

# SOLUTIONS

## PHYSICS

1. (b) : According to Boyle's law, the volume ( $V$ ) of a given mass of a perfect gas at constant temperature is inversely proportional to its pressure ( $P$ ). Mathematically,  $V \propto (1/P)$  or  $PV = K$ .

2. (a)

3. (c) : The surface area of the cylindrical bulb will be larger than that of the spherical bulb. Hence heat will be quickly transmitted to mercury through the cylindrical bulb. Therefore thermometer with cylindrical bulb will respond quickly to the temperature.

4. (b) : The surface tension of a liquid decreases with a rise in temperature except the molten cadmium and copper. For small range of temperatures, the variation of surface tension is given by the formula  $S_t = S_0(1 - at)$ , where  $S_0$  and  $S_t$  are the surface tensions of liquid at  $0^\circ\text{C}$  and  $t^\circ\text{C}$  respectively and  $a$  is the coefficient of surface tension with temperature.

5. (a) : Given: Angle of prism ( $A$ ) =  $6^\circ$ . We know that deviation ( $d$ ) =  $(m-1)A = (1.5-1)6 = 0.5 \times 6 = 3^\circ$ .

6. (a) : As the body 'A' is dropped from rest

$$\therefore h = \frac{1}{2}gt_A^2 \Rightarrow t_A = \sqrt{\frac{2h}{g}}$$

As the body B is given a horizontal velocity at the time of release, it is going to follow the same trajectory as a body on a projectile motion, projected with a velocity having the same horizontal component as the horizontal velocity of B given at H. So the time taken by B from H to Y is same as that from X to H.

Now let the vertical component of velocity at X be  $v$  then at H

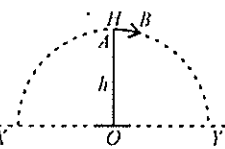
$$0 = v^2 - 2gh \quad [\because \text{at H, } v = 0]$$

$$\Rightarrow v^2 = 2gh \Rightarrow v = \sqrt{2gh}$$

$$\text{and } 0 = v - gt$$

$$\Rightarrow t = \frac{v}{g} = \frac{\sqrt{2gh}}{g} = \frac{\sqrt{2h}}{g}$$

$$\therefore t_B = t = \frac{\sqrt{2h}}{g} = t_A$$



7. (a) : We know that for a satellite of mass  $m$  moving in an orbit of radius  $r$ ,  $\frac{GM_c m}{r^2} = \frac{mv^2}{r}$  or

$$v = \sqrt{\frac{GM_c}{r}} \propto \sqrt{\frac{1}{r}} \text{ or } \frac{v_1}{v_2} = \sqrt{\frac{r_2}{r_1}}$$

Since  $r_1 > r_2$ , therefore  $v_1 < v_2$ .

8. (c)

9. (a) : Escape velocity ( $v_e$ ) =  $\sqrt{2gR_c}$ . Therefore it is independent of the mass of the particle or it will depend on  $m^0$ .

10. (c) : Given: Time ( $t$ ) = 0.4 sec and magnetic flux ( $\phi$ ) =  $8 \times 10^{-4}$  Wb. We know from the Faraday's law of electromagnetic induction that the induced e.m.f. in the wire ( $\epsilon$ ) =  $\frac{d\phi}{dt} = \frac{8 \times 10^{-4}}{0.4} = 2 \times 10^{-3}$  V.

11. (a) : Given: Frequency of the tuning fork ( $f$ ) = 256. We know that fork of the frequency 256 will resonate only with those forks, whose frequency is an integral multiple of 256 (i.e. 512 and 768). Since the frequency 738 is not an integral multiple of 256, therefore it will not resonate with the fork having frequency 256.

12. (c)

13. (a) : Given: Refractive index of glass ( $m$ ) = 1.5. We know from the Brewster's law,  $\tan i_p = m = 1.5$ . Therefore  $i_p = \tan^{-1} 1.5 = 56.3^\circ$ .

...(where  $i_p$  is the angle of reflected light).

14. (c)

15. (d) : Given: Initial pressure of the gas ( $P_1$ ) =  $P$ ; Initial mass of the gas molecules ( $m_1$ ) =  $m$ ; Final mass of gas molecules ( $m_2$ ) =  $0.5m$ ; Initial speed of molecules ( $v_1$ ) =  $v$  and final speed of the molecules ( $v_2$ ) =  $2v$ . We

know that pressure of the gas ( $P$ ) =  $\frac{1}{3} \times \frac{mn}{V} \times v^2 \propto mv^2$

$$\text{or } \frac{P_1}{P_2} = \frac{m_1}{m_2} \times \left(\frac{v_1}{v_2}\right)^2 = \frac{1}{0.5} \times \left(\frac{1}{2}\right)^2 = \frac{1}{2} \text{ or } P_2 = 2P_1.$$

...(where  $P_2$  is the resultant pressure).

16. (c) : Acceleration due to gravity on the earth's surface is given by  $g = \frac{GM_c}{R_c^2}$

Now,  $R_c$  shrinks by 1%, so the new value for radius of the earth is  $0.99 R_c$ .

$$\therefore g' = \frac{GM_c}{(0.99)^2 R_c^2} = \frac{g}{0.9801} > g$$

17. (b) : At low pressure and high temperature, the effect of molecular attraction becomes negligible and the behaviour of a gas tends to that of an ideal gas.

18. (d) : Given: Initial radius of soap bubble =  $r$ ; Surface tension of soap solution =  $T$  and final radius of soap bubble =  $2r$ . We know that energy to blow the soap bubble of radius  $r$ , ( $E_1$ ) =  $2 \times 4\pi r^2 \times T = 8\pi r^2 T$  and energy to blow a soap bubble of radius  $2r$ , ( $E_2$ ) =  $2 \times 4\pi(2r)^2 T = 32\pi r^2 T$ . Therefore extra energy needed =  $E_2 - E_1 = 32\pi r^2 T - 8\pi r^2 T = 24\pi r^2 T$ .

19. (d) : The modulus of rigidity

$$(\eta) = \frac{\text{Shearing stress}}{\text{Shearing strain}} = \frac{F/A}{\phi} = \frac{[\text{MLT}^{-2}]}{[\text{L}]} = [\text{ML}^{-1}\text{T}^{-2}]$$

20. (c)

21. (b) : The centripetal acceleration ( $a$ ) =  $\frac{mv^2}{r} \propto \frac{1}{r}$ . Therefore acceleration of the particle is inversely proportional to radius.

22. (a) : XOR gate gives the output for dissimilar values of inputs. The Boolean expression for XOR gate is  $Y = A \cdot \bar{B} + \bar{A} \cdot B$ . It is read as "Y equals A and B negated OR A negated AND B".

23. (b) : Given: Power of first lens ( $P_1$ ) = + 12 D and power of second lens ( $P_2$ ) = - 2 D. We know that power of the combination ( $P$ ) =  $P_1 + P_2 = 12 + (-2) = + 10$  D.

$$\therefore \text{Equivalent focal length } (F) = \frac{1}{P} = \frac{1}{10} \text{ m} = 10 \text{ cm.}$$

24. (d)

25. (b) : When cathode rays strike a metal plate, their kinetic energy is transformed into heat energy, which increases the temperature of the plate.

26. (c) : When the missile is launched with a velocity less than the escape velocity, it will be influenced by our gravitation and so it will constitute a bound system for which the total energy will be negative.

27. (b) : Given: Radius of sphere =  $R$  and mass of sphere =  $M$ . We know that angular momentum

$$(I\omega) = \frac{2}{5} MR^2 \times \frac{2\pi}{T} = \frac{4\pi MR^2}{5T}$$

28. (a) : Since a semiconductor has a negative

temperature coefficient of resistance, its resistance decreases with temperature.

29. (b) : Antimony and bismuth are the pair of metals producing a higher thermo e.m.f. in comparison with other pairs of metals. Therefore this pair is usually used in thermocouple.

30. (b)

31. (c) : Kinetic energy is equal to  $\frac{1}{2} \times mv^2$ , where  $v$  is velocity and its square is always positive. Therefore kinetic energy is always positive.

32. (a)

33. (c) : Diffraction exhibits wave nature of light and photoelectric effect exhibits quantum nature of light. Therefore diffraction and photoelectric effect exhibit the dual nature of light.

34. (c)

35. (b) : Given: Energy ( $E$ ) = 1 eV =  $1.6 \times 10^{-19}$  J. Average kinetic energy per molecule ( $E$ ) =  $1.6 \times 10^{-19}$  J

$$= \frac{3}{2} kT \text{ or } T = \frac{2 \times (1.6 \times 10^{-19})}{3k} = \frac{2 \times (1.6 \times 10^{-19})}{3 \times (1.38 \times 10^{-23})} = 7.7 \times 10^3 \text{ K.}$$

...(where  $k$  is Boltzman constant =  $1.38 \times 10^{-23}$ ).

36. (c)

37. (c) : Given: Surface tension in soap bubble ( $T$ ) = 0.04 N/m and diameter of soap bubble ( $d$ ) = 1 cm = 0.01 m or radius ( $r$ ) = 0.005 m. We know that potential energy = Surface tension  $\times$  Surface area. We also know that for a soap bubble, there are two surfaces. Therefore total area =  $2 \times 4\pi r^2$ . Thus potential energy =  $(0.04) \times [2 \times 4\pi \times (0.005)^2] = 8\pi \times 10^{-6}$  J.

38. (a)

39. (b) : Cadmium is a good absorber of neutrons and it effectively controls the rate of fission. Therefore in nuclear reactors, the controlling rods are made of cadmium.

40. (d) : Orbital velocity ( $v_o$ ) =  $\sqrt{\frac{GM}{r}} \propto \frac{1}{r}$  (where  $r$  is the distance from sun). Since the distance of jupiter from the sun is greater than the distance between the sun and the earth, therefore orbital speed of jupiter is less than the orbital speed of earth.

41. (c) : As per Bohr's model of hydrogen atom, the angular momentum of an electron around the nucleus, is an integral multiple of  $\frac{h}{2\pi}$ . Thus angular

momentum =  $mvr = \frac{nh}{2\pi}$  where  $n$  is an integer. Therefore the angular momentum can have only discrete values. *i.e.* it is quantised.

42. (d)

43. (d) : Dimension of work ( $W$ ) = force  $\times$  distance =  $[MLT^{-2}][L] = [ML^2T^{-2}]$ ,

power ( $P$ ) =  $\frac{\text{work}}{\text{time}} = \frac{[ML^2T^{-2}]}{[T]} = [ML^2T^{-3}]$ ; pressure

( $p$ ) =  $\frac{\text{force}}{\text{area}} = \frac{[ML^2T^{-2}]}{[L^2]} = [ML^{-1}T^{-2}]$  and impulse = force  $\times$  time =  $[MLT^{-2}][T] = [MLT^{-1}]$ . Therefore power has the same dimension as given in the question.

44. (c) : Given: Nuclear reaction:  ${}_1H^2 + {}_1H^2 \rightarrow {}_2He^3 + ?$ . We know that the balanced equation of the nuclear reaction is  ${}_1H^2 + {}_1H^2 \rightarrow {}_2He^3 + {}_0n^1$ . Where  ${}_0n^1$  is the symbol of neutron. Therefore neutron will be added in the given equation to complete it.

45. (b)      46. (c)

47. (a) : Given: One mole of hydrogen mixed with one mole of oxygen. We know that r.m.s. velocity

$(v_{rms}) = \sqrt{\frac{3RT}{M}} \propto \sqrt{\frac{1}{M}}$  or  $\frac{(v_{rms})_H}{(v_{rms})_O} = \sqrt{\frac{M_O}{M_H}} = \sqrt{\frac{32}{2}} = \frac{4}{1}$   
or  $(v_{rms})_H : (v_{rms})_O = 4 : 1$ .

48. (d)

49. (d) : Given: Initial volume ( $V_1$ ) = 47.5 units; Temperature of ice-cold water ( $T_1$ ) =  $0^\circ\text{C} = 273\text{ K}$  and final volume ( $V_2$ ) = 67 units. We know from the Charles

law,  $\frac{V_1}{T_1} = \frac{V_2}{T_2}$  or  $T_2 = \frac{V_2}{V_1} \times T_1 = \frac{67}{47.5} \times 273 = 385\text{ K} = 112^\circ\text{C}$ .  $T_2$  is the boiling point of the liquid.

50. (a)

51. (a) : Mathematically, the number of  $e-h$  pairs in the intrinsic semiconductor is given by

$$n \propto T^{\frac{3}{2}} e^{-\frac{\Delta E}{2kT}} \text{ which gives}$$

$$\Delta E \propto kT \left[ \frac{3}{2} \ln T - \ln n \right]$$

Now since in silicon the number of  $e-h$  pairs is less than that in Germanium, the energy gap  $\Delta E$  in silicon is more than that in Ge. [Note that for intrinsic semiconductor, the number of  $e-h$  pairs is same as the number of minority or majority carriers].

52. (a)

53. (b) : In the case of fission of a heavy nucleus, it gets broken up into small nuclei which are stable.

These small nuclei are stable because their  $N/Z$  ratios are small compared to their parent nucleus. Their stability comes from the fact that they are having more binding energy per nucleon.

54. (a) : The displacement vector is given by

$$\vec{D} = \epsilon_0 \vec{E} + \vec{P} \text{ where}$$

$\vec{E}$  = applied electric field and

$\vec{P}$  = polarisation or dipole moment per unit volume =  $n\vec{p} \times 2$  [ $\vec{p}$  is the component of dipole moment of each molecule in direction  $\vec{E}$  and  $n$  is the no. of molecules per unit volume]

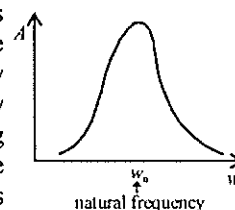
Now in the absence of an electric field ( $\vec{E}=0$ ) the polarisation vector  $\vec{P}$  vanishes (because  $\vec{p}$  is there if  $\vec{E}$  is there). Therefore displacement  $\vec{D} = 0$

55. (a) : The statement given in the Assessment is itself a form of the second law of thermodynamics which cannot be violated.

56. (c) : The principle of superposition does not state that the frequencies of the oscillation should be nearly equal. And for beats to be heard the condition is that the difference in frequencies of the two oscillations be not more than 16 times per sec for a normal human ear to recognise it. Hence we cannot hear beats in the case of two tuning forks vibrating at frequencies 256 Hz and 512 Hz respectively.

57. (a) : Due to the variation of the refractive index of the material of the lens, the focal length also varies accordingly. Now as white light is composed of different colours of light, each colour will produce its own image based on the focal length for that colour. This particular phenomenon for a single lens is known as chromatic aberration.

58. (c) : Resonance occurs when the frequency of the applied force becomes nearly equal to the natural frequency of vibration of the body. During resonance the amplitude of the forced vibration reaches its maximum value.



So, if we increase the frequency of the externally impressed periodic force, the amplitude of the forced vibration does not increase but it decreases. So the given reason is false.

59. (c) : We cannot get steam directly from ice. There is one intermediate state called water whose temperature has to be raised to  $100^\circ\text{C}$  before we can get steam. Critical point is that temperature at which a gas can

be liquefied by applying pressure. So, water cannot have a critical point.

60. (c) : The resistance offered by the fluid should be minimum with that shape.

## CHEMISTRY

61. (b) : Given: Weight of benzoic acid = 1.89 g;  
Temperature of bomb calorimeter = 25°C = 298 K;  
Mass of water ( $m$ ) = 18.94 kg = 18940 g; Increase in temperature ( $t$ ) = 0.632°C and specific heat of water ( $s$ ) = 0.998 cal/g-deg. We know that heat gained by water or heat liberated by benzoic acid ( $Q$ ) =  $m s t$  = 18940 × 0.998 × 0.632 = 11946.14 cal. Since 1.89 g of acid liberates 11946.14 cal of heat, therefore heat liberated by 122 g of acid =  $\frac{11946.14 \times 122}{1.89}$   
= 771126.5 cal = 771.12 kcal.

...(where 122 g is the molecular weight of benzoic acid)

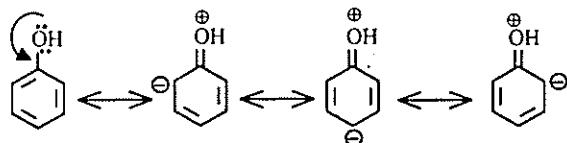
62. (a) :  $\text{CH}_3\text{CHO} + 2\text{CuO} \rightarrow \text{CH}_3\text{COOH} + \text{Cu}_2\text{O} \downarrow$   
(Blue) (Red ppt)

Thus in this reaction, precipitate of copper oxide ( $\text{Cu}_2\text{O}$ ) is formed.

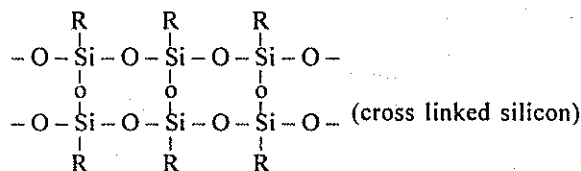
Fehling solution is an alkaline solution of cupric ion complexed with sodium potassium tartrate.

63. (a) : E.M.F. is defined as the potential difference between two electrodes when current is flowing in circuit. It is the maximum work obtainable from the cell.

64. (c) : -OH group in phenol can release electrons to the ring better than -CH<sub>3</sub> gp in toluene. Cl atom has electron withdrawing effect which inhibits electrophile attack.



65. (c) Silicones are organic silicon polymers containing Si-O-Si linkages.



66. (b) :  $\frac{\rho_{\text{O}_2}}{\rho_{\text{H}_2}} = \frac{16}{1} \Rightarrow \frac{m_{\text{O}_2}}{m_{\text{H}_2}} = \frac{16}{1}$

$$V_{rms} \propto \left(\frac{1}{m}\right)^{1/2} \Rightarrow \frac{V_{rms}(\text{O}_2)}{V_{rms}(\text{H}_2)} = \left(\frac{m_{\text{H}_2}}{m_{\text{O}_2}}\right)^{1/2} = \left(\frac{1}{16}\right)^{1/2} = \frac{1}{4}$$

67. (c) Rate of diffusion  $\propto (1/M)$

$M$  = molecular mass

$M(\text{CO}_2) = 44$                        $M(\text{N}_2) = 28$

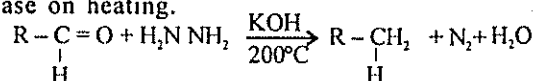
$M(\text{NH}_3) = 17$                        $M(\text{O}_2) = 32$

Therefore, rate of  $\text{NH}_3$  diffusion is greater than other.

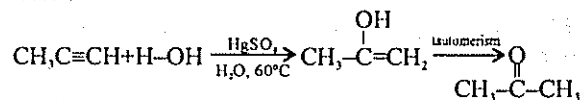
68. (a) : More is the no. of Cl atoms attached to  $\alpha$ -carbon of COOH group, greater is the acidity due to high electronegativity of Cl-atoms (it pulls electrons towards it).

69. (b) : Wolf-Kishner reduction :

Aldehyde and Ketones are reduced to hydrocarbons in the presence of excess of hydrazine and strong base on heating.



70. (a) : Ketones are formed on hydration of alkynes (other than acetylene) by following Markownikoff's rule.



71. (d) : Bronze is an alloy of Cu and Sn.

Brass is an alloy of Cu and Zn.

German-silver is an alloy of Cu, Zn and Ni.

72. (a) :  $\text{R}-\text{X} \xrightarrow[\Delta]{\text{Dry Ag}_2\text{O}} \text{R}-\text{O}-\text{R}$   
Diethyl ether

73. (d) : Ethanoic Acid -  $\text{CH}_3\text{COOH}$   
[Ethane  $\rightarrow$  2 C-atom]

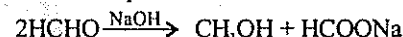
74. (c) :  $2\text{CH}_3\text{CH}_2\text{OH} + \text{Na} \rightarrow 2\text{CH}_3\text{CH}_2\text{O}^-\text{Na}^+ + \text{H}_2$   
metal

Formation of alkoxide indicates the acidic nature of alcohols as alkoxides are electrovalent compounds and are written as  $\text{RO}^-\text{M}^+$ .

75. (b) : Metamerism is due to presence of different alkyl groups attached to the same polyvalent functional group or atom.

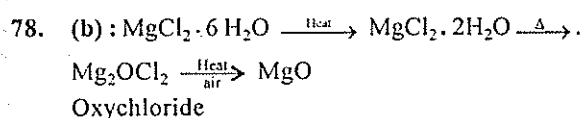
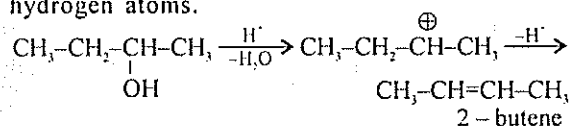
$\therefore$  This kind of isomerism is not possible in case of alkenes.

76. (b) : Only HCHO does not have  $\alpha$ -hydrogens which is the requirement of cannizarro reaction.

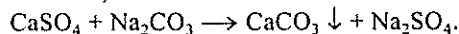


77. (d) : According to Saytzeff's rule, in the dehydration of secondary and tertiary alcohols, when there is a possibility of formation of two isomers, the

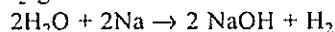
hydrogen atom is preferentially eliminated from the adjacent carbon atom with the fewer number of hydrogen atoms.



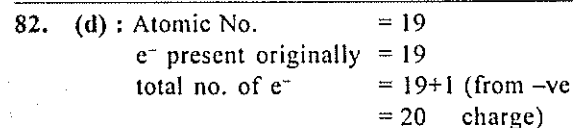
79. (a) : When hard water is treated with a certain amount of washing powder ( $\text{Na}_2\text{CO}_3$ ) the chlorides and sulphates of calcium and magnesium are converted into their respective carbonates, which get precipitated. As a result of this, the hardness of water can be removed.



80. (c) : Sodium reacts with water yielding NaOH and  $\text{H}_2$  gas.



81. (d) : The term alum is used for all the double sulphates having the composition,  $\text{M}_2\text{SO}_4 \cdot \text{M}'_2(\text{SO}_4)_3 \cdot 24\text{H}_2\text{O}$ , where M stands for monovalent basic radicals such as  $\text{Na}^+$ ,  $\text{K}^+$  etc. and M' for trivalent basic radicals such as  $\text{Al}^{3+}$ ,  $\text{Cr}^{3+}$  etc.



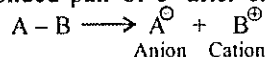
83. (d) : Boron sesquioxide  $\text{B}_2\text{O}_3$  is used in making borosilicates, heat resistant pyrex glass. Pyrex glass contains 14%  $\text{B}_2\text{O}_3$ .

84. (d) : Mohr salt is  $\text{Fe}(\text{SO}_4) \cdot (\text{NH}_4)_2\text{SO}_4 \cdot 6\text{H}_2\text{O}$ .

85. (b), (c) : According to Avogadro hypothesis, the mass of 22.4 L of the vapour of any volatile substance at NTP is equal to the molecular mass of the substance.

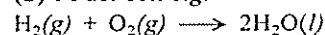
86. (c) : Formaldehyde does not contain  $\alpha$ -hydrogen so will not undergo Aldol condensation.

87. (d) : Heterolytic fission : unequal distribution of bonded pair of  $e^-$  after cleavage.

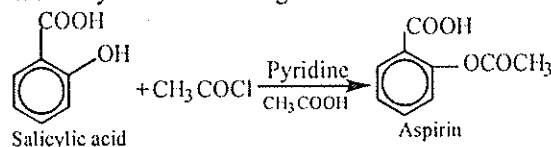


88. (a) : In general, electron affinity decreases down the group. But due to inter-electronic repulsions in small sized F-atom, chlorine has got larger E.A. than that of F.

89. (b) : Fuel cell e.g.

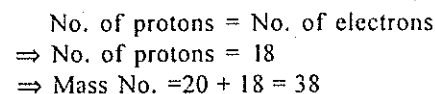


90. (b) : Aspirin (Acetyl salicylic acid) is obtained by heating salicylic acid (o-hydroxy benzoic acid) with acetyl chloride and glacial acetic acid.

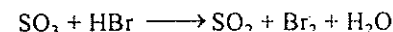
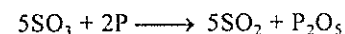
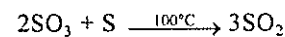


91. (c) : Ionisation energy for Na is very low as compared to other alkaline earth metal or transition elements. So it acts as a good reducing agent.

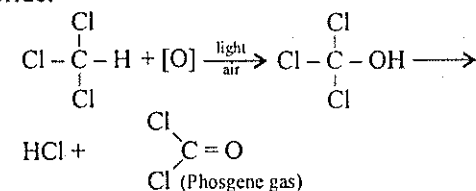
92. (c) : Mass no. = No. of protons + No. of neutrons



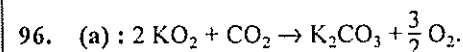
93. (c) :  $\text{SO}_3$  acts as strong oxidising agent. e.g.



94. (b) : When  $\text{CHCl}_3$  is exposed to sunlight and air, it slowly decomposes into phosgene and hydrogen chloride.

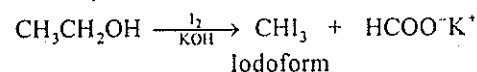


95. (b) : Modern periodic table (i.e. long form of table) is based on the periodic law which says that physical and chemical properties of the elements are periodic function of their atomic numbers.



97. (d) :  $\text{Ag}^+$  can accept electron pair so it acts as Lewis acid.

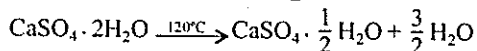
98. (c) : Iodoform test is positive for ethanol (not for methanol)



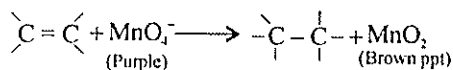
99. (a) : A catalyst speeds up the reaction both in forward and backward direction, maintaining the equilibrium constant same.

100. (b) : Gypsum :  $\text{CaSO}_4 \cdot 2\text{H}_2\text{O}$

Plaster of paris :  $\text{CaSO}_4 \cdot \frac{1}{2}\text{H}_2\text{O}$ .



101. (a) : Alkaline  $\text{KMnO}_4$  solution is called Baeyer's reagent and is used for characterisation of olefinic bond in the compound. Purple colour of  $\text{KMnO}_4$  disappears and brown ppt. due to  $\text{MnO}_2$  appears.



102. (b) :  $\frac{\text{Equivalent weight of metal}}{\text{Equivalent weight of compound}} = \frac{\text{Weight of metal}}{\text{Weight of compound}}$

$$\Rightarrow \frac{12}{12 + 35.5} = \frac{\text{Weight of metal}}{0.475}$$

$$\Rightarrow \text{Weight of metal} = 0.12 \text{ g}$$

103. (b) : No. of mole of  $\text{O}_2 = \frac{\text{Mass}}{\text{Mol. mass}} = \frac{40}{32} = 1.25 \text{ mol}$

$$\text{No. of mole of He} = \frac{40}{4} = 10 \text{ mol}$$

$$\text{mole fraction of } \text{O}_2 = \frac{1.25}{1.25 + 10} = \frac{1.25}{11.25} = \frac{1}{9}$$

$$\begin{aligned} \text{Partial Pressure of Oxygen} &= \frac{1}{9} \times 0.9 \text{ atm.} \\ &= 0.1 \text{ atm.} \end{aligned}$$

104. (d) : According to Goldberg and wage, and rate at which substance reacts is directly proportional to its active mass (i.e. molar concentration);  
 $aA + bB = xX + yY$

$$K_c = \frac{[X]^x [Y]^y}{[A]^a [B]^b} \quad K_c = \text{equilibrium constant}$$

105. (c) : Atomic wt. of metal =  $2 \times 12 = 24$   
 $\therefore$  mol. wt. of its oxide =  $24 + 16 = 40$

106. (b) : The Heisenberg uncertainty principle,

$$\Delta x \times \Delta p \leq \frac{h}{4\pi}, \text{ where } \Delta x = \text{Uncertainty in position,}$$

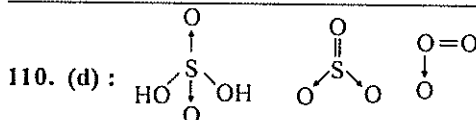
$$\Delta p = \text{Uncertainty in momentum and } \frac{h}{4\pi} = \text{constant.}$$

As  $\Delta x$  is same for electron and helium and  $\frac{h}{4\pi}$  is a constant, therefore minimum uncertainty in the measurement of the momentum of the helium atom will be same as that of an electron which is  $5.0 \times 10^{-26} \text{ kg/ms}^{-1}$ .

107. (b) : Dalton's theory say that an atom is the smallest and indivisible component of all materials.

108. (d) : de Broglie relation is  $(\lambda) = \frac{h}{mv} = \frac{h}{p}$ , where  $m = \text{mass}$ ,  $v = \text{velocity}$ ,  $p = \text{momentum}$ ,  $\lambda = \text{wavelength}$ .

109. (c) : This is the statement of third law of thermodynamics. In a perfect crystal, at absolute zero temperature, each constituent of lattice must have the lowest energy, so it leads to perfect order, therefore zero entropy.



All of them therefore contain co-ordinate bonding.

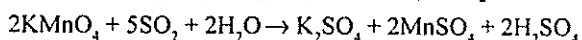
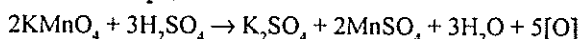
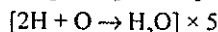
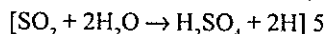
111. (a) The elements of group III have  $ns^2 np^1$ , configuration. Since  $p$ -electrons are held less tightly than  $s$ -electrons. The first IE of each element is low as compared to the first IE of alkaline earth metal.

112. (c) : Chain isomerism occurs due to difference in the arrangement of C-atoms in the chain. Simplest compound exhibiting chain isomerism is butane. e.g.



All carbon atoms in all alkanes are  $sp^3$  hybridised.

113. (a) : Acidified  $\text{KMnO}_4$  is reduced by acidic  $\text{SO}_2$ .



114. (c) : Helium :  $Z = 2; 1s^2$

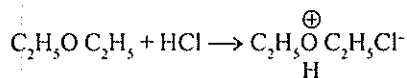
Beryllium :  $Z = 4; 1s^2, 2s^2$

Helium is an inert gas while beryllium is reactive due to unfilled  $2p$  valence shells.

115. (a) Intermolecular force of attraction involves dipole-dipole and weak van der waal's forces in the ionic compounds.

116. (a) :  $\text{H}_2\text{SO}_4$  when react with  $\text{NaBr}$  and  $\text{NaI}$ , give out  $\text{Br}_2$  and  $\text{I}_2$  as concentrated  $\text{H}_2\text{SO}_4$  is a strong oxidising agent.

117. (a) : Due to the presence of lone pair of electrons on oxygen atoms, ether behave as base and form stable oxonium salts with mineral acids.



Diethyl oxonium chloride

118. (a) : Adsorption is an exothermic process, the heat of adsorption is taken up by the surface of the catalyst which is utilised in enhancing the chemical activity of the reacting molecule.

119. (a)

120. (a) : Due to their high reactivity, halogens are not found in free state.

## BIOLOGY

121. (a) : At the time of cartilage formation, chondrification starts in mesenchymal cells and chondroblast cells are formed at the centre of chondrification. Then chondroblasts become entrapped in the extracellular matrix that they secrete, they are now known as chondrocytes. With this entrapment cartilage begins to form.

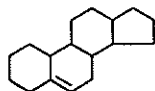
Mesenchymal cells → chondroblasts → chondrocytes → cartilage

122. (b) : Achondroplasia is a defect in the formation of cartilage at the epiphyses of long bones, producing a form of dwarfism.

123. (c) : Philadelphia chromosome is an abnormal chromosome-21 that has lost part of its long arm. It is found in leukocyte culture of many patients with chronic myelocytic leukaemia.

124. (d) : Diabetes insipidus is the inability of the kidneys to respond to vasopressin. Vasopressin is released in response to a fall in the water content of blood plasma and leads to an increase in the permeability to water of the distal and collecting tubules of the nephron in the kidney. As a result of which the reabsorption of water from the glomerular filtrate is increased. Diabetes insipidus is characterized by micturating dilute urine several times a day.

125. (d) : Cholesterol is the precursor of steroid hormones possessing a complex basic structure.



Structure of cholesterol

126. (a) : Mesozoic era is the middle era in the geological time scale, dating from about 230-270 million years ago. It is known as the 'Age of Reptiles'. It is

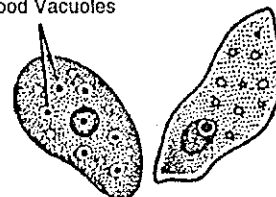
divided into three main periods, *i.e.* Triassic, Jurassic and Cretaceous.

127. (a) : Colour blindness, in which all colours are perceived as grey, is termed monochromasia. The person suffering from this disease is completely colour blind.

128. (d) : Stratum corneum is the outermost layer of epidermis of man. Its cells are dead, flattened and dry, containing a high proportion of the protein. It provides the main protection of the body against water loss and the entry of disease causing organisms.

129. (a) : Archaeocytes Food Vacuoles

of sponges are short and blunt, with lobose pseudopodia, a large nucleus and a large quantity of RNA. These are considered to be the undifferentiated 'totipotent' cells, which may transform into all other types of cells including sex cells.

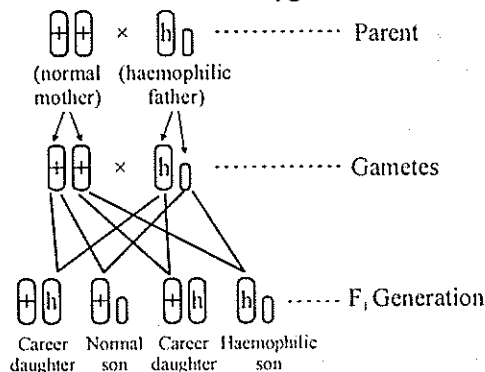


Archaeocytes

130. (b) : The surface of cartilage is surrounded by irregular connective tissue forming the perichondrium.

131. (a) : Each ramus of lower jaw or mandible is formed of a single large membrane bone (dentary), which is broad and flat in the back but narrow and conical in front. The front ends of both dentaries medially join by a symphysis.

132. (c) : Haemophilia is recessive character and is therefore masked in heterozygous condition.

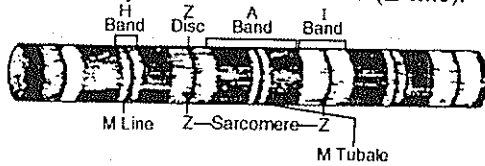


Thus the daughters born to haemophilic father and normal mother would be career but phenotypically normal.

133. (a) : During malaria, RBCs of man gets somewhat enlarged and irregular in shape. A number of orange or yellow eosinophilic granules of unknown nature,

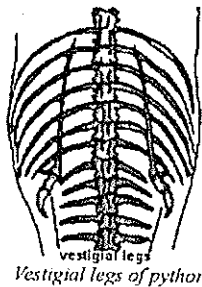
called Schuffner's dots appear in its cytoplasm.

134. (a) : Sarcomere is a contractile element in a striated muscle fibril (myofibril). Each sarcomere is joined to the next one by Krause's membrane (Z-line).



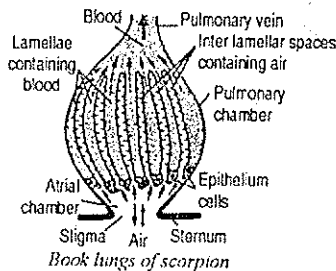
Striated muscle fibril

135. (a) : Python have hind limbs as the vestigial organ. Most of the species of snakes lost all traces of limbs but snakes in the boa and python family have a tiny pairs of hind limbs. Python's hind limbs are vestigial due to its habits and habitat. These vestigial legs can actually be seen as a pair of spur's that sticks out where the body ends and tail begins. These legs rarely do any harm.



136. (c) : Trigeminal nerve (cranial nerve V) is one of the pairs of nerves that arise from the anterior end of the vertebrate hindbrain to supply impulses to the mouth and the jaws. It carries sensory nerve fibres from the head surface and mouth cavity and motor nerve fibres serving the jaw muscles.

137. (d) : The respiratory organ of scorpion is book lung. It consists of 4 pairs of cuticular pulmonary sacs. Books lungs are formed by invaginations of cuticle at the bases of rudimentary appendages.



138. (c) : Essential fatty acids (these are essential in our diet because our body can't make them, yet use them to make many other fatty acids our body must have) are required in the diet for normal growth. In mammals, the deficiency of linoleic and gamma-linolenic acid causes poor growth, scaly skin, hair loss and eventually death.

139. (a) : Anoxia is a deficiency in oxygen reaching the tissues that is severe enough to damage the brain permanently.

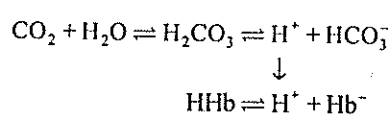
140. (a) Glissonian cirrhosis is inflammation of peritoneal coat of the liver.

141. (d) : Liver does not produce any digestive enzyme though it helps in digestion by formation of bile, helping in fat metabolism, by storing and releasing carbohydrate etc.

142. (b) : Zonula adherens is a kind of desmosome, which comprises of band of contractile actin filaments near the apical end of each epithelial cell, just under the cell membrane.

143. (d) : Lymphoid tissue (lymphatic tissue) is found in the lymph nodes, tonsils, thymus and spleen. It produces lymphocytes, which have a life span of only a few days and must be constantly replaced.

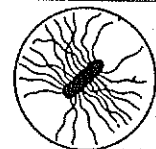
144. (a) : During transport, most of  $\text{CO}_2$  is passed into erythrocytes. A major part (nearly 70%) forms carbonic acid and then bicarbonate.



A seizable portion of bicarbonate passes out into the plasma in return from chloride ( $\text{Cl}^-$ ). It is called chloride shift or Hamburger's phenomenon.

145. (c) : Venous pathway comprising the hepatic portal vein, carries blood rich in absorbed food materials, such as glucose and amino acids, from intestine to the liver. These materials may be stored, converted or released to the general circulation via the hepatic vein.

146. (d) : *Peritrichous* bacterial cell bears a large number of flagella which are distributed evenly all over the cell surface. *Proteus vulgaris* and *Bacillus typhosus* are the common examples.



Peritrichous Bacteria

147. (b) : "Allele" is a term which indicates alternative forms of the same gene. For example "D" and "d" are two *allelomorphs* of the gene for plant height. In pure tall or pure dwarf plants, same allele is duplicated (DD or dd), while in hybrid tall both the alleles will be present (Dd). An individual is having only one allele or in other words two identical alleles, is known as *homozygous* (DD or dd). Similarly, an individual, having two different alleles will be called *heterozygous* or hybrid (Dd). Phenotype is observable or measurable distinctive structural or functional characteristic of an individual with regard to one or more characters



which is a result of gene products brought to expression in a given environment.

148. (c) : Bentham and Hooker's system of classification first appeared in a three - volume book in Latin, named *Genera Plantarum*. The system is based on groups of plant characters which are correlated with each other.

149. (a) : The aggregate of all the genes and their alleles present in an interbreeding population is known as gene pool. Genome is a complete set of chromosomes where every gene / chromosome is represented singly as in a gamete. In bacteria the heredity material is mainly made of spherical or cylindrical structure called nucleoid (genophore).

150. (d) : Transcription is synthesis of RNA, made up of a particular sequence of nucleotides, by matching with DNA, made up of a corresponding sequence of nucleotides. Translation is synthesis of a polypeptide made up of a particular sequence of amino acids by matching with an RNA made up of a corresponding sequence of nucleotides. Replication is production by duplication of exact copies of complex molecules, such as must occur during the growth and reproduction of any living thing. The only biological molecule in which the original molecules serve as a direct method for the construction of the new DNA. Transduction is the process in which usually a bacteriophage picks up DNA from one bacteria cell and incorporated into another host genome.

151. (d) : The number of linkage groups present in an individual corresponds to number of chromosomes in its one genome (all the chromosomes if haploid or homologous pairs if diploid). It is known as principle of limitation of linkage groups. Maize has 10 linkage groups, as it has 10 pairs of chromosomes.

152. (a) : Genome is the complete but single set of chromosomes as found in gametes or gametophytic cells where each chromosome is represented single. Linkage is the phenomenon of certain genes staying together during inheritance through generations without any change or separation due to their being present on the same chromosome. Gene pool is the aggregate of all the genes and their alleles present in an interbreeding population. Genotype is the gene complement or genetic constitution of an individual with regard to one or more characters irrespective of whether the genes are expressed or not.

153. (c) : In most cases the initiating codon is AUG, which otherwise codes for methionine. The corresponding codon on mRNA is usually AUG, but

rarely it could be GUG also. When GUG is used as the initiating codon, it does not code valine, but initiating methionine molecule should be found in the formylated methionine.

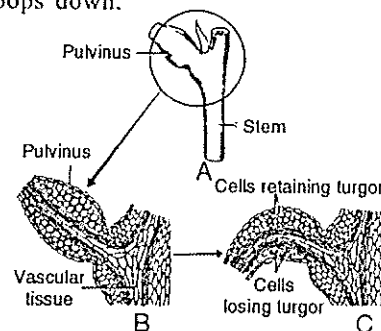
154. (b) : The phytochrome is a pigment involved in the perception of photoperiodic stimuli controlling flowering, lettuce seed germination and other morphogenetic phenomena. Phytochrome is a protein with a chromophore prosthetic group that resembles, in basic structure, the open - chain tetrapyrrole chromophore of the algal pigment 6 - phycocyanin.

155. (d) : In the phenomenon of epistasis, two independent non-allelic genes affect the same trait of individual in such a way that one overmasks the expression of other. Epistasis can be of the following types - (i) due to recessive allele : *a* masks the effect of *B*, due to a dominant allele : *A* masks the effect of *B*.

156. (b) : A small group of xerophytic species, e.g., *Selaginella lepidophylla* and *S. pilifera*, are caespitose in habit and when dry they coil closely together their rosette like shoots, by a cohesion mechanism, to form a ball-like structure and quickly unroll into a graceful green plant when moisture is readily available. Such plants are sold as curiosities under the name of "resurrection plants".

157. (c) : Transposons are movable genetic elements, which are somewhat similar to a jumping gene. Actually, they are not exactly jumping genes (discovered by Barbara Mc Clintok in maize). They are found in bacteria. Unlike jumping genes, they leave a copy of themselves in the original position when they move to a new site. This phenomenon is significant in antibiotic resistance.

158. (a) : Seismonasty is a nastic movement. When any organ of *Mimosa pudica* is touched, the stimulus reaches the base of the leaf. Owing to this stimulus, the turgor of lower half of pulvinus is lost and the leaf droops down.



Seismonasty in a *mimosa pudica*

159. (b) : In some flowers, there is a group of plants which set seeds without exposing their sex organs. Such flowers are called cleistogamous and the phenomenon cleistogamy. Dichogamy refers to maturation of male and female sex organs at different times. Heterogamy term is used for cross - pollination.

160. (b) : Zygotene stage of meiosis is characterised by pairing of homologous chromosomes (synapsis). This pairing is brought about in a zipperlike fashion and may start at centromere, at chromosome ends or at any other position. Two homologous chromosomes are called bivalent while they are pairing during meiosis. The homologous chromosomes break their connection and separate out during Anaphase I of meiosis. The process of separation is named as disjunction. Synergids are elongated cells present at the micropylar end of the embryo sac.

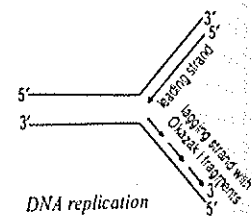
161. (d) : Gram is *Cicer arietinum* of leguminosae family. *Rhizobium* forms nodules on the roots of legume plants. They develop the ability to fix nitrogen only when they are present inside the root nodules.

162. (b) : A polygene is defined as a gene where a dominant allele controls only a unit or partial quantitative expression of a trait. In polygenic inheritance, a cross between two pure breeding parents does not produce dominant trait of one parent but instead an intermediate trait is exhibited. The Law of segregation is the first law of Mendelism. According to it, the two factors of a character which remain together in an individual do not get mixed up but keep their identity distinct, separate at the time of gametogenesis or sporogenesis, get randomly distributed to different gametes and then get paired again in different offspring as per the principle of probability. Chromosomal theory of inheritance believes that chromosomes are vehicles of hereditary information, possess Mendelism factors or genes, segregate and assort independently during transmission from one generation to the next. chromosome theory was proposed by Sutton and Boveri independently in 1902. Law of independent assortment is second law of Mendelism. According to it, the two factors of each character assort or separate independently of the factors of other characters at the time of gamete formation and get randomly re-arranged in the offspring.

163. (c) : Polygenic inheritance (quantitative inheritance) is a type of inheritance controlled by one or more genes in which the dominant alleles have

cumulative effect with each dominant alleles expressing a part or unit of the trait, the full trait being shown only when all the dominant alleles are present. The genes involved in quantitative inheritance are called polygenes. Polygenic inheritance is further characterised by the occurrence of inheritance forms (continuous variations) between the parental types. Linkage is the phenomenon of certain genes staying together during inheritance through generations without any change or separation due to their being present on the same chromosome. Epistasis is the phenomenon by which a gene suppresses the phenotypic expression of a nonallelic gene. Recombination is the new combination of genes which is possible only due to exchange of genetic material between homologous chromosome.

164. (b) : When the double helix of DNA unwinds, DNA replication on one of the two strands (3' to 5' strand) can easily proceed continuously in 5' to 3' direction. This is the leading strand. On the other strand (5' - 3') if the synthesis has to take place in 5' to 3' direction, it has to be synthesized in a direction opposite to that on the leading strands. This strand is the lagging strand and on this strand synthesis takes place in segments discontinuously and these segments are then fused to create an intact lagging strand. This behaviour where the leading strand is synthesized continuously and the lagging strand is synthesized discontinuously is called semi - discontinuous replication.



165. (b) : *Parkinsonia aculeata* is a xerophyte. In *Parkinsonia aculeata*, the rachis ends in a spine. Rachis branches are elongated, flattened and green to function as *phyllodes*. They bear small leaflets which fall off very early. Winged fruit has special flat outgrowths or wings, shows dispersal by wind. In *Cypselia*, the hairy pappus functions as umbrella of parachute. Phylloclades are flattened green stems of unlimited growth which have taken over the function of photosynthesis.

166. (c) : In Biparous or Dichasial Cyme, a terminal flower is subtended by two lateral branches which also end in flowers. The process is repeated. Cyathium has a small conical

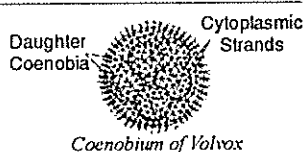


*Verticillaster of Salvia*

receptacle surrounded by an involucre of generally five green or coloured bracts having nectariferous glands. Internally, the inflorescence contains pedicellate achlamydeous and unisexual flowers of both the types, male and female. Verticillaster is an inflorescence which has two clusters, each having 3 - 9 flowers, develop on a node in the axils of opposite leaves. Each cluster consists of a dichasial cyme with monochasial branches. Thyrsus is cymose clusters borne acropetally on an axis.

167. (c) : Myxophyceae is the older name of cyanophyceae or blue-green algae (according to Fritsch's classification).

168. (d) : The term 'coenobium' means united life. All the cells of *Volvox* act in union particularly in movement.



169. (d) : Nucleoid consists of a single circular strand of DNA duplex which is repeatedly folded with the help of RNA to form a nearly compact oval or spherical structure. DNA is naked, i.e., it is not associated with histone proteins. There is no organised membrane through mesosome.

170. (d) : The five kingdom classification of Whittaker has the following characteristics.

As the viruses are on the border line of living and nonliving matter, they have been left out.

Monera was the kingdom of prokaryotes,  
 Protista - kingdom of unicellular eukaryotes,  
 Fungi - kingdom of multicellular decomposers,  
 Plantae - kingdom of multicellular producers or Metaphyta and  
 Animalia is the kingdom of multicellular consumers or Metazoa.

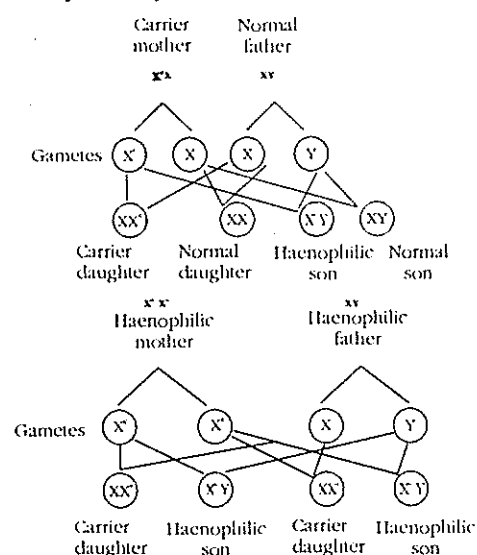
171. (c) : Cholera is an acute infectious disease which is caused by *Vibrio cholerae*. The stools and the vomit of a cholera patient are full of cholera germs and these may get into a healthy person when contaminated food or drink is taken by mouth. Since a large quantity of fluid and salts are rapidly lost through stools and vomit, therefore, the most important treatment is to replace the lost fluid and salts equally rapidly.

172. (a) : The first polio vaccine was prepared by Jones Salk (1953) at university of Pittsburgh by killing polio virus with formaldehyde. The killed virus is

called "salk vaccine" and injected to develop immunity. Sabin *et al* prepared an oral vaccine known as OPV (oral polio vaccine).

173. (c)      174. (a)

175. (a) : Haemophilia is a  $X$ -linked disease. As a person receives  $X$  chromosome from mother and  $Y$  from father, therefore the person may be a haemophilic if his mother is carrier of the disease. The person will be certainly haemophilic if his mother is haemophilic.



176. (c) :  $C_3$  plants exclusively fix  $CO_2$  via the Calvin-Benson pathway. The leaf cells of  $C_4$  plants possess two types of chloroplast, bundle sheath cells and mesophyll cells. The mesophyll cells of  $C_4$  plants exhibit high activity of phosphoenolpyruvate (PEP) carboxylase, which catalyses the fixation of  $CO_2$  with PEP to form oxaloacetic acid. The bundle sheath cells exhibit high RuBP carboxylase and the other enzymes of the Calvin-Benson cycle.  $C_4$  plants are highly productive photosynthetically in view of the low affinity of RuBP carboxylase for its substrate. But  $CO_2$  is concentrated as  $C_4$  acids due to the activity of the PEP carboxylase, which in effect maintains high pool levels of  $CO_2$ .  $C_4$  plants are related to very high light-harvesting saturation points.  $C_4$  plants exhibit low rates of photorespiration only in bundle sheath cells.  $C_4$  plants are adapted to high temperature.  $C_4$  plants show better utilization of available water but it cannot be the cause of its higher productivity.

177. (b) : mRNA brings instructions from the DNA for the formation of particular type of polypeptide. The instructions are present in the base sequence of its nucleotides. mRNA has methylated region at the 5' terminus. It functions as a cap for attachment with ribosome. Cap is followed by an initiation codon (AUG) either immediately or after a small non-coding region. Then there is coding region followed by termination codon (UAA, UAG or UGA). An mRNA may specify only a single polypeptide or a number of them. The former is called monocistronic while the latter is known as polycistronic.

178. (a) : An *absorption spectrum* is a measure of the extent to which a given substance absorbs the light of different colours or wavelengths. An *action spectrum* is the measure of the efficiency of a process induced by light of different wavelengths but of the same intensity. It is actually a plot of the extent of a response (such as photosynthesis) against different wavelengths of light. A comparison of an action spectrum with the absorption spectrum of a pigment indicates whether or not the pigment is involved in the response. For example, the absorption spectrum of chlorophyll *a* is very similar to the action spectrum of photosynthesis in most plant tissues. Although, light energy is absorbed by chlorophyll as well as by other accessory pigments, only chlorophyll *a* participates in conversion of light energy to chemical energy.

179. (a) : Linkage is association of two or more non-allelomorphic genes, so that they tend to be passed from generation to generation as an inseparable unit and fail to show independent assortment due to their being in same chromosome. Separation of such genes into different chromosomes occurs from time to time as a result of crossing-over. The nearer such genes are to each other on a chromosome the less often closely linked they are said to be. Red hair and freckles are examples of linkage.

180. (b) : Variations in the structure and number of chromosomes are called chromosomal aberrations. Structural changes can be of following types : (i) *deficiency*, which involves loss of a part of chromosome, (ii) *duplication*, which involves addition of a part chromosome, (iii) *inversion* which involves a reverse order of the genes in a part of chromosome and (iv) *translocation*, which involves exchange of segments between non-homologous chromosomes.

## GENERAL KNOWLEDGE

181. (a) : The world biggest airport at Dallas (Texas) is situated in U.S.A. and it covers over 7000 hectares.

182. (d)

183. (b) : White paper is the policy statement published by the governments on the subjects of great public importance.

184. (d)

185. (a) : The parliaments of Spain, Bangladesh, Nepal and Iran are Cortes, Jatiya Sansad, Panchayat and Majlis respectively.

186. (c)

187. (c) : Largest statue is situated in Hyderabad (statue of Budha) whose height is 17.3 metres.

188. (c)

189. (c) : Marco polo, Fahein, Macmillan and Alexander the great are the first European to visit China, first Chinese pilgrim who came to India, first British Prime Minister to visit India and first European invader of Indian soil respectively.

190. (b)

191. (a) : The heights of Everest, Godwin austen, Kanchanjunga and Mukahi are 8848 m, 8611 m, 8535 m and 8470 m respectively.

192. (b) :

193. (c) : The longest railway tunnel is situated in Japan. The length of the tunnel is 21 kilometres.

194. (c)

195. (c) : 'Calicut' which is situated about 65 kilometres from tellicherry, is re-named as Kozhikode.

196. (d)

197. (c) : Portblair, Silvassa, Kavaratti and Kohima are the capitals of Andman and Nicobar, Dadar and Nagar Haveli, Lakshadweep and Nagaland respectively.

198. (d)

199. (a) : Wheat, gram, oil seeds etc. are the rabi crops but groundnut is the jayad crop.

200. (d)