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SCIENCE & TECHNOLOGY

I. Physics

1. Concepts:

Mass: It is the quantity of matter contained in a body. It is measured in Kilogram or Grams

Weight: Is the downward force acting on a body due to the attraction of the earth. It is measured in Newtons or Dynes (the same units as force).

Mass and Weight: An ordinary pair of scales helps us to compare masses and not the weights, for both the substances in the pans are equally affected by gravity - the force with the earth attracts bodies. In case of spring balance we measure the weight, for an increase in the length of the spring depends upon the force pulling it downwards. Note that the weight of a body differs at different places on the earth, on account of the variation in gravity, but its mass remains the same. Similarly, body will have the same mass on the Moon as on Earth whereas its weight on the Moon will be a sixth of its weight on Earth.

Mass is measured in kilograms, grams or pounds, whereas weight is measured in Newtons or Dynes (1 Newton = 107 Dynes).

Internationally, it is measured in terms of a kilogram.

1000 grams = 1 kilogram.	1 milligram = of a gram.
1 kilogram = 2.2 lbs. Approx.	1 litre of water weighs 1 kgm.
1 pound weigh 453.6 gms.	1 cubic centimeter of water weighs 1 gram.

Density: The mass contained in a unit volume of a body is called its density. It can be expressed in terms of Kg/Litre or Gm/Cubic Centimeter. A substance having more density will obviously occupy lesser space as compared to another substance having lesser density. For instance, you may be able to store 1 Kg. gold in a small container, but you may find it difficult to contain cotton in the same container for the simple reason that gold is having more density as compared to cotton.

Specific Gravity: Is the ratio of the mass of a given volume of the substance to the mass of an equal volume of water.

Illustrations:

(i) Lactometer is a kind of hydrometer which is immersed in milk to test its density and it is based on the principle that the greater the density of a liquid the lesser will be the immersion.

(ii)The ship floats on the surface of water because the weight of water that it displaces is equal to its own weight.

(iii) Ice floats on water because its weight is less than the weight of an equal volume of water, and is equal to the weight of water actually displaced by its immersed portion.

Stream-lining: Is the designing of the fast moving bodies, i.e., locomotives and airplanes etc., in such a way as to minimize the resistance of air. All modern cars, locomotive or airplanes are streamlined. An example of a streamlined vehicle is the Maruti 800 car, while an example of a non-streamlined vehicle is an ordinary bus.

Motion: Motion is the change of position of a body with respect to its surroundings.

Speed: Is the rate of motion. It is a scalar quantity, i.e., it does not have direction. Velocity is the rate of motion in a particular direction. It is a vector quantity, i.e., it possesses both magnitude and direction. Thus in a uniform circular motion, though the speed remains constant, the velocity continually goes on changing.

Uniform speed: When a body traverses equal distances in equal intervals of time, however small the interval of time may be, it is said to have a uniform speed.

Acceleration: Is the rate of increase of velocity. Its units are m/s2. When a physical object falls freely under the influence of the gravitational pull of the Earth, the acceleration with which it falls below is known as the Acceleration of Free Fall or Acceleration due to gravity (9.8 m/s2).

Retardation or Deceleration: Is the rate of decrease of velocity. Force is that which changes or tends to change the state of rest or of uniform motion of a body in a straight line.

Newton's First Law of Motion: States that a body continues in its state of rest or of uniform motion in a straight line unless compelled by an external force to change that state. This law can be reworded like this: "Departure from a straight line motion path indicates the presence of an external force."

Illustrations:

(i) A man jumping of the moving train falls forward because his feet suddenly come to rest, while his body is in motion with the train.

(ii) A running person falls down when is foot stumbles against a stone. This is because the foot is brought to rest while the upper part remains moving.

(iii) **Centripetal Force:** When a small piece of stone tied to a string is whirled, one has to pull the string inwards. This pull on the stone is called the centripetal force. An equal and opposite force is exerted by the stone on the hand. This force on the hand is called centrifugal force. Thus centripetal force is directed towards the center while centrifugal force is directed away from the centre.

Illustrations:

(i) Mud sticking to a bicycle tyre is pulled in radially by the force of adhesion; when the latter force is less than the centripetal force required to move the mud in a circle, the mud files off tangentially.

(ii) The sparks, which fly off from the grinding stone of a blacksmith, are also due to the same phenomenon.

(iii) Curved roads or rail tracks are banked or raised on one side so that a fast-moving train or a motor car leans inwards, thus providing the required centripetal force to enable it to move round in curve.

(iv) A cyclist while rounding a curve leans inwards so as to provide him with the necessary centripetal force, which would enable him to take a turn on the circular path.

(v) In a laundry, wet clothes are whirled in a large vessel the sides of which are perforated with hundreds of small holes. The water is thrown off at a tangent through these holes, and clothes thereby get dried soon.
(vi) In a dairy, cream is separated from the rest of the milk, (skimmed milk) by means of a cream separator. The principle is that heavier the body the greater is the centripetal force required by it to move in circle. Skimmed milk is heavier than cream, its particles require a greater force to move than the cream particles, and, therefore, the former remains nearer the walls of the spinning vessel, and the latter remains near the axis.

Newton's Second Law of Motion: States that the rate of change of momentum is in proportion to the impressed fore and takes place in the direction of force. The harder a football is kicked, the faster will it move, and it will move in the same direction in which it is kicked.

Newton's Third Law of Motion: Says that to every action, there is an equal and opposite reaction.

Illustrations:
(i) If we step out of a boat, we go in one direction and the boat goes in the other direction.
(ii) When a bullet is fired from a gun, the bullet goes forward and the gun kicks backward. This is called the recoil of the gun. **Unless there is action we cannot have reaction.**
(iii) We cannot drive a nail into a wooden block unless it is supported against something to offer reaction.
(iv) We cannot cut a piece of paper with one blade of a pair of scissors, since there will be no reaction.
(v) When a man wants to walk or run, he presses the ground backward with his feet. The ground, therefore, exerts an equal and opposite force on the man. This force acting on the man enables him to move forward.
(vi) In order to fly an airplane the engine is first started and the propellers or blades are made to revolve rapidly. These blades are curved in such a way that, on revolving, they throw the air back with a great force, and consequently the air pushes them forward with an equal and opposite force. Hence, if the obstacles placed before the wheels are removed, the airplane runs forward at a great speed.

Gravity: Is the pull of the earth with which it attracts bodies towards itself.

Law of Gravitation: States that "every particle in this universe attracts every other particle with a force which is directly proportional to the product of other masses and inversely proportional to the square of the distance between them." We believe this law to be true because the motion of heavenly bodies can be easily explained by this law. Astronomical calculations based on this law predicted the existence of new stars.

(i) The forecasts of eclipses of the sun and the moon are made several years in advance.
(ii) It is theoretically quite true that we cannot move a finger without disturbing all the stars. When we move our finger the distance between the finger and the star will change. Hence the force of gravitation exerted by the finger on the star will also change. Owing to the change of force caused by the moving of our finger, the position of every star will be disturbed. Of course, the effect is very negligible.

Relative Velocity: Is the velocity of one body in relation to another body. Supposing a body A moves with a velocity of 10 miles per hour towards the east and another body B moves in the same direction with a velocity of 5 miles/hour, then relative velocity of A with respect to B is 5 miles/hour to the east and that of B with respect to A is 5 miles/hour to the west. Relative velocity produces certain interesting effects. For example, to a man standing still in rain with an umbrella, the rain appears to fall vertically. But if the man were to drive a car in the rain, the rain will appear to fall at a slant.

Momentum literally means the quantity of motion in a body. Mathematically, Momentum = mass x velocity of the body. Thus force is equivalent to mass x acceleration of the body.

Erg: Is the amount of work done when a force of a 1 dyne moves a body through 1 cm. in the direction of the force. It is the C.G.S. unit of work. Joule is the international unit of work and is equal to 107 ergs.

Power: The rate of doing work is called Power. Horse Power is a unit of power (1 H.P. = 746 watts). 1 Watt (= 107 erg/sec.) is S.I. unit of power.

Energy: The capacity of doing work is called Energy. This is of two types: Potential Energy is the energy which a body possesses owing to its position and Kinetic Energy is the energy possessed by a body due to its motion. In the case of stretched or wound up string or bent how, the energy is potential. The ball lying on the roof of a house is capable of driving a nail into the ground, if allowed to fall on it. A watch spring when wound up possesses energy to keep the wheels of the watch in motion for a day. Each one provides an example of Potential Energy. On the other hand, the water flowing downstream on account of gravity is, by virtue of its motion, capable of setting a water mill in motion. Similarly, a bullet shot from a gun pierces through objects and overcomes resistance offered by them. Each one here provides an example of Kinetic Energy.

Equilibrium: When all the forces acting on a body produce no change in its state of rest or motion, it is said to be in equilibrium. The equilibrium is called stable when the body after being disturbed is let free, it returns to its former state of rest, e.g., a tub lying on a smooth table. The centre of gravity of a stable body is normally in the lowest position, and it is raised when disturbed. The equilibrium is called unstable when the body on slight displacement moves further off from its original position, e.g., a brick resting on a small face. In this case the centre of gravity gets lower on being disturbed. The equilibrium is called neutral when on slight displacement it neither comes back to its original position nor topples over but simply rolls, e.g., a ball. In this case the centre of gravity is unaffected, i.e., it remains at the same height from the base. A body is in stable equilibrium when its centre of gravity is as low as possible.

Illustration: A boat would capsize and it would not move easily, if the men were standing in it than it would, if they were all sitting. The stability of an object may be increased by enlarging the base, and by having the centre of gravity as low as possible. Leaning tower of Pisa which is 179 ft. high leans 3 ft. out of the vertical, and is still in stable equilibrium. It is because the vertical line through the centre of gravity falls within the base. It is for this reason that a rope dancer uses an umbrella; a man carrying a heavy load on his back bends forward; and it is for this reason that it is more convenient to carry two buckets in two hands than carry one only in one hand.

Principle of work: Input = output

Work done on a machine = Work done by the machine

What we gain in power, we lose in speed or distance. A screw jack lifts a huge car through small distance by the application of small force through a large distance. The various kinds of simple machines are: lever, wheel and axle, pulley, inclined plane, wedge and screw.

Surface Tension: The force of tension on account of the inter-molecular forces on the surface of a liquid is called surface tension. The effect of surface tension is to make the area of the free surface as small as possible. It is on account of this fact that rain drops are spherical, and the free surface of water is plain like a stretched membrane. Another effect of surface tension is to raise liquids in capillary tubes. The rise of kerosene oil in a lamp wick or the absorption of ink by a blotting paper or the raising of melted wax in the wick of a candle is due to the capillary action. Bricks and mortar are porous so that the water of the soil rises through them by capillary and keeps them constantly damp.

Viscosity: Is the force of drag between molecules of the same substance. For example, honey pours itself into a container very slowly as compared to water or milk. This is simply due to the fact the honey molecules exercise a lot of backward acting force on the molecules which want to leave their field. Owing to this, honey or glycerine pour themselves very slowly while water and milk do not.

Pascal's Law: The liquids transmit pressure equally in all directions. If a vessel has two pistons A and B, cross section area of piston B being twice that of A, then if A is pushed in with a force of 1 lb, B will be pushed out with a force of 2 lbs. This principle is employed in Brahma Press or Hydraulic Press.

Archimedes' Principle (The Eureka! Experience) Says that when a body is immersed in a fluid, it experiences an upward thrust. The upward thrust or loss of weight is equal to the weight of the fluid displaced.

A ship's hull is so shaped that the weight of steel and other parts together with the weight of the cargo and air inside are equal to the weight of the water displaced by the immersed portion; and hence it floats. An iron nail displaces such a small volume of water because of its tiny profile that the upward thrust generated is much less than the weight of the nail. Hence it sinks. On the other hand, a piece of straw of the same profile floats because its low weight is easily supported by the upward thrust set up. A man can float on the surface of a river more easily by filling his lungs with air than when he has emptied them by breathing out. This is the principle of life jackets also. They prevent a man from drowning when inflated.

Pressure: Air has a weight and therefore it exerts pressure on the surface of the earth. Pressure is defined as force per unit area.
Atmospheric pressure = weight of 76 cm of Mercury column
Considering the average area of a human body as 1.3 sq. metre the total pressure (or force) acting on a human being is about 13.4 metric tons, which is enormous but our bodies have been adjusted to this in its long evolutionary history. The pressure 150 m below the surface of the ocean is 16 atmospheres and at the height of around 16 km above the surface of the earth, it is less than 1/6th (0.156 atmosphere) of the atmospheric pressure. The instrument used to measure pressure is called barometer.

HEAT:

Effects of heat

1. Raises temperature
2. Increases volume
3. Changes state
4. Brings about chemical action
5. Changes physical properties

Illustrations:

(i) On a hot day while cycling on a road if we touch the handle of a bicycle, the handle will seem to be otter than the grips because the handle is a good conductor of heat and when we touch any part of it, heat flows to the hand, not only from the part but also from the neighboring parts: whereas in the case of grips the heat flows to the hand from only that part which is touched. The handle seems hotter because it is a good conductor of heat and the flow of heat to the hand is greater and more rapid than in the case of the grips.

(ii) The rails on a railway line are laid with a small gap between them so that with a rise in temperature in summer the gap would provide room for expansion.

(iii) The iron tyre of a cart wheel is always made a bit smaller in diameter than the wooden wheel. After making the tyre red hot, it is slipped on the wheel, and water is poured on it. On cooling the iron tyre contracts, and holds the parts firmly together.

Temperature: It is the degree of hotness, and it can be measured on three scales: Centigrade, Fahrenheit, Reaumur and Absolute or Kelvin scales. The freezing and boiling points of water in these scales are as follows:

Freezing Point	Boiling	Point
Centrigrade	0^0	1000
Fahrenheit	320	2120
Reaumur	00	800
Kelvin or Absolute	273.150	373.150

They are related to each other as

$$\frac{C}{100} = \frac{F-32}{180} \frac{R}{80} = \frac{K-273.15}{100}$$

In Kelvin scale the Triple Point of water (0.010C) is taken instead of freezing point. On this scale Kelvin temperature is 273.160. Normal temperature of the human body is 98.40F (370C).

Calorie: Is a unit of heat. It is equal to the heat given to one gm of water to raise its temperature by 1^0C.

Latent Heat: Is the heat which is used up in changing the state of a body without raising its temperature. One gram of ice at 0^0C takes in 80 calories of heat to change into 1 gm. of water at 0^0C and one gram of water at 100^0C needs to be given 537 calories of heat to change it to 1 gm. of steam at

100^0C. 80 cal. and 537 cal. are called the latent heat of fusion of ice and latent heat of vaporization of water respectively.

Illustration:

(i) Burns from steam at 100^0C are more severe than burns from hot boiling water at 100^0C. This is because, as stated above, 1 g of water at 100^0C needs to be given 537 calories of (latent) heat to change it to 1 g of steam at 100^0C. Thus steam packs this much more heat than boiling water and so causes burns more severely.

Evaporation: It is the change of state from liquid to vapour. Cooling is caused by evaporation.

1. We feel cold immediately after sprinkling water on our body. It is because the evaporation of the water gives the cooling effect.

2. When the forehead of a person is sponged with Eau-de-cologne, he feels refreshed for the liquid which contains a large proportion of alcohol evaporates quickly, and takes away much of the local heat.

3. For the same reason a wet khus screen hung on the doors of a room keeps it delightfully cool.

Transference of Heat: Heat can be transferred in three ways:-

(a) Conduction is a process in which heat is transferred from particle to particle.

For example, when one end of a metal rod is put in the fire the other end outside gets hot. Here heat travels from one end to the other by conduction. The rate of heat flow is directly proportional to the cross sectional area of the rod and inversely proportional to its length. That is why long thin handles are preferred for parts used in foundry work and in cooking.

(ii) Tea kettles have wooden or plastic handles, because these are poor conductors of heat. Gases are very poor conductors of heat.

Illustrations:

(i) The warmth of woolen clothing is mostly due to the presence of air in the minute spaces in the cloth. Such spaces which contain air, do not let the outside cold to reach the body and simultaneously do not allow the body heat to escape from it, thus leading to a sense of warmth.

(ii)People in the Arctic regions make double-walled houses to live in. The air between the walls being a bad conductor does not allow the heat inside to go out. The same principle applies to thermos flasks, which contain a double layer of coated walls to prevent the escape of heat from inside.

(b) Convection: Is the transmission of heat from one part of the body to another by the actual motion of the heated particles of liquid or gas.

Illustration: Ventilation is an application of the convection currents in gases. The air in a dwelling room is always warmer than the free air outside, and hence it rises upwards and passes out through the ventilators, while cold fresh air comes into the room through the doors and windows to take its place.

(c) Radiation: It is the process by which heat is transmitted from one point to another without heating the medium. It takes place through the Electro-magnetic waves.

Illustrations:

(i) Thermos flask is a glass vessel with double walls, the space between the walls being vacuum. The outer surface of the inner walls and the inner surface of the outer walls are silvered. The vacuum does not allow the conduction and convection to take place and the polished surface minimizes radiation of heat.

(ii) While linen is more suitable in summer as it absorbs very little of the sun's rays. Black clothing is preferred in winter, for it absorbs almost the whole of the incident radiation, and thus it gives more warmth.

(iii) It is warm on a cloudy night because the heat radiated by the earth is obstructed, and thus trapped in the atmosphere by the clouds.

(iv) Dew is more copious on a clear night because radiation takes place freely so that the surface of the earth cools rapidly.

Water possesses the maximum density at 4^oC. This fact plays a very important part in nature. The cooling of water in winter goes on till the ponds and tanks are all at 4^oC. Further cooling results in the water at the surface becoming lighter and, therefore, remaining at the top, leaving the water at the bottom 4^oC, and hence unaffected. The cooling of the top layers may be so much that they may entirely freeze. Since ice is a bad conductor of heat, it does not allow the layers below the ice to be cooled by the cold outside. This enables aquatic animals to continue to live in the most severe winter.

The melting point of a substance which expands on freezing (water on becoming ice) is lowered by the increase of pressure; whereas it is raised in the case of substance which contracts on freezing (e.g. wax).

Latent Heat of Vaporization: Is that amount of heat which is needed to convert a unit amount of a liquid into gaseous state e.g. water (540 calories/gm.). This is too high and that is why burns caused by steam are much more dangerous as compared to those caused by water at the same temperature, because steam contains this much heat into addition to its high temperature.

Latent Heat of Fusion: Is the amount of heat to change the state of a unit amount of solid into liquid state. For example, ice has a high value of latent heat. If it were low, ice would melt very soon and disastrous floods would result. Moreover, the ponds and lakes would freeze very much sooner than they do at present.

LIGHT

Rectilinear Propagation of Light: Light travels in a straight line. This is why we place a small obstacle between the object and our eyes, when we do not want to look at it. Shadows are formed due to the same phenomenon of rectilinear propagation of light.

Reflection: When a ray of light falls on a mirror, it is sent back to the first medium in a certain direction according to certain laws. This is referred to as reflection. Many day-to-day phenomena can be easily explained with the help of this principle.

Illustrations:

(i) When an object is placed between two mirrors parallel to each other we see infinite images due to successive reflections. They look smaller because their distance from the eye is successively increased.

(ii) Construction of a toy, called kaleidoscope (made by using small pieces of mirror and pieces of broken bangles) is due to successive reflection at the surface of inclined mirrors.

(iii) When a candle is placed close in front of a thick glass mirror and we look somewhat obliquely at the mirror, a number of images are seen due to multiple reflections. Of these the images nearest the candle will be brightest of the series. The other images formed gradually decrease in brightness. The first image is formed by the light which is reflected from the front surface at the back, it is all reflected to the front surface, where some of it is reflected back to the silvered surface and is again reflected to the front surface and so on. Each time some light comes out showing one image.

Refraction: Is there when a ray of light is incident obliquely on a surface of separation between two media, part of it goes into the second medium along a path different from the direction of the incident beam.

(i) A pond looks shallower than it really is because of refraction. When rays start from a denser to a rarer medium, the rays get bent away from the normal. Hence a point at the bottom of the pond appears to be raised.

(ii) It is due to refraction that a stick immersed in water appears bent.

(iii) The brilliance of a diamond is due to the fact that when light enters a piece of diamond, on account of high refractive index (and consequential small critical angle) and the cut of its face, it gets totally reflected at most of the face. The few faces from which it comes out throw a good deal of light and make them appear brilliantly lit.

(iv) Air bubbles in water and cracks in transparent bodies appear glittering due to total internal reflection.

(v) Mirage is an optical illusion owing to total internal reflection. In sandy deserts the air in contact with the hot earth is rarer than the upper layers. As we go towards the earth the density of the air goes on decreasing. Hence the rays of light from a distant object traverse through successively rare layers and hence go on bending away from the normal and ultimately get totally reflected at the rarest layer, and reach the observer's eye as if they come from a point as far below the reflecting layer as the object is above it. Since these layers of air are shaking the inverted image as seen by total internal reflection also is shaking, giving man the illusion of 'splashing water everything'.

(vi) Stars twinkle because the atmospheric air close to the earth is disturbed by convection currents and on account of passing through such disturbed 'areas', the light from a star travelling in a given direction sometimes comes through and sometimes is deflected away.

ELECTRICITY & MAGNETISM: Magnet is a substance which has the property of attracting pieces of iron, cobalt and nickel, and when freely suspended, it points towards North and South.

Natural Magnet: A naturally occurring mineral called magnetite is found in Asia.

Minor: It is a compound of iron and oxygen. It is also called lodestone. It attracts piece of iron, cobalt and nickel and when suspended points in the north-south direction. It is a natural magnet.

Artificial Magnets: These are pieces of iron to which the properties of a magnet have been imparted by artificial means. Steel is mostly employed for making permanent artificial magnets.

How does lightning strike a building?: Let us consider a charged cloud hanging over the earth. By induction, the earth and other bodies below get charged with opposite kind of electricity. When the strain becomes too great the insulation of moist air in between, breaks down and the discharge takes place between the cloud and some object below it. A heavy charge thus passes between the cloud and building, and in its passage damage the building.

Current Electricity: When two vessels filled with water up to different levels are connected together, water flows from the higher to the lower level. Similarly when two bodies having different 'degrees of electrification' are connected together, electricity flows from higher 'degree of electrification' to the lower, and this gives rise to current electricity.

Potential: Is called the degree of electrification. For example, in a dry cell, the metal tip at the top of the carbon rod is at a higher (positive) potential than the zinc cylinder, which is at a lower (negative) potential. If these two ends are connected by means of a conducting wire to a bulb, it will keep on glowing, till the difference of potential between the carbon and zinc in the cell is maintained.

Heating Effects of Current: When an electric current is passed through wire of any metal it experiences (electron) resistance to its flow. This resistance manifests itself as heat and light, the proportion of the two depending on the properties of the material. In wires of Nichrome, more heat is produced than light. Construction of electric heaters, electric tea-kettles, stoves, boilers, electric irons, etc., is based on the heating effects of electric current. The heat H, produced when a current I amperes flows through a conductor is given by Joule's Law.

$$\text{i.e., } H = VIt \text{ Joules}$$

Where V is the potential difference in volts, and t is the time for which the current flows.

$$\text{Or } H = I^2Rt$$

Lighting Effects: When an electric current is passed through a long thin wire of platinum, tungsten or carbon, the wire offers resistance to the passage of current. It becomes white hot and glows. Thus light is produced by electric current. Electric bulbs are constructed on this principle. An electric lamp usually consists of a thin wire of tungsten, enclosed in glass bulb. The bulb is first evacuated and then some nitrogen or argon is filled which retards the vaporization of the filament and hence permits the filament to be heated to higher temperature.

Magnetic Effects: When an electric current is passed through a coil of insulated copper wire wrapped around a soft iron core then the steel or soft iron placed in the coil becomes a magnet. This is due to the magnetic field which is produced in the coil due to passage of current through it. This magnetic effect is made use of in making electromagnets used in electric bells, telegraphy, dynamos, etc.

Microwaves: Electromagnetic waves having a wavelength in the centimeter range and occupying a region in the electromagnetic spectrum between Radio waves and Infrared waves.

Microwave Cooker: It uses microwaves for food processing. In conventional heating, a heat source (like the flame of a gas stove) transfers heat to the foodstuffs by conducting, convection or radiation; the surface of the foodstuff is first heated after which heat is slowly transferred to the interior. Microwave heating is bulk heating since there is direct conversion of microwave energy into heat throughout the material, hence it is faster. Microwaves interact differently with different materials. They pass through paper, glass, ceramics; hence they make good containers for foodstuffs for microwave cooking. They are reflected by metals; hence containers should never be metallic. They are absorbed by and so heat up food products, water etc. Apart from dramatically reducing cooking times, microwave cooking increases the efficiency of energy utilization.

SOUND: Sound is a form of energy which produces a sensation of hearing. Sound waves are longitudinal in character. These can propagate in solids, liquids and gases. Human ear is sensitive to frequencies from about 20 cycle/s are called infrasonic and those above 20,000 cycle/s are called ultrasonic. The sound waves originate in the vibration of bodies like strings, air columns plates and membranes etc. In human being the vocal cards vibrate to produce sound. In air the speed of the sound is affected by pressure, temperature, density, humidity and wind speed. In dry air at 0^oC the speed in about 331 m/s. It travels faster in damp air or the speed also increases with temperature. In water at 15^oC the speed in about 1450 m/s and in iron at 20^0C is about 5130 m/s. When expressed in decibels (dB) the intensity of the loudest painless sound equals 120 dB. The normal conversation has the intensity of about 65 dB. The intensity of the sound from a nearby airplane is about 120 dB. The intensity varies inversely as a square of the distance from the source.

Sound shows the phenomenon of reflection, refraction, interference and diffraction. Sound waves which are approximately periodic give rise to pleasing sensation (if there are no sudden changes in loudness) e.g. musical sounds, like humming of a bee. Sound waves with no regularity or a super position of periodic waves having very large number of components is heard as noise. The three characteristics of sound are

(i) loudness (ii) pitch and (iii) quality

Loudness is determined by the intensity of sound or the degree of sensation produced in the ear drum. Pitch is directly proportional to the frequently of sound. Higher the pitch the shriller is the sound. The sound of women has higher pitch. Quality is that characteristic of sound which distinguishes between tow sounds of the same pitch and same loudness. It is because of the quality that different musical instruments produce different sound. It is on account of the quality that we recognize a person’s voice while talking on a telephone.

2. Area wise Summary of Key Concepts

Newtonian mechanics

Kinematics

1. Distance is the total length that an object in motion covers. Displacement is a vector quantity that indicates the change in position that an object moves in a particular direction. Average speed is the distance covered per unit time. Average velocity is the displacement divided by the time interval.
2. Acceleration occurs whenever there is a change of speed or direction of motion.
3. Free fall problems can be solved like other acceleration problems by substituting 'a' for
'g' = 9.8 m/s2. The sign of 'g' is (+) or (-) depending on the choice of up or down as the positive direction.
4. A ball rolled off a horizontal table will take the same amount of time to hit the ground as another dropped from the same height.
5. Projectile motion:
a. horizontal and vertical components are independent,
b. the horizontal component of the velocity remains constant, the vertical component has constant acceleration 'g',
c. only the vertical component of the velocity at the maximum height is zero,
d. for projectiles fired at an angle you may assign negative signs to all vectors going down.

Forces

6. Force is a vcetor quantity, with Newton and Dyne being the mks and cgs units respectively.
7. Newton's First Law: for objects at rest or moving at constant velocity the net force is zero.
8. For Newton's Second Law: a net unbalanced force produces acceleration.
9. The normal force and the gravitational force are not an action-reaction pair.
10. Static friction exists between two surfaces when motion is impending; kinetic friction occurs when two surfaces are in relative motion. In either case, the friction forces are proportional to the normal force.

Work, Energy And Momentum

12. Work and energy are scalar quantities.
13. Work is equal to the product of the displacement and the component of the force in the direction of the displacement.
14. For an object traveling in circular motion, the centripetal force never does work.
15. Mechanical energy is the sum of all kinetic and potential energies.
16. Work-Energy Theorem: the net work is equal to the change in kinetic energy.
17. Conservation of mechanical energy under the action of a dissipative force includes the work due to frictional forces (non-conservative forces).
18. Power is the time rate of change of work or energy, but it can also be calculated using force x speed.
19. The impulse is the product of the average force and the time interval through which it acts. Impulse is equal to the change in momentum.
20. Momentum is conserved in all collision systems. Kinetic energy is conserved only in elastic collisions.
21. Objects stick together in perfectly inelastic collisions.

Circular Motion And Gravitation

22. Uniform circular motion refers to motion in a circle where the speed is constant and only the direction changes. The change in direction produced by a central force is called centripetal acceleration.

23. The centripetal force is not a special kind of force; therefore never label a force on a free-body-diagram as 'centripetal'. The centripetal force is provided by the component of the force that is directed towards the center of the circular path e.g. friction, tension, gravity, normal, etc.

24. The gravitational force is directly proportional to the product of the masses and inversely proportional to the square of the distance between them.

Oscillations

25. Simple harmonic motion is periodic motion in which the restoring force is proportional to the displacement.

26. The maximum displacement of an object from its equilibrium position is the amplitude.

27. At the maximum displacement the object experiences the maximum acceleration and maximum elastic potential energy.

28. At the equilibrium position the object experiences zero acceleration, maximum velocity and maximum kinetic energy.

29. The period of a pendulum depends on its length and the value of 'g' at that particular location.

30. The period of a mass-spring system depends on the mass and the spring constant 'k'.

Fluid Mechanics And Thermal Physics

Fluid Mechanics

31. Absolute pressure is equal to the gauge pressure plus the atmospheric pressure.

32. Fluid pressure is independent of the shape or area of the container.

33. Archimedes' Principle: An object that is completely or partly submerged in fluid experiences an upward force (buoyant force) equal to the weight of the fluid displaced.

34. An object will float (sink) in a fluid if the density of the object is less (greater) than the density of the fluid.

35. The submerged fraction of an object is the ratio of the submerged volume to the total volume or the ratio of the density of the object to the density of the fluid.

36. Pascal's Principle: An external pressure applied to a confined fluid is transmitted throughout the fluid.

37. Bernoulli's Equation: The net work done on a fluid is equal to the changes in kinetic and potential energy of the fluid in terms of quantities per volume.

Thermal Energy And Thermodynamics

38. Thermal energy represents the total internal energy of an object, the sum of its molecular kinetic and potential energies.

39. Kinetic theory relates the average kinetic energy of the molecules in a gas to the temperature of the gas in Kelvins.

40. First Law of Thermodynamics: $\Delta U = W + Q$

Where W is the work done ON the system.

41. Thermodynamic Processes:

- Adiabatic process: $Q = 0$
- Isovolumetric (isochoric) process: $W = 0$

- Isothermal process: $\Delta U = 0$
- Isobaric process: $\Delta U = W + Q$

42. On a PV diagram, if the cycle is clockwise the system is a heat engine and the net work is negative. If the cycle is counterclockwise the system is a refrigerator and the net work is positive.

42. Carnot cycles involve only isothermal and adiabatic processes. To determine the efficiency use the Kelvin temperatures of the reservoirs.

44. Second Law of Thermodynamics:

- Heat flows naturally from an object at higher temperature to one of lower temperature.
- All natural systems tend toward a state of higher disorder (entropy).

Electricity and Magnetism

Electricity

45. Coulomb's Law: the force of attraction or repulsion between two point charges is directly proportional to the product of the two charges and inversely proportional to the square of the separation between the charges.

46. Use the sign of the charges to determine the direction of the forces and Coulomb's Law to determine their magnitudes.

47. Electric forces and electric fields are vectors, electric potentials are scalars.

48. Electric fields point in the direction of the force on a positive test charge.

49. The electric field inside a closed conductor is zero. Outside the conductor the electric field is not zero and the electric field lines are drawn perpendicular to the surface.

50. Electric field lines are perpendicular to equipotential lines.

51. Electric fields between two parallel plates are uniform in strength except at the edges.

52. The electric potential energy increases as a positive charge is moved against the electric field, and it decreases as a negative charge is moved against the same field.

53. The energy gained by a charged particle that is accelerated through a potential difference can be expressed in electronvolts (eV). (1 eV = 1.6x10-19 J)

54. The electric potential (V) is equal to the work per unit charge.

55. No work is done in moving a charged object along an equipotential line.

56. Capacitance is the ratio of charge to the potential for a given conductor.

57. The capacitance for a parallel-plate capacitor depends on the surface area of each plate, the plate separation and the permittivity or dielectric constant.

58. A source of electromotive force (emf) is a device that converts chemical, mechanical, or other forms of energy into electric energy.

59. Resistance depends on the kind of material (resistivity), the length, cross-sectional area, and temperature. Resistance is proportional to length and inversely proportional to cross-sectional area.

60. All resistors in parallel have equal voltage. Adding a resistor in parallel decreases the total resistance of a circuit.

61. All resistors in series have equal current. Adding a resistor in series increases the total resistance of a circuit.

62. Voltmeters have a high resistance (to keep from drawing current) and are wired in parallel (because voltage is the same in parallel). Ammeters have a low resistance (to keep from reducing the current) and are wired in series (because current is the same in series).

63. Kirchhoff's First Rule: The sum of all the currents entering a junction point equals the sum of all the currents leaving the junction point. This rule is based on the conservation of electric charge.
64. Kirchhoff's Second Rule: The algebraic sum of all the gains and losses of potential around any closed path must equal zero. This rule is based on the law of conservation of energy.
65. All capacitors in parallel have equal voltage. The total charge is equal to the sum of the charges and the effective capacitance is the sum of the individual capacitances.
66. All capacitors in series have equal charge. The potential difference across the battery is equal to the sum of the drops across each capacitor.
67. For circuits that contain capacitors and resistors:
- A capacitor that is empty allows the flow of current such as a wire.
- A capacitor that is full acts like a broken wire.

Magnetism

68. Magnetic fields point from the north to the south outside the magnet.
69. A particle entering a magnetic field between two plates will follow a circular path. The magnetic force provides the centripetal force.
70. Magnetic force on a charged particle is at its maximum when the field and velocity vectors are at right angles. The force is at a minimum (0) when the field and velocity vectors are parallel or antiparallel.
71. Right hand rules are for positive charges, for negative charges the direction is the opposite of the one found with the right hand rule.
72. Moving electric charges (current) creates magnetic field (Oersted), but a changing magnetic field creates an electric current (Faraday).
73. Relative motion between a conductor and a magnetic field induces an emf in the conductor.
74. The direction of the induced emf depends upon the direction of motion of the conductor with respect to the field.
75. The magnitude of the emf is directly proportional to the rate at which the conductor cuts magnetic flux lines.
76. According to Lenz's law, the induced current must be in a direction that opposes the change that produced it.

Waves and optics

Waves and sound

77. Transverse wave particles vibrate perpendicular to the wave direction and longitudinal wave particles vibrate parallel to the direction of the wave propagation.
78. Sound waves are mechanical longitudinal waves. Light waves are electromagnetic transverse waves.
79. The speed of a wave depends only on the properties of the medium.
80. The energy of a wave is directly proportional to the square of the amplitude.
81. The intensity of sound is inversely proportional to the distance.
82. Superposition Principle: When two or more waves exist simultaneously in the same medium, the resultant amplitude at any point is the algebraic sum of the amplitudes of each wave.
83. The harmonics produced in open pipes are similar to those produced in strings. The fundamental occurs when the length of the pipe (or string) equals 1/2 λ.
84. The fundamental on a closed pipe occurs when the length of the pipe equals 1/4 λ. Only the odd harmonics are possible for a closed pipe.

85. Whenever two waves exist simultaneously in the same medium and they are nearly at the same frequency, beats are set up.

86. Doppler effect is the apparent change in frequency of a source of sound when there is relative motion of the source and the listener.

Geometrical And Physical Optics

87. The wave behavior of light is proven by diffraction, interference and the polarization of light.

88. The particle behavior of light is proven by the photoelectric effect.

89. The electromagnetic spectrum (radio, microwaves, infrared, visible, ultraviolet, x-ray and gamma rays) is listed from lowest frequency to highest (longer to smaller wavelength).

90. The range of wavelengths for visible light goes from 400 nm for violet to 700 nm for red.

91. All angles in reflection and refraction are measured with respect to the normal.

92. At the critical angle a wave will be refracted to 90 degrees.

93. Total internal reflection occurs at angles greater than the critical angle.

94. Light rays bend away from the normal as they enter a lower index of refraction medium while the frequency remains constant.

95. Light bends toward the normal and has a shorter wavelength when it enters a higher index of refraction medium while the frequency remains constant.

96. In Young's double-slit experiment interference and diffraction account for the production of bright and dark fringes.

97. Single slit diffraction produces a much wider central maximum than double slit.

98. Waves in phase undergo constructive interference; waves out of phase ($1/2\ \lambda$) will undergo destructive interference.

99. When light reflects from a medium with higher index of refraction than that of the medium in which it is traveling, a 180° phase change ($1/2\ \lambda$) occurs.

100. For a single optical device, real images are always inverted and virtual images are always upright.

101. Concave mirrors are converging and convex mirrors are diverging. Concave lenses are diverging and convex lenses are converging.

102. Convex mirrors and concave lenses produce only small virtual images.

Atomic and Nuclear Physics

103. The kinetic energy of the ejected electrons is the energy of the incident radiation minus the work function of the surface.

104. Increasing light frequency increases the kinetic energy of the emitted photoelectrons.

105. Increasing light intensity increases the number of emitted photoelectrons but not their kinetic energy.

106. Below a certain frequency, called the threshold frequency no electrons are emitted no matter how intense the light beam.

107. Stopping potential is the voltage needed to stop the emission of electrons and it is equal to the maximum kinetic energy per unit charge.

108. De Broglie proposed that all objects have wavelengths related to their momentum.

109. The lowest energy state of an atom is called the ground state.

110. Emission spectra are photons leaving the atom as electrons come down energy levels. Absorption spectra are photons being absorbed as electrons move up energy levels from the ground state.

111. Alpha particles are the same as helium nuclei: 2 protons, 2 neutrons. Beta particles are electrons, and gamma “particles” are photons.
112. The mass of a nucleus is always less than the sum of the masses of the nucleons. This mass defect is converted into binding energy. (E=mc2) One amu of mass is equal to 931 MeV of energy.
113. Nuclear fusion is a reaction in which two nuclei are combined to form a large nucleus. Fusion is the source of energy in stars.
114. Nuclear fission is a reaction in which a nucleus is split.

3. Classic Experiments:

J.J. Thomson: Experimentally measured the charge to mass ratio of cathode rays.

Ernest Rutherford: The scattering of alpha particles by a thin sheet of gold foil. This experiment demonstrated that atoms consist of mostly empty space with a very dense core, the nucleus.

Neils Bohr: Bohr's planetary model of the atom correctly describes the spectra of hydrogen.

R.A. Millikan: Millikan's oil drop experiment confirmed that the fundamental electric charge is quantized.

Hertz and Einstein: The photoelectric effect was first observed by Hertz and later explained by E instein. Einstein obtained a Nobel Prize for the mathematical description of the photoelectric effect.

A.H. Compton: The scattering of x-rays photons provided the final confirmation of the validity of Planck's quantum hypothesis that electromagnetic radiation came in discrete massless packets (photons) with energy proportional to frequency.

Davisson-Germer: Their experiment of the diffraction of electrons demonstrated the wave nature of the electron, confirming the earlier hypothesis of de Broglie.

4.Graphical Analysis:

Valuable information can be obtained by analyzing graphs.

A. Most common slopes:

1. The slope of a position-time graph gives the velocity.
2. The slope of a velocity-time graph gives the acceleration.
3. The slope of a force-elongation graph gives the spring constant.
4. For Ohmic materials the slope of a voltage-current graph gives the resistance.
5. The slope of a charge-voltage graph for a capacitor is its capacitance.
6. The slope of a sine incident angle-sine refracted angle graph gives the index of refraction.
7. The slope of a kinetic energy maximum-frequency graph gives Planck's constant.

B. Most common areas under the curve:

8. The area under the curve of a velocity-time graph gives the displacement.
9. The area under the curve of an acceleration-time graph gives the change in velocity.

10. The area under the curve of a force-time graph gives the impulse (change in momentum).
11. The area under the curve of a force-distance graph gives the work done.
12. The area under the curve of a pressure-volume graph gives the work done by the gas.
13. The area under a charge-voltage graph is the work required to charge the capacitor i.e. energy stored.

C. Most common intercepts:

14. The x-intercept of a kinetic energy maximum-frequency graph gives the threshold frequency.
15. The y-intercept of a kinetic energy maximum-frequency graph gives the work function.

5. Important Units:

MEASUREMENT	UNIT	SYMBOL	EXPRESSED IN BASE UNITS	EXPRESSED IN OTHER SI UNITS
Acceleration		m/s^2	m/s^2	
Capacitance	Farad	F	$A^2.s^4/kg.m^2$	
Current	Ampere	A		C/s
Electric charge	Coulomb	C	A.s	
Electric field		N/C	$kg.m/C.s^2$	
Electric resistance	Ohm	☐	$kg.m^2/A^2.s^3$	V/A
Energy, work	Joule	J	$kg.m^2/s^2$	N.m
Emf, voltage	Volt	V	$kg.m^2/A.s^3$	
Force	Newton	N	$kg.m/s^2$	
Frequency	Hertz	Hz	s^{-1}	
Magnetic field	Tesla	T	$kg/A.s^2$	N.s/C.m or Wb/m^2
Magnetic flux	Weber	Wb	$kg.m^2/A.s^2$	V.s
Pressure	Pascal	Pa	kg/ms^2	N/m^2
Potential difference	Volt	V	$kg.m^2/A.s^3$	W/A or J/C
Power	Watt	W	$Kg.m^2/s^3$	J/s

II. Chemistry

1. General Concepts:

Physical Change: It is a temporary change in which only the physical properties, e.g., colour, state, etc., alter but no new substance with new properties is formed. By reversing conditions we can get the original substances, e.g., changing ice into water; glowing of an electric bulb; adding common salt to water; magnetizing a steel needle.

Chemical Change: It is a permanent change in which new substances with new properties are formed. It is not possible to get back the original substance, e.g., burning a candle; boiling an egg; heating magnesium ribbon; souring of milk.

Element: It cannot be split into simpler substances, e.g., iron, sulphur, oxygen, gold. There are about 106 elements.

Compound: It can be split into simpler substances and is formed by the union of two or more elements in definite proportions by weight, e.g.

1. Water can be split into hydrogen and oxygen.
2. Iron sulphide is split into iron and sulphur.
3. Chalk is made of calcium, carbon and oxygen.
4. Carbondixoide is made up of carbon and oxygen.

Mixture: It is one in which two or more substances are mixed together in any ratio without altering their properties.

1. Sand and salt
2. Sugar and water
3. Air is a mixture of nitrogen and oxygen
4. Gun-powder is a mixture of nitre, charcoal and sulphur

Hard and Soft Water: Hard water is that water which does not produce lather with soap easily.
Soft water produces lather with soap very easily. There is two kinds of hardness: -
(i) Temporary (ii) Permanent.

Temporary is due to bicarbonates of calcium and magnesium. Can be removed by
(i) boiling, (ii) addition of lime.

Permanent is due to the sulphates and chlorides of calcium and magnesium. Permanent hardness can be removed by
(I) addition of washing soda, or (ii) by distillation.

Alloy: Is a mixture of two or more metals in a certain proportion. Alloys are made to impart certain special properties to the metals in question. For example, stainless steel is made using Iron, Manganese, Carbon etc. to give it high strength, elasticity etc which is not found in Iron.

Amalgam: any alloy containing Mercury as an essential component is known as amalgam.

2. Chemical Names of substances:

Substance	Chemical Name	Composition
1. Green vitriol	Iron sulphate	Iron, sulphur and oxygen
2. Litharge	Lead monoxide	Lead and oxygen
3. White vitriol	Zinc sulphate	Zinc sulphur and oxygen
4. Caustic lotion	Silver nitrate	Silver, nitrogen and oxygen
5. Candy fluid	Potassium permanganate	Potassium, manganese and oxygen
6. Blue vitriol	Copper sulphate	Copper, sulphur and oxygen
7. Kansi (Alloy)	Bronze	Copper, zinc, tin
8. Pital (Alloy)	Brass	Copper, zinc
9. Shora or nitre	Potassium nitrate	Potassium, nitrogen and oxygen
10. Caustic potash	Potassium hydroxide	Potassium, hydrogen and oxygen
11. Chile saltpeter	Sodium nitrate	Sodium, nitrogen and oxygen
12. Baking soda	Sodium bicarbonate	Sodium, hydrogen, carbon and oxygen
13. Washing soda	Sodium carbonate	Sodium, carbon and oxygen
14. Common salt	Sodium chloride	Sodium and chlorine
15. Caustic soda	Sodium hydroxide	Sodium, hydrogen and oxygen
16. Gluber's salt	Sodium sulphate	Sodium, sulphur and oxygen
17. Iron pyrites	Iron sulphide	Iron and sulphur
18. Galena	Lead sulphide	Lead and sulphur
19. Gyspum	Calcium sulphate	Calcium, sulphur and oxygen
20. Epsom	Magnesium sulphate	Magnesium, sulphur and oxygen
21. Aspirin	Acetyl Salicylic Acid	
22. Vinegar	Acetic Acid (Glacial)	Carbon, Hydrogen, Oxygen
23. Bleaching Powder	Calcium Oxychloride	Calcium, Oxygen, Chlorine
24. Marble	Calcium Carbonate	Calcium, Carbon, Oxygen
25. Rust	Ferric Hydroxide	Iron, Hydrogen, Oxygen
26. Plaster of Paris	Hydrated Calcium Sulphate	Calcium, Sulphur, Hydrogen, Oxygen

3. Glossary of Chemistry Terms:

A

- **absolute zero** - a theoretical condition concerning a system at zero Kelvin where a system does not emit or absorb energy (all atoms are at rest)
- **accuracy** - how close a value is to the actual or true value; also see precision
- **acid** - a compound that, when dissolved in water, gives a pH of less than 7.0 or a compound that donates a hydrogen ion
- **acid anhydride** - a compound with two acyl groups bound to a single oxygen atom
- **acid dissociation constant** - an equilibrium constant for the dissociation of a weak acid
- **actinides** - the fifteen chemical elements that are between actinium (89) and lawrencium (103)
- **activated complex** - a structure that forms because of a collision between molecules while new bonds are formed
- **addition reaction** - within organic chemistry, when two or more molecules combine to make a larger one

- **aeration** - the mixing of air into a liquid or solid
- **alkali metals** - the metals of Group 1 on the periodic table
- **alkaline earth metals** - the metals of Group 2 on the periodic table
- **allomer** - a substance that has different composition than another, but has the same crystalline structure
- **allotropy** - elements that can have different structures (and therefore different forms), such as Carbon (diamonds, graphite, and fullerene)
- **anion** - negatively charge ions
- **aromaticity** - chemical property of conjugated rings that results in unusual stability. See also benzene.
- **atom** - a chemical element in its smallest form, and is made up of neutrons and protons within the nucleus and electrons circling the nucleus
- **atomic number** - the number representing an element which corresponds with the number of protons within the nucleus
- **atomic orbital** - the region where the electron of the atom may be found

B

- **base** - a substance that accepts a proton and has a high pH; a common example is sodium hydroxide (NaOH)
- **biochemistry** - the chemistry of organisms
- **boiling** - the phase transition of liquid vaporizing
- **bond** - the attraction and repulsion between atoms and molecules that is a cornerstone of chemistry
- **burette** (also buret) - glassware used to dispense specific amounts of liquid when precision is necessary (e.g. titration and resource dependent reactions)

C

- **catalyst** - a chemical compound used to change the rate (either to speed up or slow down) of a reaction, but is regenerated at the end of the reaction.
- **cation** - positively charged ion
- **centrifuge** - equipment used to separate substances based on density by rotating the tubes around a centred axis
- **cell potential** - the force in a galvanic cell that pulls electron through reducing agent to oxidizing agent
- **chemical Law** - certain rules that pertain to the laws of nature and chemistry - examples
- **chemical reaction** - the change of one or more substances into another or multiple substances
- **colloid** - mixture of evenly dispersed substances, such as many milks
- **combustion** - an exothermic reaction between an oxidant and fuel with heat and often light
- **compound** - a substance that is made up of two or more chemically bonded elements
- **condensation** - the phase change from gas to liquid
- **conductor** - material that allows electric flow more freely
- **covalent bond** - chemical bond that involves sharing electrons
- **crystal -** a solid that is packed with ions, molecules or atoms in an orderly fashion
- **cuvette** - glassware used in spectroscopic experiments. It is usually made of plastic, glass or quartz and should be as clean and clear as possible

D

- **deionization** - the removal of ions, and in water's case mineral ions such as sodium, iron and calcium
- **deliquescence** - substances that absorb water from the atmosphere to form liquid solutions
- **deposition** - settling of particles within a solution or mixture
- **dipole** - electric or magnetic separation of charge
- **dipole moment** - the polarity of a polar covalent bond
- **dissolution or solvation** - the spread of ions in a solvent
- **double bond** - sharing of two pairs of electrons

E

- **earth metal** - see alkaline earth metal
- **electrolyte** - a solution that conducts a certain amount of current and can be split categorically as weak and strong electrlytes
- **electrochemical cell** - using a chemical reaction's current, electromotive force is made
- **electromagnetic radiation** - a type of wave that can go through vacuums as well as material and classified as a self-propagating wave
- **electromagnetism** - fields that have electric charge and electric properties that change the way that particles move and interact
- **electromotive force** - a device that gains energy as electric charges pass through it
- **electron** - a subatomic particle with a net charge that is negative
- **electron shells** - an orbital around the atom's nucleus that has a fixed number electrons (usually two or eight)
- **electric charge** - a measured property (coulombs) that determine electromagnetic interaction
- **element** - an atom that is defined by its atomic number
- **energy** - A system's ability to do work
- **enthalpy** - measure of the total energy of a thermodynamic system (usually symbolized as H)
- **entropy** - the amount of energy not available for work in a closed thermodynamic system (usually symbolized as S)
- **enzyme** - a protein that speeds up (catalyses) a reaction
- **eppendorf tube** - generalized and trademarked term used for a type of tube; see microcentrifuge

F

- **freezing** - phase transition from liquid to solid
- **Faraday constant** - a unit of electrical charge widely used in electrochemistry and equal to ~ 96,500 coulombs.
  It represents 1 mol of electrons, or the Avogadro number of electrons: 6.022 × 1023 electrons. F = 96 485.339 9(24) C/mol
- **Faraday's law of electrolysis** - a two part law that Michael Faraday published about electrolysis
  - the mass of a substance altered at an electrode during electrolysis is directly proportional to the quantity of electricity transferred at that electrode
  - the mass of an elemental material altered at an electrode is directly proportional to the element's equivalent weight.
- **frequency** - number of cycles per unit of time. Unit: 1 hertz = 1 cycle per 1 second

G

- **galvanic cell -** battery made up of electrochemical with two different metals connected by salt bridge
- **gas -** particles that fill their container though have no definite shape or volume
- **geochemistry -** the chemistry of and chemical composition of the Earth
- **Gibbs energy -** value that indicates the spontaneity of a reaction (usually symbolized as G)

H

- **halogens -** Group 17 on the Periodic Table and are all non-metals
- **jodium –** Latin name of the halogen element iodine

I

- **indicator -** a special compound added to solution that changes color depending on the acidity of the solution; different indicators have different colors and effective pH ranges
- **inorganic compound** - compounds that do not contain carbon, though there are exceptions (see main article)
- **inorganic chemistry** - a part of chemistry concerned with inorganic compounds
- **International Union of Pure and Applied Chemistry (IUPAC) -**
- **insulator** - material that resists the flow of electric current
- **ion -** a molecule that has gained or lost one or more electrons
- **ionic bond** - electrostatic attraction between oppositely charged ions
- **ionization** -The breaking up of a compound into separate ions.

K

- **Kinetics** - A sub-field of chemistry specializing in reaction rates
- **Kinetic energy** - The energy of an object due to its motion.

L

- **lanthanides** - Elements 57 through 71
- **lattice** - Unique arrangement of atoms or molecules in a crystalline liquid or solid.
- **Laws of thermodynamics**
- **liquid** - A state of matter which takes the shape of its container
- **light -** Portion of the electromagnetic spectrum which is visible to the naked eye. Also called "visible light."
- **London dispersion forces -** A weak intermolecular force

M

- **Metal** - CheẂmical element that is a good conductor of both electricity and heat and forms cations and ionic bonds with non-metals.
- **melting -** The phase change from a solid to a liquid
- **metalloid -** A substance possessing both the properties of metals and non-metals
- **methylene blue** - a heterocyclic aromatic chemical compound with the molecular formula C16H18N3SCl
- **microcentrifuge** - a small plastic container that is used to store small amounts of liquid
- **mole -** abbreviated mol - a measurement of an amount of substance; a single mole contains approximately 6.022×10^{23} units or entities
  - a mole of water contains 6.022×10^{23} H_2O molecules

- **molecule** - a chemically bonded number of atoms that are electrically neutral
- **molecular orbital** - region where an electron can be found in a molecule (as opposed to an atom)

N

- **neutron** - a neutral unit or subatomic particle that has no net charge
- **neutrino** - a particle that can travel at speeds close to the speed of light and are created as a result of radioactive decay
- **nucleus** - the centre of an atom made up of neutrons and protons, with a net positive charge
- **noble gases** - group 18 elements, those whose outer electron shell is filled
- **non-metal** - an element which is not metallic
- **nuclear** - of or pertaining to the atomic nucleus
- **nuclear** - magnetic resonance spectroscopy - technique that exploits the magnetic properties of certain nuclei, useful for identifying unknown compounds
- **number density** – a measure of concentration of countable objects (atoms, molecules, etc.) in space; number per volume

O

- **orbital** - may refer to either an atomic orbital or a molecular orbital
- **organic compound** - compounds that contain carbon
- **organic chemistry** - a part of chemistry concerned with organic compounds

P

- **pH** - the measure of acidity (or basicity) of a solution
- **plasma** - state of matter similar to gas in which a certain portion of the particles are ionized
- **poor metal** - Metallic elements in the p-block, characterized by lower melting and boiling points than other metals
- **potential energy** - energy stored in a body or in a system due to its position in a force field or due to its configuration
- **precipitate** - formation of a solid in a solution or inside another solid during a chemical reaction or by diffusion in a solid
- **precision** - How close the results of multiple experimental trials are. See also accuracy.
- **photon** - a carrier of electromagnetic radiation of all wavelength (such as gamma rays and radio waves)
- **proton** - a positive unit or subatomic particle that has a positive charge
- **protonation** - the addition of a proton (H^+) to an atom, molecule, or ion

Q

- **Quantum mechanics** - the study of how atoms, molecules, subatomic particles, etc. behave and are structured
- **quarks** - elementary particle and a fundamental constituent of matter

R

- **radiation** - energy in the form of waves or subatomic particles when there is a change from high energy to low energy states
- **radioactive decay** - the process of an unstable atomic nucleus losing energy by emitting radiation

S

- **s-block elements** - Group 1 and 2 elements (alkali and alkaline metals), which includes Hydrogen and Helium
- **salts** - ionic compounds composed of anions and cations
- **salt bridge** - devices used to connection reduction with oxidation half-cells in an electrochemical cell
- **saline solution** - general term for NaCl in water
- **Schrödinger equation** - quantum state equation which represents the behaviour of an election around an atom
- **semiconductor** - an electrically conductive solid that is between a conductor and an insulator
- **single bond** - sharing of one pair of electrons
- **sol** - a suspension of solid particles in liquid. Artificial examples include sol-gels.
- **solid** - one of the states of matter, where the molecules are packed close together, there is a resistance of movement/deformation and volume change; see Young's modulus
- **solute** - the part of the solution that is mixed into the solvent (NaCl in saline water)
- **solution** - homogeneous mixture made up of multiple substances. It is made up of solutes and solvents.
- **solvent** - the part of the solution that dissolves the solute (H_2O in saline water)
- **spectroscopy** - study of radiation and matter, such as X-ray absorption and emission spectroscopy
- **speed of light** - the speed of anything that has zero rest mass ($Energy_{rest} = mc^2$ where m is the mass and c is the speed of light)
- **Standard conditions for temperature and pressure** or SATP - a standardisation used in order compare experimental results (25 °C and 100.000 kPa)
- **state of matter** - matter having a homogeneous, macroscopic phase; gas, plasma, liquid, and solid are the most well known (in increasing concentration)
- **sublimation** - a phase transition from solid to gas
- **subatomic particles** - particles that are smaller than an atom; examples are protons, neutrons and electrons
- **substance** - material with definite chemical composition

T

- **talc** - a mineral representing the one on the Mohs Scale and composed of hydrated magnesium silicate with the chemical formula $H_2Mg_3(SiO_3)_4$ or $Mg_3Si_4O_{10}(OH)_2$
- **temperature** - the average energy of microscopic motions of particles
- **theoretical yield** - see yield
- **theory** - a model describing the nature of a phenomenon
- **thermal conductivity** - a property of a material to conduct heat (often noted as)
- **thermochemistry** - the study of absorption/release of heat within a chemical reaction
- **thermodynamics** - the study of the effects of changing temperature, volume or pressure (or work, heat, and energy) on a macroscopic scale
- **thermodynamic stability** - when a system is in its lowest energy state with its environment (equilibrium)
- **thermometer** - device that measures the average energy of a system
- **titration** - the process of titrating one solution with another, also called volumetric analysis
- **torr** - a unit to measure pressure (1 Torr is equivalent to 133.322 Pa or 1.3158×10^{-3} atm)

- **transition metal** - elements that have incomplete d sub-shells, but also may be referred to as the d-block elements
- **transuranic element** - element with atomic number greater than 92; none of the transuranic elements are stable
- **triple bond** - the sharing of three pairs of electrons within a covalent bond (example N_2)
- **triple point** - the place where temperature and pressure of three phases are the same (Water has a special phase diagram)
- **tyndall effect** - the effect of light scattering by colloidal (mixture where one substance is dispersed evenly through another) or suspended particles

U

- **UN number** - a four digit code used to note hazardous and flammable substances
- **uncertainty** - a characteristic that any measurement that involves estimation of any amount cannot be exactly reproducible
- **Uncertainty principle** - knowing the location of a particle makes the momentum uncertain, while knowing the momentum of a particle makes the location uncertain
- **unit cell** - the smallest repeating unit of a lattice
- **unit factor** - statements used in converting between units
- **universal or ideal gas constant** - proportionality constant in the ideal gas law (0.08206 L·atm/(K·mol))

V

- **valence electron** - the outermost electrons of an atom, which are located in electron shells
- **Valence bond theory** - a theory explaining the chemical bonding within molecules by discussing valencies, the number of chemical bonds formed by an atom
- **van der Waals force** - one of the forces (attraction/repulsion) between molecules
- **van 't Hoff factor** - ratio of moles of particles in solution to moles of solute dissolved
- **vapor** - when a substance is below the critical temperature while in the gas phase
- **vapour pressure** - pressure of vapour over a liquid at equilibrium
- **vaporization** - phase change from liquid to gas
- **viscosity** - the resistance of a liquid to flow (oil)
- **volt -** one joule of work per coulomb - the unit of electrical potential transferred
- **voltmeter** - instrument that measures the cell potential [disambiguation needed]
- **volumetric analysis** - see titration

W

- **water** - H_2O - a chemical substance, a major part of cells and Earth, and covalently bonded
- **wave function** - a function describing the electron's position in a three dimensional space
- **work** - the amount of force over distance and is in terms of joules (energy)

X

- **X-ray** - form of ionizing, electromagnetic radiation, between gamma and UV rays
- **X-ray diffraction** - a method for establishing structures of crystalline solids using singe wavelength X-rays and looking at diffraction pattern
- **X-ray photoelectron spectroscopy** - a spectroscopic technique to measure composition of a material

Y

- **yield** - the amount of product produced during a chemical reaction

Z

- **zone melting** - a way to remove impurities from an element by melting it and slowly travel down an ingot (cast)
- **Zwitterion** - is a chemical compound whose net charge is zero and hence is electrically neutral. But there are some positive and negative charges in it, due to the formal charge, owing to the partial charges of its constituent atoms.

III. Biology

A major part of the planet Earth comprises living beings, which make up the biological world. There are millions of varieties of plants and animal that can be distinguished. All living beings are distinguished by their ability for movement, respiration, growth and reproduction which are absent in non-living things. Studying these millions of varieties is a Herculean task for any scientist. To achieve this purpose, therefore, the scientist have grouped together similar types of plants/animals to make their study simpler. By studying a representative of each group, we can know fairly well the characteristic features of the whole group. Such a system of grouping together of living beings is known as classification. Several systems of classification have been proposed.

Scientists in different parts of the world call the same animal/plant by different names in their local languages. This may create a lot of confusion and problems in communication. To rid of this problem, a uniform system of naming has been proposed by Carl Von Linneaus. According to this system, every organism has been assigned two names

1. generic name known as genus and
2. a special name known as species. For instance, both cat and lion have a common genus Felis, but since there is considerable difference in their characters, each is having a separate species name. Obviously having a common genus name implies great similarity in their basic biological features. The common names and the corresponding scientific names of some common living beings are given elsewhere in this discussion.

Animal And Plant Groups:

1. Phylum Protozoa e.g. Amoeba, Plasmodium, Entamoeba
2. Phylum Porifera e.g. sponges
3. Phylum Coelentrata e.g. Corals, Jelly-fish, Star-fish
4. Phylum Platyhelminthess e.g. Tapeworm
5. Phylum Nemahelminthes e.g. Ascaris
6. Phylum Insecta e.g. Silver Fish, Cockroaches
7. Phylum Echinodermata .
8. Phylum Mollusca
9. Phylum Chordata e.g. Rat, Whale, Fishes

1. Algae e.g. seaweeds, Spirogyra
2. Fungi e.g. Penicillium
3. Bryophytes e.g. Marchantia
4. Pteridophytes e.g. Ferns
5. Gymnosperms e.g. Pinus
6. Angiosperms e.g. Triticum

(Bacteria and viruses have been excluded from this discussion because their grouping is still a matter of debate for the reason that bacteria possess features characteristic of both plants and animals. For instance, some bacteria can make their own food, which brings them closer to plants. Viruses, on the other hand are creatures which can multiply only on a living host, can survive extreme environmental conditions and posses features of both living and non-lining beings. Like living beings, they can multiply. And like non-living things, they can crystallize themselves under appropriate environmental conditions. Many bacteria and viruses are responsible for some major human diseases, which will be discussed very shortly.)

Of these, chordates are the most highly advanced group in terms of biological organization. They are distinguished by the presence of a notochord or vertebral column. They are further divided into many types.

A. Pisces (Swimming Fishes) B. Amphibia C. Reptilia (Crawling Reptiles)
D. Aves (Flying Birds) E. Mammalia (Child-Bearing Mammals)

Each of the animal groups is characterized by certain features which are unique to them e.g.

1. Fishes are defined by the presence of gills for respiration in the adult stage, presence of fins all over the body and internal fertilization. Therefore, swimming doesn't define a fish nor does the name tag of fish attached to the name of an animal make it a fish. For example, the commonly known animal Silver Fish is not fish at all (it is an insect), because it lacks gills, fins and other features exclusive to fishes.

2. Amphibians are those animals that can live on both land and in water. A typical example is a frog which lives in ponds normally, but can come on earth if required.

3. Reptiles are defined as those animals which have scales found all over the body. Since they live in dry places, it helps them in conserving body water to a large extent.

4. From birds onwards, a true four-chambered heart is found in all animals, which means that pure and impure blood are actually separated in separate chambers of the heart. Birds are identified by the presence of wings (which are actually modified fore-limbs) and a constant body temperature, apart from a four-chambered heart. Of course, they can fly, but the ability to fly does not make an animal a bird. For instance, many insects can fly with wings that are extensions of the skin. So technically speaking, they cannot be called birds.

5. Mammals are the most advanced lot of the animal groups. Many features distinguish them other groups like

A. Presence of hair all over the body.
B. Internal fertilization (in all other groups, fertilization takes place outside the body, i.e. is external)
C. Ability to give birth to young ones directly (birds and fishes lay eggs)

D. A constant body temperature which does not change according to environmental changes in temperature. Such constant-temperature animals are called warm-blooded while those whose body temperature changes according to environmental changes are referred to as cold-blooded e.g. fish, reptiles. Having a constant internal temperature is a great advantage for an animal because it lets its body function without any hindrance (Most of the body processes need a suitable range of temperature to happen). The importance of this fact can be easily supported by the example of a frog, which is a cold-blooded animal. In winters when temperature dips to very low levels, frogs bury themselves in the bed of the ponds (hibernation) so as to avoid the low temperature, which does not allow their bodies to function appropriately. On the other hand, most mammals have internal biological mechanisms which adjust their temperature so as to avoid excessive heat or cold to the body, thus making a state of constant internal environment for the body reactions to take place (homeostasis)

E. Extreme care of the young ones is a special feature of this group. Generally speaking, the more advanced the animal on the phylogenetic scale, the more the degree of parental care.

F. A highly developed Central Nervous System, which allows them to think, plan and reason their activities, all the essential attributes of intelligence. Of course, no animal apart from humans can speak but some remarkable research shows that chimpanzees can definitely communicate by using sign languages. Many scientists counter it by saying that the chimpanzees' speech lacks the true features of human speech. However, research is still going on this topic.

Structural Organization: Robert Hook was the first man to observe ells in a living being. All living beings are made of tiny chambers called cells. A cell is the smallest functional structural unit of a living organism. By functional unit, we mean that a cell works in totality and any part of a cell cannot function independently of other parts. A group of cells that performs a specialized function for the body is known as a tissue. Many tissues make up an organ and many organs together make up an organ-system. For example the human digestive system comprises many different organs, the tissues in which are highly specialized for performing digestive functions and not functions of any other type. Many systems together constitute a living organism. This organization of cell- tissue- system-body is not uniform throughout the living world. There are many animals which consist of just one single cell (e.g. protozoa) and there are cases where a creature does have many cells, but those cells are not organized into specialized tissues for separate functions. However, the typical cell- tissue- system-body outline above is true of all higher animals.

Many animals living together in a particular habitat make a population. All the different animals or plant species living together in mutual inter-link with one another in a habitat make a biological community. And a community of living organisms living together with its physical environment make it an ecosystem. The study of the interactions between the living creatures themselves and their physical environment and vice-versa is known as ecology.

Nucleus, mitochondria and centriole are some of the major parts of a cell. In fat, the animal and plant cells do not differ much in structure and function, except the fact that all plant cells are additionally covered by a cell wall and that they lack centriole. The nucleus controls all the cell functions while actual production of energy takes place on the mitochondria. This energy is released in the form of ATP molecules (Adenosine Triphosphate) and that's why mitochondria is often known as the powerhouse of the cells. Inside the nucleus, a thread-like network of chromatin can be seen under a microscope. Under conditions of cell division, this network is clearly differentiated into chromosomes, bodies that contains genes responsible for transmission of traits from one generation to the next. Every species is having a fixed number of chromosomes in all body cells. For example, in case of humans, the number of chromosomes is 46, which is organized into 23 pairs. The chromosomes and the genes always occur in pairs.

A cell keeps on growing until a certain stage, beyond which it has to divide. The division of a cell can take place in two ways:

Mitosis: This is an equational division in which a body cell divides into two equal halves, each containing all the essential parts to run it as a cell. In such a division, first the chromosome number gets doubled i.e. each chromosome gets divided into two, thereby doubling the total number of chromosomes in the cell. Later on, each half receives half the chromosomes. For example, each human cell has 46 chromosomes, which become 92 in number at the time of mitosis. Each new mitotic cell gets half of it, i.e. 46. Thus the chromosome number remains constant in the species in each cell.
This type of division goes on in the body cells (except sex cells) all the time and is the major source of repair, growth and development.

Meiosis: Meiosis is a special type of cell division exclusively found in sex cells (sperms and eggs). In this case, a reduction division takes place first i.e. after duplication of each chromosome, the 92 chromosomes thus produced get divided into four parts, each having 23 chromosomes. Thus each daughter cell gets 23 chromosomes. That is why this is called a reduction division. Each of the four sperms containing 23 chromosomes will combine with an egg having 23 chromosomes, thus giving rise to a zygote having 16 chromosomes in all. Thus the number of chromosomes has again stayed the same in the specie.

Twins: When two offspring are born at the same time, they are referred to as twins. Depending upon the mode of formation, they are of two types.

Identical or Monozygotic Twins: Such twins develop from a single fertilized egg, which divides into exactly two halves some time after fertilization has occurred. Twins born as a result of such division are known as identical twins and they share virtually identical physical and psychological features.

Dizygotic or Fraternal Twins: Fraternal twins are the result of fertilization of two ova with two separate sperms. Twins produced as a result of such separate fertilization are no more alike than ordinary siblings.

Cloning: Cloning is the production of genetically identical individuals without the help of sexual reproduction. In other words, cloning is production of multiple identical copies. The copies could be of molecules like DBA, antibody-producing cells, or even an animal.

Why a body cell cannot be grown into an embryo or an adult has been a puzzling question because a cell has practically all the information contained in the zygote from which it has grown. Scientific efforts in this direction bore fruit for the first time when JB Gurdon was able to perform cloning on the African clawed frog. He showed the possibility of using nuclei from embryos to grow generations of similar embryos. Very recently, Dr. Ian Wilmut of the Roselin Institute, Scotland has been able to clone the first-ever mammal, a sheep called Dolly. He had used a cell taken from the udder of an ewe to produce a full-fledged lamb. Thereafter, many more full-fledged animals have been cloned like the cow, rat etc. by different scientists, Human cloning is a distinct theoretical possibility but it is banned by international treaties, because it has grave moral and social implications.

Gene Expression & Genetic Disorders: Each chromosome is composed of many individual hereditary units called genes. A gene is a segment of Deoxyribonucleic Acid (DNA), which is the actual carrier of all genetic information. The DNA molecule looks like a twisted ladder or a double-stranded helix. The gene, a segment of the DNA molecule will give coded instruction to the cells, directing it to perform a particular function (usually to manufacture a particular protein). Although all cells in the body contain the same genes, the specialized nature of each cell is due to the fact that only 5 to 10 percent of the genes are active in any given cell. In the process of developing from a fertilized egg, each cell switches on some genes and switches off all others. When "nerve genes" are active, for example, a cell develops as a neuron because the genes are directing the cell to make the chemicals that allow it to perform neural functions.

Genes, like chromosomes, occur in pairs. One gene of each pair comes from the sperm chromosome and the other from the ovum chromosome. Thus, a child receives only half of his genes from each parent's total genes. The total number of genes in each human chromosome is around 10000 - perhaps higher. Since the number of genes is so high, it is extremely unlikely that two human beings would have the same heredity, even if they were siblings. The only exception is the identical twins, who, because they developed from the same fertilized egg, have exactly the same genes.

An important attribute of many genes is dominance or recessiveness. When both members of a gene pair are dominant, the individual manifests the form of the trait specified by those genes. When one gene is dominant and the other recessive, the dominant gene again decides the form of the trait expressed. Only if the genes contributed by both parents are recessive is the trait specified by them expressed. The genes determining eye colour, for example, act in a pattern of dominance and recessiveness; blue is recessive and brown is dominant. Thus, a blue-eyed child may have two blue-eyed parents, or one blue-eyed parent and one brown-eyed parent(who carries a recessive gene for blue eyes) or two brown-eyed parents(each of whom carries a recessive gene for blue eyes).

A brown-eyed child, in contrast, never has two blue-eyed parents.

Some of the characteristics that are carried by recessive genes are baldness, hemophilia and a susceptibility to poison ivy. However, not all gene pairs follow the dominant-recessive a pattern and most of the human traits are determined by many genes acting together.

Some human characteristics are determined by a single gene pair. For instance, Phenylketunoria (PKU) and Huntington's Disease. In case of PKU, the person is not able to digest an essential amino acid which gets logged in the nervous system.

Heredity: Heredity is the process of transmission of characters from one generation to the next. It studies how those characters are transmitted from parents to their offspring, what are the basic laws applicable to such processes etc. The field of genetics studies heredity in detail.

Gregor John Mendel, an Austrian monk, was responsible for formulating the basic laws of heredity on the basis of his studies conducted on the Garden Pea. For this reason, he is remembered as the Father of Heredity.

In the present century, much more has been learnt about the mechanism of heredity. Much of the credit for this research goes to Morgan Hunt, an American biologist who has added to our genetic knowledge tremendously by way of his experiments on the butterfly Drosophila.

Sex-linked Genes And Related Disorders: The X chromosome may carry either dominant or recessive genes, the Y chromosome carries a few genes dominant for some male sexual characteristics, but otherwise carries only recessive genes. Thus, most recessive characteristics carried by a man's X chromosome (received from his mother) are expressed since they are not blocked by dominant genes. For example, colour-blindness is a recessive sex-linked characteristic. A man will be colour-blind if he inherits a colour-blind gene on the X chromosome received from mother. Females are less often colour-blind, because a colour-blind female has to have both a colour-blind father and a mother who is either colour-blind or who carries a recessive gene for colour-blindness. A number of genetically determined disorders are linked to abnormalities of the 23rd pair of chromosomes, or by recessive genes carried by this pair. They are called sex-linked disorders.

Chromosomal Abnormalities: On rare occasions, a female may be born with only one chromosome instead of the usual XX. Such a condition is referred to as Turner's Syndrome.

Sometimes, when the 23rd chromosome fails to divide properly, the developing organism ends up with an extra X or Y chromosome. An individual with XXY condition is said to be suffering from the Klinefelter's syndrome. Such a person is physically a male, but with marked feminine traits. A person born with XYY composition will be known as supermale, a person with exaggerated male features.

Theories Of Biological Evolution: The living world consists of millions of species and how they came into being has been a great mystery all along. Several attempts have been made to account for this vast variety of living beings prominent among which are as follow:

1. Darwin's Theory of Natural Selection: Originally propounded by Charles Darwin in his book Origin of Species in 1859, this theory says that nature favours the perpetuation of those species which have more chances of survival in future.

2. Lamarck's Theory of Use and Disuse of Organs: This theory proposes that those organs which have some utility for a particular animal are retained, while those which do not have any utility for it, fall into disuse and are consequently lost in the next generation, after a no. of such generations have come.

3. Hugo de Varies' Theory of Mutations: This theory believes that evolution is a sudden process of change, not a slow and continuous process as proposed by Darwin and Lamarck.

Infectious Diseases: These are conveyed from one person to another by air, inanimate objects, water, wounds and direct physical contact with the affected person e.g. small-pox, cholera and dysentery, tetanus, cholera (through flies), malaria (through mosquitoes), typhus (by lice), AIDS, Syphilis, Herpes(all three by sexual contact), common cold etc.

Certain terms are used to describe the method of occurrence of infectious diseases:-

Tuberculosis: Tuberculosis of lungs is called Phthisis or Consumption. It is caused by tubercle bacillus-weak chest, dusty occupation, over-work, chronic worry, starvation, intemperance, early marriage, malaria, influenza, pleurisy; all these increase susceptibility to TB by lowering general vitality.
Cure. **B.C.G.** vaccine; use of Streptomycin and Rifampicin.

Smallpox: It is caused by a virus. The onset is sudden, with headache and backache followed by vomiting, fever and running of the nose. Eruption on the skin, small red pimples become pocks on the third day. Scabs fall on the 14th day leaving behind pits or scars on the skin.

Cholera: It is caused by cholera vibrio. Characterized by passing copious colourless stools and also vomiting, pain in legs and back, cramps, suppression of urine and collapse.

Malaria: Bite of female anopheles mosquito. Malarial parasites (protozoa) enter red-blood corpuscles where they multiply till the red blood corpuscles burst. The process is repeated. Plasmodium is the causal microbe in usual cases. However, a fatal type of malaria caused by Plasmodium falciparum (which is spread through mosquitoes)
Symptoms: Repeated attacks of high fever with shivering and a feeling of cold, and its going away with sweating. Quinine, obtained from the bark of Cinchona is widely used in cases of malaria.

Filaria: It is caused by the bite of a male mosquito-it generally occurs in Bengal, Bihar and Orissa and practically all those places with poor drainage. Other important diseases carried through the bites of insects are

Kala-Azar: By the bite of bed bug.

African sleeping sickness: By Tse-tse fly (Trypanosome gambiense -causal microbe)

Diabetes: Inability of pancreas to secrete sufficient insulin to make use of sugar in the food. The excess sugar is excreted through urine.

Typhoid : Typhoid bacillus. Infection conveyed mostly through water or milk.

Pyorrhea: An infection of gums which causes edges of the tooth sockets to bleed easily. In later stages, there is constant discharge of pus.

Mumps: The swelling of the salivary glands in front of the ears which makes the face look dull. Fluid diet and rest in bed is the best cure.

Rabies or Hydrophobia: A disease caused by the bite of a mad dog, cat or jackal. There is no cure, until the symptoms have developed. The best treatment is inoculation invented by Louis Pasteur.

Diphtheria: It is a children's disease, which causes the inflammation of the throat. It is highly infectious, and the best way to fight it is immunize the children by diphtheria vaccine.

Poliomyelitis: Infantile paralysis. It is a viral infection of the nerves of movement. Usually the muscles affected are those of legs or arms, but if the breathing organs are affected, the results are disastrous. Polio begins with sore throat, fever and sometimes vomiting. The Salk vaccine prevents infection.

Meningitis: It means inflammation of the meninges.

Encephalitis: This is an infection of the brain caused by a virus.
Aids: The Acquired Human Immuno-Deficiency Syndrome is caused by the infections of HIV-3 virus. Symptoms include unexplained loss of weight, opportunistic infections like pneumonia, TB etc. So far, there is no known cure for this disease. It is spread by means of shared syringes, sexual intercourse etc.

Vaccination: A vaccine is a biological preparation which gives the vaccinated person immunity from a specified illness for a considerable period of time. In most of the vaccines, either dead or weakened germs of a particular diseases (the germs are always of the same disease against which the person is to be secured) are injected (or given orally in certain cases) inside the person's body. The germs on entering the body prompt the body to create its internal defences against the germs, in the form of antibodies (antibodies are those chemicals which are released by the body to fight any external attack of a disease). Since the germs injected are too weak to cause any disease but the body is ready with its own defences to fight it, a vaccine provides protection against a disease for a considerable period. So in future, if an attack of a disease takes place, the body is always ready to fight it. It can be likened to a defence force put on constant alert which can repel the enemy attack any time.

Minerals and their significance to the Human Body

Mineral Elements	Sources	Significance	Effects of deficiency
Macro Elements			
Calcium(Ca)#	Milk, cereals, Cheese, Green Vegetables.	Required for formation of teeth and Bones , blood clotting, function of nerves and muscles	Weak theeth and bones ; retarded body growth.
Phosphorus(P)			Weak theeth and bones ; retarded body growth and physiology.
Sulphur(S)	Many protiens of food.	Component of many amino acids.	Distributed protein metabolism.
Pottassium(K)	Meat, milk, cereals,fruits and vegetables.	Required for acid-base balance, water regulation nad function of nerevs..	Low blood pressure, weak muscles; risk of paralysis..
Chlorine(Cl)	Table salt	Required for acid base balance; component of gastric juice.	Loss of appetite; muscles cramps
Magnesium(Mg)	Cereals, green vegetables.	Cofactor of many enzymes of glycolysis anda number of another metabolic reactions dependent upon ATP	Irregularties of metabolism principally affecting nervous functions.
Iron(Fe)	Meat, eggs , cereals, green vegetables.	Component of haemoglobin and cytochromes.	Anaemia, weakness and weak immunity.
Iodine(I)	Milk, cheese, sea food, iodized salt	important component of thyroxine hormone	Goitre, Cretinism
Fluorine(F)	Drinking water, tea , sea food	Maintence of bones and teeth.	Weak theeth, larger amount causes motting of teeth.
Zinc(Zn)	Cereals, Milk, eggs, meat, sea food	Cofactor of digestive and many other enzymes	Retarded growth, anaemia, rough skin, weak immunity and fertility
Copper(Cu)	Meat, dry fruits , POds , Green vegetables, sea food	Cofactor of cytochrome oxidase enzyme.Necessary for iron metabolism and development of blood vessels and connective tissues	Anaemia,weak blood vessels and connective tissues

Macro Elements			
Manganese(MN)	Dry fruits, cereals,tea fruits and green vegetables	Cofactor of some enzymes of urea synthesis and transfer of phosphate group	Irregular growth of bones, cartilages and connective tissues
Cobalt(Co)	MIlk, cheese, meat	Important component of vitamin B12	Anaemia
Selenium(SE)	Meat, cereals, sea food	Cofactor of many enzymes; assists vitamin E	Muscular pain; weakness of cardiac muscles
Chromium(CR)	Yeast, sea food, meat, some vegetables	Important for catabolic metabolism	Irregularities of catabolic meatbolism and ATP production
Molybdenum(MO)	Cereals, pods, some vegetables	Cofactor of some enzymes	Irregular excreation of nitrogenous waste products

Food And Nutrition: Our diet contains substances known as proximal principles, essential for maintenance of life and health.

Fats and Energy Producers: Fats are in oils, ghee and butter. Carbohydrates are in sugars, starches, etc. Unsaturated fats are good from the health point of view, and are advised for heart-patients. Saturated fats create cholesterol in the arteries, which can block them, leading to heart problems.

Carbohydrates, Proteins and Vitamins are Body builders. Found in eggs, meat, pulses beans, milk and cheese. Water and Vitamins are necessary for health.

Balanced diet: Is one which contains all the necessary proximal principles in the right proportion required for the maintenance of health. We cannot get all these in a single article of food. To get these in right proportion, we have to mix certain articles in our diet and thus we require a `mixed diet' or a balanced diet. Vitamins are found naturally in certain foods and the absence of any of these leads to one or the other of the 'deficiency disease' which may even cause death. Vitamins are both water soluble and fat soluble.

Vitamin A: It is a general health-giving vitamin and it increases resistance to infection and tones up the whole system. It ensures good appetite, promotes growth and makes for long life. Its deficiency causes night blindness, disorders of skin and respiratory diseases. Found in milk, butter, egg yolk, ghee, carrot, tomatoes, fresh leafy and yellow vegetables, fresh fruits and cod liver oil.

Vitamin B: Present in cereals, peas and beans. Protects the body from nerve diseases such as beri-beri, pellagra, and it cures pernicious anaemia, degeneration of sex glands and enlargement of liver and adrenals.

Vitamin C: Ensures healthy teeth, bones, and protects the body against scurvy. Present in fresh vegetables, orange, lemon, lettuce, tomato, cabbage, turnip.

Vitamin D: Present in milk, butter, ghee, cod liver oil, yolk of eggs, and it is also produced under the skin by rays of the sun. Promotes bone formation and prevents rickets.

Vitamins E: It has vital influence on organs of reproduction. Its absence causes sterility. It is present in germinating wheat.

Vitamin K: Found in fish, oats, wheat. It helps in coagulation of blood.

Vitamin	Chemical Name	Properties	Deficiency disease
A	Retinol	General health giving vitamin, can be stored liver	Night blindness
B1	Thiamine	For Growth, carbohydrate metabolism, functioning of heart	Beri-Beri
B2	Riboflavin	For Keeping skin and mouth healthy	Cheilosis
B5	Niacin	For healthy skin, sound mental health	Pellagra
B6	Pyridoxine	Processing of proteins and for nervous system	Convulsions in child
B12	Cynacobalamin	Required for formation and maturation of RBCs	Pernicious anaemia
C	Ascorbic Acid	For keeping teeth , gums and joints healthy .Gets destroyed on heating	Scurvy
D	Calciferol	For normal bones and teeth, can be stored in liver	Rickets
E	Tocopherol	For normal reproduction , removes scars and wrincles	Sterility
K	Phylloquinone	For normal clotting of blood	Haemophilia

Blood Groups : Dr. Costtello and later Dr. Moss in 1910 were responsible for classification of blood; the blood groups are AB, A, B, and O. Patients must be given transfusion of blood of their own group with the exception of Group O, which is universal. Another classification of blood groups is done on the basis of presence or absence of a chemical factor known as Rh factor (derived from Rhesus monkey). If a person has Rh in his blood, he will be referred to as Rh+ while an Rh negative person will not be having such a factor in his blood. This aspect also needs to be considered while transfusing blood because mixing Rh+ with Rh – blood leads to agglutination
(clumping together) and immediate death.

Glands: A gland is a group of cells which makes some useful chemical for the use of the body in its various reactions. There are two kinds of glands in the human body:

1. Exocrine glands - as liver, spleen, pancreas. The secretions are transported to the desired part by means of a special channel called duct.

2. Endocrine Or Ductless glands - as pituitary (The Master Gland), suprarenal, thyroid. The secretions are transported by means of blood to the desired part of the body.

Liver: The largest gland is in the body, it performs the following functions in the body - (1) Stores excessive sugar in the form of glycogen (insoluble carbohydrate), which helps in the digestion of fats.

Pancreas: It is both an ordinary as well as an endocrine gland. As an ordinary gland, it secretes pancreatic juice which, through pancreatic duct, goes to duodenum to help digestion there. As an Endocrine gland, it secretes insulin which helps utilizing sugar in the body, and its deficiency causes 'diabetes', a disease in which the patient passes sugar along with urine.

Spleen: White blood corpuscles are formed here

Pituitary Gland: Its secretion regulates growth and stature of the body, milk secretion in mammals, and influences sex organs.

Adrenal Glands: They are small, yellowish glands just above the kidneys one on each side. Their secretion is known as adrenaline and noradrenaline. This secretion is released in emergencies and prepares the body to fight such situations by releasing excessive energy.

Thyroid: Brownish red body situated in front of the neck. Its abnormal increase in size is known as goitre. Its secretion, known as thyroxine, is rich in iodine.

Sense organs or organs of special sense:
(a) Sense of touch is due to touch corpuscles in the skin.
(b) Sense of taste is due to taste buds in the papillae of the tongue. Tip of the tongue is most sensitive to sweet taste, and the back part is sensitive to bitter taste.
(c) Sense of sight: To see an object, its image must be formed on the retina. Convexity of the lens of the eye increases when the object is nearer and it decreases when the object is far away to get the image in each case on the retina. The property of the lens by which it is able to adjust its convexity to form distinct image of the object at various distances from it on the retina is called accommodation. When ciliary muscles do no work properly to bring about accommodation of the lens, the eye becomes defective.

The human retina contains two types of cells:
1. Cone Cells-Meant for seeing during the day, also responsible for colour vision
2. Rod Cells: Meant for seeing in low intensity lights.

Since humans have many more cone cells as compared to rod cells, they are much better at seeing the things in bright intensity as compared to other. Humans see with both the eyes together and both the eyes form separate images of an object. Those two separate images are then fused in the brain to create an impression of depth.
(Otherwise, the human retina is a 2-D structure, does not give perception of depth). This difference in images in the two eyes is referred to as binocular disparity.

(i) Myopia (or short-sightedness). When a person can see nearer objects distinctly but not distant ones, he is said to be suffering from myopia. In this case the convexity of the lens of his eye cannot be sufficiently decreased to form the image of the distant object on the retina. It is remedied by the use of concave glasses.
(ii) Hypermetropia (or long-sightedness). When a person can see distant objects clearly but not the never he is said to be suffering from hypermetropia. It is remedied by the use of convex glasses.

(iii) Astigmatism. The person can see vertical liens clearly but not the horizontal ones, or vice versa. It is remedied by the use of cylindrical glasses.

(iv) Colour Blindness: If a person cannot distinguish between different colours (especially between red and green), he is said to be suffering from this defect.

IV. Scientific Appliances

Aeroplane: An aeroplane usually consists of the following three parts:

(i) Wings,

(ii) The engine and the propeller; and

(iii) The tail.

In order to operate an aeroplane, the propeller is made to revolve at a very high speed with the help of a powerful petrol engine. The direction of the blades is so adjusted as to push the air in a backward direction, thereby producing a relative velocity between the 'plane and air—thus pushing the aeroplane in a forward direction. The push should be large enough to overcome the drag and should supply power for climbing.

Air conditioning: is the process of controlling the humidity, temperature, purity and circulation of air in a certain factory, a public building, hotels or a private house. The major aim of air-conditioning is to regulate the temperature, thereby producing a "cooling effect" on the whole. Exhaust machines are devised at a particular place for driving out waste and dirty gases, thereby completely purifying the air.

Binoculars: is an instrument used for seeing distant objects; the rays of light are twice reflected by means of right-angled prisms.

Carburettor: It is an apparatus for getting liquid fuel mixed with air as it is taken into an automobile or other like engines.

CD-Rom: It is a computer peripheral device that employs compact disk technology to store large amounts of digitized data for later retrieval.

Cellular Phone: This phone allows you to make a telephone while on the move. It can be installed in vehicles or can be carried along.

Cinematography: The principle of persistence of vision is utilised in cinematography. A cinematograph is an apparatus for projecting the pictures of moving objects on the screen. The instantaneous photographs of the successive positions of the moving body are photographed on a continuous film with the help of a special camera called the movie camera, with an automatic shutter at the rate of nearly 16 per second. The film duly developed is projected intermittently with a similar shutter as above so that it opens when the film is stationary and closes when it jerks off.

Computer: A complicated electronic machine which can perform incredibly complex calculations at incomprehensible speeds. It was invented by Charles Babbage. It can do whatever we know how to order it to perform. A computer consists of a Central Processing Unit (C.P.U.) and a number of peripheral units. A computer does not do anything which a human being cannot do. Only that it does is much faster and accurately.

Dewar Flask: is a double-walled glass flask, the inner surface of the outer vessel and the outer surface of the inner vessel of which have been silvered. The vacuum is created in the space between the two walls. This principle successfully prevents any interchange of temperature of the contents, because:
(1) glass is a bad conductor
(2) convection is not possible because there is vacuum between the walls and
(3) a little radiation that takes place from the inner vessel is reflected by the inner surface of the outer wall.

Daniel Cell: In this a rod of zinc is placed in dilute sulphuric acid contained in a cylindrical porous pot. The porous pot and its contents are placed in a large cylindrical copper vessel which also functions as positive pole of the cell. The space between the porous pot and the copper vessel is occupied by a solution of copper sulphate. The hydrogen produced by the action of the zinc on sulphuric acid travels towards the copper electrode. On delivering its electricity to the copper, it reacts with the copper sulphate turning copper out of the solution and forming sulphuric acid. The particles of copper liberated from the solution adhere to the outer copper vessel and thus the hydrogen is rendered harmless so far as polarisation is concerned.

Diesel Engine: It is a particular type of internal combustion engine, known as compression ignition engine. The air inside the cylinder is usually compressed to over 500 lbs. per sq. in. and the temperature is attained up to 800°F. At this stage the oil is injected into the hot compressed air, which gets ignited immediately, thereby producing a continuous gas stream, which pushes the piston upward. And thereafter the engine gets into operation.

Dynamo: The origin of the electricity in a dynamo is the transformation of mechanical energy into electrical energy. It depends on the principle of electro-magnetic induction whereby a current is produced on traversing a magnetic field.

Electric Bell: In an electric bell, there is one horse-shoe electromagnet, which plays an important role. A soft iron armature which is connected to a hammer H, is placed in front of the pole pieces of the electromagnet.

Electric Lamp: The electric lamp is based on the principle that when an electric current is passed through a very fine metallic filament inside an evacuated glass bulb, it is heated so as to render the wire white hot or incandescent. The wire being very thin offers great resistance to the passage of the current so that considerable heat is developed and the temperature rises to make it luminous and thus emit light. The resistance generally increases as the temperature rises and soon an equilibrium is reached and there is no further rise of temperature, the amount of heat radiated by the filament being equal to that generated in it by the electric current. In order that the metallic filament shall not oxidise or rust, oxygen is removed from the bulb by pumping out air or generally some inert gas such as nitrogen or some other gas is made to fill the bulb.

Electric Motor: An electric motor is a device which converts electrical energy into mechanical energy. A D.C. motor generally consists of several segments of a coil of a wire of a large number of turns wound over a soft iron cylinder called the armature. It is mounted on an axle about which it revolves and is placed between the poles of an electromagnet called the field magnets. There are the commutator, brushes and the leads. It is based on the principle that a conductor carrying current experiences a force when placed in a magnetic field.

Electro Cardio-gram (E.C.G.): It is actually a graphic picture of the heart-beat which the physician can make use of in the diagnosis. When the heart beats, its muscles contract and this causes a change in the electrical potential of the system. This change in potential is recorded on a paper by an electrical instrument known as electrocardiograph. The electrodes are connected to the two wrists and the left leg of the patient, and the machine acts like a galvanometer, the needle of which rests on a rotating drum covered with a paper, and thus the movements of the needle are recorded.

Electromagnet: whenever an electric current passed through a coil of wire, a large number of turns, wound round a soft iron core, the iron core gets magnetised and it becomes a powerful magnet, and is known as an electromagnet. This magnetism is temporary and lasts so long as the current passes through the coil. Looking at the end of the soft iron bar if the current in the coil is clockwise in direction that end of the bar is South Pole; if the current is counter-clockwise, that end is a North Pole.

Electron Microscope: It is just analogous to optical microscope in a way that beams of electrons are focused by magnetic lenses in a similar way to the focusing of light beams in the ordinary optical microscope. Germans were the pioneer to invent the electron microscope, during the year 1930. Direct magnification up to 10,000 times is possible. Still higher magnification is possible with the Proton Microscope.

FAX: Short for facsimile, it is a device that transmits pictures, drawings, text to a similar device at the receiving end, using telephone lines.

Fibre Optics: It is a branch of physics based on the transmission of light through transparent fibres of glass or plastic. These optical fibres can carry light over distances ranging from a few inches or centimetres to more more than 100 miles (160 kilometres). Such fibres work individually or in bundles. Some individual fibres measure less than 0.004 millimetre in diameter.

Optical fibres have a highly transparent core of glass or plastic surrounded by a covering called a cladding. Light impulses from a laser, a light bulb, or some other source enter one end of the optical fibre. As light travels through the core, it is typically kept inside it by the cladding. The cladding is designed to bend or reflect-inward-light rays that strike its inside surface. At the other end of the fibre, a detector, such as a photosensitive device or the human eye, receives the light.

Optical fibres have a number of uses. Various industries use optical fibres to measure temperature, pressure, acceleration, and voltage. In fibre-optic communication systems, lasers transmit coded messages by flashing on and off at high speeds. The messages travel through optical fibres to interpreting devices that decode the messages, converting them back into the form of the original signal. Fibre-optic communication systems have a number of features that make them superior to systems that use traditional copper cables. For example, they have a much larger information-carrying capacity and are not subject to electrical interference. In addition, signals sent over long-distance fibre-optic cables need less amplification than do signals sent over copper cables of equal length. Optical fibres are well-suited for medical use. They can be made in extremely thin, flexible strands for insertion into the blood vessels, lungs, and other hollow parts of the body. Optical fibres are used in a number of techniques that enable physicians to look and work inside the body through tiny incisions.

Fire Extinguisher: works by spraying continuous streams of carbon dioxide gas, which does not support combustion, and so acts as a fire extinguishing agent. Fire extinguisher is a medium size metallic cylinder fitted with a head-knob and a handle. At the time of emergency, the knob is struck against the floor, and carbon dioxide gas begins to evolve. Inside this cylinder a bottle of dilute solution of sulphuric acid is embedded in sodium carbonate powder. When the bottle is broken, sulphuric acid reacts with sodium carbonate to produce large quantities of the gas.

Fusion Torch: is an instrument to be evolved by the U.S. Atomic Energy Commission. It will use the power of the Hydrogen bomb to vaporise solid waste like junk-cars and bearcans, into their basic elements. The idea is based on the assumption that within a few years scientists will be able to harness the energy of the Hydrogen bomb—Controlled thermo-nuclear fusion—for use in electrical power plants.

Geiger Counter: A G.M. counter or Geiger-Muller counter is a device used for detecting and/or counting nuclear radiation and particles.

Heart Lung Machine: A machine which operates the function of the heart and lung at the time when the heart or lung is under operation. It directs the circulation of blood into body.

Incandescent lamp: If a body of sufficiently high melting point say platinum wire is raised to a high temperature, some of the radiations coming out fall within the range termed "light". The range comprises of radiation of short wave lengths and high frequencies. When such a body is heated it emits different colours at different temperatures, and ultimately, it gives dazzling white light at 1500°C and above. So the incandescent lamp consists of a metal of a high melting point (generally tungsten) enclosed in an evacuated glass globe and heated by an electric current. The filament is either in the form of an open spiral of straight wire or in the form of a ring of coiled wire. This lamp consumes about 1.4 watt per candle.

Internal Combustion Engine: is an engine in which energy supplied by a burning fuel is directly transformed into mechanical energy by the controlled combustion of the fuel in an enclosed cylinder behind a piston. It is usually applied to the petrol- burning or Diesel oil-burning engine.

Jet Engine: The essential components of the jet engine is the Gas turbine. It drives the rotary air compressor, which supplies compressed air to the combustion chamber, where a fuel like kerosene oil or gasoline enters and burns. The hot exploded gases are then expelled to the rear in a high velocity jet exhaust. It is the reaction of the plane on this jet of ejected gases that drives it forward.

Jet Propulsion: It is now being commonly employed for propulsion of aircraft and the underlying principle is Newton's third law of motion, that is, "to every action there is an equal and opposite reaction". Here a gas turbine drives the rotary air compressor which supplies compressed air to the combustion chamber, where the fuel-like gasoline enters and burns. The hot exploded gases are expelled to the rear in a high velocity jet exhaust. It is the reaction of the 'plane on this jet of fastly ejected gases that drives it forward. It has made possible supersonic speeds.

Difference between Rocket and Jet Engine: The essential difference between the propulsion of a jet engine and a rocket is that the gas turbines used in a jet engine require air to supply oxygen for the burning of the fuel. Rockets contain both fuel and an oxidizer to make them burn. Liquid oxygen is often used. So a jet engine would work only in the lower strata of the atmosphere where sufficient oxygen can be supplied by the air-compressors. The high velocity jet from a rocket is available for thrust in the upper atmosphere and even beyond the limits of our atmosphere. For rocket flights of course, the wings and rudders would be absolutely useless since there would be no air to exert force on them.

LASER: or Light Amplification by Stimulated Emission of Radiation, LASER is a device that harnesses light to produce an intense beam of radiation of a very pure, single colour. The power of the beam can be low (as in a food store laser scanner which reads prices on packages) or high (as in lasers used to cut metals). The first laser was built in 1960.

Lightning Conductor: It consists of a metal rod, the upper part of which is made up of copper with a number of conical points, the lower portion being an iron strip which extends deep into the earth's moist layers. A lightning conductor protects the building from the effect of lightning in two ways:

(i) The pointed conductors are charged by induction oppositely thus setting up an opposite wind which brings about a slow and silent discharge of the cloud.
(ii) If however the lightning does strike, the discharge may be carried to the earth through the metal strip without doing any damage to the building. In ships also, lightning conductors are fixed to the masts and carried down through the ship's keel-sheathing.

Loud Speaker: It is a device for converting electrical energy into sound energy. There are various types of loud speakers but the commonest and most efficient type used now-a-days is the moving coil type. It is based on the principle that when a varying current is passed through a conductor in a magnetic field, the conductor is acted on by a variable force and if the current is oscillatory, the conductor is set into vibrations.

Mariner's Compass: is an apparatus which is used to guide the sailors. The needle always points north-south. It consists of a magnetised bar with a card bearing the directions viz., north, south, east etc. The card is correctly mounted above and firmly attached to the magnetised bar. When the magnet moves in relation to the ship's course, the card automatically moves with it.

Motor-Car: A motor-car usually consists of the following working parts:
(i) Internal combustion engine
(ii) Gear Box
(iii) Battery
(iv) Carburettor
(v) Dynamo
(vi) Radiator

In order to operate a motor-car, the petrol from a container is ignited with the help of the battery. The vapours produced thereof are allowed to mix with air in the carburettor section, and thereafter the mixture is allowed to enter the cylinder of the internal combustion engine. The gases on expansion push the piston upwards thereby moving the crank-shaft, which in turn moves the main axle of the car. The motion of axle is controlled by the gear box.

Periscope: It is a device for viewing objects which are above the eye-level of the observer, or are placed so that direct vision is obstructed. It is usually used by the crew of a submarine to survey the ships etc., on the surface of the sea while the submarine is under water. It also enables sailors to observe objects on the other side of an obstacle without exposing themselves. It consists of a long tube, at each end of which is a right-angled prism, so situated that, by total internal reflection at the longest faces, light is turned through an angle of 90° by each prism. The light from a viewed object thus enters the observer's eye in a direction parallel to, but below, the original direction of the object.

Phytotron: is a big machine costing two million dollars and capable of producing any type of climate to order. It has been installed in Duke University, Durham, North Carolina to facilitate studies of environmental biology—particularly growing of plants under varying climatic conditions. The machine can duplicate any set of climatic conditions from the tropical to the Arctic in the brick and glass building in which it is housed. It has six specially equipped green houses and 40 controlled plant chambers. It is a useful device for the study of environmental biology.

Radar: precisely means: Radio, Angle, Detection And Range. It is one of the interesting developments of wireless waves the principle of which has been utilised in the radio location technique or popularly known as RADAR. It is an electrical device used for the detection and location of the aircraft with the help of radio frequency waves.

Wireless waves having very short wavelengths are set free in the shape of concentrated beam to flood or cover the required area of the sky. An aircraft entering that particular area is supposed to intercept the spreading waves, and an echo is reflected back to the transmitting station. In addition to detection of the aircraft, its distance from a particular place can also be calculated by recording the time taken by the wireless waves in travelling back. A discrimination between the aircraft of an enemy and a friendly nation can be made by understanding the nature of Echo.

Refrigerator: It is an apparatus or chamber for producing and maintaining a low temperature. The principle employed in the working of a refrigerator is that heat is absorbed by a liquid as it evaporates, thus producing a cooling effect. The substance commonly employed is liquid ammonia sulphur dioxide.

Rocket: The underlying principle of the flight of a rocket is Newton's Third Law of Motion viz., To every action there is an equal and opposite reaction. It is a self-propelled vehicle which depends upon the force provided by a fuel carried along with it. As the fuel burns, products of combustion are forced out at terrific speed at the rear of the vehicle and ejection imparts motion to it in the forward direction. It has its own oxygen supply for burning the fuel and therefore, there is no dependence on air for combustion or propulsion.

Rocket Bomb: If a rocket engine is used as a missile to carry an explosive charge it is termed as a Rocket Bomb. The principle of a rocket engine is the same as that of a jet engine but unlike the jet engine it carries its supply of oxygen with it to burn the fuel and is thus independent of the oxygen of the air. The hot gases formed in the combustion of the fuel are led through a nozzle. If a quantity of gas of mass m leaves the nozzle in time t with a velocity v, the force exerted on the mass of gas and hence the force also on the rocket = mv/t. Such a rocket bomb can be hurled from a place outside our atmosphere.

Safety Lamp, Davy's: It is based on the principle of rapid conduction of heat by a metal. In the miner's safety lamp, the flame of the lamp is surrounded by glass and above this is a space surrounded by five copper gauzes. Inflammable gases which may be present in the mine can pass through and burn inside the lamp. The copper gauze conducts away the heat so rapidly and effectively that the ignition point of the gas outside the gauze is never reached and thus the possibility of an explosion is avoided.

Seismograph: It is an instrument used for the registration of earth tremors, and consists of principle of a heavy pendulum system, the supporting framework following the ground movements and the bob remaining at rest on account of its large inertia thereby setting up a relative movement between the two parts of the seismograph. This movement is recorded with the help of electromagnetic transducers, galvanometers and electronic amplifiers. In order to record the displacements completely, usually three seismographs are made to set at one particular station.

Sound Barrier: Before the advent of aircraft with supersonic speeds, it was apprehended that when the speeds of the aircraft and sound were equal, the compressional waves produced by the flight of the aircraft will be unable to get away and will give rise to a sound barrier which will offer a considerable resistance to the motion of the aircraft and huge structural stresses and strains will be called into play attended by great noise likely to react unfavourably on the crew. But no such effects have been observed now that the speed of the jet-propelled aircraft and rockets far exceeds that of sound.

Spring Balance: A Spring Balance is used for measuring weights. The principle involved is that the stretching in the case of a Spring is proportional to the load suspended and if a load of 1 kilogram produces a stretching of 1 cm, a load of two kilograms will stretch it by 2 cm and so on. The spring is held at the upper end and load is suspended by a hook attached to the lower end with a pointer attached to the upper end of the spring which moves over a scale.

Steam Engine: is a machine utilizing steam power through a device by virtue of which heat is converted into mechanical energy. The steam engine has two main parts: (i) boiler, and (ii) proper engine. It consists essentially of a cylinder in which a piston is moved backwards and forwards by the expansion of steam under pressure.

Stereoscope: It is an optical device that makes photographs seem to have three dimensions. An ordinary camera sees things only in a flat plane and never in the round. But if two cameras set several inches apart photograph the same object simultaneously, and if these two photographs are then mounted side by side and viewed through a combination of lenses and prisms in such a manner that the two units enter the two eyes without strain, the resulting mental picture (image) appear to have three dimensions. Everything is seen in the round, the way our two eyes normally view things. These are employed in aerial survey and in astronomical telescopes.

Submarine: may be regarded as a ship having a variable and controllable specific gravity. It is equipped with large ballast tanks (in the low, the middle and the stern of the ship) into which water can be admitted through valves so that the vessel can be made to sink when desired. On the water being expelled again by pumps worked by compressed air, the ship rises to the surface. Inside the water it is the electric motors which drive it forward and there are horizontal rudders (or hydroplanes) which are fitted on both sides of the vessel so that by tilting them the vessel is gradually submerged, the same rudders help to maintain it at a desired depth of submergence.

Tape Recorder: It is an instrument which converts sound waves into electrical impulses which are recorded as a wavy groove on the tape. When it is required to produce the voice, the electrical impulses are again converted into sound waves.

Telephone: It is a device to produce sound to enable two persons to talk to each other from distance. The circuit, which is closed when the line is connected, consists of a transmitter and a receiver connected by an electrical conductor. The transmitter which is usually a carbon microphone causes variable electrical impulses to flow through the circuit. In the telephone-receiver, these impulses flow through a pair of coils of wire wound upon soft iron pole-pieces which are attached to the poles of a magnet. An iron diaphragm near these coils experiences variable pulls and vibrates so as to produce sounds corresponding to those made into the microphone.

Telephotography: is a process by which the transmission of moving objects is made by radio from one place to another. A succession of still pictures is transmitted at the rate of twenty-five per second which gives an illusion of continuous movement. The television camera changes the light pattern of the transmitted scene into a series of electrical signals which modulate a very high frequency radio carrier wave. The received signals are changed into light variations and reassembled on the screen of a cathode-ray tube at the receiver.

Teleprinter: It is an instrument which prints automatically messages sent from one place to another. It consists of a telegraph transmitter with a type-writer key-board by which characters of a message are transmitted electrically in combination of 5 units, being recorded similarly by the receiving instrument. The receiving instrument then translates the matter mechanically into printed characters.

Telescope: A simple refracting astronomical telescope is an optical arrangement for seeing very distant objects. Two convex lenses are mounted at the ends of two tubes so that by sliding one tube within the other, the distance between the lenses can be changed and the images thereby can be focused correctly. The lens at the larger end of the telescope is of considerable focal length and is called the object glass and a smaller lens of short focal length is called the eye-piece. Parallel rays proceeding from a distant object form its real image at the principal focus of the object glass. The position of the eye-piece is adjusted so that a magnified virtual image of it is seen. Since the real image is inverted, this virtual image is also upside down—a fact of little importance in astronomical work. For viewing terrestrial objects, the real image formed by the object glass is re-inverted by another convex lens before it is magnified by the eye-piece.

Television: It is the transmission of images of moving objects by radio waves. The scene to be transmitted or its image on a photo-mosaic inside an iconoscope camera is scanned with the help of a fine beam of light traversing horizontally and vertically. The reflected pulses in the former case are picked up by photoelectric cells which convert light energy into varying electric currents, or in the latter case, the photo-mosaic with the help of suitable electrical circuits generates varying currents. These currents are amplified with the help of valve amplifiers and are then made to modulate the carrier waves from a transmitter. At the receiving station, the electrical vibrations are reconverted into light waves which are collected on the fluorescent screen of a cathode ray oscilloscope at the same rate with which they are generated at the sending station. With the help of the property of persistence of vision possessed by the eye, we can see on the screen an exact photograph of the transmitted scene.

Thermometer, Clinical: A clinical thermometer is used to note the temperature of a human body and has graduations from 65°F to 100°F. It consists of a thin glass bulb connected with a thick walled capillary tube known as the stem. There is a constriction in the bore near the bulb. When the thermometer is placed below the tongue (or in the arm-pit) of a person, mercury in the bulb gets heated and expands. The force of expansion pushes the mercury past the constriction, which thus rises into the stem. When thermometer is removed, the temperature falls and mercury contracts. But the level remains intact as the thread is now broken at the constriction. The temperature can thus be conveniently read. The mercury can be again brought into the bulb by giving it a slight jerk.

Thermos Flask (Vacuum Flask): It is used to keep hot liquids hot and cold liquids cold. The principles involved in its construction are:
(i) It is made of glass which is a bad conductor of heat;
(ii) As there is vacuum between the walls, convection is not possible;
(iii) The outer face of the inner vessel is silvered, so there is very little radiation as polished surfaces are bad radiators. The inner surface of the outer vessel is polished which serves as a good reflector of any small radiation from the inner surface.

Tokamak T-3: is a machine designed by Russians to harness fusion reaction for peaceful purposes. A fusion reaction takes place under extreme pressure and temperatures such as exist in the core of the sun. In this machine such conditions are created by generating a hot gas or plasma. The Russians are already at work on an improved version of the machine which should achieve self-supporting generation of fusion-energy.

Transformer: It is an apparatus by which the voltage of an alternating current is made higher (step-up Transformer) or lower (step-down Transformer) or its frequency. Transformer is made up of two coils, one of a small number of turns of thick wire and the other of a great number of turns of thin wire. A current going through the first of these causes an induction current of higher voltage in the second. If the main current goes through the second one, induction current of a lower voltage is generated in the first coil.

Transistor: It is an active component of an electric circuit which may be used as an amplifier or detector. It consists of a small block of a semi-conducting material to which at least three electrical contacts are made, two of them being closely spaced rectifying contacts generally and one ohmic or loose (non-rectifying) contact. Transistors are now being used in radio receivers, in electronic computers, in electronic control equipments, in place of vacuum tubes where the required voltages are not too high. They are much smaller than their vacuum tube counterparts, consume less power and have no filaments to burn out.

Ultrasonoscope: It is a compact, diagnostic instrument designed to measure and use ultrasonic sound (with a frequency higher than 20,000 cycles per second, beyond human hearing). It emits brief bursts of ultrasound which are reflected back by bone, fluid or tissue in the body and give an "echo-gram". The instrument can be helpful in detecting deep-seated brain tumours, defective heart valves and abnormal growths.

Videophone: The world's first commercial videophone service was started for limited experimental use in Pittsburgh, Pennsylvania. It is as much of an advance on the ordinary telephone as the addition of sound and colour was to the movies. The visual dimension also increases the functional utility of this ommunication apparatus, but the trouble so far has been in designing and making videophones which will be cheap enough to be installed and used by thousands of people.

V. Scientific Instruments and Laws

Scientific Instruments:

Altimeter: an apparatus used in aircraft for measuring altitudes.

Ammeter: is used for to measure intensity of sound.

Anemometer: is an instrument for measuring the force and velocity of wind.

Audiometer: an instrument to measure intensity of sound.

Audiophone: is an instrument required for improving imperfect sense of hearing.

Barograph: for continuous recording of atmospheric pressure.

Barometer: is an apparatus used for measuring the atmospheric pressure.

Binoculars: is an instrument used for seeing distant objects, the rays of light are twice reflected by means of right-angled prisms.

Callipers: a compass with legs for measuring the inside or outside diameter of bodies.

Calorimeter: an instrument used for measuring quantities of heat.

Carburettor: is an apparatus for charging air with petrol vapours in an internal combustion engine.

Cardiogram: a medical instrument used for tracing the movements of the heart.

Cardiograph: is a medical instrument for tracing heart movements.

Chronometer: is an instrument kept on board the ships for measuring accurate time.

Cinematograph: It consists of a series of lenses arranged to throw on a screen an enlarged image of photographs. The lens system which forms the image on the screen is termed the focusing lens.

Commutator: split ring which forms the main part of a D.C. Dynamo.

Compass needle: for knowing approximately the North-South direction at a place.

Crescograph: is an instrument for use in recording growth of plants; invented by J.C. Bose.

Dip Circle: It is an instrument used to determine the angle between the direction of the resultant intensity of earth's field and the horizontal component at a place. This particular angle is know as the dip of that place.

Drinker's apparatus: to help breathing in infantile paralysis.

Dynamo: The origin of electricity in a Dynamo is the transformation of mechanical energy into electrical energy. It depends on the principle of electro-magnetic induction whereby a current is produced on traversing a magnetic field.

Electroencephalograph (EEG): It is the technique of recording and interpreting the electrical activity of the brain. Records of the electrical activity of the brain, commonly known as "brain waves", are called electroencephalograms or electroencephalographs. EEG is the common abbreviation for both the technique and the records.

Epidiascope: for projecting films as well as images of opaque articles on a screen.

Eudiometer: It is a glass tube for measuring volume changes in chemical reactions between gases.

Fathometer: is an instrument used for measuring depth of the ocean.

Galvanometer: an instrument for measuring currents of small magnitude.

G.M. Counter (Geiger Muller Counter): This special device is used for detecting the presence of radiation and counting certain atomic particles.

Gramophone: an instrument with which we can reproduce the sound recorded by a suitable recording apparatus. It is fitted with a special type of apparatus known as sound box invented by Berliner.

Gravimeter: is an instrument for recording measurement under water and to determine the presence of oil deposits under water.

Gyroscope: is an instrument used to illustrate dynamics of rotating bodies. It is a type of spinning wheel fixed to the axle.

Hydrometer: is an instrument used for measuring the specific gravity of liquids.

Hydrophone: is an instrument used for recording sound under water.

Hygrometer: is an instrument used for measuring humidity in air.

Kymograph: is an instrument used to record graphically various physiological movements i.e., blood pressure, heart beating, study of lungs etc in living beings.

Lactometer: is an apparatus used for measuring the purity of milk.

Manometer: for determining the pressure of a gas.

Mariner's Compass: is an apparatus which is used to guide the sailors. The needle always points north-south.

Micrometer: is an instrument used for converting sound i.e., fraction of the lowest division of a given scale.

Microphone: is an instrument used for converting sound waves into electrical vibrations.

Microscope: is an instrument which is used for magnifying minute objects by a lens system.

Microtome: is used for cutting an object into thin parts for microscopic inspection.

Odometer: is an instrument by virtue of which the distance covered by wheeled vehicles is recorded.

Periscope: It is usually used by the crew of a submarine to survey the ships etc, on the surface of the sea while the submarine is under water. It also enables the sailors to observe objects on the other side of an obstacle without exposing themselves.

Phonograph: is an instrument used for reproducing sound.

Photometer: is an apparatus used to compare the illuminating power of two sources of light.

Pipette: It is a glass tube with the aid of which a definite volume of liquid may be transferred.

Potentiometer: is used for comparing the e.m.f.s, of cells, measurements of the thermal e.m.f.s, large potential differences and currents. It is also used for measuring low resistances.

Psychrometer: is an instrument for measurement of the humidity of the atmosphere.

Pyrometer: is an instrument for recording high temperatures from a great distance (i.e., for recording temperature of the sun etc.) by making use of the laws of radiation.

Radar: Radio, Angle, Detection And Range is used to detect the direction and range of an approaching aeroplane by means of radio microwaves.

Rain Gauge: is an apparatus for recording of rainfall at a particular place.

Radiometer: is an instrument for measuring the emission of radiant energy.

Refractometer: is an instrument to measure refractive indices.

Saccharimeter: is an instrument for determining the amount of sugar in a solution. It is used in breweries.

Seismometer or Seismograph: is an instrument used for recording earthquake shocks.

Sextant: is an instrument invented by John Hadley used for measuring the altitude of the sun and of other inaccessible heavenly bodies.

Spectrometer:
(1) It is a type of spectroscope suitable for the precise measurements of refractive indices.
(2) An instrument for measuring the energy distribution of a particular type of radiation.

Speedometer: is an instrument which indicates speed at which a vehicle is moving.

Spherometer: is an instrument for measuring curvature of surfaces.

Sphygmomanometer: an instrument used for measuring arterial blood-pressure.

Sphygmophone: an instrument, with the help of which a pulse beat makes a sound.

Sphygmoscope: an instrument, by virtue of which, arterial pulsations become visible.

Stereoscope: It is a special type of binocular, through which a double photograph snapped from two different angles by a two-lensed camera is viewed in solid relief.

Stethoscope: is an instrument to hear and analyse movements of heart and lungs.

Stop watch: for recording small intervals of time in the laboratory, in races and other events.

Stroboscope: is an instrument for viewing objects moving rapidly with a periodic motion and to see them as if they were at rest.

Tachometer: is an instrument for determining speeds of aeroplanes and motor boats.

Telephone: a device by virtue of which two persons at two different places can communicate. It consists of two main parts
(i) a microphone and
(ii) a receiver.

Teleprinter: an instrument which prints automatically messages sent from one place to another, on telegraph lines.

Telescope: is an apparatus used for observing distant objects.

Theodolite: is an instrument for measuring horizontal and vertical angles.

Thermocouple: an instrument based on thermo-electricity used for measuring temperatures.

Thermometer: is an apparatus used for measuring temperature.

Thermostat: It is an instrument used to regulate the temperature to a particular degree.

Viscometer: is an instrument to measure viscosity.

Scientific Laws

Archimedes' Principle: It states that a body, when immersed in a liquid, experiences an upward thrust equal to the weight of the liquid displaced by it.

Avogadro's Hypothesis: It is a modification of Berzelius' hypothesis. It states that equal volumes of all gases under similar conditions of temperature and pressure contain equal number of molecules. Avogadro's law is applicable only to gases.

Boyle's Law: states that the volume of certain gas is inversely proportional to the pressure at a constant temperature. In other words the product of pressure and volume remains constant provided the temperature is kept constant i.e., P x V = a constant if T remains the same.

Charles's Law: It states that at constant pressure all gases expand by 1/273 of their volume at 0°C for a rise in temperature of 1°C i.e., the volume of a given mass of gas at constant pressure is directly proportional to the absolute temperature.

Dulong and Petit's Law: states that the product of atomic weight and specific heat of solid elements is nearly equal to 6.4 i.e., At wt. x sp. heat = 6.4 approx.

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.

Graham's Law of Diffusion: 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.

Kepler's Law: According to this law, a line drawn from the sun to a planet, moving around it, sweeps over a fixed area in a given interval of time.

Law of definite proportions: A chemical compound is always found to be made up of the same elements combined together in the same ratio by weight.

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.

Lenz's Law: When there is change in the magnetic flux linked with a circuit, the electric current induced in the circuit will have a magnetic field opposing the change producing it.

Newton's Law of Universal Gravitation: states that "Every portion of matter attracts or tends to approach every other portion of matter in the universe with a force proportional to the masses and inversely as the square of the distance."

Newton's First Law of Motion: "A body continues in its state of rest or of uniform motion in a straight line unless compelled by an external force to change that state."

Newton's Second Law of Motion: "The rate of change of momentum is proportional to the impressed force and takes place in the direction of the force."

Newton's Third Law of Motion: "To every action, there is an equal and opposite reaction."

Newton's Law of Cooling: states that the rate of loss of heat of a hot body is directly proportional to the difference of temperature between the body and the surroundings and is independent of the nature of the body.

Ohm's Law: states that the ratio of the potential difference between the ends of a conductor and the current flowing in the conductor is constant, e.g., for a potential difference of E volts and a current I amperes, the resistance R, in ohms is equal to E/I.

Principle of conservation of energy: It states that, in any system, energy cannot be created or destroyed; the sum of mass and energy remains constant.

Snell's Law: It states that the ratio of the sine of angle of incidence to the sine of the angle of refraction remains constant for any two given media.

Specific heat of substance: The quantity of heat required to raise the temperature of 1 gram. of a substance through 1°C.

VI. Prominent Scientists:

Abdul Kalam, Dr A.P.J.: is credited with advancement of missile technology in India. He was honoured with Bharat Ratna award on November 26, 1997. He is known as "father of India's Missile Technology". Elected 11th President of India.

Alvares, Luis W.: is an American physicist teaching at the University of California, Berkeley, U.S.A. He won the Nobel Prize for Physics in 1968 for an important breakthrough he made in elementary physics in

1960 when he discovered a new resonance particle—a discovery that shattered the then prevailing notions as to how matter was built.

Anfinsen, Dr Christian B.: of the U.S.A.'s National Institute of Health, Bethseda, Maryland was one of the three co-winners of the Nobel Prize in Chemistry, 1972.

Archimedes: Greek mathematician (born in Sicily) who lived about 250 B.C. is known for the discovery of the Archimedes' principle viz., The volume of any insoluble solid can be found by noting its loss of weight when immersed in water. He is also credited with the invention of Archimedean Screw, a cylindrical device for raising water.

Arrow, Kenneth, J.: of Harvard University, U.S.A. is co-winner of the Nobel Prize for Economics, 1972 with Sir John Richard Hicks of Oxford University. The two men are known for their pioneering contributions to general economic equilibrium and welfare theories.
Aryabhatta: (A.D. 476-520) after whom India's first scientific satellite has been named, was a great Indian astronomer and mathematician. Among his important contributions are the recognition of the importance of the mov ement of the earth round the sun, determination of the physical parameters of various celestial bodies, such as diameter of the earth and the moon. He laid the foundations of algebra and was responsible for pointing out importance of "zero".

Avogadro, Amedeo: (1776-1856) Italian physicist; founder of Avogadro's hypothesis: "Equal volumes of all gases under similar conditions of temperature and pressure, contain equal number of molecules." He also defined a molecule.

Bardeen, Prof John: of the University of Illinois (U.S.A.) is co-winner of the Nobel Prize for Physics, 1972 (with Prof Leon N. Cooper and Prof John Robert Schrieffer) for researches into the "theory of super-conductivity" usually called the BCS theory.

Barnard, Christian: South African surgeon who shot into world news in December 1967 when he completed the first heart transplant operation on Louis Washkansky.

Beadle, Dr G.: American scientist awarded Nobel Prize for medicine in 1958 for his work concerning the actual basis of heredity—the way in which characteristics are transmitted from one generation to another.

Becquerel, Henri: (1852-1908) French physicist known for his discovery in 1896 of Becquerel rays, the first indications of radio-activity; these rays were later named gamma rays. He shared Nobel Prize for Physics with the Curies in 1903.

Berzelius, J.J: (1779-1848) Swedish Chemist, known for introduction of chemical shorthand symbols and atomic weights.

Bessemer, Sir Henry: (1813-1898) English engineer. He invented the process for the manufacture of steel known after his name.

Bhabha, Dr H.J.: (1909-66) Indian scientist. He published important papers on Cosmic Rays and Quantum Theory. He was professor at the Indian Science Institute, Bangalore; Chairman, Atomic Energy Commission; Director, Tata Institute of Fundamental Research; President, Indian Science Congress in 1951 and presided at the Atoms for Peace Conference held at Geneva in 1956. He had many significant researches in structure of atom and contributed largely to the setting up of atomic reactors at Trombay (Mumbai).

Bhagvantam, Dr S.: is an eminent Indian scientist who has made a rich contribution to research in radio astronomy and cosmic rays. He has published more than 150 research papers and several books. He retired in October 1969 as the Scientific Adviser to the Ministry of Defence, and Director General of the Defence Research Development Organisation. He is an old-time associate of Sir C.V. Raman.

Bhaskaracharya: Born in A.D. 1114, he was almost the last great Hindu mathematician and astronomer until modern times. He wrote Sidhanta-Siromani in 1150 which consisted of two mathematical and two astronomical parts. Bhaskara anticipated the modern theory on the convention of signs (minus by minus makes plus, minus by plus makes minus). He also anticipated Kepler's method for determining the surface and volume of sphere.

Bhatnagar, Dr Shanti Swarup: (1895-1955) great Indian scientist. He was Director of Council of Scientific and Industrial Research (C.S.I.R.). A chain of National Laboratories has been established in the country due to his able organisation and unbounded energy.

Bohr, Neils: (born 1885) Danish Physicist. He was awarded Nobel Prize for Physics in 1922. He greatly extended the theory of atomic structure of devising an atomic model in 1913 and evolving theory of nuclear structure; assisted America in atom bomb research.

Borlaug, Norman Ernest: American agricultural scientist and winner of the Nobel Prize for Peace in 1970. He was one of those who laid the groundwork of the Green Revolution.

Bose, Sir J.C.: (1858-1937) Eminent Indian physicist and Botanist; founder of Bose Research Institute, Calcutta. Inventor of crescograph which is used to magnify movements made by plants. Bose, S.N.: Eminent Indian scientist who won fame by expounding the Bose-Einstein theory, which is concerned in detection of a group of nuclear particles—named after him 'Boson' in recognition of his contribution to the subject; contributed to Plank's law. Professor of physics, Calcutta University; nominated member to the Council of States. Awarded Padma Vibhushan in 1954. He died on February 4, 1974.
Boyle, Robert: (1627-1691) Irish natural philosopher; one of the founders of modern chemistry and Boyle's law: "Temperature remaining constant, volume of a given mass of gas varies inversely as its pressure."

Bragg, Sir William: (1862-1942) British physicist known for researches on the behaviour of crystals with regard to X-rays incident upon them. Author of the book: "Atomic Structure of Minerals".

Cavendish, Henry: (1731-1810) English physicist and chemist; he discovered properties of hydrogen in 1766 and identified it as an element.

Chadwick, Sir James: (1891-1974) British physicist. He discovered the particle in an atomic nucleus which became known as the neutron, because it has no electric charge.

Chandrasekhar, Dr Subramanian: He was a scientist of Indian origin settled in the U.S.A., who shared the 1983 Nobel Prize for physics with an American, William Fowler. He was one of the most outstanding astrophysicist of the world. His theory of stellar evolution—the birth and death of stars—is more than 30 years old. When he first propounded his finding that old stars just collapse and disappear in the light of denser stars of low light, the world's top-flight astronomers laughed at him and rejected his theory. A disappointed Dr Chandrasekhar left Trinity, Cambridge, to pursue his research in the University of Chicago. Over the next two decades the "Chandrasekhar Limit" became an intrinsic part of text-books on advanced astrophysics. Global recognition and awards poured in, and the 1983 Nobel Prize tops a remarkable career spanning almost half a century.

Charak: (c.A.D. 80-180) was a court physician to Kushan king Kanishka. His writings are invaluable in the study of Hindu medicine.

Charles, Jacques Alexander Cesar: (1746-1823) a French scientist of great repute. He was the first to make a balloon ascension with hydrogen. He is known for his work on the effect of temperature on the volume of gases.

Clarke, Arthur C.: He is known for his suggestion of the concept of Geostationary Orbit.

Clark Maxwell, James: (1831-79) British physicist. His theoretical work prepared the way for wireless telegraphy and telephony. His principal works include: Perception of Colour, Colour Blindness, Theory of Heat, Electricity and Magnetism, Matter and Motion.

Claude, Albert: is a biologist of Luxembourg who shared the 1974 Nobel Prize in Medicine. His field of research relates to causes and treatment of cancer.

Columbus, Christopher: (1446-1506) A well-known Italian navigator set out on his first voyage in 1492; he discovered West Indies Islands, Cuba and Bahamas; he also discovered South America in 1498.

Cooper, Leon N.: Of the Brown University, Providence, Rhode Island (U.S.A.) was one of the three co-winners of the Nobel Prize in Physics, 1972 for researches into the theory of super-conductivity.

Copernicus: (1413-1543) A prominent astronomer of Poland who discovered the "Solar System".

Cornforth, John Warcup: co-winner of the 1975 Nobel Prize in Chemistry is a deaf professor. He is an Australian living in England. His chief distinction is mapping out the formation of cholesterols which he calls "a great discovery" and contains the key to, for instance, sex hormones.

Curie, Madame Marie: (1867-1934) Polish physicist and chemist; famous for her discovery of radium was awarded Nobel Prize in chemistry in 1911 and shared Nobel Prize in physics in 1903 with her husband and Becquerel.

Dalton, John: (1766-1844) British scientist. He was founder of the Atomic Theory and law of Multiple Proportions.

Darwin, Charles: (1809-82) was the British scientist who discovered the principle of natural selection. His famous work is "The Origin of Species".

Davy, Sir Humphrey: (1771-1829) British chemist. First to apply electric current for the isolation of metals. Studied anaesthetic action of nitrous oxide, properties of chlorine and alkali metals.

Debreu, Gerard: Gerard Debreu of the University of California at Berkeley, who has been awarded the 1983 Nobel memorial prize in economics is known for his research on market equilibrium in which he "incorporated new analytical methods into economic theory". Mr Debreu has expanded on a mathematical model designed by the two men in the early 1950s that confirmed the logic of Adam Smith's "theory of general equilibrium" in which prices supply and demand tend to reach a balance within a free market economy.

Delbrueck, Dr Max: is a German-born American doctor working at the California Institute of Technology. He was one of the three American co-winners of the Nobel Prize for Medicine, 1969 for discoveries in molecular genetics.

De Vries: is known for Mutation theory.

Dhanvantri: a great physician during the reign of Chandragupta Vikramaditya (375-413 A.D.).

Dhawan, Prof Satish: He is former Chairman of the Indian Space Research Organisation (ISRO). Under his dynamic leadership India entered Space Age by launching "Aryabhata", a scientific satellite, into space on April 19, 1975.

Edelman, Dr Gerald Maurice: of U.S.A. is co-winner of the Nobel Prize for Medicine, 1972. He is known for researches into the chemical structure of blood-proteins or antibodies which shield the human body against infection. He shared the prize with Dr Rodney Robert Porter of Oxford. The two Nobel-laureates were able to break the giant molecules formed by antibodies into their component sections.
Edison, Thomas Alva: (1847-1931) American inventor of Dutch-Scottish parentage. He started life as a newsboy and then a telegraph operator. His inventions include: phonograph, the incandescent lamp, a new type of storage battery, an early form of cinematography etc.

Einstein, Prof Albert: (1879-1955) was German-Swiss world-famous scientist known for his theory of relativity. He was awarded Nobel Prize for his work on photoelectric effect.

Faraday, Michael: (1791-1867) An eminent English scientist; showed great prominence in the field of electromagnetism; discovered the laws of electrolysis and wrote a number of useful books on the subject.

Fleming, Alexander: (1881-1955) British bacteriologist. His notable discovery was lysozyme (1922), followed by penicillin (1929)—an antibiotic drug.

Fleming, Sir John Ambrose: (1849-1945) British physicist and engineer who was pioneer in the development of the telephone, electric light and radio.

Fraunhofer: German physicist. He gained prominence on the researches of 'Light' while performing spectrum-analysis of Sunlight; he discovered the spectrum to be crossed with some indifferent black lines. And the lines are so named as Fraunhofer Lines.

Freud, Sigmund: (1856-1939) originator of psycho-analysis, born of Jewish parents. Works: The Interpretation of Dreams; The Psychopathology of Every-day Life; The Ego and the Id; Civilization and Its Discontents.

Gabor, Dr Dennis: Who won the 1971 Nobel Prize award for Physics is a 71-year old British electrical engineer working as a scientist in the U.S.A. He was cited for his "invention in development of the holographic method"—three dimensional photography. Dr Gabor was the 16th Briton to have won the Nobel Prize in Physics. He was born and educated in Hungary. He later worked as research engineer in Germany and came to join the staff of the Imperial College in London in 1949. He invented holography in the late forties. But the science became fully developed with the coming of the laser in 1960. A holographic image is so lifelike that a viewer can see around things in a holograph by moving his head just as he looks around the real object.

Galileo: (1564-1642) Italian scientist. He was professor of mathematics. His view that all falling bodies, great or small, descend with equal velocity, made him unpopular with the orthodox scientists. He improved telescope and with it was the first man to see the satellites of Jupiter.

Gell-Mann, Prof Murray: was the recipient of the 1969 Nobel Prize for Physics. He is a teacher in the California Institute of Technology. Born in New York in 1929, Prof Gell-Mann has been the leading theorist in elementary particle research for the last 15 years. He was the 28th American to be awarded the Nobel Prize for Physics in which the U.S.A. now leads. The Nobel Prize was given to him for "his classification of elementary particles and their interactions".

Goddard, Robert H.: was an American who mentioned the possibility of shooting a rocket to the moon in a paper entitled "A Method of Reaching Extreme Altitudes" published by him in 1919. By 1926 he had put some of his ideas into practice. He is looked upon as one of the pioneers of space research.

Graham, Thomas: (1805-1914) Scottish chemist called the "father of colloidal chemistry". He did remarkable work on diffusion of substances in solution.

Heisenberg: is known for his theory of Uncertainty Principle.

Hahn, Otto: was a German pioneer of nuclear research. He won the Nobel Prize for Chemistry in 1944. It was Hahn who had proved in 1938 that atomic fission can be achieved by bombarding uranium with neutrons. The discovery revolutionised atomic science.

Hall, Charles Martin: (1863-1914) American chemist who discovered the modern method of extraction of aluminium by electrolysis of bauxite in 1886.

Harvey, William: (1578-1675) English physician who discovered the circulation of blood.

Herzberg, Dr Gehard: has been awarded the 1971 Nobel Prize in Chemistry, for his researches in atomic and molecular structures, particularly free radicals. He is the first Canadian to win a Nobel Prize in Chemistry.

Holley, Robert: Co-winner of the Nobel Prize for Medicine, 1968, belongs to Cornell. His researches into the genetic code and its function in building protein led to the discovery of the complete structure of a transfer RNA molecule and the way it works.

Hopkins, Sir Frederick Gowland: He was an eminent English biochemist famous for his important work on proteins and vitamins. He was awarded the Nobel Prize in medicine in 1929 for the discovery of Vitamin D.

Hoyle, Fred: is a British scientist and science-fiction writer who won the £ 1,000 Kalinga Prize in 1968.

Jenner, Edward: (1749-1823) Eminent English physician who discovered the vaccination system of alleviating small pox.

Josephson, Dr Brian: is a British scientist who co-shared the 1973 Nobel Prize for physics for "his theoretical predictions of the properties of a super-current through a tunnel barrier, in particular those phenomena which are generally known as Josephson effects".

Joshi, Prof S.S.: He has done commendable work on physical and chemical reactions under electric discharge on active nitrogen; colloids; hydrogen peroxide; permanganates and a phenomenon called "Joshi Effect".

Joule, James Prescott: (1874-1937) a great English physicist who first demonstrated that mechanical energy can be converted into heat.

Kepler, Johannes: (1571-1630) German astronomer. He discovered 3 laws of planetary motion that bear his name viz.,

(1) The orbit of each planet is an ellipse with the sun at one of the foci;

(2) the Radius vector of each planet describes equal areas in equal times;

(3) The squares of the periods of the planets are proportional to the cubes of their mean distances from the sun. Kepler had evolved a set of laws governing man in space with rare prescience. In a kind of allegory, he referred to the dangers of solar radiation, the need to overcome gravitational resistance, gravitational capture of spacecraft by the moon etc. What he wrote nearly 360 years ago was, however, little understood and his family was persecuted for it. His mother had to die in jail having been condemned as a witch.

Khorana Hargobind: who shared with two others the 1968 Nobel Prize for Medicine is an Indian by birth and an American by domicile. He deciphered the genetic code and later created an artificial gene.

Krishnan, Dr K.S.: (born 1898) collaborated with Sir C.V. Raman in the discovery of "Raman Effect". President, Indian Science Congress, 1949; delegate to several international scientific conferences; Director, National Physical Laboratory, New Delhi.

Lavoisier, A.L.: (1743-1794) French chemist; established law of Indestructibility of Matter, Composition of Water and Air.

Lister, Joseph: (1827-1912) British surgeon. He was the first to use antiseptic treatment for wounds; introduced antiseptic surgery.

Lodge, Sir Oliver Joseph: (1851-1940) British physicist. He is chiefly known for his researches on radiation, and the relation between matter and ether.

Lovell, Sir Bernard: He is professor of Radio-Astronomy in the University of Manchester and is also Director of the Jodrell Bank Observatory. He remains very much in the news for tracking space-ships.

Lysenko: Author of Agro-biology, Lysenko gained fame as a Soviet geneticist. In 1948, he declared the Mendelian theory obsolete and erroneous.

Marconi: (1873-1937) Italian scientist; pioneer in wireless telegraphy and radio.

Max Planck: He was a German theoretical physicist who formulated the quantum theory which revolutionized physics. He was awarded the Nobel Prize in 1918.

Mendel, Johann Gregory: (1822-84) Austrian monk and naturalist whose discovery of certain principles of inheritance (heredity) is of deep significance in the study of biology.

Mendeleef, D.I.: (1834-1901) a Russian chemist, founder of periodic law and famous for the development of petroleum and other industries in Russia.

Meyer, Victor: (1848-1897) discovered a method to determine the molecular weights of volatile substances.

Morley, Edward William: (1818-1923) American chemist and physicist best known for his work in determining the composition of water by weight.

Moseley, Henry G.: (1887-1915) British physicist who did valuable work on atomic structure, and in 1913, devised the series of atomic numbers.

Nagarjuna: the renowned chemist of Buddhist era whose works are mostly preserved in China and Tibet. A great Philosopher and Chemist. He makes a mention of crucibles, distillation stills, sublimation, colouring process, alloying of metals, extraction of copper and use of many metallic oxides in medicines. About chemistry he said, "As long as the science of chemistry prevails, let hunger, pain and poverty not torment men."

Nag-Chowdhury, B.D.: an eminent Indian nuclear physicist, known all over the world.

Narlikar, J.V.: Indian scientist; co-author of Hoyle-Narlikar Theory of continuous creation. The theory of which he is co-author has been hailed as supplying some important missing links in Einstein's theory of Relativity. The new theory of gravitation propounded by both the scientists, Narlikar and Hoyle, shows that gravitation is always attractive and there is no gravitational repulsions.

Newton, Sir Isaac: (1642-1727) was the British natural philosopher. He discovered binomial theorem; the differential and integral calculus. He expounded the universal law of gravitation. He is author of Principia Mathematica.

Nirenberg, Dr Marshall: is a U.S. molecular biologist who shared the 1968 Nobel Prize for Medicine with Dr Robert Holley and Dr Hargobind Khorana. Nirenberg is the author of a very simple but ingenious experiment which helped a great deal in clarifying the general character of the genetic code.

Oberth, Hermann: is a Rumanian-German Professor who is credited with establishing the experimental basis of modern rocketry. In 1923, the publication of his book, "The Rocket into Interplanetary Space" aroused great interest in space travel.

Ohm, George Simon: (1787-1854) physicist and mathematician; discovered the law known as Ohm's Law.

Onsager, Lars: is a U.S. Professor who became a Nobel laureate in 1968 by winning the prize for Chemistry "for the discovery of the reciprocal relations bearing his name which are fundamental for the thermo-dynamics of irreversible processes".

Paraceisus: (1493-1541) a Swiss mystic and chemist. He was the first to employ laudanum and antimony in Pharmacy.

Parson, Sir Charles: (1854-1931) British engineer; inventor of Parson steam turbine.

Pasteur, Louis: (1822-95) He was a French chemist who discovered the causes of fermentation in alcohol and milk and founded the Pasteur Institute in 1888. He made researches in silkworm disease, anthrax, and hydrophobia. Pauling, Linus: American bio-chemist. He applied the quantum theory to chemistry and was awarded Nobel Prize (1954) for his contribution to the electrochemical theory of valency.

Porter, Dr Rodney Robert: is Professor of Biochemistry in Oxford University. Dr Porter is known for his discoveries relating to the chemical structure of antibodies.

Priestley, Joseph: (1733-1804) British Chemist; discovered oxygen and methods of collecting gases.

Pythagoras: is known as the father of Geometry.

Rainwater, James: of the U.S.A. who co-shared the 1975 Nobel Prize in Physics is known for the development of the theory that atomic nucleus is not always spherical but can also be egg-shaped which has no immediate practical meaning but is extremely essential to scientists.

Ramanna, Dr Raja: former Director of Bhabha Atomic Research Centre at Trombay. He was one of the Indian scientists associated with staging India's first nuclear blast at Pokhran on May 18, 1974.

Raman, Sir C.V.: (1888-1970) Eminent Indian Scientist (F.R.S.) National Professor of Physics and founder Director of Raman Research Institute, Bangalore. He was awarded Nobel Prize for his discovery of 'Raman Effect' (Feb 28, 1928). His work on study of crystal structure is of unique importance. Feb 28 is celebrated every year as National Science Day.

Ramanujan, Srinivas: (1887-1920) Indian mathematician who contributed to the theory of numbers, theory of partitions, and the theory of continued fractions.

Ramsay, Sir William: (1852-1916) English chemist who discovered helium and later on neon, argon in collaboration with Rayleigh and others. He was awarded Nobel Prize in 1904. Rao, Prof U. Ramachandra: is the Director of Indian Scientific Satellite Project (ISSP) at Peenya near Bangalore.

Ray, Sir P.C.: (1861-1944) founder of Indian Chemical Society and Bengal Chemical and Pharmaceutical Works Ltd., and author of 'Hindu Chemistry'. His work about nitrous acid and its salts deserves special mention.

Richards, T.W.: He was Prof of Chemistry at Harvard University in U.S.A. He did notable work in the accurate determination of atomic weights and was awarded Nobel Prize in 1916.

Roger Bacon: (1214-1294) He was inventor of Gun Powder and founder of experimental science; man of remarkable gifts and inventive power.

Rontgen, W. Konrad: (1845-1923) German physicist. He discovered X-rays, also called Rontgen rays. He was awarded the first Nobel Prize in 1901 for discovery of X-Rays. Ross, Ronald: (1857-1932) leading British physician who discovered the cause of Malaria; awarded Nobel Prize for medicine in 1902.

Rutherford, Daniel: (1749-1819) a Scottish scientist who is given the credit for the discovery of nitrogen.

Rutherford, Lord: (1871-1937) won a Nobel Prize for his work on structure of atom and radio-activity.

Ryle, Sir Martin: of the U.K. who shared the 1974 Nobel Prize in Physics is known for the development of "aperture synthesis" technique designed to identify stellar objects through radio signals.

Saha, Dr Meghnad: (1893-1956) late Palit Prof of Physics, University College of Science and Technology, Calcutta University—well known for his researches in nuclear physics, cosmic rays, spectrum analysis and other branches of theoretical physics.

Sanger, Dr Frederik: British scientist awarded Nobel Prize in Chemistry in 1958 for his work in determining the composition of the insulin molecule. By his discovery he has put science a step forward towards knowing how disease attacks the human body. In 1980, he became only the fourth person ever to be awarded a second Nobel Prize.

Sarabhai, Dr Vikram A.: former Chairman of India's Atomic Energy Commission and the Indian Space Research Organization (ISRO) died on December 30, 1971. Dr Sarabhai was an eminent physicist mainly interested in the astrophysical implications of Cosmic Ray Time Variations.

Sen, P.K. (Dr): is the Indian surgeon who performed Asia's first heart transplant operation in Mumbai.

Simpson, Sir James Young: (1811-70) British physicist who was largely instrumental in the introduction of chloroform as an anaesthetic in 1847.

Soddy, Frederick: (1877-1956) British physical chemist. He was a pioneer of research into atomic disintegration. He coined the term "isotopes"; did classic work on radioactivity.

Solvay, Earnest: (1838-1922) Belgian chemist known for devising a process known after his name for manufacture of sodium carbonate.

Susruta: Was a fourth century Hindu surgeon and physician. He wrote an important book on medicine and also a thesis on the medical properties of garlic.

Sutherland, Dr Earl W.: was the recipient of the Nobel Prize for Medicine, 1971. He is credited with the discovery that the hormones in the human body produce another substance known as cyclic A.M.P., which activates them and controls the body's cells. He has demonstrated that changes in the level of cyclic A.M.P. in the body can influence its disease-resisting capacity. This discovery opens up new vistas for the development of drugs that can treat diseases which have so far been regarded as incurable.

Teller, Edward (Dr): is a U.S. nuclear scientist who has played a major role in developing the hydrogen bomb. He is in fact known as the "father of the H-bomb".

Thomson, Sir J.J.: (1856-1940) British physicist. He discovered the electron which inaugurated the electrical theory of the atom. He is regarded as the founder of modern physics.

Tsiolkovsky: was a Russian teacher who in 1903 published a treatise presenting remarkably accurate calculations on rocket dynamics and space-travel. He is looked upon as the earliest among the pioneers who laid the foundations of space exploration. The Russians call him the "Father of Rocketry".

Varahmihira: (505-587) was a distinguished Indian astronomer, mathematician and philosopher. He was one of the nine gems of the court of king Vikramaditya.

Verne, Jules: (1828-1905) French science-fiction writer was author of "From the Earth to the Moon" published in 1865. The book carried a more or less accurate prediction of the launching and flight of Apollo-8.

Volta, A.: (1745-1827) Italian physicist and pioneer of electrical science; invented voltaic pile, the electrophorus and electroscope. The volt is named after him.

Voronoff, S.: Russian scientist best known for his method of preventing or delaying senility by grafting healthy animal glands, into the human body.

Watson and Crick: known for DNA double helix.

Watson-Watt, Sir Robert: British physicist. He developed radar.

Watt, James: (1736-1819) was Scottish engineer. He invented steam engine.

Yukawa, Dr H.: (born 1907) predicted a new particle meson which holds the protons and neutrons of the atomic nucleus. He is the first Japanese to win the Nobel Prize in Physics (1949).

VII. Scientific Inventions & Discoveries:

Inventions and discoveries in Physics and Chemistry

Anderson—Discovered positive electrons.

Archimedes—Discovery of the Principles of lever and of specific gravity; invention of the famous Archimedean screw.

Avogadro—An Italian scientist known for Avogadro's Hypothesis.

Bacquerel— Radio-activity of uranium.

Baird—Television.

Baron Napier—Logarithms.

Benjamin Franklin—Invented lightning conductor.

Bessemer—Steel smelting process.

Bhabha, Dr H.J.—Research in Cosmic rays and Quantum theory.

Binet—Intelligence Test.

Birbal Sahni—Researches in Botany.

Bose, **J.C.—**Invented Crescograph and published many works on plant physiology. He discovered that plants have sense and perception.

Bose, S.N.—Discovery of a group of nuclear particles named after him "Boson".

Boyle—Boyle's law; Pressure x volume = constant at a constant given temperature. Boyle was the greatest scientist of England in his time.

Bohr—Electron Theory—Atomic structure.

Braun, Dr Wernher von—space flying.

Bunsen—Invention of the spectroscope.

Carothers—Nylon plastics.

Cavendish—Discovery of chemical composition of water; discovery of hydrogen (Inflammable Air); 'rare gases'.

Chadwick—Discovery of the neutron.

Chandrasekhar—Mathematical Astrophysics.

Charles Darwin—Theory of Evolution; Origin of Species.

Clarke, Arthur C.—Concept of Geostationary Orbit.

Curie, Madame—Discovery of radium.

Dalton—Atomic theory; laws of chemical combination; law of partial pressures; the law of multiple proportions.

Democritus—Greek philosopher—(Atomic theory).

Dewar—Invented cordite, liquid oxygen and introduced thermos flask.

Einstein—Theory of relativity.

Euclid—Science of geometry.

Fahrenheit—Fahrenheit mercury thermometric scale in which freezing point is –32° and boiling point is 212°.

Faraday—Electromagnetic induction and laws of electrolysis.

Fermi—Discovered artificial splitting of atoms.

Freud—Doctrine of Psycho-analysis.

Gay Lussac—Law of gases.

Gauss—System of absolute electric measurements.

Good Year—Discovered the art of vulcanising rubber.

Herschel, **William—**Discovered the Planet—Uranus.

Hertz—Electrical waves.

Hippalus—Founder of scientific astronomy.

Hoffmann—Discovered the first aniline dye.

Kelvin, Lord—Dynamical theory of heat.

Khorana, Dr Hargobind—Deciphering the genetic code.

Kodak—Film and photographic goods.

Lablanc—Manufacture of washing soda.

Lawrence—Invention of cyclotron.

Lockyer—Helium gas.

Louis Braille—Perfected his system of reading and writing for the blind.

Marconi—Wireless telegraphy; radio.

Maria-Montessori—'Montessori' method of teaching children.

Maxwell—Electro-magnetic Theory of Light.

Meghnad Saha—Effect of pressure on Radiation through bodies.

Mendel—Laws of heredity.

Mandeleev—Periodic Table.

Morse—Morse system of electric telegraphy.

Newton—Laws of gravitation; Law of Motion.

Nobel—Dynamite.

Oliver Lodge—Physicist. Researches in wireless communications.

Oppenheimer—Researches in atomic theory.

Otto Hahn—Discovery of uranium fission.

Parkes—Celluloid.

Parsons—Steam turbine.

Pavlov—Theory of Conditioned Reflex.

Perkin—'Mauve dye'.

Pitman—Founded the Pitman system of phonographic shorthand.

Planck—Quantum theory.

Plimsoll—Introduced a line of demarcation on the ships beyond which the ships cannot be loaded.

Priestley—Discovery of Oxygen.

Raman, C.V.—"Raman Effect" on polarisation of light and theories on crystals and diamond formation.

Ramanathan—Molecular scattering of light in fluids.

Ramanujam—A great Indian mathematician.

Ramsay—Discovery of Inert gases such as Argon, Neon, Helium etc.

Ray, P.C.—Researches in chemistry.

Regnault—Experiments in regard to the physical properties of bodies and their relation to heat.

Roger Bacon—Gun powder.

Rontgen—Discovery of X-rays.

Rohmkorff—Induction coil.

Rutherford—Atomic Research; succeeded in splitting the atom for the first time in 1918.

Shalimar—Paints.

Stephenson—British engineer and pioneer in Railways. He was the first to put a locomotive on the line that was able to draw a train of 31 carriages.

Thomson, J.J.—Discovered electron.

Travers—Discovery of Neon gas (Working with Ramsay).

Urey—Discovery of Heavy Hydrogen.

Volta—Current electricity and electric battery.

Pioneers in Mechanical Inventions and Discoveries

Austin—Motor Car.

Bell, Graham—Telephone.

Berliner—Microphone.

Brequet—Helicopter.

Bushwell—Submarine.

Caxton—Printing Press.

Colt—Revolver.

Daimler—Gas engine.

Davy—Miner's Safety Lamp.

Diesel—Internal Combustion engine (Diesel engine).

Dunlop—Pneumatic tyre.

Edison—First electric bulb and gramophone.

Faraday—Dynamo.

Fick—Law of Diffusion—Fick's Law.

Frank Whittle—Jet propulsion.

Fulton—Stream boat.

Galileo—Telescope.

Gillette—Safety razor.

Guttenburg—Art of Printing.

Hoe—Rotary Printing Press.

Howe—Sewing Machine.

Huygens—Pendulum clock.

James Watt—Steam engine (patented in 1769).

Landstrom, J.E.—Safety Matches.

Macmillan—Bicycle (1842).

Mauser—Magazine of rifle.

Mercator—Celestial and a terrestrial globe.

Montgolfier—Balloon (1883)

Pascal—Calculating Machine.

Puckle, James—Machine gun

Shockley—Transistor.

Sholes—Typewriter.

Stephenson—Railway engine.

Swinton—Military tank.

Torricelli—Barometer.

Watt, Robert Watson—Radar.

W. & O. Wright (Wright Brothers)—Aeroplane (1903).

Waterman—Fountain pen.

Zeiss—Lenses; Camera.

Pioneers in Medical Inventions and Discoveries

Banting—Insulin (as a palliative for diabetes)

Barnard, Christian—Replacing the human heart.

Brahmchari, U.M.—Cure of Kala-a-zar fever.

Davy—Isolation of metals by electricity; studied properties of chlorine.

Domagk—Sulpha drugs as bactericides.

Eijkman—Cause of Beri-Beri.

Finsen—Discovered curative effect of ultra violet rays; photography.

Fleming, Alexander—Penicillin (in 1929).

Harvey—Circulation of blood.

Hahnemann—Homoeopathy (founder).

Hopkins, Frederick Gowland—Vitamin D.

Jenner—Smallpox Vaccination.

Koch—Tubercle Bacillus.

Lainnec—Stethoscope.

Lister, Lord—Antiseptic treatment.

Pasteur, Louis—Treatment of rabies; cure of hydrophobia.

Ronald Ross—Malaria Parasite.

Salk, Jonas E.—Anti-polio Vaccine.

Simpson and Harrison—Chloroform.

Waksman—Streptomycin