substances leached from soil can pollute local water supplies. In Sweden, as many as 10,000 lakes have been polluted by mercury released from soils damaged by acid rain, and residents have been warned to avoid eating fish caught in these lakes. In the air, acids join with other chemicals to produce urban smog, which can irritate the lungs and make breathing difficult, especially for people who already have asthma, bronchitis, or other respiratory diseases. Solid particles of sulfates, a class of minerals derived from sulfur dioxide, are thought to be especially damaging to the lungs.

H -Acid Rain and Global Warming: Acid pollution has one surprising effect that may be beneficial. Sulfates in the upper atmosphere reflect some sunlight out into space, and thus tend to slow down global warming. Scientists believe that acid pollution may have delayed the onset of warming by several decades in the middle of the 20th century.

EFFORTS TO CONTROL ACID RAIN

Acid rain can best be curtailed by reducing the amount of sulfur dioxide and nitrogen oxides released by power plants, motorized vehicles, and factories. The simplest way to cut these emissions is to use less energy from fossil fuels. Individuals can help. Every time a consumer buys an energy-efficient appliance, adds insulation to a house, or takes a bus to work, he or she conserves energy and, as a result, fights acid rain.

Another way to cut emissions of sulfur dioxide and nitrogen oxides is by switching to cleaner-burning fuels. For instance, coal can be high or low in sulfur, and some coal contains sulfur in a form that can be washed out easily before burning. By using more of the low-sulfur or cleanable types of coal, electric utility companies and other industries can pollute less. The gasoline and diesel oil that run most motor vehicles can also be formulated to burn more cleanly, producing less nitrogen oxide pollution. Clean-burning fuels such as natural gas are being used increasingly in vehicles. Natural gas contains almost no sulfur and produces very low nitrogen oxides. Unfortunately, natural gas and the less-polluting coals tend to be more expensive, placing them out of the reach of nations that are struggling economically.

Pollution can also be reduced at the moment the fuel is burned. Several new kinds of burners and boilers alter the burning process to produce less nitrogen oxides and more free nitrogen, which is harmless. Limestone or sandstone added to the combustion chamber can capture some of the sulfur released by burning coal.

Once sulfur dioxide and oxides of nitrogen have been formed, there is one more chance to keep them out of the atmosphere. In smokestacks, devices called scrubbers spray a mixture of water and powdered limestone into the waste gases (flue gases), recapturing the sulfur. Pollutants can also be removed by catalytic converters. In a converter, waste gases pass over small beads coated with metals. These metals promote chemical reactions that change harmful substances to less harmful ones. In the United States and Canada, these devices are required in cars, but they are not often used in smokestacks.

Once acid rain has occurred, a few techniques can limit environmental damage. In a process known as liming, powdered limestone can be added to water or soil to neutralize the acid dropping from the sky. In

Norway and Sweden, nations much afflicted with acid rain, lakes are commonly treated this way. Rural water companies may need to lime their reservoirs so that acid does not eat away water pipes. In cities, exposed surfaces vulnerable to acid rain destruction can be coated with acid-resistant paints. Delicate objects like statues can be sheltered indoors in climate-controlled rooms.

Cleaning up sulfur dioxide and nitrogen oxides will reduce not only acid rain but also smog, which will make the air look clearer. Based on a study of the value that visitors to national parks place on clear scenic vistas, the U.S. Environmental Protection Agency thinks that improving the vistas in eastern national parks alone will be worth $1 billion in tourist revenue a year.

INTERNATIONAL AGREEMENTS

Acid rain typically crosses national borders, making pollution control an international issue. Canada receives much of its acid pollution from the United States—by some estimates as much as 50 percent. Norway and Sweden receive acid pollutants from Britain, Germany, Poland, and Russia. The majority of acid pollution in Japan comes from China. Debates about responsibilities and cleanup costs for acid pollutants led to international cooperation. In 1988, as part of the Long-Range Transboundary Air Pollution Agreement sponsored by the United Nations, the United States and 24 other nations ratified a protocol promising to hold yearly nitrogen oxide emissions at or below 1987 levels. In 1991 the United States and Canada signed an Air Quality Agreement setting national limits on annual sulfur dioxide emissions from power plants and factories. In 1994 in Oslo, Norway, 12 European nations agreed to reduce sulfur dioxide emissions by as much as 87 percent by 2010.

Legislative actions to prevent acid rain have results. The targets established in laws and treaties are being met, usually ahead of schedule. Sulfur emissions in Europe decreased by 40 percent from 1980 to 1994. In Norway sulfur dioxide emissions fell by 75 percent during the same period. Since 1980 annual sulfur dioxide emissions in the United States have dropped from 26 million tons to 18.3 million tons. Canada reports sulfur dioxide emissions have been reduced to 2.6 million tons, 18 percent below the proposed limit of 3.2 million tons.

Monitoring stations in several nations report that precipitation is actually becoming less acidic. In Europe, lakes and streams are now growing less acid. However, this does not seem to be the case in the United States and Canada. The reasons are not completely understood, but apparently, controls reducing nitrogen oxide emissions only began recently and their effects have yet to make a mark. In addition, soils in some areas have absorbed so much acid that they contain no more neutralizing alkaline chemicals. The weathering of rock will gradually replace the missing alkaline chemicals, but scientists fear that improvement will be very slow unless pollution controls are made even stricter.

BRAIN

Brain, portion of the central nervous system contained within the skull. The brain is the control center for movement, sleep, hunger, thirst, and virtually every other vital activity necessary to survival. All human emotions—including love, hate, fear, anger, elation, and sadness—are controlled by the brain. It also receives and interprets the countless signals that are sent to it from other parts of the body and from the external environment. The brain makes us conscious, emotional, and intelligent.

ANATOMY

The adult human brain is a 1.3-kg (3-lb) mass of pinkish-gray jellylike tissue made up of approximately 100 billion nerve cells, or neurons; neuroglia (supporting-tissue) cells; and vascular (blood-carrying) and other tissues. Between the brain and the cranium—the part of the skull that directly covers the brain—are three protective membranes, or meninges. The outermost membrane, the dura mater, is the toughest and thickest. Below the dura mater is a middle membrane, called the arachnoid layer. The innermost membrane, the pia mater, consists mainly of small blood vessels and follows the contours of the surface of the brain.

A clear liquid, the cerebrospinal fluid, bathes the entire brain and fills a series of four cavities, called ventricles, near the center of the brain. The cerebrospinal fluid protects the internal portion of the brain from varying pressures and transports chemical substances within the nervous system. From the outside, the brain appears as three distinct but connected parts: the cerebrum (the Latin word for brain)—two large, almost symmetrical hemispheres; the cerebellum ("little brain")—two smaller hemispheres located at the back of the cerebrum; and the brain stem—a central core that gradually becomes the spinal cord, exiting the skull through an opening at its base called the foramen magnum. Two other major parts of the brain, the thalamus and the hypothalamus, lie in the midline above the brain stem underneath the cerebellum.

The brain and the spinal cord together make up the central nervous system, which communicates with the rest of the body through the peripheral nervous system. The peripheral nervous system consists of 12 pairs of cranial nerves extending from the cerebrum and brain stem; a system of other nerves branching throughout the body from the spinal cord; and the autonomic nervous system, which regulates vital functions not under conscious control, such as the activity of the heart muscle, smooth muscle (involuntary muscle found in the skin, blood vessels, and internal organs), and glands.

A –Cerebrum: Most high-level brain functions take place in the cerebrum. Its two large hemispheres make up approximately 85 percent of the brain's weight. The exterior surface of the cerebrum, the cerebral cortex, is a convoluted, or folded, grayish layer of cell bodies known as the gray matter. The gray matter covers an underlying mass of fibers called the white matter. The convolutions are made up of ridgelike bulges, known as gyri, separated by small grooves called sulci and larger grooves called fissures. Approximately two-thirds of the cortical surface is hidden in the folds of the sulci. The extensive convolutions enable a very large surface area of brain cortex—about 1.5 m2 (16 ft2) in an adult—to fit within the cranium. The pattern of these convolutions is similar, although not identical, in all humans.

The two cerebral hemispheres are partially separated from each other by a deep fold known as the longitudinal fissure. Communication between the two hemispheres is through several concentrated bundles of axons, called commissures, the largest of which is the corpus callosum. Several major sulci divide the cortex into distinguishable regions. The central sulcus, or Rolandic fissure, runs from the middle of the top of each hemisphere downward, forward, and toward another major sulcus, the lateral ("side"), or Sylvian, sulcus. These and other sulci and gyri divide the cerebrum into five lobes: the frontal, parietal, temporal, and occipital lobes and the insula.

The frontal lobe is the largest of the five and consists of all the cortex in front of the central sulcus. Broca's area, a part of the cortex related to speech, is located in the frontal lobe. The parietal lobe consists of the cortex behind the central sulcus to a sulcus near the back of the cerebrum known as the parieto-occipital sulcus. The parieto-occipital sulcus, in turn, forms the front border of the occipital lobe, which is the rearmost part of the cerebrum. The temporal lobe is to the side of and below the lateral sulcus. Wernicke's area, a part of the cortex related to the understanding of language, is located in the temporal lobe. The insula lies deep within the folds of the lateral sulcus.

The cerebrum receives information from all the sense organs and sends motor commands (signals that result in activity in the muscles or glands) to other parts of the brain and the rest of the body. Motor commands are transmitted by the motor cortex, a strip of cerebral cortex extending from side to side across the top of the cerebrum just in front of the central sulcus. The sensory cortex, a parallel strip of cerebral cortex just in back of the central sulcus, receives input from the sense organs.

Many other areas of the cerebral cortex have also been mapped according to their specific functions, such as vision, hearing, speech, emotions, language, and other aspects of perceiving, thinking, and remembering. Cortical regions known as associative cortex are responsible for integrating multiple inputs, processing the information, and carrying out complex responses.

B –Cerebellum: The cerebellum coordinates body movements. Located at the lower back of the brain beneath the occipital lobes, the cerebellum is divided into two lateral (side-by-side) lobes connected by a fingerlike bundle of white fibers called the vermis. The outer layer, or cortex, of the cerebellum consists of fine folds called folia. As in the cerebrum, the outer layer of cortical gray matter surrounds a deeper layer of white matter and nuclei (groups of nerve cells). Three fiber bundles called cerebellar peduncles connect the cerebellum to the three parts of the brain stem—the midbrain, the pons, and the medulla oblongata.

The cerebellum coordinates voluntary movements by fine-tuning commands from the motor cortex in the cerebrum. The cerebellum also maintains posture and balance by controlling muscle tone and sensing the position of the limbs. All motor activity, from hitting a baseball to fingering a violin, depends on the cerebellum.

C -Thalamus and Hypothalamus: The thalamus and the hypothalamus lie underneath the cerebrum and connect it to the brain stem. The thalamus consists of two rounded masses of gray tissue lying within the middle of the brain, between the two cerebral hemispheres. The thalamus is the main relay station for incoming sensory signals to the cerebral cortex and for outgoing motor signals from it. All sensory input to the brain, except that of the sense of smell, connects to individual nuclei of the thalamus.

The hypothalamus lies beneath the thalamus on the midline at the base of the brain. It regulates or is involved directly in the control of many of the body's vital drives and activities, such as eating, drinking, temperature regulation, sleep, emotional behavior, and sexual activity. It also controls the function of internal body organs by means of the autonomic nervous system, interacts closely with the pituitary gland, and helps coordinate activities of the brain stem.

D -Brain Stem: The brain stem is evolutionarily the most primitive part of the brain and is responsible for sustaining the basic functions of life, such as breathing and blood pressure. It includes three main structures lying between and below the two cerebral hemispheres—the midbrain, pons, and medulla oblongata.

D1 –Midbrain: The topmost structure of the brain stem is the midbrain. It contains major relay stations for neurons transmitting signals to the cerebral cortex, as well as many reflex centers—pathways carrying sensory (input) information and motor (output) commands. Relay and reflex centers for visual and auditory (hearing) functions are located in the top portion of the midbrain. A pair of nuclei called the superior colliculus control reflex actions of the eye, such as blinking, opening and closing the pupil, and focusing the lens. A second pair of nuclei, called the inferior colliculus, control auditory reflexes, such as adjusting the ear to the volume of sound. At the bottom of the midbrain are reflex and relay centers relating to pain, temperature, and touch, as well as several regions associated with the control of movement, such as the red nucleus and the substantia nigra.

D2 –Pons: Continuous with and below the midbrain and directly in front of the cerebellum is a prominent bulge in the brain stem called the pons. The pons consists of large bundles of nerve fibers that connect the two halves of the cerebellum and also connect each side of the cerebellum with the opposite-side cerebral hemisphere. The pons serves mainly as a relay station linking the cerebral cortex and the medulla oblongata.

D3 -Medulla Oblongata: The long, stalklike lowermost portion of the brain stem is called the medulla oblongata. At the top, it is continuous with the pons and the midbrain; at the bottom, it makes a gradual transition into the spinal cord at the foramen magnum. Sensory and motor nerve fibers connecting the brain and the rest of the body cross over to the opposite side as they pass through the medulla. Thus, the left half of the brain communicates with the right half of the body, and the right half of the brain with the left half of the body.

D4 -Reticular Formation: Running up the brain stem from the medulla oblongata through the pons and the midbrain is a netlike formation of nuclei known as the reticular formation. The reticular formation controls respiration, cardiovascular function digestion, levels of alertness, and patterns of sleep. It also determines which parts of the constant flow of sensory information into the body are received by the cerebrum.

E -Brain Cells: There are two main types of brain cells: neurons and neuroglia. Neurons are responsible for the transmission and analysis of all electrochemical communication within the brain and other parts of the nervous system. Each neuron is composed of a cell body called a soma, a major fiber called an axon, and a system of branches called dendrites. Axons, also called nerve fibers, convey electrical signals away from the soma and can be up to 1 m (3.3 ft) in length. Most axons are covered with a protective sheath of myelin, a substance made of fats and protein, which insulates the axon. Myelinated axons conduct neuronal signals faster than do unmyelinated axons. Dendrites convey electrical signals toward the soma, are shorter than axons, and are usually multiple and branching.

Neuroglial cells are twice as numerous as neurons and account for half of the brain's weight. Neuroglia (from glia, Greek for "glue") provide structural support to the neurons. Neuroglial cells also form myelin, guide developing neurons, take up chemicals involved in cell-to-cell communication, and contribute to the maintenance of the environment around neurons.

F -Cranial Nerves: Twelve pairs of cranial nerves arise symmetrically from the base of the brain and are numbered, from front to back, in the order in which they arise. They connect mainly with structures of the head and neck, such as the eyes, ears, nose, mouth, tongue, and throat. Some are motor nerves, controlling muscle movement; some are sensory nerves, conveying information from the sense organs; and others contain fibers for both sensory and motor impulses. The first and second pairs of cranial nerves—the olfactory (smell) nerve and the optic (vision) nerve—carry sensory information from the nose and eyes, respectively, to the undersurface of the cerebral hemispheres. The other ten pairs of cranial nerves originate in or end in the brain stem.

HOW THE BRAIN WORKS?

The brain functions by complex neuronal, or nerve cell, circuits (see Neurophysiology). Communication between neurons is both electrical and chemical and always travels from the dendrites of a neuron, through its soma, and out its axon to the dendrites of another neuron. Dendrites of one neuron receive signals from the axons of other neurons through chemicals known as neurotransmitters. The neurotransmitters set off electrical charges in the dendrites, which then carry the signals electrochemically to the soma. The soma integrates the information, which is then transmitted electrochemically down the axon to its tip.

At the tip of the axon, small, bubblelike structures called vesicles release neurotransmitters that carry the signal across the synapse, or gap, between two neurons. There are many types of neurotransmitters, including norepinephrine, dopamine, and serotonin. Neurotransmitters can be excitatory (that is, they excite an electrochemical response in the dendrite receptors) or inhibitory (they block the response of the dendrite receptors).
One neuron may communicate with thousands of other neurons, and many thousands of neurons are involved with even the simplest behavior. It is believed that these connections and their efficiency can be modified, or altered, by experience.

Scientists have used two primary approaches to studying how the brain works. One approach is to study brain function after parts of the brain have been damaged. Functions that disappear or that are no longer normal after injury to specific regions of the brain can often be associated with the damaged areas. The second approach is to study the response of the brain to direct stimulation or to stimulation of various sense organs.

Neurons are grouped by function into collections of cells called nuclei. These nuclei are connected to form sensory, motor, and other systems. Scientists can study the function of somatosensory (pain and touch), motor, olfactory, visual, auditory, language, and other systems by measuring the physiological (physical and chemical) changes that occur in the brain when these senses are activated. For example, electroencephalography (EEG) measures the electrical activity of specific groups of neurons through electrodes attached to the surface of the skull. Electrodes inserted directly into the brain can give readings of individual neurons. Changes in blood flow, glucose (sugar), or oxygen consumption in groups of active cells can also be mapped.

Although the brain appears symmetrical, how it functions is not. Each hemisphere is specialized and dominates the other in certain functions. Research has shown that hemispheric dominance is related to whether a person is predominantly right-handed or left-handed (see Handedness). In most right-handed people, the left hemisphere processes arithmetic, language, and speech. The right hemisphere interprets music, complex imagery, and spatial relationships and recognizes and expresses emotion. In left-handed people, the pattern of brain organization is more variable.

Hemispheric specialization has traditionally been studied in people who have sustained damage to the connections between the two hemispheres, as may occur with stroke, an interruption of blood flow to an area of the brain that causes the death of nerve cells in that area. The division of functions between the two hemispheres has also been studied in people who have had to have the connection between the two hemispheres surgically cut in order to control severe epilepsy, a neurological disease characterized by convulsions and loss of consciousness.

A –Vision: The visual system of humans is one of the most advanced sensory systems in the body (see Vision). More information is conveyed visually than by any other means. In addition to the structures of the eye itself, several cortical regions—collectively called primary visual and visual associative cortex—as well as the midbrain are involved in the visual system. Conscious processing of visual input occurs in the primary visual cortex, but reflexive—that is, immediate and unconscious—responses occur at the superior colliculus in the midbrain. Associative cortical regions—specialized regions that can associate, or integrate, multiple inputs—in the parietal and frontal lobes along with parts of the temporal lobe are also involved in the processing of visual information and the establishment of visual memories.

B –Language: Language involves specialized cortical regions in a complex interaction that allows the brain to comprehend and communicate abstract ideas. The motor cortex initiates impulses that travel through the brain stem to produce audible sounds. Neighboring regions of motor cortex, called the supplemental motor cortex, are involved in sequencing and coordinating sounds. Broca's area of the frontal lobe is responsible for the sequencing of language elements for output. The comprehension of language is dependent upon Wernicke's area of the temporal lobe. Other cortical circuits connect these areas.

C –Memory: Memory is usually considered a diffusely stored associative process—that is, it puts together information from many different sources. Although research has failed to identify specific sites in the brain as locations of individual memories, certain brain areas are critical for memory to function. Immediate recall—the ability to repeat short series of words or numbers immediately after hearing them—is thought to be located in the auditory associative cortex. Short-term memory—the ability to retain a limited amount of information for up to an hour—is located in the deep temporal lobe. Long-term memory probably involves exchanges between the medial temporal lobe, various cortical regions, and the midbrain.

D -The Autonomic Nervous System: The autonomic nervous system regulates the life support systems of the body reflexively—that is, without conscious direction. It automatically controls the muscles of the heart, digestive system, and lungs; certain glands; and homeostasis—that is, the equilibrium of the internal environment of the body (see Physiology). The autonomic nervous system itself is controlled by nerve centers in the spinal cord and brain stem and is fine-tuned by regions higher in the brain, such as the midbrain and cortex. Reactions such as blushing indicate that cognitive, or thinking, centers of the brain are also involved in autonomic responses.

BRAIN DISORDERS:
The brain is guarded by several highly developed protective mechanisms. The bony cranium, the surrounding meninges, and the cerebrospinal fluid all contribute to the mechanical protection of the brain. In addition, a filtration system called the blood-brain barrier protects the brain from exposure to potentially harmful substances carried in the bloodstream.
Brain disorders have a wide range of causes, including head injury, stroke, bacterial diseases, complex chemical imbalances, and changes associated with aging.

A -Head Injury: Head injury can initiate a cascade of damaging events. After a blow to the head, a person may be stunned or may become unconscious for a moment. This injury, called a concussion, usually leaves no permanent damage. If the blow is more severe and hemorrhage (excessive bleeding) and swelling occur, however, severe headache, dizziness, paralysis, a convulsion, or temporary blindness may result, depending on the area of the brain affected. Damage to the cerebrum can also result in profound personality changes. Damage to Broca's area in the frontal lobe causes difficulty in speaking and writing, a problem known as Broca's aphasia. Injury to Wernicke's area in the left temporal lobe results in an inability to comprehend spoken language, called Wernicke's aphasia.

An injury or disturbance to a part of the hypothalamus may cause a variety of different symptoms, such as loss of appetite with an extreme drop in body weight; increase in appetite leading to obesity; extraordinary thirst with excessive urination (diabetes insipidus); failure in body-temperature control, resulting in either low temperature (hypothermia) or high temperature (fever); excessive emotionality; and uncontrolled anger or aggression. If the relationship between the hypothalamus and the pituitary gland is damaged (see Endocrine System), other vital bodily functions may be disturbed, such as sexual function, metabolism, and cardiovascular activity.
Injury to the brain stem is even more serious because it houses the nerve centers that control breathing and heart action. Damage to the medulla oblongata usually results in immediate death.

B –Stroke: A stroke is damage to the brain due to an interruption in blood flow. The interruption may be caused by a blood clot, constriction of a blood vessel, or rupture of a vessel accompanied by bleeding. A pouch like expansion of the wall of a blood vessel, called an aneurysm, may weaken and burst, for example, because of high blood pressure.

Sufficient quantities of glucose and oxygen, transported through the bloodstream, are needed to keep nerve cells alive. When the blood supply to a small part of the brain is interrupted, the cells in that area die and the function of the area is lost. A massive stroke can cause a one-sided paralysis (hemiplegia) and sensory loss on the side of the body opposite the hemisphere damaged by the stroke.

C -Brain Diseases: Epilepsy is a broad term for a variety of brain disorders characterized by seizures, or convulsions. Epilepsy can result from a direct injury to the brain at birth or from a metabolic disturbance in the brain at any time later in life.
Some brain diseases, such as multiple sclerosis and Parkinson disease, are progressive, becoming worse over time. Multiple sclerosis damages the myelin sheath around axons in the brain and spinal cord. As a result, the affected axons cannot transmit nerve impulses properly. Parkinson disease destroys the cells of the substantia nigra in the midbrain, resulting in a deficiency in the neurotransmitter dopamine that affects motor functions.

Cerebral palsy is a broad term for brain damage sustained close to birth that permanently affects motor function. The damage may take place either in the developing fetus, during birth, or just after birth and is the result of the faulty development or breaking down of motor pathways. Cerebral palsy is nonprogressive—

that is, it does not worsen with time.
A bacterial infection in the cerebrum or in the coverings of the brain (see Meningitis), swelling of the brain (see Edema), or an abnormal growth of healthy brain tissue (see Tumor) can all cause an increase in intracranial pressure and result in serious damage to the brain.

Scientists are finding that certain brain chemical imbalances are associated with mental disorders such as schizophrenia and depression. Such findings have changed scientific understanding of mental health and have resulted in new treatments that chemically correct these imbalances.
During childhood development, the brain is particularly susceptible to damage because of the rapid growth and reorganization of nerve connections. Problems that originate in the immature brain can appear as epilepsy or other brain-function problems in adulthood.

Several neurological problems are common in aging. Alzheimer's disease damages many areas of the brain, including the frontal, temporal, and parietal lobes. The brain tissue of people with Alzheimer's disease shows characteristic patterns of damaged neurons, known as plaques and tangles. Alzheimer's disease produces a progressive dementia (see Senile Dementia), characterized by symptoms such as failing attention and memory, loss of mathematical ability, irritability, and poor orientation in space and time.

BRAIN IMAGING

Several commonly used diagnostic methods give images of the brain without invading the skull. Some portray anatomy—that is, the structure of the brain—whereas others measure brain function. Two or more methods may be used to complement each other, together providing a more complete picture than would be possible by one method alone.
Magnetic resonance imaging (MRI), introduced in the early 1980s, beams high-frequency radio waves into the brain in a highly magnetized field that causes the protons that form the nuclei of hydrogen atoms in the brain to reemit the radio waves. The reemitted radio waves are analyzed by computer to create thin cross-sectional images of the brain. MRI provides the most detailed images of the brain and is safer than imaging methods that use X rays. However, MRI is a lengthy process and also cannot be used with people who have pacemakers or metal implants, both of which are adversely affected by the magnetic field.

Computed tomography (CT), also known as CT scans, developed in the early 1970s. This imaging method X-rays the brain from many different angles, feeding the information into a computer that produces a series of cross-sectional images. CT is particularly useful for diagnosing blood clots and brain tumors. It is a much quicker process than magnetic resonance imaging and is therefore advantageous in certain situations—for example, with people who are extremely ill.

Changes in brain function due to brain disorders can be visualized in several ways. Magnetic resonance spectroscopy measures the concentration of specific chemical compounds in the brain that may change during specific behaviors. Functional magnetic resonance imaging (fMRI) maps changes in oxygen concentration that correspond to nerve cell activity.

Positron emission tomography (PET), developed in the mid-1970s, uses computed tomography to visualize radioactive tracers (see Isotopic Tracer), radioactive substances introduced into the brain intravenously or by inhalation. PET can measure such brain functions as cerebral metabolism, blood flow and volume, oxygen use, and the formation of neurotransmitters. Single photon emission computed tomography (SPECT), developed in the 1950s and 1960s, uses radioactive tracers to visualize the circulation and volume of blood in the brain.

Brain-imaging studies have provided new insights into sensory, motor, language, and memory processes, as well as brain disorders such as epilepsy; cerebrovascular disease; Alzheimer's, Parkinson, and Huntington's diseases ; and various mental disorders, such as schizophrenia.

EVOLUTION OF THE BRAIN

In lower vertebrates, such as fish and reptiles, the brain is often tubular and bears a striking resemblance to the early embryonic stages of the brains of more highly evolved animals. In all vertebrates, the brain is divided into three regions: the forebrain (prosencephalon), the midbrain (mesencephalon), and the hindbrain (rhombencephalon). These three regions further subdivide into different structures, systems, nuclei, and layers.

The more highly evolved the animal, the more complex is the brain structure. Human beings have the most complex brains of all animals. Evolutionary forces have also resulted in a progressive increase in the size of the brain. In vertebrates lower than mammals, the brain is small. In meat-eating animals, particularly primates, the brain increases dramatically in size.

The cerebrum and cerebellum of higher mammals are highly convoluted in order to fit the most gray matter surface within the confines of the cranium. Such highly convoluted brains are called gyrencephalic. Many

lower mammals have a smooth, or lissencephalic ("smooth head"), cortical surface.
There is also evidence of evolutionary adaption of the brain. For example, many birds depend on an advanced visual system to identify food at great distances while in flight. Consequently, their optic lobes and cerebellum are well developed, giving them keen sight and outstanding motor coordination in flight. Rodents, on the other hand, as nocturnal animals, do not have a well-developed visual system. Instead, they rely more heavily on other sensory systems, such as a highly developed sense of smell and facial whiskers.

RECENT RESEARCH
Recent research in brain function suggests that there may be sexual differences in both brain anatomy and brain function. One study indicated that men and women may use their brains differently while thinking. Researchers used functional magnetic resonance imaging to observe which parts of the brain were activated as groups of men and women tried to determine whether sets of nonsense words rhymed. Men used only Broca's area in this task, whereas women used Broca's area plus an area on the right side of the brain.

MILKY WAY

Milky Way, the large, disk-shaped aggregation of stars, or galaxy, that includes the Sun and its solar system. In addition to the Sun, the Milky Way contains about 400 billion other stars. There are hundreds of billions of other galaxies in the universe, some of which are much larger and contain many more stars than the Milky Way.

The Milky Way is visible at night, appearing as a faintly luminous band that stretches across the sky. The name Milky Way is derived from Greek mythology, in which the band of light was said to be milk from the breast of the goddess Hera. Its hazy appearance results from the combined light of stars too far away to be distinguished individually by the unaided eye. All of the individual stars that are distinct in the sky lie within the Milky Way Galaxy.

From the middle northern latitudes, the Milky Way is best seen on clear, moonless, summer nights, when it appears as a luminous, irregular band circling the sky from the northeastern to the southeastern horizon. It extends through the constellations Perseus, Cassiopeia, and Cepheus. In the region of the Northern Cross it divides into two streams: the western stream, which is bright as it passes through the Northern Cross, fades near Ophiuchus, or the Serpent Bearer, because of dense dust clouds, and appears again in Scorpio; and the eastern stream, which grows brighter as it passes southward through Scutum and Sagittarius. The brightest part of the Milky Way extends from Scutum to Scorpio, through Sagittarius. The center of the galaxy lies in the direction of Sagittarius and is about 25,000 light-years from the Sun (a light-year is the distance light travels in a year, about 9.46 trillion km or 5.88 trillion mi).

STRUCTURE: Galaxies have three common shapes: elliptical, spiral, and irregular. Elliptical galaxies have an ovoid or globular shape and generally contain older stars. Spiral galaxies are disk-shaped with arms that curve around their edges, making these galaxies look like whirlpools. Spiral galaxies contain both old and young stars as well as numerous clouds of dust and gas from which new stars are born. Irregular galaxies have no regular structure. Astronomers believe that their structures were distorted by collisions with other galaxies.

Astronomers classify the Milky Way as a large spiral or possibly a barred spiral galaxy, with several spiral arms coiling around a central bulge about 10,000 light-years thick. Stars in the central bulge are close together, while those in the arms are farther apart. The arms also contain clouds of interstellar dust and gas. The disk is about 100,000 light-years in diameter and is surrounded by a larger cloud of hydrogen gas. Surrounding this cloud in turn is a spherical halo that contains many separate globular clusters of stars mainly lying above or below the disk. This halo may be more than twice as wide as the disk itself. In addition, studies of galactic movements suggest that the Milky Way system contains far more matter than is accounted for by the visible disk and attendant clusters—up to 2,000 billion times more mass than the Sun contains. Astronomers have therefore speculated that the known Milky Way system is in turn surrounded by a much larger ring or halo of undetected matter known as dark matter.

TYPES OF STARS:
The Milky Way contains both the so-called type I stars, brilliant, blue stars; and type II stars, giant red stars. Blue stars tend to be younger because they burn furiously and use up all of their fuel within a few tens of millions of years. Red stars are usually older, and use their fuel at a slower rate that they can sustain for tens of billions of years. The central Milky Way and the halo are largely composed of the type II population. Most of this region is obscured behind dust clouds, which prevent visual observation.
Astronomers have been able to detect light from this

region at other wavelengths in the electromagnetic spectrum, however, using radio and infrared telescopes and satellites that detect X rays (see Radio Astronomy; Infrared Astronomy; X-Ray Astronomy). Such studies indicate compact objects near the galactic center, probably a massive black hole. A black hole is an object so dense that nothing, not even light, can escape its intense gravity. The center of the galaxy is home to clouds of antimatter particles, which reveal themselves by emitting gamma rays when they meet particles of matter and annihilate. Astronomers believe the antimatter particles provide more evidence for a massive black hole at the Milky Way's center.

Observations of stars racing around the center also suggest the presence of a black hole. The stars orbit at speeds up to 1.8 million km/h (1.1 million mph)—17 times the speed at which Earth circles the Sun—even though they are hundreds of times farther from the center than Earth is from the Sun. The greater an object's mass, the faster an object orbiting it at a given distance will move. Whatever lies at the center of the galaxy must have a tremendous amount of mass packed into a relatively small area in order to cause these stars to orbit so quickly at such a distance. The most likely candidate is a black hole.

Surrounding the central region is a fairly flat disk comprising stars of both type II and type I; the brightest members of the latter category are luminous, blue supergiants. Imbedded in the disk, and emerging from opposite sides of the central region, are the spiral arms, which contain a majority of the type I population together with much interstellar dust and gas. One arm passes in the vicinity of the Sun and includes the great nebula in Orion. See Nebula.

ROTATION: The Milky Way rotates around an axis joining the galactic poles. Viewed from the north galactic pole, the rotation of the Milky Way is clockwise, and the spiral arms trail in the same direction. The period of rotation decreases with the distance from the center of the galactic system. In the neighborhood of the solar system the period of rotation is more than 200 million years. The speed of the solar system due to the galactic rotation is about 220 km/sec (about 140 mi/sec).

WEATHER

Weather, state of the atmosphere at a particular time and place. The elements of weather include temperature, humidity, cloudiness, precipitation, wind, and pressure. These elements are organized into various weather systems, such as monsoons, areas of high and low pressure, thunderstorms, and tornadoes. All weather systems have well-defined cycles and structural features and are governed by the laws of heat and motion. These conditions are studied in meteorology, the science of weather and weather forecasting. Weather differs from climate, which is the weather that a particular region experiences over a long period of time. Climate includes the averages and variations of all weather elements.

TEMPERATURE: Temperature is a measure of the degree of hotness of the air. Three different scales are used for measuring temperature. Scientists use the Kelvin, or absolute, scale and the Celsius, or centigrade, scale. Most nations use the Celsius scale, although the United States continues to use the Fahrenheit scale.

Temperature on earth averages 15° C (59° F) at sea level but varies according to latitude, elevation, season, and time of day, ranging from a record high of 58° C (140° F) to a record low of -88° C (-130° F). Temperature is generally highest in the Tropics and lowest near the poles. Each day it is usually warmest during midafternoon and coldest around dawn.

Seasonal variations of temperature are generally more pronounced at higher latitudes. Along the equator, all months are equally warm, but away from the equator, it is generally warmest about a month after the summer solstice (around June 21 in the northern hemisphere and around December 21 in the southern hemisphere) and coldest about a month after the winter solstice (around December 21 in the northern hemisphere and around June 21 in the southern hemisphere). Temperature can change abruptly when fronts (boundaries between two air masses with different temperatures or densities) or thunderstorms pass overhead.

Temperature decreases with increasing elevation at an average rate of about 6.5° C per km (about 19° F per mi). As a result, temperatures in the mountains are generally much lower than at sea level. Temperature continues to decrease throughout the atmosphere's lowest layer, the troposphere, where almost all weather occurs. The troposphere extends to a height of 16 km (10 mi) above sea level over the equator and about 8 km (about 5 mi) above sea level over the poles. Above the troposphere is the stratosphere, where temperature levels off and then begins to increase with height. Almost no weather occurs in the stratosphere.

HUMIDITY: Humidity is a measure of the amount of water vapor in the air. The air's capacity to hold vapor is limited but increases dramatically as the air warms, roughly doubling for each temperature increase of 10° C (18° F). There are several different measures of humidity. The specific humidity is the fraction of the mass of air that consists of water vapor, usually given as parts per thousand. Even the warmest, most humid air seldom has a specific humidity greater than 20 parts per thousand. The most common measure of humidity is the relative humidity, or the amount of vapor in the air divided by the air's vapor-holding capacity at that temperature. If the amount of water vapor in the air remains the same, the relative humidity decreases as the air is heated and increases as the air is cooled. As a result, relative humidity is usually highest around dawn, when the temperature is lowest, and lowest in mid afternoon, when the temperature is highest.

CLOUDINESS: Most clouds and almost all precipitation are produced by the cooling of air as it rises. When air temperature is reduced, excess water vapor in the air condenses into liquid droplets or ice crystals to form clouds or fog. A cloud can take any of several different forms—including cumulus, cirrus, and stratus—reflecting the pattern of air motions that formed it. Fluffy cumulus clouds form from rising masses of air, called thermals. A cumulus cloud often has a flat base, corresponding to the level at which the water vapor first condenses. If a cumulus cloud grows large, it transforms into a cumulonimbus cloud or a thunderstorm. Fibrous cirrus clouds consist of trails of falling ice crystals twisted by the winds. Cirrus clouds usually form high in the troposphere, and their crystals almost never reach the ground. Stratus clouds form when an entire layer of air cools or ascends obliquely. A stratus cloud often extends for hundreds of miles.

Fog is a cloud that touches the ground. In dense fogs, the visibility may drop below 50 m (55 yd). Fog occurs most frequently when the earth's surface is much colder than the air directly above it, such as around dawn and over cold ocean currents. Fog is thickened and acidified when the air is filled with sulfur-laden soot particles produced by the burning of coal. Dense acid fogs that killed thousands of people in London up to 1956 led to legislation that prohibited coal burning in cities.

Optical phenomena, such as rainbows and halos, occur when light shines through cloud particles. Rainbows are seen when sunlight from behind the observer strikes the raindrops falling from cumulonimbus clouds. The raindrops act as tiny prisms, bending and reflecting the different colors of light back to the observer's eye at different angles and creating bands of color. Halos are seen when sunlight or moonlight in front of the observer strikes ice crystals and then passes through high, thin cirrostratus clouds.

PRECIPITATION: Precipitation is produced when the droplets and crystals in clouds grow large enough to fall to the ground. Clouds do not usually produce precipitation until they are more than 1 km (0.6 mi) thick. Precipitation takes a variety of forms, including rain, drizzle, freezing rain, snow, hail, and ice pellets, or sleet. Raindrops have diameters larger than 0.5 mm (0.02 in), whereas drizzle drops are smaller. Few raindrops are larger than about 6 mm (about 0.2 in), because such large drops are unstable and break up easily. Ice pellets are raindrops that have frozen in midair. Freezing rain is rain that freezes on contact with any surface. It often produces a layer of ice that can be very slippery.

Snowflakes are either single ice crystals or clusters of ice crystals. Large snowflakes generally form when the temperature is near 0° C (32° F), because at this temperature the flakes are partly melted and stick together when they collide. Hailstones are balls of ice about 6 to 150 mm (about 0.2 to 6 in) in diameter. They consist of clusters of raindrops that have collided and frozen together. Large hailstones only occur in violent thunderstorms, in which strong updrafts keep the hailstones suspended in the atmosphere long enough to grow large. Precipitation amounts are usually given in terms of depth. A well-developed winter storm can produce 10 to 30 mm (0.4 to 1.2 in) of rain over a large area in 12 to 24 hours. An intense thunderstorm may produce more than 20 mm (0.8 in) of rain in 10 minutes and cause flash floods (floods in which the water rises suddenly). Hurricanes sometimes produce over 250 mm (10 in) of rain and lead to extensive flooding.

Snow depths are usually much greater than rain depths because of snow's low density. During intense winter storms, more than 250 mm (10 in) of snow may fall in 24 hours, and the snow can be much deeper in places where the wind piles it up in drifts.

Extraordinarily deep snows sometimes accumulate on the upwind side of mountain slopes during severe winter storms or on the downwind shores of large lakes during outbreaks of polar air.

WIND: Wind is the horizontal movement of air. It is named for the direction from which it comes—for example, a north wind comes from the north. In most places near the ground, the wind speed averages from 8 to 24 km/h (from 5 to 15 mph), but it can be much higher during intense storms. Wind speeds in hurricanes and typhoons exceed 120 km/h (75 mph) near the storm's center and may approach 320 km/h

(200 mph). The highest wind speeds at the surface of the earth—as high as 480 km/h (300 mph)—occur in tornadoes. Except for these storms, wind speed usually increases with height to the top of the troposphere.

PRESSURE: Pressure plays a vital role in all weather systems. Pressure is the force of the air on a given surface divided by the area of that surface. In most weather systems the air pressure is equal to the weight of the air column divided by the area of the column. Pressure decreases rapidly with height, halving about every 5.5 km (3.4 mi).

Sea-level pressure varies by only a few percent. Large regions in the atmosphere that have higher pressure than the surroundings are called high-pressure areas. Regions with lower pressure than the surroundings are called low-pressure areas. Most storms occur in low-pressure areas. Rapidly falling pressure usually means a storm is approaching, whereas rapidly rising pressure usually indicates that skies will clear.

SCALES OF WEATHER: Weather systems occur on a wide range of scales. Monsoons occur on a global scale and are among the largest weather systems, extending for thousands of miles. Thunderstorms are much smaller, typically 10 to 20 km (6 to 12 mi) across. Tornadoes, which extend from the bases of thunderstorms, range from less than 50 m (55 yd) across to as much as 2 km (1.2 mi) across.
The vertical scale of weather systems is much more limited. Because pressure decreases so rapidly with height and because temperature stops decreasing in the stratosphere, weather systems are confined to the troposphere. Only the tallest thunderstorms reach the stratosphere, which is otherwise almost always clear.

CAUSES OF WEATHER: All weather is due to heating from the sun. The sun emits energy at an almost constant rate, but a region receives more heat when the sun is higher in the sky and when there are more hours of sunlight in a day. The high sun of the Tropics makes this area much warmer than the poles, and in summer the high sun and long days make the region much warmer than in winter. In the northern hemisphere, the sun climbs high in the sky and the days are long in summer, around July, when the northern end of the earth's axis is tilted toward the sun. At the same time, it is winter in the southern hemisphere. The southern end of the earth's axis is tilted away from the sun, so the sun is low in the sky and the days are short.

The temperature differences produced by inequalities in heating cause differences in air density and pressure that propel the winds. Vertical air motions are propelled by buoyancy: A region of air that is warmer and less dense than the surroundings is buoyant and rises. Air is also forced from regions of higher pressure to regions of lower pressure. Once the air begins moving, it is deflected by the Coriolis force, which results from the earth's rotation. The Coriolis force deflects the wind and all moving objects toward their right in the northern hemisphere and toward their left in the southern hemisphere. It is so gentle that it has little effect on small-scale winds that last less than a few hours, but it has a profound effect on winds that blow for many hours and move over large distances.

WEATHER SYSTEMS: In both hemispheres, the speed of the west wind increases with height up to the top of the troposphere. The core of most rapid winds at the top of the troposphere forms a wavy river of air called the jet stream. Near the ground, where the winds are slowed by friction, the air blows at an acute angle toward areas of low pressure, forming great gyres called cyclones and anticyclones. In the northern hemisphere, the Coriolis force causes air in low-pressure areas to spiral counterclockwise and inward, forming a cyclone, whereas air in high-pressure areas spirals clockwise and outward, forming an anticyclone. In the southern hemisphere, cyclones turn clockwise and anticyclones, counterclockwise.

The air spreading from anticyclones is replaced by sinking air from above. As a result, skies in anticyclones are often fair, and large regions of air called air masses form; these have reasonably uniform temperature and humidity. In cyclones, on the other hand, as air converges to the center, it rises to form extensive clouds and precipitation.

During summer and fall, tropical cyclones, called hurricanes or typhoons, form over warm waters of the oceans in bands parallel to the equator, between about latitude 5° and latitude 30° north and south. Wind speed in hurricanes increases as the air spirals inward. The air either rises in a series of rain bands before reaching the center or proceeds inward and then turns sharply upward in a doughnut-shaped region called the eye wall, where the most intense winds and rain occur. The eye wall surrounds the core, or eye, of the hurricane, which is marked by partly clear skies and gentle winds.

In the middle and high latitudes, polar and tropical air masses are brought together in low-pressure areas called extratropical cyclones, forming narrow zones of sharply changing temperature called fronts. Intense extratropical cyclones can produce blizzard conditions in their northern reaches while at the same time producing warm weather with possible severe thunderstorms and tornadoes in their southern reaches.

Thunderstorms are small, intense convective storms that are produced by buoyant, rapidly rising air. As thunderstorms mature, strong downdrafts of rain- or hail-filled cool air plunge toward the ground, bringing intense showers. However, because thunderstorms are only about 16 km (about 10 mi) wide, they pass over quickly, usually lasting less than an hour. Severe thunderstorms sometimes produce large hail. They may also rotate slowly and spout rapidly rotating tornadoes from their bases.

Most convective weather systems are gentler than thunderstorms. Often, organized circulation cells develop, in which cooler and denser air from the surroundings sinks and blows along the ground to replace the rising heated air. Circulation cells occur on many different scales. On a local scale, along the seashore during sunny spring and summer days, air over the land grows hot while air over the sea remains cool. As the heated air rises, the cooler and denser air from the sea rushes in. This movement of air is popularly called a sea breeze. At night, when the air over the land grows cooler than the air over the sea, the wind reverses and is known as a land breeze.

On a global scale, hot, humid air near the equator rises and is replaced by denser air that sinks in the subtropics and blows back to the equator along the ground. The winds that blow toward the equator are called the trade winds. The trade winds are among the most steady, reliable winds on the earth. They approach the equator obliquely from the northeast and southeast because of the Coriolis force.

The tropical circulation cell is called the Hadley cell. It shifts north and south with the seasons and causes tropical monsoons in India. For example, around July the warm, rising air of the Hadley cell is located over India, and humid winds blow in from the Indian Ocean. Around January the cooler, sinking air of the Hadley cell is located over India, and the winds blow in the opposite direction.

A variable circulation cell called the Walker Circulation exists over the tropical Pacific Ocean. Normally, air rises over the warm waters of the western Pacific Ocean over the Malay Archipelago and sinks over the cold waters in the eastern Pacific Ocean off the coast of Ecuador and Peru. Most years around late December this circulation weakens, and the cold waters off the coast of South America warm up slightly. Because it occurs around Christmas, the phenomenon is called El Niño (The Child). Once every two to five years, the waters of the eastern Pacific Ocean warm profoundly. The Walker Circulation then weakens drastically or even reverses, so that air rises and brings torrential rains to normally dry sections of Ecuador and Peru and hurricanes to Tahiti. On the other side of the Pacific Ocean, air sinks and brings drought to Australia. El Niño can now be predicted with reasonable accuracy several months in advance.

WEATHER FORECASTING: Since the early 20th century, great strides have been made in weather prediction, largely as a result of computer development but also because of instrumentation such as satellites and radar. Weather data from around the world are collected by the World Meteorological Organization, the National Weather Service, and other agencies and entered into computer models that apply the laws of motion and of the conservation of energy and mass to produce forecasts. In some cases, these forecasts have provided warning of major storms as much as a week in advance. However, because the behavior of weather systems is chaotic, it is impossible to forecast the details of weather more than about two weeks in advance.

Intense small-scale storms, such as thunderstorms and tornadoes, are much more difficult to forecast than are larger weather systems. In areas in which thunderstorms are common, general forecasts can be made several days in advance, but the exact time and location of the storms, as well as of flash floods and tornadoes, can only be forecast about an hour in advance.

WEATHER MODIFICATION: Human beings can change weather and climate. Water-droplet clouds with tops colder than about -5° C (about 23° F) can be made to produce rain by seeding them with substances such as silver iodide. Cloud seeding causes ice crystals to form and grow large enough to fall out of a cloud. However, although cloud seeding has been proven effective in individual clouds, its effect over large areas is still unproven.

Weather near the ground is routinely modified for agricultural purposes. For example, soil is darkened to raise its temperature, and fans are turned on during clear, cold nights to stir warmer air down to the ground and help prevent frost damage.

Human activities have also produced inadvertent effects on weather and climate. Adding gases such as carbon dioxide and methane to the atmosphere has increased the greenhouse effect and contributed to global warming by raising the mean temperature of the earth by about 0.5° C (about 0.9° F) since the beginning of the 20th century. More recently, chlorofluorocarbons (CFCs), which are used as refrigerants and in aerosol propellants, have been released into the atmosphere, reducing the amount of ozone worldwide and causing a thinning of the ozone layer over Antarctica each spring (around October). The potential consequences of these changes are vast. Global warming may cause sea level to rise, and the incidence of skin cancer may increase as a result of the reduction of ozone. In an effort to prevent such consequences, production of CFCs has been curtailed and many measures have been suggested to control emission of greenhouse gases, including the development of more efficient engines and the use of alternative energy sources such as solar energy and wind energy.

INFORMATION TECHNOLOGY: COMPUTER

Hardware & Software Fundamentals; Application and business Software, Social Media Websites. Information Systems

1) **Application Software**
- An application is a program, or group of programs, that is designed for the end user.
- Application software (an application) is a set of computer programs designed to permit the user to perform a group of coordinated functions, tasks, or activities.
- Application software cannot run on itself but is dependent on system software to execute.
- Application software can be divided into two general classes: systems software and applications software.
- Applications software (also called end-user programs) includes such things as database programs, word processors, Web browsers and spreadsheets.
- Applications may be bundled with the computer and its system software or published separately, and may be coded as e.g. proprietary, open-source or university projects

2) **Business Software**

a. Business software or business application is any software or set of computer programs that are used by business users to perform various business functions.

b. These business applications are used to increase productivity, to measure productivity and to perform business functions accurately.

c. Business software is likely to be developed specifically for a business and therefore is not easily transferable to a different commercial enterprise, unless its nature and operation is identical.

d. Types of business tools
   i. Enterprise application Software
   ii. Resource Management
   iii. Digital Dashboards
   iv. Reporting software

e. Business applications are built based on the requirements from the business users.

f. The term covers a large variation of users within the business environment,
   - The small business market: home accounting software, and office suites such as OpenOffice.org or Microsoft Office.
   - The medium size (SME): accounting, groupware, customer relationship management, human resource management systems, outsourcing relationship management etc
   - Enterprise level: enterprise resource planning, enterprise content management (ECM), business process management (BPM) and product lifecycle management.

g. Technologies that previously only existed in peer-to-peer software applications, like Kazaa and Napster, are starting to feature within business applications.

3) **Social Media Websites**

a. forms of electronic communication (as Web sites for social networking and microblogging) through which users create online communities to share information, ideas, personal messages, and other content (as videos)

b. with social networking, we have even more access to news and opinions than ever before.

c. It's now entirely common to hear someone ask you to share something on Facebook or to receive breaking news via Twitter on your phone.

d. The best social media sites we found are Facebook, Twitter and Google+ because each is unique and does what it does better than any other site.

e. What to look for in social Networking: Networking Features, Profiles, Search, Security

f. Social Media Sites
- Twitter: enable people to post their thoughts instantly, best way to get a quick fix of celebrity gossip, friend updates and important news stories. created in 2006
- LinkedIn: benefiting you with career connections and giving you a strong online reputation. site launched in 2003
- Google plus: launched in mid 2011, a total communication social network, site focuses on is creating circles to distinguish connections. The four

standard circles are friends, family, acquaintances and those you're following.

- Facebook: started in Feb 2006

4) **Information Systems**

a. An information system is any organized system for the collection, organization, storage and communication of information.

b. Such a system may be as simple as a 3x5 card catalog system on a desk, a Rolodex, a desktop calendar

c. Or, it may be as complicated as a multi-node computer database system used to manage vast quantities of related information.

d. A computer Information System (IS) is a system composed of people and computers that processes or interprets information.

e. The term is also sometimes used in more restricted senses to refer to only the software used to run a computerized database or to refer to only a computer system.

f. Information systems is an academic study of systems with a specific reference to information and the complementary networks of hardware and software that people and organizations use to collect, filter, process, create and also distribute data.

g. The six components that must come together in order to produce an information system are:

- **Hardware:** machinery, computer (CPU), and all of its support equipments.
- **Software:** The term software refers to computer programs and the manuals (if any) that support them. Computer programs are machine-readable instructions that direct the circuitry within the hardware parts of the system to function in ways that produce useful information from data. Programs are generally stored on some input / output medium, often a disk or tape.
- **Data:** Data are facts that are used by programs to produce useful information. Like programs, data are generally stored in machine-readable form on disk or tape until the computer needs them.
- **Procedures:** Procedures are the policies that govern the operation of a computer system. "Procedures are to people what software is to hardware" is a common analogy that is used to illustrate the role of procedures in a system.
- **People:** Every system needs people if it is to be useful. This includes "not only the users, but those who operate and service the computers, those who maintain the data, and those who support the network of computers."
- **Feedback:** it is another component of the IS, that defines that an IS may be provided with a feedback (Although this component isn't necessary to function).

h. Types of Information Systems

- data warehouses
- enterprise resource planning
- enterprise systems
- expert systems
- search engines
- geographic information system
- global information system
- office automation

DETAILED NOTES

Machine capable of executing instructions to perform operations on data. The distinguishing feature of a computer is its ability to store its own instructions. This ability makes it possible for a computer to perform many operations without the need for a person to enter new instructions each time. Modern computers are made of high-speed electronic components that enable the computer to perform thousands of operations each second.
Generations of computers are characterized by their technology. First-generation digital computers, developed mostly in the U.S. after World War II, used vacuum tubes and was enormous. The second generation, introduced c. 1960, used transistors and were the first successful commercial computers. Third-generation computers (late 1960s and 1970s) were characterized by miniaturization of components and use of integrated circuits. The microprocessor chip, introduced in 1974, defines fourth-generation computers.

Microprocessor: A microprocessor is a computer processor on a microchip. It's sometimes called a logic chip. It is the "engine" that goes into motion when you turn your computer on. A microprocessor is designed to perform arithmetic and logic operations that make use of small number-holding areas called registers. Typical microprocessor operations include adding, subtracting, comparing two numbers, and fetching numbers from one area to another. These operations are the result of a set of instructions that are part of the microprocessor design. When the computer is turned on, the microprocessor is designed to get the first instruction from the basic input/output system (BIOS) that comes with the computer as part of its memory.

After that, either the BIOS, or the operating system that BIOS loads into computer memory, or an application program is "driving" the microprocessor, giving it instructions to perform.

Digital Computers: A digital computer is designed to process data in numerical form. Its circuits perform directly the mathematical operations of addition, subtraction, multiplication, and division. The numbers operated on by a digital computer are expressed in the binary system; binary digits, or bits, are 0 and 1, so that 0, 1, 10, 11, 100, 101, etc., correspond to 0, 1, 2, 3, 4, 5, etc. Binary digits are easily expressed in the computer circuitry by the presence (1) or absence (0) of a current or voltage. A series of eight consecutive bits is called a "byte"; the eight-bit byte permits 256 different "on-off" combinations. Each byte can thus represent one of up to 256 alphanumeric characters, and such an arrangement is called a "single-byte character set" (SBCS); the de facto standard for this representation is the extended ASCII character set. Some languages, such as Japanese, Chinese, and Korean, require more than 256 unique symbols. The use of two bytes, or 16 bits, for each symbol, however, permits the representation of up to 65,536 characters or ideographs. Such an arrangement is called a "double-byte character set" (DBCS); Unicode is the international standard for such a character set. One or more bytes, depending on the computer's architecture, is sometimes called a digital word; it may specify not only the magnitude of the number in question, but also its sign (positive or negative), and may also contain redundant bits that allow automatic detection, and in some cases correction, of certain errors. A digital computer can store the results of its calculations for later use, can compare results with other data, and on the basis of such comparisons can change the series of operations it performs. Digital computers are used for reservations systems, scientific investigation, data-processing and word-processing applications, desktop publishing, electronic games, and many other purposes.

Analog Computers: Computer in which continuously variable physical quantities, such as electrical potential, fluid pressure, or mechanical motion, are used to represent (analogously) the quantities in the problem to be solved. The analog system is set up according to initial conditions and then allowed to change freely. Answers to the problem are obtained by measuring the variables in the analog model. Analog computers are especially well suited to simulating dynamic systems; such simulations may be conducted in real time or at greatly accelerated rates, allowing experimentation by performing many runs with different variables. They have been widely used in simulating the operation of aircraft, nuclear power plants, and industrial chemical processes.

Minicomputers: A minicomputer, a term no longer much used, is a computer of a size intermediate between a microcomputer and a mainframe. Typically, minicomputers have been stand-alone computers (computer systems with attached terminals and other devices) sold to small and mid-size businesses for general business applications and to large enterprises for department-level operations. In general, a minicomputer is a multiprocessing system capable of supporting from 4 to about 200 users simultaneously.

Microcomputers: A digital computer whose central processing unit consists of a microprocessor, a single semiconductor integrated circuit chip. Once less powerful than larger computers, microcomputers are now as powerful as the minicomputers and super minicomputers of just several years ago. This is due in part to the growing processing power of each successive generation of microprocessor, plus the addition of mainframe computer features to the chip, such as floating-point mathematics, computation hardware, memory management, and multiprocessing support.

Microcomputers are the driving technology behind the growth of personal computers and workstations. The capabilities of today's microprocessors in combination with reduced power consumption have created a new category of microcomputers: hand-held devices. Some of these devices are actually general-purpose microcomputers: They have a liquid-crystal-display (LCD) screen and use an operating system that runs several general-purpose applications. Many others serve a fixed purpose, such as telephones that provide a display for receiving text-based pager messages and automobile navigation systems that use satellite-positioning signals to plot the vehicle's position.

Mainframe: A mainframe (also known as "big iron") is a high-performance computer used for large-scale computing purposes that require greater availability and security than a smaller-scale machine can offer. Historically, mainframes have been associated with centralized rather than distributed computing, although that distinction is blurring as smaller computers become more powerful and mainframes become more multi-purpose.

A mainframe may support 100-500 users at one time. Typically, mainframes have a word length of 64 bits and are significantly faster and have greater capacity than the minicomputer and the microcomputer.

Supercomputers: Supercomputer is a computer that performs at or near the currently highest operational rate for computers. A supercomputer is typically used for scientific and engineering applications that must handle very large databases or do a great amount of computation (or both). At any given time, there are usually a few well-publicized supercomputers that operate at the very latest and always incredible speeds. The term is also sometimes applied to far slower (but still impressively fast) computers. Most supercomputers are really multiple computers that perform parallel processing. In general, there are two parallel processing approaches: symmetric multiprocessing (SMP) and massively parallel processing (MPP).

Hardware: Mechanical and electronic parts that constitute a computer system, as distinguished from the computer programs (Software) that drive the system. The main hardware elements are the Central Processing Unit, Disk or magnetic tape data storage devices, Cathode-Ray Tube display terminals, keyboards, and Printers. In operation, a computer is both hardware and software. One is useless without the other. The hardware design specifies the commands it can follow, and the software instructions tell it what to do.

Software: A set of instructions that cause a computer to perform one or more tasks. The set of instructions is often called a program or, if the set is particularly large and complex, a system. Computers cannot do any useful work without instructions from software; thus a combination of software and hardware (the computer) is necessary to do any computerized work. A program must tell the computer each of a set of minuscule tasks to perform, in a framework of logic, such that the computer knows exactly what to do and when to do it.

Input Devices: An input device is a hardware mechanism that transforms information in the external world for consumption by a computer. Often, input devices are under direct control by a human user, who uses them to communicate commands or other information to be processed by the computer, which may then transmit feedback to the user through an output device. Input and output devices together make up the hardware interface between a computer and the user or external world. Typical examples of input devices include keyboards and mice. However, there are others which provide many more degrees of freedom. In general, any sensor which monitors, scans for and accepts information from the external world can be considered an input device, whether or not the information is under the direct control of a user.

Keyboard: In computing, a keyboard is a peripheral partially modeled after the typewriter keyboard. Keyboards are designed to input text and characters, as well as to operate a computer. Physically, keyboards are an arrangement of rectangular buttons, or "keys". Keyboards typically have characters engraved or printed on the keys; in most cases, each press of a key corresponds to a single written symbol. However, to produce some symbols requires pressing and holding several keys simultaneously or in sequence; other keys do not produce any symbol, but instead affect the operation of the computer or the keyboard itself. Roughly 50% of all keyboard keys produce letters, numbers or signs (characters). Other keys can produce actions when pressed, and other actions are available by the simultaneous pressing of more than one action key.

Mouse: A device that controls the movement of the cursor or pointer on a display screen. A mouse is a small object you can roll along a hard, flat surface. Its name is derived from its shape, which looks a bit like a mouse, its connecting wire that one can imagine to be the mouse's tail, and the fact that one must make it scurry along a surface. As you move the mouse, the pointer on the display screen moves in the same direction. Mice contain at least one button and sometimes as many as three, which have different functions depending on what program is running.

Output Devices: Any machine capable of representing information from a computer. This includes display screens, printers, plotters, and synthesizers.

Display Screen: The monitor displays the video and graphics information generated by the computer through the video card. Monitors are very similar to televisions but display information at a much higher quality. The Monitor is also known as monitor. The term monitor, however, usually refers to the entire box, whereas display screen can mean just the screen.

Printer: A printer outputs data that is seen on the computer screen. Most printers are used through a parallel port, but some newer ones use USB connections. USB is somewhat faster, but there's not much of a difference for printers. Networked computers usually print to a printer through the network card. The most crucial printer measurement is its dots per inch rating. Although this can be misleading, a higher number is generally better. Printers are best chosen by actually seeing the quality of the printer output.

Scanner: A scanner is a piece of hardware used to scan a document, i.e., create a digital copy. Although flatbed scanners are the most common type and operate much like a photocopy machine, there are many types of scanners, including some that never touch the document itself. Scanners use a variety of connection formats including Parallel Port, USB, and SCSI. USB is simple, SCSI is fast, and Parallel Port is extremely slow.

CPU (Central Processing Unit): This is the pretty much the brain of computer. It processes everything from basic instructions to complex functions. Any time something needs to be computed, it gets sent to the CPU.

Generally, the CPU is a single microchip, but that doesn't necessarily have to be the case. In the consumer desktop and laptop market, the CPU market is dominated by Intel, AMD, and IBM. These manufacturers supply the computer makers such as Dell, HP, and Apple.

Due to its importance to every computing task, the speed of the CPU, usually measured in gigahertz (GHz) is the number that most vendors use in their marketing campaigns. In the past, the larger the number, the faster the computer could be expected to be. However, in recent years, the speed of the CPU has had less impact as other components of a computer take on more and more of the workload. Also, differences in technology mean that a slower chip that performs more calculations per cycle can actually be faster than a higher rate chip doing fewer calculations per cycle.

Bit: A binary digit. The term was first used in 1946 by John Tukey, a leading statistician and adviser to five presidents. In the computer, electronics, and communications fields, "bit" is generally understood as a shortened form of "binary digit." In a numerical binary system, a bit is either a 0 or 1. Bits are generally used to indicate situations that can take one of two values or one of two states, for example, on and off, true or false, or yes or no. If, by convention, 1 represents a particular state, then 0 represents the other state. For example, if 1 stands for "yes," then 0 stands for "no." A bit is abbreviated with a small "b".

Byte: The common unit of computer storage from desktop computer to mainframe. The term byte was coined by Dr. Werner Buchholz in July 1956, during the early design phase for the IBM Stretch computer. It is made up of eight binary digits (bits). A ninth bit may be used in the memory circuits as a parity bit for error checking. The term was originally coined to mean the smallest addressable group of bits in a computer, which has not always been eight. A byte is abbreviated with a "B".

RAM: RAM stands for Random Access Memory. Computer main memory in which specific contents can be accessed (read or written) directly by the CPU in a very short time regardless of the sequence (and hence location) in which they were recorded. Two types of memory are possible with random-access circuits, static RAM (SRAM) and dynamic RAM (DRAM). A single memory chip is made up of several million memory cells. In a SRAM chip, each memory cell stores a binary digit (1 or 0) for as long as power is supplied. In a DRAM chip, the charge on individual memory cells must be refreshed periodically in order to retain data. Because it has fewer components, DRAM requires less chip area than SRAM; hence a DRAM chip can hold more memory, though its access time is slower. The size of the RAM (measured by kilobytes) is an important indicator of the capacity of the computer.

ROM: ROM stands for Read Only Memory. A memory chip that permanently stores instructions and data. Also known as "mask ROM," its content is created in the last masking stage of the chip manufacturing process, and it cannot be changed. Once data has been written onto a ROM chip, it cannot be removed and can only be read.

Unlike main memory (RAM), ROM retains its contents even when the computer is turned off. ROM is referred to as being nonvolatile, whereas RAM is volatile.

Computer Networking: A computer network is an interconnected group of computers. Networks may be classified by the network layer at which they operate according to basic reference models considered as standards in the industry, such as the four-layer Internet Protocol Suite model. While the seven-layer Open Systems Interconnection (OSI) reference model is better known in academia, the majority of networks use the Internet Protocol Suite (IP).

Computer networks may be classified according to the scale.

Personal Area Network (PAN): A personal area network (PAN) is the interconnection of information technology devices within the range of an individual person, typically within a range of 10 meters. For example, a person traveling with a laptop, a personal digital assistant (PDA), and a portable printer could interconnect them without having to plug anything in, using some form of wireless technology. Typically, this kind of personal area network could also be interconnected without wires to the Internet or other networks.

Local Area Network (LAN): Communications network connecting computers by wire, cable, or fiber optics link. Usually serves parts of an organization located close to one another, generally in the same building or within 2 miles of one another. Allows users to share software, hardware and data. The first LAN put into service occurred in 1964 at the Livermore Laboratory to support atomic weapons research. LANs spread to the public sector in the late 1970s and were used to create high-speed links between several large central computers at one site.
Initially, LANs were limited to a range of 185 meters or 600 feet and could not include more than 30 computers. Today, a LAN could connect a max of 1024 computers at a max distance of 900 meters or 2700 feet.

Campus Area Network (CAN): A campus area network (CAN) is a computer network interconnecting a few local area networks (LANs) within a university campus or corporate campus. Campus area network may link a variety of campus buildings including departments, the university library and student halls of residence. A campus area network is larger than a local area network but smaller than a metropolitan area network (MAN) or wide area network (WAN). CAN can also stand for corporate area network.

Metropolitan area network (MAN): A metropolitan area network (MAN) is a network that interconnects users with computer resources in a geographic area or region larger than that covered by even a large local area network (LAN) but smaller than the area covered by a wide area network (WAN). The term is applied to the interconnection of networks in a city into a single larger network (which may then also offer efficient connection to a wide area network). It is also used to mean the interconnection of several local area networks by bridging them with backbone lines. The latter usage is also sometimes referred to as a campus network.
MAN networks use a different standard for communications; 802.6 as assigned by the Institute of Electrical and Electronics Engineers (IEEE), which uses a different bus technology to transmit and receive data than most larger or smaller networks. This allows MAN networks to operate more efficiently than they might if they were simply LAN networks linked together.

Wide Area Network (WAN): The wide area network, often referred to as a WAN, is a communications network that makes use of existing technology to connect local computer networks into a larger working network that may cover both national and international locations. This is in contrast to both the local area network and the metropolitan area network, which provides communication within a restricted geographic area. The largest WAN in existence is the Internet.

Arithmetic Logic Unit (ALU): In computing, an arithmetic logic unit (ALU) is a digital circuit that performs arithmetic and logical operations. The ALU is a fundamental building block of the central processing unit of a computer, and even the simplest microprocessors contain one for purposes such as maintaining timers. The processors found inside modern CPUs and GPU have inside them very powerful and very complex ALU; a single component may contain a number of ALU.
Mathematician John von Neumann proposed the ALU concept in 1945, when he wrote a report on the foundations for a new computer called the EDVAC.

Control Unit: The control unit is the circuitry that controls the flow of information through the processor, and coordinates the activities of the other units within it. In a way, it is the "brain within the brain", as it controls what happens inside the processor, which in turn controls the rest of the PC.

The functions performed by the control unit vary greatly by the internal architecture of the CPU, since the control unit really implements this architecture. On a regular processor that executes x86 instructions natively, the control unit performs the tasks of fetching, decoding, managing execution and then storing results. On a processor with a RISC core the control unit has significantly more work to do. It manages the translation of x86 instructions to RISC micro-instructions, manages scheduling the micro-instructions between the various execution units, and juggles the output from these units to make sure they end up where they are supposed to go. On one of these processors the control unit may be broken into other units (such as a scheduling unit to handle scheduling and a retirement unit to deal with results coming from the pipeline) due to the complexity of the job it must perform.

Modem: Equipment that converts digital signals into analog signals for purpose of transmission over a telephone line. Signal is then converted back to digital form so that it can be processed by a receiving computer. Modems are typically used to link computers via telephone lines; Short for modulator-demodulator. The speed at which a modem transmits data is measured in units called bits per second or bps. The first modems ran at even less than 300 bps. Now 1200, 2400, and 9600 bps modems are considered slow. The faster models reach speeds of 14,400 and 28,800 bps. The faster the modem, the faster the data (for example, images from the Web) appear. Even a 28,800 bps modem, however, cannot compare to the several million bps speed that a campus Ethernet connection gives you.

Register: A small, high-speed computer circuit that holds values of internal operations, such as the address of the instruction being executed and the data being processed. When a program is debugged, register contents may be analyzed to determine the computer's status at the time of failure.
In microcomputer assembly language programming, programmers look at the contents of registers routinely. Assembly languages in larger computers are often at a higher level.

Cache Memory: Cache memory is extremely fast memory that is built into a computer's central processing unit (CPU), or located next to it on a separate chip. The CPU uses cache memory to store instructions that are repeatedly required to run programs, improving overall system speed. The advantage of cache memory is that the CPU does not have to use the motherboard's system bus for data transfer. Whenever data must be passed through the system bus, the data transfer speed slows to the motherboard's capability. The CPU can process data much faster by avoiding the bottleneck created by the system bus.

Cache that is built into the CPU is faster than separate cache, running at the speed of the microprocessor itself. However, separate cache is still roughly twice as fast as Random Access Memory (RAM). Cache is more expensive than RAM, but it is well worth getting a CPU and motherboard with built-in cache in order to maximize system performance.

Computer Virus: A virus is a program designed to infect and potentially damage files on a computer that receives it. The code for a virus is hidden within an existing program—such as a word processing or spreadsheet program—and when that program was launched. The virus inserts copies of itself into other programs on the system to infect them as well. Because of this ability to reproduce itself, a virus can quickly spread to other programs, including the computer's operating system. A virus may be resident on a system for a period of time before taking any action detectable to the user. The impact of other viruses may be felt immediately. Some viruses cause little or no damage. For example, a virus may manifest itself as nothing more than a message that appears on the screen at certain intervals. Other viruses are much more destructive and can result in lost or corrupted files and data. At their worst, viruses may render a computer unusable, necessitating the reinstallation of the operating system and applications.

IT: I/O PROCESSING AND DATA STORAGE, NETWORKING & INTERNET STANDARDS

I/O PROCESSING

a. In computing, input/output or I/O (or, informally, io or IO) is the communication between an information processing system, such as a computer, and the outside world, possibly a human or another information processing system.
b. Inputs are the signals or data received by the system and outputs are the signals or data sent from it.
c. Typical I/O devices are printers, hard disks, keyboards, and mouses.
d. In fact, some devices are basically input-only devices (keyboards and mouses); others are primarily output-only devices (printers); and others provide both input and output of data (hard disks, diskettes, writable CD-ROMs).
e. to "perform I/O" is to perform an input or output operation
f. An I/O interface is required whenever the I/O device is driven by the processor.
g. Channel I/O requires the use of instructions that are specifically designed to perform I/O operations.

DATA STORAGE

h. A data storage device is a device for recording (storing) information (data).
i. Recording can be done using virtually any form of energy, spanning from manual muscle power in handwriting, to acoustic vibrations in phonographic

recording, to electromagnetic energy modulating magnetic tape and optical discs.

j. A storage device may hold information, process information, or both.
k. A device that only holds information is a recording medium.
l. Devices that process information (data storage equipment) may either access a separate portable (removable) recording medium or a permanent component to store and retrieve data.
m. Electronic data storage requires electrical power to store and retrieve that data.
n. Except for barcodes and OCR data, electronic data storage is easier to revise and may be more cost effective than alternative methods due to smaller physical space requirements
o. Data storage equipment uses either: portable methods (easily replaced), semi-portable methods, requiring mechanical disassembly tools and/or opening a chassis, or Volatile methods, meaning loss of memory if disconnected from the unit.
p. A recording medium is a physical material that holds data expressed in any of the existing recording formats.

NETWORKING AND INTERNET STANDARDS

q. In information technology, networking is the construction, design, and use of a network, including the physical (cabling, hub, bridge, switch, router, and so forth), the selection and use of telecommunication protocol and computer software for using and managing the network, and the establishment of operation policies and procedures related to the network.
r. The computers on a network may be linked through cables, telephone lines, radio waves, satellites, or infrared light beams. Two very commontypes of networks include: Local Area Network (LAN) Wide AreaNetwork (WAN)
s. In computer network engineering, an Internet Standard (abbreviated as "STD") is a normative specification of a technology or methodology applicable to the Internet. Internet Standards are created and published by the Internet Engineering Task Force (IETF).
t. An Internet Standard is a special Request for Comments (RFC) or set of RFCs.
u. An RFC that is to become a Standard or part of a Standard begins as an Internet Draft, and is later (usually after several revisions) accepted and published by the RFC Editor as an RFC and labeled a Proposed Standard.
v. Later, an RFC can be labeled Internet Standard.
w. An Internet Standard is characterized by a high degree of technical maturity and by a generally held belief that the specified protocol or service provides significant benefit to the Internet community.
x. The most fundamental of the Internet Standards are the ones defining the Internet Protocol.
y. An Internet Standard ensures that hardware and software produced by different vendors can work together.

All Internet Standards are given a number in the STD series. The first document in this series, STD 1, describes the remaining documents in the series, and has a list of Proposed Standards

TELECOMMUNICATIONS

BASICS OF WIRELESS COMMUNICATION; SURVEILLANCE AND GPS AND FIBER OPTIC

Wireless communication is the transfer of information between two or more points, such as a long-range communications, that are not connected by an electrical conductor. The most common wireless technologies use radio. The term is commonly used in the telecommunications industry to refer to telecommunications systems. It encompasses various types of fixed, mobile, and portable applications, including two-way radios, cellular telephones, personal digital assistants (PDAs), and wireless networking Other examples of applications of radio wireless technology include GPS units, garage door openers, Somewhat less common methods of achieving wireless communications include the use of other electromagnetic wireless technologies, such as light, magnetic, or electric fields or the use of sound.

LAND SLIDES (LAND SLIP)

It is a geological phenomenon that included a wide range of ground movements. It takes place when dirt, pebbles, rocked and boulders slide down a slope together.

CAUSES OF LANDSLIDES:

- Earthquakes
- Volcanic Eruptions
- Gravity
- Rain which add additional weight to side of slope
- Erosion as the base of slope is removed.

CLASSIFICATION OF LANDSLIDES:

Rate of Movement
Type of Material
Nature of Movement.

TYPES OF LANDSLIDES:

1: ROCK FALL when block of sediments soil, rock fall down from a steep bank.
2: FLOWS displacement of incoherent soils in a fluid like flow.

3: ROCK SLIDES instead of falling they glide or slide down.

EFFECTS OF LANDSLIDES:

- Destruction of habitat
- Damage of quality and character of rivers
- Economic loss
- Property damage
- Destruction of forests

PREVENTIVE MEASURES:

- Prevent soil erosion
- Plant vegetation
- Altering the slop gradient

SOME FACTS ABOUT LAND SLIDES:

- Also found on mars and Venus
- While moving down it can pick speed up to 200 miles per hour.
- Largest land slide was on May 1980 by eruption of Mount St. Helen.
- Each year it kills between 25-50 people.

HARD WATER & SOFT WATER

Hard Water: Hard water contains a significant quantity of dissolved minerals, such as calcium and magnesium. In general, hard water is not harmful for health. In fact, it may confer some benefits because it is rich in minerals and reduces the solubility of potentially toxic metal ions such as lead and copper.

- The most common technique to determine the hardness of water is by looking at sod formation with soap.
- A high concentration of multivalent cations (i.e. charge greater than 1+) leads to hardness in the water. Calcium and magnesium (Ca^{2+} and Mg^{2+}) are the most common sources. Water usually collects these minerals from the ground as it flows. Rainwater and distilled water are soft.
- Hardness that cannot be removed by boiling the water is called permanent hardness. Temporary water hardness is caused by the presence of bicarbonate minerals (calcium bicarbonate and magnesium bicarbonate).
- A single-number scale cannot describe hardness of water accurately because the behavior of hardness depends upon a variety of factors such as minerals in the water, pH and temperature.
- While hard water does not have an adverse effect on human health, it can leave spots and film on dishes and bathtubs and be more damaging to household appliances.
- Hard water is not considered to be dangerous to one's health, and it is perfectly healthy to drink. However, the minerals found in hard water can be detected in the taste, and so some people may find that it is slightly bitter, whereas soft water has a very pure, although occasionally very slightly salty taste.
- Hair washed in hard water can feel sticky and look dull. Studies also suggest that hard water can cause an increase in eczema in children. This is because the minerals in hard water can dry out skin and hair.

Hard water can be "softened" by reducing the concentration of calcium, magnesium and other minerals. Temporary hardness of water can be treated either by boiling it or by adding lime (calcium hydroxide). Permanent hardness of water can also be treated with ion-exchange resins in which hardness ions (Ca, Mg and other metallic cations) are exchanged for sodium ions.

HARD WATER & HEAVY WATER

HARD WATER

- Hard water contains the salts of calcium and magnesium.
- It does not make lather with soap.
- It is not used in nuclear reactor as moderator.
- It is denser than ordinary water but its density depends upon the amount of salt present in it.
- **Hard Water** contains minerals such as calcium and magnesium, Reaction with soap: Film, Problems: Leaves deposit called "scale".
- **Lather formation:** Doesn't form lather with detergents
- **Removed by:** permute it process, by exchange of ions

HEAVY WATER

- It is made up of heavy isotopes of hydrogen i.e deuterium.
- It makes lather with soap
- It used as moderator in nuclear reactors
- 11% denser than ordinary water.

NUCLEAR FISSION REACTION

It is a nuclear reaction in which the atom is split into two approximately equal masses. It is accompanied by the emission of extremely high quantities of energy.
The energy is released by the Einstein's equation
$E=mc^2$

NUCLEAR FUSION REACTION

Nuclear fusion reaction is a reaction in which fusing of the nuclei of lighter elements such as hydrogen into those of a heavier element such as helium. The resultant loss, in their combined mass, is converted into energy.

SOLAR ENERGY AND THERMAL ENERGY

Solar power is energy from the sun. "Solar" is the Latin word for "sun" and it's a powerful source of energy. Solar energy is, simply, energy provided by the sun. This energy is in the form of solar radiation, which makes the production of solar electricity possible. Solar energy is radiant light and heat from the sun harnessed using a range of ever-evolving technologies such as solar heating, photo-voltaics, solar thermal energy, solar architecture and artificial photosynthesis.

Electricity can be produced directly from photovoltaic, PV, cells. (Photovoltaic literally means "light" and "electric.") These cells are made from materials which exhibit the "photovoltaic effect" i.e. when sunshine hits the PV cell, the photons of light excite the electrons in the cell and cause them to flow, generating electricity.
Solar energy produces electricity when it is in demand – during the day particularly hot days when air-conditioners drive up electricity demand.
In use, solar energy produces no emissions. One megawatt hour of solar electricity offsets about 0.75 to 1 tonne of CO_2.

Solar cells: Solar cells are devices that convert light energy directly into electrical energy. In these cells, there are semiconductors (silicon alloys and other materials). You may have seen small solar cells on calculators or some mobile phones. Larger arrays of solar cells are used to power road signs, and even larger arrays are used to power satellites in orbit around Earth. Solar cells are also called photovoltaic cells or PV devices.

Solar panels: Solar panels are different to solar cells. Solar panels do not generate electricity directly. Instead they heat up water directly. A pump pushes cold water from a storage tank through pipes in the solar panel. The water is heated by heat energy from the Sun and returns to the tank. They are often located on the roofs of buildings where they can receive the most sunlight.

Thermal Energy: Thermal energy is energy possessed by an object or system due to the movement of particles within the object or the system. Thermal energy is one of various types of energy, where 'energy' can be defined as 'the ability to do work.' Work is the movement of an object due to an applied force. A system is simply a collection of objects within some boundary. Therefore, thermal energy can be described as the ability of something to do work due to the movement of its particles. Because thermal energy is due to the movement of particles, it is a type of kinetic energy, which is the energy due to motion. Thermal energy results in something having an internal temperature, and that temperature can be measured - for example, in degrees Celsius or Fahrenheit on a thermometer. The faster the particles move within an object or system, the higher the temperature that is recorded.

In thermodynamics, thermal energy refers to the internal energy present in a system by virtue of its temperature. Thermal energy is the portion of the thermodynamic or internal energy of a system that is responsible for the temperature of the system. Microscopically, the thermal energy may include both the kinetic energy and potential energy of a system's constituent particles, which may be atoms, molecules, electrons, or particles. Macroscopically, the thermal energy of a system at a given temperature is proportional to its heat capacity. Heat is the thermal energy transferred across a boundary of one region of matter to another. As a process variable, heat is a characteristic of a process, not a property of the system; it is not contained within the boundary of the system. On the other hand, thermal energy is a property of a system, and exists on both sides of a boundary.

HUMAN PHYSIOLOGY

INTRODUCTION TO PHYSIOLOGY

- ✓ Physiology is the study of how cells, tissues, and organs function.
- ✓ Human physiology is the science of the mechanical, physical, and biochemical functions of normal humans or human tissues or organs.

HOMEOSTASIS AND FEEDBACK CONTROL

I. Homeostasis refers to the dynamic constancy of the internal environment.
   - A. Homeostasis is maintained by mechanisms that act through negative feedback loops.
   - B. Positive feedback loops serve to amplify changes and may be part of the action of an overall negative feedback mechanism.
   - C. The nervous and endocrine systems provide extrinsic regulation of other body systems and act to maintain homeostasis.
   - D. The secretion of hormones is stimulated by specific chemicals and is inhibited by negative feedback mechanisms.

THE PRIMARY TISSUES, ORGANS, AND SYSTEMS

The body is composed of four primary tissues: muscle, nervous, epithelial, and connective tissues.

There are three types of muscle tissue: skeletal, cardiac, and smooth muscle.

- ✓ Skeletal and cardiac muscle are striated.
- ✓ Smooth muscle is found in the walls of the internal organs.

Nervous tissue is composed of neurons and supporting cells.

- ✓ Neurons are specialized for the generation and conduction of electrical impulses.
- ✓ Supporting cells provide the neurons with anatomical and functional support.

Epithelial tissue includes membranes and glands.

✓ Epithelial membranes cover and line the body surfaces, and their cells are tightly joined by junctional complexes.
✓ Epithelial membranes may be simple or stratified, and their cells may be squamous, cuboidal, or columnar.
✓ Exocrine glands, which secrete into ducts, and endocrine glands, which lack ducts and secrete hormones into the blood, are derived from epithelial membranes.

Connective tissue is characterized by large intercellular spaces that contain extracellular material.
Connective tissue proper includes subtypes such as loose, dense fibrous, adipose, and others.
Cartilage, bone, and blood are classified as connective tissues because their cells are widely spaced with abundant extracellular material between them.

Organs are units of structure and function that are composed of at least two, and usually all four, primary tissues. The skin is a good example of an organ.
The epidermis is a stratified squamous keratinized epithelium, which serves to protect underlying structures and also produces vitamin D. The dermis is an example of loose connective tissue. Hair follicles, sweat glands, and sebaceous glands are exocrine glands located within the dermis. Sensory and motor nerve fibers enter the spaces within the dermis to innervate sensory organs and smooth muscles. The arrector pili muscles that attach to the hair follicles are composed of smooth muscle. Organs that are located in different regions of the body and perform related functions are grouped into systems. These include, among others, the circulatory system, digestive system, endocrine system.

The fluids of the body are divided into two major compartments.
The intracellular compartment refers to the fluid within the cells. The extracellular compartment refers to the fluid outside of cells; this is subdivided into plasma (the fluid portion of the blood) and tissue fluid.

SYSTEMS

The Nervous System; the network of nerve cells and fibres which transmits nerve impulses between parts of the body.

Cardiovascular System: It is also called the cardiovascular system, is an organ system that permits blood to circulate and transport nutrients (such as amino acids and electrolytes), oxygen, carbon dioxide, hormones, and blood cells to and from the cells in the body to provide nourishment and help in fighting diseases, stabilize temperature and pH, and maintain homeostasis.

Respiratory System (called also respiratory apparatus, ventilatory system) is a biological system consisting of specific organs and structures used for the process of respiration in an organism.

The Endocrine System: It is the collection of glands that produce hormones that regulate metabolism, growth and development, tissue function, sexual function, reproduction, sleep, and mood, among other things

The Reproductive System or genital system is a system of sex organs within an organism which work together for the purpose of sexual reproduction.

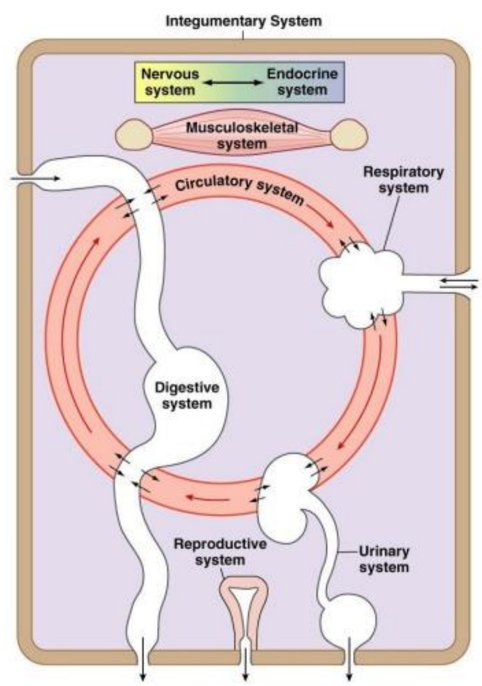
The Gastrointestinal System: A long tube running right through the body, with specialised sections that are capable of digesting material put in at the top end and extracting any useful components from it, then expelling the waste products at the bottom end. The whole system is under hormonal control.

The Urinary System also known as the renal system, consists of the kidneys, ureters, bladder, and the urethra. Each kidney consists of millions of functional units called nephrons.

The Muscular System: An organ system consisting of skeletal, smooth and cardiac muscles. It permits movement of the body, maintains posture, and circulates blood throughout the body.

The Immune System: A system of many biological structures and processes within an organism that protects against disease. To function properly, an immune system must detect a wide variety of agents, known as pathogens, from viruses to parasitic worms, and distinguish them from the organism's own healthy tissue.

Integumentary System: An organ system that protects the body from various kinds of damage, such as loss of water or abrasion from outside. The system comprises the skin and its appendages (including hair, scales, feathers, hooves, and nails).



BIO FUEL METHOD

INTRODUCTION

- ✓ A biofuel is a fuel that is produced through contemporary biological processes, such as agriculture and anaerobic digestion, rather than a fuel produced by geological processes
- ✓ Also known as agrofuel, these fuels are mainly derived from biomass or bio waste
- ✓ Biofuels can be derived directly from plants, or indirectly from agricultural, commercial, domestic, and/or industrial wastes
- ✓ Renewable biofuels generally involve contemporary carbon fixation, such as those that occur in plants or microalgae through the process of photosynthesis.
- ✓ Other renewable biofuels are made through the use or conversion of biomass
- ✓ In ecology, biomass refers to the entire mass of all living things in a given area or ecosystem at any one time. Biomass is derived from plant materials but can also include animal materials.

BIOMASS CONVERSION

Biofuel can be easily produced through any carbon source; making the photosynthetic plants the most commonly used material for production.
This biomass can be converted to convenient energy containing substances A.K.A Second Generation Extraction Technology

Thermochemical Conversion:

- ✓ **Gasification:** carbon-based materials are converted to carbon monoxide, hydrogen, and carbon dioxide; oxygen is limited.
- ✓ **Pyrolysis:** Pyrolysis is carried out in the absence of oxygen and often in the presence of an inert gas like halogen.
- ✓ **Torrefaction;** carried out at lower temperatures; used to convert biomass feedstock into a form that is more easily transported and stored.

Biochemical Conversion; Fermentation with unique or genetically modified bacteria is particularly popular for second generation feedstock like landfill gas and municipal waste.

This biomass conversion can result in fuel in solid, liquid, or gas form. This new biomass can also be used directly for biofuels.

TYPES OF BIOFUEL

First generation biofuels are made from sugar, starch, or vegetable oil; feedstock is not sustainable/green; "original" biofuels

- ✓ Bioalcohol, Ethanol, Propanol, Butanol: Starches from wheat, corn, sugar cane, molasses, potatoes, other fruits
- ✓ Biodiesel: Oils and fats including animal fats, vegetable oils, nut oils, hemp, and algae
- ✓ Green Diesel: Made from hydrocracking oil and fat feedstock
- ✓ Vegetable Oil, Castor Oil, Olive Oil, Fat, Sunflower Oil
- ✓ Bioethers: Dehydration of alcohols
- ✓ Biogas: Methane made from waste crop material through anaerobic digestion or bacteria
- ✓ Solid Biofuels; Wood, Dried plants, Bagasse, Manure, Seeds: Everything from wood and sawdust to garbage, agricultural waste, manure

Second generation biofuels are "greener" in that they are made from sustainable feedstock.

- ✓ Cellulosic ethanol: Usually made from wood, grass, or inedible parts of plants
- ✓ Algae - based biofuels: Multiple different fuels made from algae
- ✓ Biohydrogen: Made from algae breaking down water
- ✓ Methanol: Inedible plant matter
- ✓ Dimethylfuran: MadeÂ from fructose found in fruits and some vegetables
- ✓ Fischer-Tropsch Biodiesel: Waste from paper and pulp manufacturing

Third generation biofuel has only recently enter the mainstream it refers to biofuel derived from algae; algae can produce results from two characteristics of the microorganism

- ✓ Firstly, algae produce an oil that can easily be refined into diesel or even certain components of gasoline
- ✓ Secondly, it can be genetically manipulated to produce everything from ethanol and butanol to even gasoline and diesel fuel directly.
- ✓ The list of fuels that can be derived from algae includes; Biodiesel, Butanol, Gasoline, Methane, Ethanol, Vegetable Oil, and Jet Fuel

BIOFUEL USES

a. Transportation
b. Power Generation
c. Heat

CONCLUSION

NERVOUS SYSTEM & ENDOCRINE SYSTEM

The nervous system is a complex network of nerves and cells that carry messages to and from the brain and spinal cord to various parts of the body. The nervous system includes both the Central nervous system and Peripheral nervous system. The Central nervous system is made up of the brain and spinal cord and The Peripheral nervous system is made up of the Somatic and the Autonomic nervous systems.

THE CENTRAL NERVOUS SYSTEM

The central nervous system is divided into two major parts: the brain and the spinal cord.

The Brain

The brain lies within the skull and is shaped like a mushroom. The brain consists of four principal parts: the brain stem, the cerebrum, the cerebellum, and the diencephalon. The brain weighs approximately 1.3 to 1.4 kg. It has nerve cells called the neurons and supporting cells called the glia.
There are two types of matter in the brain: grey matter and white matter. Grey matter receives and stores impulses. Cell bodies of neurons and neuroglia are in the grey matter. White matter in the brain carries impulses to and from grey matter. It consists of the nerve fibers (axons).

The brain stem

The brain stem is also known as the Medulla oblongata. It is located between the pons and the spinal cord and is only about one inch long.

The cerebrum

The cerebrum forms the bulk of the brain and is supported on the brain stem. The cerebrum is divided into two hemispheres. Each hemisphere controls the activities of the side of the body opposite that hemisphere. The hemispheres are further divided into four lobes: Frontal lobe, Temporal lobes, Parietal lobe, and Occipital lobe.
The cerebellum: This is located behind and below the cerebrum.
The diencephalon: is also known as the fore brain stem. It includes the thalamus and hypothalamus. The thalamus is where sensory and other impulses go and coalesce. The hypothalamus is a smaller part of the diencephalon

Other parts of the brain

Other parts of the brain include the midbrain and the pons: the midbrain provides conduction pathways to and from higher and lower centers, the pons acts as a pathway to higher structures; it contains conduction pathways between the medulla and higher brain centers

The Spinal Cord

The spinal cord is along tube like structure which extends from the brain. The spinal cord is composed of a series of 31 segments. A pair of spinal nerves comes out of each segment. The region of the spinal cord from which a pair of spinal nerves originates is called the spinal segment. Both motor and sensory nerves are located in the spinal cord. The spinal cord is about 43 cm long in adult women and 45 cm long in adult men and weighs about 35-40 grams. It lies within the vertebral column, the collection of bones (back bone).

OTHER PARTS OF THE CENTRAL NERVOUS SYSTEM: The meninges are three layers or membranes that cover the brain and the spinal cord. The outermost layer is the dura mater. The middle layer is the arachnoid, and the innermost layer is the pia mater. The meninges offer protection to the brain and the spinal cord by acting as a barrier against bacteria and other microorganisms. The Cerebrospinal Fluid (CSF) circulates around the brain and spinal cord. It protects and nourishes the brain and spinal cord.

Neurons

The neuron is the basic unit in the nervous system. It is a specialized conductor cell that receives and transmits electrochemical nerve impulses. A typical neuron has a cell body and long arms that conduct impulses from one body part to another body part.

There are three different parts of the neuron: the cell body, dendrites, and axon

Cell body of a Neuron

The cell body is like any other cell with a nucleus or control center.
Dendrites: The cell body has several highly branched, thick extensions that appear like cables and are called dendrites. The exception is a sensory neuron that has a single, long dendrite instead of many dendrites. Motor neurons have multiple thick dendrites. The dendrite's function is to carry a nerve impulse into the cell body.
Axon: An axon is a long, thin process that carries impulses away from the cell body to another neuron or tissue. There is usually only one axon per neuron.

Myelin Sheath: The neuron is covered with the Myelin Sheath or Schwann Cells. These are white segmented covering around axons and dendrites of many peripheral neurons. The covering is continuous along the axons or dendrites except at the point of termination and at the nodes of Ranvier.

The neurilemma is the layer of Schwann cells with a nucleus. Its function is to allow damaged nerves to regenerate. Nerves in the brain and spinal cord do not have a neurilemma and, therefore cannot recover when damaged.

Types of Neuron

Neurons in the body can be classified according to structure and function. According to structure neurons may be multipolar neurons, bipolar neurons, and unipolar neurons:

Multipolar neurons have one axon and several dendrites. These are common in the brain and spinal cord

Bipolar neurons have one axon and one dendrite. These are seen in the retina of the eye, the inner ear, and the olfactory (smell) area.

Unipolar neurons have one process extending from the cell body. The one process divides with one part acting as an axon and the other part functioning as dendrite. These are seen in the spinal cord.

THE PERIPHERAL NERVOUS SYSTEM

The Peripheral nervous system is made up of two parts: Somatic nervous system, and Autonomic nervous system.

Somatic nervous system: The somatic nervous system consists of peripheral nerve fibers that pick up sensory information or sensations from the peripheral or distant organs (those away from the brain like limbs) and carry them to the central nervous system. These also consist of motor nerve fibers that come out of the brain and take the messages for movement and necessary action to the skeletal muscles. For example, on touching a hot object the sensory nerves carry information about the heat to the brain, which in turn, via the motor nerves, tells the muscles of the hand to withdraw it immediately.

The whole process takes less than a second to happen. The cell body of the neuron that carries the information often lies within the brain or spinal cord and projects directly to a skeletal muscle.

Autonomic Nervous System: Another part of the nervous system is the Autonomic Nervous System. It has three parts: the sympathetic nervous system, the parasympathetic nervous system, and the enteric nervous system.

This nervous system controls the nerves of the inner organs of the body on which humans have no conscious control. This includes the heartbeat, digestion, breathing (except conscious breathing) etc. The nerves of the autonomic nervous system enervate the smooth involuntary muscles of the (internal organs) and glands and cause them to function and secrete their enzymes etc.

The Enteric nervous system is the third part of the autonomic nervous system. The enteric nervous system is a complex network of nerve fibers that innervate the organs within the abdomen like the gastrointestinal tract, pancreas, gall bladder etc. It contains nearly 100 million nerves. Neurons in the peripheral nervous system

The smallest worker in the nervous system is the neuron. For each of the chain of impulses there is one preganglionic neuron, or one before the cell body or ganglion, that is like a central controlling body for numerous neurons going out peripherally.

The preganglionic neuron is located in either the brain or the spinal cord. In the autonomic nervous system this preganglionic neuron projects to an autonomic ganglion. The postganglionic neuron then projects to the target organ.

In the somatic nervous system there is only one neuron between the central nervous system and the target organ while the autonomic nervous system uses two neurons.

DIESEASES

Patients with nerve disorders experience functional difficulties, which result in conditions such as:

1) Epilepsy, in which abnormal electrical discharges from brain cells cause seizures
2) Parkinson's disease, which is a progressive nerve disease that affects movement
3) Multiple sclerosis (MS), in which the protective lining of the nerves is attacked by the body's immune system
4) Amyotrophic lateral sclerosis (ALS), also known as Lou Gehrig's disease, is a motor neuron disease which weakens the muscles and progressively hampers physical function
5) Huntington's disease, which is an inherited condition that cause the nerve cells in the brain to degenerate
6) Alzheimer's disease, which covers a wide range of disorders that impacts mental functions, particularly memory.

It is also noted that the nervous system can also be affected by vascular disorders such as:

1) Stroke, which occurs when there is bleeding on the brain or the blow flow to the brain is obstructed;
2) Transient ischemic attack (TIA), which are mini-type strokes that last a shorter period of time but mimic stroke symptoms; and
3) Subarachnoid hemorrhage, which is specifically bleeding in the space between your brain and the surrounding membrane that can be the result of a trauma or rupturing of a weak blood vessel;
4) Infections such as meningitis, encephalitis, polio, and epidural abscess can also affect the nervous system, the NIH noted.

Treatments vary from anti inflammatory medications and pain medications such as opiates, to implanted nerve stimulators and wearable devices. Many people also turn to herbal and holistic methods to reduce pain, such as acupuncture.

ENDOCRINE SYSTEM

The endocrine system includes all of the glands of the body and the hormones produced by those glands. The glands are controlled directly by stimulation from the nervous system as well as by chemical receptors in the blood and hormones produced by other glands. By regulating the functions of organs in the body, these glands help to maintain the body's homeostasis. Cellular metabolism, reproduction, sexual development, sugar and mineral homeostasis, heart rate, and digestion are among the many processes regulated by the actions of hormones.

Hypothalamus: The hypothalamus is a part of the brain located superior and anterior to the brain stem and inferior to the thalamus. It serves many different functions in the nervous system, and is also responsible for the direct control of the endocrine system through the pituitary gland. The hypothalamus contains special cells called neurosecretory cells—neurons that secrete hormones: Thyrotropin-releasing hormone (TRH), Growth hormone-releasing hormone (GHRH), Growth hormone-inhibiting hormone (GHIH), Gonadotropin-releasing hormone (GnRH), Corticotropin-releasing hormone (CRH), Oxytocin, and Antidiuretic hormone (ADH)
All of the releasing and inhibiting hormones affect the function of the anterior pituitary gland. TRH stimulates the anterior pituitary gland to release thyroid-stimulating hormone. GHRH and GHIH work to regulate the release of growth hormone—GHRH stimulates growth hormone release, GHIH inhibits its release. GnRH stimulates the release of follicle stimulating hormone and luteinizing hormone while CRH stimulates the release of adrenocorticotropic hormone. The last two hormones—oxytocin and antidiuretic hormone—are produced by the hypothalamus and transported to the posterior pituitary, where they are stored and later released.

Pituitary Gland

The pituitary gland, also known as the hypophysis, is a small pea-sized lump of tissue connected to the inferior portion of the hypothalamus of the brain. Many blood vessels surround the pituitary gland to carry the hormones it releases throughout the body. Situated in a small depression in the sphenoid bone called the sella turcica, the pituitary gland is actually made of 2 completely separate structures: the posterior and anterior pituitary glands.

Posterior Pituitary: The posterior pituitary gland is actually not glandular tissue at all, but nervous tissue instead. The posterior pituitary is a small extension of the hypothalamus through which the axons of some of the neurosecretory cells of the hypothalamus extend. These neurosecretory cells create 2 hormones in the hypothalamus that are stored and released by the posterior pituitary.

Oxytocin triggers uterine contractions during childbirth and the release of milk during breastfeeding.
Antidiuretic hormone (ADH) prevents water loss in the body by increasing the re-uptake of water in the kidneys and reducing blood flow to sweat glands.

Anterior Pituitary: The anterior pituitary gland is the true glandular part of the pituitary gland. The function of the anterior pituitary gland is controlled by the releasing and inhibiting hormones of the hypothalamus. The anterior pituitary produces 6 important hormones:
Thyroid stimulating hormone (TSH), as its name suggests, is a tropic hormone responsible for the stimulation of the thyroid gland.

Adrenocorticotropic hormone (ACTH) stimulates the adrenal cortex, the outer part of the adrenal gland, to produce its hormones.
Follicle stimulating hormone (FSH) stimulates the follicle cells of the gonads to produce gametes—ova in females and sperm in males.
Luteinizing hormone (LH) stimulates the gonads to produce the sex hormones—estrogens in females and testosterone in males.
Human growth hormone (HGH) affects many target cells throughout the body by stimulating their growth, repair, and reproduction.
Prolactin (PRL) has many effects on the body, chief of which is that it stimulates the mammary glands of the breast to produce milk.

Pineal Gland

The pineal gland is a small pinecone-shaped mass of glandular tissue found just posterior to the thalamus of the brain. The pineal gland produces the hormone melatonin that helps to regulate the human sleep-wake cycle known as the circadian rhythm. The activity of the pineal gland is inhibited by stimulation from the photoreceptors of the retina. This light sensitivity causes melatonin to be produced only in low light or darkness. Increased melatonin production causes humans to feel drowsy at nighttime when the pineal gland is active.

Thyroid Gland: The thyroid gland is a butterfly-shaped gland located at the base of the neck and wrapped around the lateral sides of the trachea. The thyroid gland produces 3 major hormones: Calcitonin, Triiodothyronine (T3), Thyroxine (T4)

Calcitonin is released when calcium ion levels in the blood rise above a certain set point. Calcitonin functions to reduce the concentration of calcium ions in the blood by aiding the absorption of calcium into the matrix of bones. The hormones T3 and T4 work together to regulate the body's metabolic rate. Increased levels of T3 and T4 lead to increased cellular activity and energy usage in the body.

Parathyroid Glands: The parathyroid glands are 4 small masses of glandular tissue found on the posterior side of the thyroid gland. The parathyroid glands produce the hormone parathyroid hormone (PTH), which is involved in calcium ion homeostasis. PTH is released from the parathyroid glands when calcium ion levels in the blood drop below a set point. PTH stimulates the osteoclasts to break down the calcium containing bone matrix to release free calcium ions into the bloodstream. PTH also triggers the kidneys to return calcium ions filtered out of the blood back to the bloodstream so that it is conserved.

Adrenal Glands: The adrenal glands are a pair of roughly triangular glands found immediately superior to the kidneys. The adrenal glands are each made of 2 distinct layers, each with their own unique functions: the outer adrenal cortex and inner adrenal medulla.

Adrenal cortex: The adrenal cortex produces many cortical hormones in 3 classes: glucocorticoids, mineralocorticoids, and androgens. Glucocorticoids have many diverse functions, including the breakdown of proteins and lipids to produce glucose. Glucocorticoids also function to reduce inflammation and immune response. Mineralocorticoids, as their name suggests, are a group of hormones that help to regulate the concentration of mineral ions in the body. Androgens, such as testosterone, are produced at low levels in the adrenal cortex to regulate the growth and activity of cells that are receptive to male hormones. In adult males, the amount of androgens produced by the testes is many times greater than the amount produced by the adrenal cortex, leading to the appearance of male secondary sex characteristics.

Adrenal medulla: The adrenal medulla produces the hormones epinephrine and norepinephrine under stimulation by the sympathetic division of the autonomic nervous system. Both of these hormones help to increase the flow of blood to the brain and muscles to improve the "fight-or-flight" response to stress. These hormones also work to increase heart rate, breathing rate, and blood pressure while decreasing the flow of blood to and function of organs that are not involved in responding to emergencies.

Pancreas: The pancreas is a large gland located in the abdominal cavity just inferior and posterior to the stomach. The pancreas is considered to be a heterocrine gland as it contains both endocrine and exocrine tissue. The endocrine cells of the pancreas make up just about 1% of the total mass of the pancreas and are found in small groups throughout the pancreas called islets of Langerhans. Within these islets are 2 types of cells—alpha and beta cells. The alpha cells produce the hormone glucagon, which is responsible for raising blood glucose levels. Glucagon triggers muscle and liver cells to break down the polysaccharide glycogen to release glucose into the bloodstream. The beta cells produce the hormone insulin, which is responsible for lowering blood glucose levels after a meal. Insulin triggers the absorption of glucose from the blood into cells, where it is added to glycogen molecules for storage.

Gonads: The gonads—ovaries in females and testes in males—are responsible for producing the sex hormones of the body. These sex hormones determine the secondary sex characteristics of adult females and adult males.

Testes: The testes are a pair of ellipsoid organs found in the scrotum of males that produce the androgen testosterone in males after the start of puberty. Testosterone has effects on many parts of the body, including the muscles, bones, sex organs, and hair follicles. This hormone causes growth and increases in strength of the bones and muscles, including the accelerated growth of long bones during adolescence. During puberty, testosterone controls the growth and development of the sex organs and body hair of males, including pubic, chest, and facial hair. In men who have inherited genes for baldness testosterone triggers the onset of androgenic alopecia, commonly known as male pattern baldness.

Ovaries: The ovaries are a pair of almond-shaped glands located in the pelvic body cavity lateral and superior to the uterus in females. The ovaries produce the female sex hormones progesterone and estrogens. Progesterone is most active in females during ovulation and pregnancy where it maintains appropriate conditions in the human body to support a developing fetus. Estrogens are a group of related hormones that function as the primary female sex hormones. The release of estrogen during puberty triggers the development of female secondary sex characteristics such as uterine development, breast development, and the growth of pubic hair. Estrogen also triggers the increased growth of bones during adolescence that lead to adult height and proportions.

Thymus: The thymus is a soft, triangular-shaped organ found in the chest posterior to the sternum. The thymus produces hormones called thymosins that help to train and develop T-lymphocytes during fetal development and childhood. The T-lymphocytes produced in the thymus go on to protect the body from pathogens throughout a person's entire life. The thymus becomes inactive during puberty and is slowly replaced by adipose tissue throughout a person's life.

DISEASES OF THE ENDOCRINE SYSTEM
Hormone diseases also occur if your body does not respond to hormones in the appropriate ways. Stress, infection, and changes in the blood's fluid and electrolyte balance can also influence hormone levels. The most common endocrine disease in the United States is diabetes, a condition in which the body does not properly process glucose, a simple sugar. Hormone imbalances can have a significant impact on the reproductive system, particularly in women. Another disorder, hypothyroidism, occurs when the thyroid gland does not produce enough thyroid hormone to meet the body's needs. It is noted that insufficient thyroid hormone can cause many of the body's functions to slow or shut down completely. Thyroid cancer begins in the thyroid gland and starts when the cells in the thyroid begin to change, grow uncontrollably and eventually form a tumor. Hypoglycemia, also called low blood glucose or low blood sugar, occurs when blood glucose drops below normal levels. This typically happens as a result of treatment for diabetes when too much insulin is taken.

FORMS OF ENERGY

Nature of Energy: Energy is all around you!
- ✓ You can hear energy as sound.
- ✓ You can see energy as light.
- ✓ And you can feel it as wind.

Energy can be defined as the ability to do work.
If an object or organism does work (exerts a force over a distance to move an object) the object or organism uses energy. Because of the direct connection between energy and work, energy is measured in the same unit as work: joules (J).
In addition to using energy to do work, objects gain energy because work is being done on them Living organisms need energy for growth and movement.
Energy is involved when:
- ✓ A bird flies.
- ✓ A bomb explodes.
- ✓ Rain falls from the sky.
- ✓ Electricity flows in a wire.

States of Energy: The most common energy conversion is the conversion between potential and kinetic energy.
All forms of energy can be in either of two states:
1. Potential (Potential Energy is stored energy.)
2. Kinetic (Kinetic Energy is the energy of motion.)

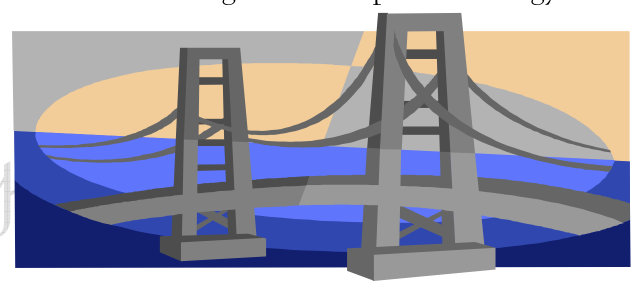
Kinetic Energy: The energy of motion is called kinetic energy. The faster an object moves, the more kinetic energy it has. The greater the mass of a moving object, the more kinetic energy it has. Kinetic energy depends on both mass and velocity.

$$K.E. = \frac{\text{mass x velocity}^2}{2}$$

Potential Energy: Potential Energy is stored energy; stored chemically in fuel, the nucleus of atom, and in foods or stored because of the work done on it:
- ✓ Stretching a rubber band.
- ✓ Winding a watch.
- ✓ Pulling back on a bow's arrow.
- ✓ Lifting a brick high in the air.

Gravitational Potential Energy
Potential energy that is dependent on height is called gravitational potential energy.

A waterfall, a suspension bridge, and a falling snowflake all have gravitational potential energy.



If you stand on a 3-meter diving board, you have 3 times the G.P.E, than you had on a 1-meter diving board.

The bigger they are the harder they fall" is not just a saying. It's true. Objects with more mass have greater G.P.E. The formula to find G.P.E. is

G.P.E. = Weight X Height
W = mgh

FORMS OF ENERGY
Heat Energy: The internal motion of the atoms is called heat energy, because moving particles produce heat. Heat energy can be produced by friction. Heat energy causes changes in temperature and phase of any form of matter.
Chemical Energy: Chemical Energy is required to bond atoms together. And when bonds are broken, energy is released. Fuel and food are forms of stored chemical energy.
Electromagnetic Energy: Power lines carry electromagnetic energy into your home in the form of electricity. Light is a form of electromagnetic energy.

Each color of light (Roy G Bv) represents a different amount of electromagnetic energy. Electromagnetic Energy is also carried by X-rays, radio waves, and laser light.

Mechanical Energy: When work is done to an object, it acquires energy. The energy it acquires is known as mechanical energy. When you kick a football, you give mechanical energy to the football to make it move.

Gravitational Energy: The energy an object or substance has because of its position; anything "up high".

Nuclear Energy: The nucleus of an atom is the source of nuclear energy. When the nucleus splits (fission), nuclear energy is released in the form of heat energy and light energy. Nuclear energy is also released when nuclei collide at high speeds and join (fuse). The sun's energy is produced from a nuclear fusion reaction in which hydrogen nuclei fuse to form helium nuclei. Nuclear energy is the most concentrated form of energy.

Stored Mechanical Energy: Energy stored in an object by the application of force must push or pull on an object.

Sound Energy: Movement of energy through substances in the form of longitudinal (compression) waves.

Radiant Energy: Electromagnetic energy that travels in transverse waves

ENERGY CONVERSIONS

All forms of energy can be converted into other forms.

- The sun's energy through solar cells can be converted directly into electricity.
- Green plants convert the sun's energy (electromagnetic) into starches and sugars (chemical energy).
- In an electric motor, electromagnetic energy is converted to mechanical energy.
- In a battery, chemical energy is converted into electromagnetic energy.
- The mechanical energy of a waterfall is converted to electrical energy in a generator.
- In an automobile engine, fuel is burned to convert chemical energy into heat energy. The heat energy is then changed into mechanical energy.

Chemical → Heat → Mechanical

Energy can be neither created nor destroyed by ordinary means.

- It can only be converted from one form to another.
- If energy seems to disappear, then scientists look for it – leading to many important discoveries.
- In 1905, Albert Einstein said that mass and energy can be converted into each other.
- He showed that if matter is destroyed, energy is created, and if energy is destroyed mass is created.

$$E = mc^2$$

Elastic Potential Energy

Energy that is stored due to being stretched or compressed is called elastic potential energy.

SOME EQUIPMENT USED TO TRANSFORM ENERGY

1. **Dynamo**
Mechanical energy into electrical energy
2. **Candle**
Chemical energy into light and heat energy
3. **Microphone**
Sound energy into electrical energy
4. **Loud Speaker**
Electrical energy into sound energy
5. **Solar cell**
Solar energy into electrical energy
6. **Tube light**
Electrical energy into light energy
7. **Electric Bulb**
Electrical energy into light and heat energy
8. **Battery**
Chemical energy into electrical energy
9. **Electric motor**
Electrical energy into mechanical energy
10. **Sitar**
Mechanical energy into sound energy

SCIENTIFIC NAMES OF COMMON PLANT/ TREES/ VEGETABLES /CEREALS/FRUITS ETC

Apple Pyrusmalus
Bamboo Bamboosaaridinarifolia
Brinjal Solanummelongena
Banana Musa paradisicum
Black Gram PalsoesMungo
Banyan Ficusbenghalensis
Black Pepper Piper nigrum
Clove Syzygiumaromaticum
Carrot Daucascarota
Cucumber Cucumissativas
Capsicum Capsicum fruitscence
Chiku Achrassapota
Cotton Gossypiumherbaceum
Green Gram Phaseoliesauicus
Guava Psidium guava
Ginger Zingiberofficinale
Garlic Allium sativum
Jack fruit Artocarpusintegra
Jowar Sorghum Vulgare
Kadamb Anthocephalusindicus
Lemon Citrus limonium
Maize Zea mays
Mango Mangiferaindica
Neem Azadhirachtaindica
Onion Allium cepa
Orange Citrus aurantium
Potato Solanumtubersum
Pomegranate Punicagranatum
Peepal Ficusreligiosa Linn.
Pineapple Ananussativus
Radish Raphanussativus
Rice Oryza sativa
Silver Oak Grevillearobusta
Sandalwood Santalum album
Spinach Lactuca sativa
Turmeric Curcuma longa
Tobacco Nicotinatobaccum
Tulsi Ocimum sanctum
Teak Tectonagrandis Linn.
Tamarind tree Tamarindusindica
Tomato Lycopersicanesculentum
Watermelon Citrullus vulgaris
Wheat TriticumAestivum

SCIENTIFIC NAMES OF ANIMALS

Cat Feliscatus
Cobra Elapidaenaja
Camel Cameluscamelidae
Cheetah Acinonyxjubatus
Chimpanzee Pan troglodytes
Crocodile Crocodilianiloticus
Chameleon Chamaeleontidate
Dog Cannisfamiliaris
Deer Artiodactyl cervidae
Dolphin Delphinidaedelphis
Elephant Proboscideaelephantidae
Frog Anuraranidae
Fox Cannisvulpes
Giraffe Giraffacamalopardalis
Giant Panda Ailuropodamelanoleuca
Goat Capra hircus
Housefly Muscadomestica
Hippopotamus Hippopotamus amphibius
Horse Eqquscaballus
Hyena Hyaenidaecarnivora
Kangaroo Macropusmacropodidae
Lion Pantheraleo
Lizard Saurialacertidae
Mouse Rodentiamuridae
Panther Pantherapardus
Pig Artiodactylasuidae
Porcupine **Hystricomorphhystricidae**
Rabbit **Leporidaecuniculas**
Rhinoceros **Perrissodanctylrthinocerotidae**
Scorpion **Archinidascorpionida**
Sea Horse **Hippocampus syngnathidae**
Squirrel **Rodentiasciurus**
Tiger **Pantheratigris**
Zebra **Equidaeburcheli**

COMMON HUMAN DISEASES AND AFFECTED BODY PART

AIDS Immune system of the body
Arthritis Joints
Asthma Bronchial muscles
Bronchitis Lungs
Carditis Heart
Cataract Eye
Cystitis Bladder
Colitis Intestine
Conjunctivitis Eye
Dermatitis Skin
Diabetes Pancreas and blood
Diphtheria Throat
Eczema Skin
Goitre Thyroid gland
Glossitis Tongue

Glaucoma Eye
Gastritis Stomach
Hepatitis Liver
Jaundice Liver
Malaria Spleen
Meningitis Brain and spinal cord
Myelitis Spinal cord
Neuritis Nerves
Otitis Ear
Osteomyelitis Bones
Paralysis Nerves and limb
Pyorrhoea Teeth
Peritonitis Abdomen
Pneumonia Lungs
Rhinitis Nose
Rheumatism Joints
Tuberculosis Lungs
Tonsillitis Tonsils
Trachoma Eye

VIRAL DISEASES IN CROPS/ PLANTS

Potato Leaf Roll, Mosaic
Banana Bunchy Top
Papaya Leaf Curl
Tobacco Mosaic
Carrot Red Leaf
Beans, Rice Blight
Cotton Black Arm
Tomato Canker
Potato Ring Rot, Brown Rot

SOME FRUITS AND THEIR EDIBLE PARTS

Apple Fleshy thalamus
Pear Fleshy thalamus
Mango Mesocarp
Guava Entire fruit
Grapes Pericarp and placenta
Papaya Mesocarp
Coconut Endosperm
Tomato Pericarp and placenta
Banana Mesocarp and Endocarp
Wheat Starchy endosperm
Cashew nut Peduncle and cotyledons
Lichi Aril
Gram Cotyledons and embryo
Groundnut Cotyledons
Mulberry Entire fruit
Jackfruit Bract, Parianth and seed
Pineapple Bract, Parianth
Orange Juicy hair

COMMON NAMES OF CHEMICAL COMPOUNDS

	Compounds	Formula
Baking Powder	Sodium Bicarbonate	$NaHCO_3$
Blue Vitriol	Copper Sulphate	$CuSO_4.5H_2O$
Bleaching Powder	Calcium Oxychloride	$CaOCL_2$
Chloroform	Trichloro Methane	$CHCl_3$
Chalk (Marble)	Calcium Carbonate	$CaCO_3$
Caustic Potash	Potassium Hydroxide	KOH
Caustic Soda	Sodium Hydroxide	NaOH
Dry Ice	Solid Carbondioxide	CO_2
Epsom	Magnesium Sulphate	$MgSo_4$
Gypsum	Calcium Sulphate	$CaSO_4$
Green Vitriol	Ferrous Sulphate	$FeSO_4$
Heavy Water	Deuterium Oxide	D_2O
Vinegar	Acetic Acid	CH_3COOH
Washing Soda	Sodium Carbonate	Na_2CO_3
Slaked Lime	Calcium Hydroxide	$Ca(OH)_2$
Potash Alum	Potassium AluminiumSulphate	$KALSO_4$
Quick Lime	Calcium Oxide	CaO
Plaster of Paris	Calcium Sulphate	$CaSO_{4}{}_{2}H_2O$
Mohr's Salt	Ammonium Ferrous Sulphate	$FeSO_4.(NH_4)_2SO_4.6H_2O$
White Vitriol	Zinc Sulphate	$ZnSO_4.7H_2O$
Marsh Gas	Methane	CH_4
Magnesia	Magnesium Oxide	MgO
Laughing Gas	Nitrous Oxide	N_2O
Vermelium	Mercuric Sulphide	HgS
Sugar	Sucrose	$C_{12}H_{22}O_{11}$
T.N.T	Trinitrotoluene	$C_7H_5N_3O_6$
Sand	Silicon Oxide	SiO_2

SUGGESTED WEBSITES:

WWW.SPACEANDMOTION.COM
WWW.42EXPLORE.COM
WWW.ENCYCLOPEDIA.COM
WWW.VULUMS.VU.EDU.PK
WWW.FOSSIL-MUSEUM.COM
WWW.EVOLUTIONDOCUMENTARY.COM