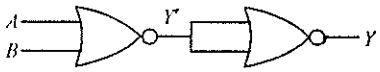
SOLUTIONS

PHYSICS

1. (b)

2. (c) : In a photon-particle collision (such as photon-electron), the total energy and total momentum are conserved. However, the number of photons may not be conserved in a collision. The photon may be absorbed or a new photon may be created.

3. (a) :



Truth Table of this gate

A	B	Y'	Y
0	0	1	0
1	0	0	1
0	1	0	1
1	1	0	1

$Y' = \overline{A+B} = \overline{A} \cdot \overline{B}$

and $Y = \overline{Y'} = \overline{\overline{A} \cdot \overline{B}} = \overline{\overline{A}} + \overline{\overline{B}} = A + B$

This is the boolean expression for the OR gate.

4. (c) : The power of lens

$P = \frac{1}{f} = \frac{1}{v} - \frac{1}{u} = \left[\frac{1}{25} - \frac{1}{\text{N.P.}}\right]$ where N.P. = Near point of vision

$P = \left[\frac{1}{25} - \frac{1}{100}\right]$

$P = \frac{4-1}{100} = \frac{3}{100\text{ cm}} = \frac{3}{1\text{ m}} = 3\text{ D}$

5. (b) : The kinetic energy of the projectiles is maximum at the point of release.

The ratio of K.E. of projectiles

$\frac{\frac{1}{2}mu_1^2}{\frac{1}{2}mu_2^2} = \frac{4}{1}$

$\frac{u_1^2}{u_2^2} = \frac{4}{1}$ .... (i)

The ratio of maximum heights of projectiles

$\frac{H_1}{H_2} = \frac{4}{1}$

$\frac{\frac{u_1^2 \sin^2\theta_1}{2g}}{\frac{u_2^2 \sin^2\theta_2}{2g}} = \frac{4}{1}$

$\frac{u_1^2}{u_2^2} \cdot \frac{\sin^2\theta_1}{\sin^2\theta_2} = \frac{4}{1}$

$\frac{4}{1} \cdot \frac{\sin^2\theta_1}{\sin^2\theta_2} = \frac{4}{1}$ (from equation (i))

$\sin^2\theta_1 = \sin^2\theta_2$

$\theta_1 = \theta_2$

Now, ratio of ranges of projectiles

$\frac{R_1}{R_2} = \frac{u_1^2 \sin 2\theta_1}{u_2^2 \sin 2\theta_2}$

$\frac{R_1}{R_2} = \frac{u_1^2 \sin 2\theta_1}{u_2^2 \sin 2\theta_1}$ ($\because \theta_1 = \theta_2$)

$\frac{R_1}{R_2} = \frac{u_1^2}{u_2^2}$, $\frac{R_1}{R_2} = \frac{4}{1}$

6. (d)

7. (c) : Relative magnetic permeability of diamagnetic substances is always less than unity.

i.e. $\mu_r < 1$

$\mu_r = (1 + \chi_m)$ as $\mu_r < 1$, χ_m is negative.

Hence, susceptibility of diamagnetic substances has a small negative value.

8. (b)

9. (c) : Fundamental frequency of a vibrating string is expressed as

$f = \frac{1}{2L}\sqrt{\frac{T}{\mu}} = \frac{1}{LD}\sqrt{\frac{T}{\pi\rho}}$

where, D = diameter of string

ρ = density of the material of string

As length L and radius are doubled, the new frequency

$f' = \frac{1}{(2L)(2D)}\sqrt{\frac{T}{\pi\rho}} = \frac{1}{4}f$

10. **(c)** : Since the bubbles coalesce in vacuum and there is no change in temperature, hence its surface energy does not change. This means that the surface area remains unchanged. Hence

$4\pi a^2 + 4\pi b^2 = 4\pi R^2$ or $R = \sqrt{a^2 + b^2}$

11. **(a)** : Capacitors C_1 and C_2 are in parallel, their equivalent capacitance is in series with capacitor C_3. Hence, the equivalent capacitance of the given circuit is

$$C_{eq} = \frac{(C_1 + C_2)C_3}{C_1 + C_2 + C_3}$$

Charge on capacitor C_3 is

$$Q = V C_{eq} = \frac{V(C_1 + C_2)C_3}{C_1 + C_2 + C_3}$$

Voltage across C_3 is

$$= \frac{Q}{C_3} = \frac{V(C_1 + C_2)}{C_1 + C_2 + C_3}$$

12. **(c)** : For Brackett series, $n_1 = 4$, $n_2 = 5, 6, 7$ .....

$$\frac{1}{\lambda} = R\left(\frac{1}{n_1^2} - \frac{1}{n_2^2}\right)$$

where $R = 1.09678 \times 10^7\ m^{-1}$, called Rydberg's constant.

$$\frac{1}{\lambda} = R\left(\frac{1}{4^2} - \frac{1}{n_2^2}\right)$$

For maximum wavelength, $n_2 = 5$

$$\frac{1}{\lambda_{max}} = 1.09687 \times 10^7\left(\frac{1}{4^2} - \frac{1}{5^2}\right)$$

$\lambda_{max} = 40519$ Å

13. **(a)** : $r = \frac{n^2}{Z} \times 0.529$

For He^+, $n = 2$, $Z = 1$

$r = \frac{4}{2} \times 0.529$

$= 1.058$ Å

14. **(c)** : $x = 3t^2 - 6t$; So $(\text{velocity})_x = \frac{dx}{dt} = 6t - 6$;

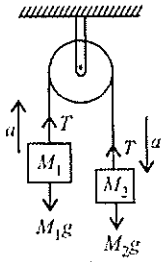
$y = t^2 - 2t$

So, $(\text{velocity})_y = \frac{dy}{dt} = 2t - 2$

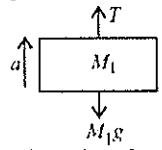
At time $t = 1$,

$= \frac{dx}{dt} = 6 \times 1 - 6 = 0$ and $\frac{dy}{dt} = 2 \times 1 - 2 = 0$.

15. **(c)** : Since $M_2 > M_1$, therefore M_2 moves downwards and M_1 moves upwards with an acceleration a as shown in the figure.



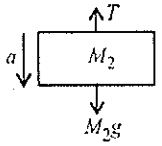
Free body diagram of M_1



The equation of motion for M_1 is

$T - M_1g = M_1a$ .....(i)

Free body diagram of M_2



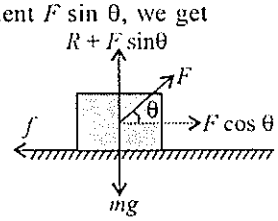
The equation of motion for M_2 is

$M_2g - T = M_2a$ .....(ii)

Adding (i) and (ii), we get

$$a = \frac{(M_2 - M_1)g}{M_2 + M_1} = \frac{(10-5)g}{(10+5)} = \frac{g}{3}$$

16. **(b)** : Because the block moves with a uniform velocity, the resultant force is zero. Resolving F into horizontal component $F\cos\theta$ and vertical component $F \sin \theta$, we get



$R + F \sin \theta = mg$ or $R = mg - F \sin\theta$

Also $f = \mu R = \mu(mg - F\sin\theta)$

But $F\cos\theta = f$

or $F\cos\theta = \mu(mg - F\sin\theta)$

or $F(\cos\theta + \mu \sin\theta) = \mu mg$

$$\therefore\ F = \frac{\mu mg}{\cos\theta + \mu\sin\theta}$$

Work $W = Fs\cos\theta$

$$\therefore\ W = \frac{\mu mgd\cos\theta}{\cos\theta + \mu\sin\theta}$$

$(\because s = d)$

17. (b) : $\rho = \frac{PM}{RT}$ or $\rho \propto \frac{P}{T}$

$\left(\frac{P}{T}\right)_A = \frac{P_0}{T_0}$ and $\left(\frac{P}{T}\right)_B = \frac{3}{2}\left(\frac{P_0}{T_0}\right)$

$\left(\frac{P}{T}\right)_B = \frac{3}{2}\left(\frac{P}{T}\right)_A$

$\therefore \quad \rho_B = \frac{3}{2}\rho_A = \frac{3}{2}\rho_0$

18. (a)

19. (a) : $\eta_1 = 1 - \frac{T_L}{T_H} = \frac{W}{Q_1} = \frac{1}{6}$

or $5T_H - 6T_L = 0$ ...(i)

$\eta_2 = 1 - \frac{T_L - 62}{T_H} = 2\eta_1 = \frac{1}{3}$ (Given)

$\Rightarrow \quad 1 - \frac{1}{3} = \frac{T_L - 62}{T_H}$

or $2T_H - 3T_L = -186$ ...(ii)

Solving (i) and (ii), we get

$\therefore \quad T_H = 372\ \text{K} = 99°\text{C}$

$T_L = \frac{5}{6}T_H = \frac{5}{6} \times 372\ \text{K} = 310\ \text{K} = 37°\text{C}$

20. (c) :According to first law of thermodynamics

$\Delta Q = \Delta U + P\Delta V$

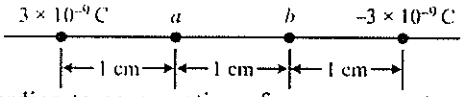
If ΔQ is absorbed at constant volume, $\Delta V = 0$

$C_V = \left(\frac{\Delta Q}{\Delta T}\right)_V = \left(\frac{\Delta U}{\Delta T}\right)_V = \frac{\Delta U}{\Delta T}$

for an ideal monoatomic gas

$\frac{\Delta U}{\Delta T} = \frac{3}{2}R; \quad C_V = \frac{3}{2}R$

21. (c) :



According to conservation of energy, we get

$K_a + U_a = K_b + U_b$

Here, $K_a = 0$ and the potential energies are $U_a = q'V_a$ and $U_b = q'V_b$.

$\therefore \quad 0 + q'V_a = \frac{1}{2}mv^2 + q'V_b.$

or $v = \sqrt{\frac{2q'(V_a - V_b)}{m}}$

$V_a = (9.0 \times 10^9\ \text{Nm}^2\text{C}^{-2})$

$\left(\frac{3\times10^{-9}\ \text{C}}{0.01\ \text{m}} + \frac{-3\times10^{-9}\ \text{C}}{0.02\ \text{m}}\right) = 1350\ \text{V}$

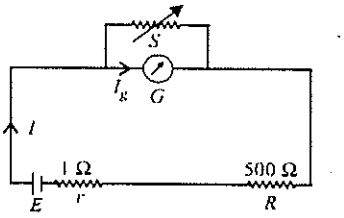
$V_b = (9.0 \times 10^9\ \text{Nm}^2\text{C}^{-2})$

$\left(\frac{3\times10^{-9}\ \text{C}}{0.02\ \text{m}} + \frac{-3\times10^{-9}\ \text{C}}{0.01\ \text{m}}\right) = -1350\ \text{V}.$

$\therefore \quad v = \sqrt{\frac{2(2\times10^{-9}\ \text{C})(2700\ \text{V})}{5\times10^{-3}\ \text{kg}}} = 4.65\times10^{-2}\ \text{m s}^{-1}$

$= 4.65\ \text{cm s}^{-1}$

22. (a) :



Here, $I = \frac{E}{R + r + \frac{GS}{G+S}}$ and $I_g = \frac{IS}{G+S}$

$I_g = \frac{E}{(R+r) + \frac{GS}{(G+S)}} \times \frac{S}{(G+S)}$

$\therefore \quad I_g = \frac{ES}{(R+r)(G+S) + GS}$

For S = 5 ohm, $I_g = 5 \times 10^{-3}$ A

and for S = 25 ohm,

$I_g = 20 \times 10^{-3}$ A

Hence, $5\times10^{-3} = \frac{E\times5}{501(G+5)+5G}$ ...(i)

and $20\times10^{-3} = \frac{E\times25}{501(G+25)+25G}$ ...(ii)

Dividing and solving,

$G = 88.2\ \Omega$

From (i), we get

$E = 10^{-3}\ [501\ (88.2 + 5) + 5 \times 88.2]$

$= 47.1$ volt

23. (a) : Let us refer to the coil as circuit 1 and the solenoid as circuit 2. The field in the central region of the solenoid is uniform, so the flux through the coil is

$\Phi_{12} = B_2A_1 = (\mu_0 n_2 I_2)A_1$

where $n_2 = N_2/l = 1500$ turns/m. The mutual inductance is

$M = \frac{N_1\Phi_{12}}{I_2} = \mu_0 n_2 N_1 A_1$

$= (4\pi \times 10^{-7}\ \text{T} \cdot \text{m/A})\ (1500\ \text{m}^{-1})\ (10)\ (4 \times 10^{-4}\ \text{m}^2)$

$= 7.54 \times 10^{-6}$ H

24. (b) : $K_1 = \frac{hc}{\lambda_1} - \phi_0$ ....(i)

and $K_2 = \frac{hc}{\lambda_2} - \phi_0$ or $\frac{hc}{\lambda_2} = (K_2 + \phi_0)$ .... (ii)

$\therefore \quad K_1 - K_2 = hc\left[\frac{1}{\lambda_1} - \frac{1}{\lambda_2}\right]$

$= hc\left[\frac{1}{3\lambda_2} - \frac{1}{\lambda_2}\right] = \frac{2hc}{3\lambda_2}$

$= -\frac{2}{3}(K_2 + \phi_0)$ From (ii)

or $K_1 = K_2 - \frac{2}{3}K_2 - \frac{2}{3}\phi_0 = \frac{K_2}{3} - \frac{2}{3}\phi_0$

or $K_1 < \frac{K_2}{3}$

25. **(c)** : At $t = 0$, $N = N_0$ for both the substances A and B

$\therefore \quad N_A = N_0 e^{-\lambda_A t}$ and $N_B = N_0 e^{-\lambda_B t}$

$\frac{N_A}{N_B} = \frac{e^{-\lambda_A t}}{e^{-\lambda_B t}} = e^{(\lambda_B - \lambda_A)t} = e^{(\lambda - 5\lambda)t}$

$= e^{-4\lambda t} = \left(\frac{1}{e}\right)^{4\lambda t}$

As $\frac{N_A}{N_B} = \left(\frac{1}{e}\right)^2$ [According to question]

$\therefore \quad 4\lambda t = 2$

or $t = \frac{2}{4\lambda} = \frac{1}{2\lambda}$

26. **(b)** : $\because \quad I = I_0 e^{-kx} \Rightarrow \frac{I}{I_0} = e^{-kx}$

$\therefore \quad \ln\left(\frac{I}{I_0}\right) = -kx$

In first case

$\ln\left(\frac{1}{8}\right) = -k \times 36$

$\ln (2^{-3}) = - k \times 36$

or $3\ln 2 = k \times 36$ .....(i)

In second case, $\ln\left(\frac{1}{2}\right) = -k \times x$

or $\ln(2^{-1}) = - kx$

or $\ln 2 = kx$ ..... (ii)

From (i) and (ii)

$3 \times (kx) = k \times 36$

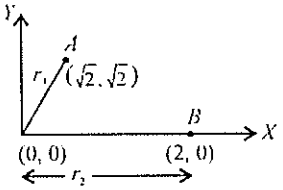
or $x = 12$ mm.

27. **(c)** : $\vec{r}_1 = \sqrt{2}\hat{i} + \sqrt{2}\hat{j}$

$|\vec{r}_1| = r_1 = \sqrt{\left(\sqrt{2}\right)^2 + \left(\sqrt{2}\right)^2} = 2$

$\vec{r}_2 = 2\hat{i} + 0\hat{j}$

or $|\vec{r}_2| = r_2 = 2$



Potential at point A is

$V_A = \frac{1q}{4\pi\varepsilon_0 r_1}$

$= \frac{1}{4\pi\varepsilon_0}\frac{10^{-3} \times 10^{-6}}{2}$

Potential at point B is

$V_B = \frac{1}{4\pi\varepsilon_0}\frac{q}{r_2} = \frac{1}{4\pi\varepsilon_0}\frac{10^{-3} \times 10^{-6}}{2}$

$\therefore \quad V_A - V_B = 0.$

28. **(a)** : $E = G^p h^q c^r$ ...(i)

$[M^1L^2T^{-2}] = [M^{-1}L^3T^{-2}]^p [ML^2T^{-1}]^q [LT^{-1}]^r$

$= M^{-p+q} L^{3p+2q+r} T^{-2p-q-r}$

Applying principle of homogeneity of dimensions, we get

$-p + q = 1$ ...(ii)

$3p + 2q + r = 2$ ...(iii)

$-2p - q - r = -2$ ...(iv)

Add (iii) and (iv), $p + q = 0$ ...(v)

Add (ii) and (v), we get $q = \frac{1}{2}$

From (ii), we get $p = q - 1 = \frac{1}{2} - 1 = -\frac{1}{2}$.

Put in (iii), we get $-\frac{3}{2} + 1 + r = 2, \quad r = 5/2$

29. **(d)** : If M is mass of the square plate before cutting the holes, then mass of portion of each hole,

$m = \frac{M}{16R^2} \times \pi R^2 = \frac{M\pi}{16}$

$\therefore$ Moment of inertia of remaining portion about Z axis

$I = I_{\text{square}} - 4\ I_{\text{hole}}$

$= \frac{M}{12}(16R^2 + 16R^2) - 4\left[\frac{mR^2}{2} + m(\sqrt{2}R)^2\right]$

$= \frac{M}{12} \times 32R^2 - 10mR^2$

$= \frac{8}{3}MR^2 - \frac{10}{16}MR^2\pi$

$I = \left(\frac{8}{3} - \frac{10\pi}{16}\right)MR^2.$

30. **(b)** : From Bernoulli's theorem,

$P_A + \frac{1}{2}dv_A^2 + dgh_A = P_B + \frac{1}{2}dv_B^2 + dgh_B$

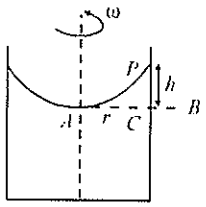
Here, $h_A = h_B$

$\therefore\ P_A + \frac{1}{2}dv_A^2 = P_B + \frac{1}{2}dv_B^2$

$P_A - P_B = \frac{1}{2}d[v_B^2 - v_A^2]$

Now, $v_A = 0$, $v_B = r\omega$

and $P_A - P_B = hdg$



$\therefore\ hdg = \frac{1}{2}dr^2\omega^2$ or $h = \frac{r^2\omega^2}{2g}$

31. (a) : Initial K.E., $E_1 = \frac{1}{2}mv^2$

$= \frac{1}{2}\times 10\times(10)^2 = 500$ J

At x = 20 m, retarding force,

$F_1 = 0.1 \times 20 = 2$ N

At x = 30 m, retarding force,

$F_2 = 0.1 \times 30 = 3$ N.

Average Retarding Force $F = \frac{F_1 + F_2}{2} = \frac{2+3}{2} = 2.5$

Work done by retarding force = loss in K.E.

$= F \times s = 2.5\ (30 - 20) = 25$ J

Final K.E. = E_1 – loss in K.E. = 500 – 25 = 475 J

32. (c) : $h = \frac{2S\cos\theta}{r\rho g}$

Mass of water in the first tube,

$m = \pi r^2 h\rho = \pi r^2 \times \left(\frac{2S\cos\theta}{r\rho g}\right)\times\rho$

$= \frac{2\pi rS\cos\theta}{g}$

$\therefore\ m \propto r$. Hence, $\frac{m'}{m} = \frac{2r}{r} = 2$

or $m' = 2m = 2 \times 5\ g = 10\ g$.

33. (b) : Impulse = $F \times t$

$= \frac{m(v_2 - v_1)}{t}\times t = m(v_2 - v_1)$

= change in momentum

$\therefore$ [Impulse] = [Momentum]

Angular momentum, L = mvr

Planck's constant, [h] = [energy] × [time]

$\Rightarrow\ [F \times r \times \text{time}) = \frac{m(v_2 - v_1)}{t}\times r \times t$

$\Rightarrow\ m(v_2 - v_1) \times r$ = (change of momentum) × r

$\therefore\ [h] = [L]$.

Work, $W = \vec{F}.\vec{d}$; Torque, $\tau = \vec{r}\times\vec{F}$

$\therefore\ [W] = [\tau]$

Moment of inertia, $I = mr^2$ = mass × (distance)^2

Moment of force, $\tau = \vec{r}\times\vec{F}$ = distance × force

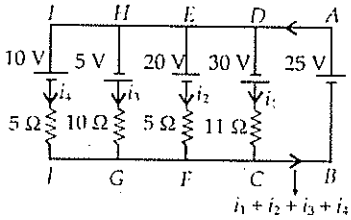
$= \text{distance} \times \frac{\text{change of momentum}}{\text{time}}$

$\therefore\ [I] \neq [\tau]$.

Therefore, moment of inertia and moment of force have different dimensions.

34. (a)

35. (c) :



Applying KVL in loop $ABCDA$, $ABFEA$, $ABGHA$ and $ABJIA$, we get

$30 - i_1 \times 11 = -25$ ...(i)

$20 + i_2 \times 5 = 25$ ...(ii)

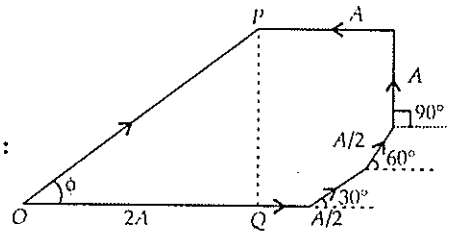
$5 - i_3 \times 10 = -25$ ....(iii)

$10 + i_4 \times 5 = 25$ ...(iv)

Solving equations (i), (ii), (iii) and (iv) we get i_1 = 5 A, i_2 = 1 A, i_3 = 3 A and i_4 = 3 A.

Hence, current flowing through 25 V cell is 12 A.

36. (b) :



$y_1 = 2A\sin\omega t$; $y_2 = \frac{A}{2}\sin\left(\omega t + \frac{\pi}{6}\right)$

$y_3 = \frac{A}{2}\sin\left(\omega t + \frac{\pi}{3}\right)$; $y_4 = A\sin\left(\omega t + \frac{\pi}{2}\right)$

$y_5 = A\sin(\omega t + \pi)$

By phasor diagram, $\tan\phi = \frac{PQ}{OQ} = 1$

$\Rightarrow\ \phi = 45°$

37. (b) : Let L be the length of the open pipe. The fundamental frequency of the open pipe is given by

$\upsilon = \frac{v}{2L}$, v = velocity of sound in air

The second overtone of the open pipe has a

frequency $3\upsilon_o = \frac{3v}{2L_o}$ Hz

The length of the closed pipe $L_C = 2$ m.

The fundamental frequency of the closed pipe is given by $\upsilon = \frac{v}{4L}$

The first overtone of the closed pipe has a frequency

$3\upsilon_c = \frac{3v}{4L_C} = \frac{3v}{4\times 2} = \frac{3v}{8}$ Hz

Now $3\upsilon_o = 3\upsilon_c$ or $\frac{3v}{2L_o} = \frac{3v}{8}$

or $2L_o = 8$ or $L_o = 4$ m

38. **(c)** : $T_1 = 2\pi\sqrt{\frac{M}{k_1}}$ or $k_1 = \frac{4\pi^2 M}{T_1^2}$

and $k_2 = \frac{4\pi^2 M}{T_2^2}$

In series combination, $k_{eff} = \frac{k_1 k_2}{k_1 + k_2} = \frac{4\pi^2 M}{T_1^2 + T_2^2}$

$\therefore\ T = 2\pi\sqrt{\frac{M}{k_{eff}}} = \sqrt{T_1^2 + T_2^2}$.

39. **(c)** : Average value of A.C. for complete cycle is zero. Hence A.C. can not be measured by D.C. ammeter.

40. **(a)** : The energy loss due to eddy currents is reduced by using laminated core in a transformer.

41. **(a)** : $h = ut - (1/2)gt^2$ and $v^2 = u^2 - 2gh$
The above equations are independent of mass

42. **(d)** : If a body is projected from a place above the surface of earth, then for the maximum range, the angle of projection should be less than 45°.

43. **(b)** : The apparent weight of a body in an elevator moving with downward acceleration a is given by $W = m(g - a)$

44. **(d)** : If electric field is used for detecting the electron beam, then very high voltage will have to be applied or very long tube will have to be taken.

45. **(c)** : In the first few steps, work has to be done against limiting friction and afterwards, work is to be done against dynamic friction, which is smaller than the limiting friction.

46. **(a)**

47. **(a)**

48. **(b)** : Rolling occurs only on account of friction which is a tangential force capable of providing torque when the inclined plane is perfectly smooth, it will simply slip under the effect of its own weight. Once the perfect rolling begins, force of friction becomes zero. Hence, the work done against friction is zero.

49. **(a)**

50. **(a)** Water would evaporate quickly because there is no atmosphere on moon, due to which surface temperature of moon is much higher than earth (maximum surface temperature of moon is 123°C).

51. **(a)**

52. **(c)** : As conductivity of an intrinsic semiconductor is less than that of a lightly doped p-type

53. **(b)** : As UHF/VHF waves are not reflected by ionosphere being of higher frequency.

54. **(d)** : We cannot interchange the objective and eye lenses of a microscope to make a telescope. The reason is that the focal length of lenses in microscope are very small, of the order of mm or a few cm and the difference $(f_o - f_e)$ is very small, while the telescope objective have a very large focal length as compared to eye lens of microscope.

55. **(a)** : The period of a charged particle in a magnetic field is given by $T = \frac{2\pi m}{qB}$, *i.e.*, $T \propto \frac{m}{q}$

We know that, $m_p = m$, $m_\alpha = 4m$, $q_p = e$, $q_\alpha = 2e$

$\therefore\ \frac{T_p}{T_\alpha} = \frac{1}{2}$ or $T_\alpha = 2T_p$

56. **(a)** : As, $p_2 = p_1 + 50\%$ of $p_1 = (3/2)\ p_1$

$\therefore\ v_2 = (3/2)\ v_1$

As, kinetic energy, $K \propto v^2$

$\therefore\ K_2 = \frac{9}{4}\ K_1$

Increase in K.E. $= \frac{(K_2 - K_1)\times 100}{K_1} = 125\%$.

57. **(b)** : Acceleration due to gravity,

$g' = g - R_e\omega^2 \cos^2\lambda$

At equator, $\lambda = 0°$, $\therefore \cos 0° = 1$

$\therefore\ g_e = g - R_e\omega^2$

At poles, $\lambda = 90°$, $\therefore \cos 90° = 0$ $\therefore\ g_p = g$

Thus, $g_p - g_e = g - g + R_e\omega^2 = R_e\omega^2$

Also, the value of g is maximum at poles and minimum at equator.

58. (c) : As $P = Vi$, hence for the transmission of same power, high voltage implies less current. Therefore heat energy loses ($H = i^2 Rt / 4.2$) are minimized if power is transmitted at high voltage.

59. (c) : The earth's atmosphere is transparent to visible light and radio waves, but absorbs X-rays. Therefore
X-rays telescope cannot be used on earth surface.

60. (a)

CHEMISTRY

61. (c)

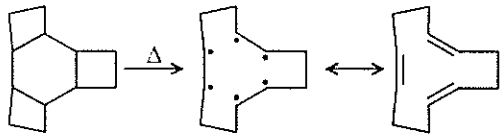
62. (b) : The constituents of Mischmetal is approximately 50% cerium and 25% lanthanum with small amounts of neodymium and praseodymium.

63. (a) : For a first order reaction, rate = $k[A]$, when concentration of A is doubled, the rate becomes double.

64. (c) : In tetragonal system,
$a = b \neq c$, $\alpha = \beta = \gamma = 90°$

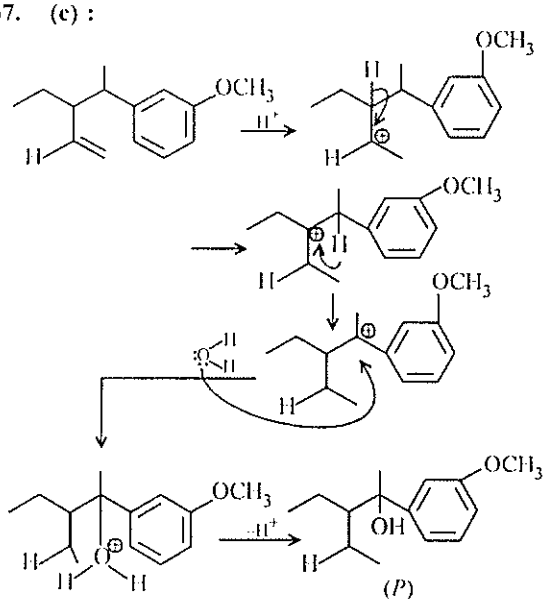
65. (c) : (c) is correct answer because $r_{ionic} \propto \frac{1}{Z_{eff}}$

66. (a) :



Free radical

67. (c) :



(P)

68. (c) : If product concentration is x.
For a zero order reaction $\frac{x}{t} = k$
Thus graph would be a straight line passing through origin. So the given information is for zero order reaction. For a zero order reaction, rate of the reaction is constant. Thus, plot of rate *vs* time, *i.e.*, $-\frac{d[X]}{dt}$ *vs* time will be a straight line parallel to x-axis.

69. (c) : $\frac{W_{Ca}}{E_{Ca}} = \frac{W_{Al}}{E_{Al}} \Rightarrow \frac{40}{20} = \frac{W_{Al}}{9} \Rightarrow W_{Al} = 18$ kg
As current efficiency is 50% so, $W_{Al} = 9$ kg

70. (b) : Let the weight of CO = weight of $CH_4 = a$ g
Moles of CO $= \frac{a}{28}$
Moles of $CH_4 = \frac{a}{16}$
Total moles $= \frac{a}{28} + \frac{a}{16}$

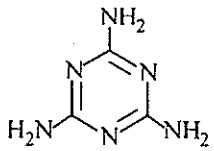
$$x_{CH_4} = \frac{\frac{a}{16}}{\frac{a}{28} + \frac{a}{16}} = \frac{a}{16} \times \frac{28 \times 16}{44a} = \frac{14}{22} = \frac{7}{11}$$

$\therefore$ Fraction of pressure exerted by $CH_4 = 7/11$.

71. (c) : For $Cr^{3+} = 3d^3$, $\mu = \sqrt{3(3+2)} = \sqrt{15}$ B.M.
For $Fe^{2+} = 3d^6$, $\mu = \sqrt{4(4+2)} = \sqrt{24}$ B.M.
For $Ni^{2+} = 3d^8$, $\mu = \sqrt{2(2+2)} = \sqrt{8}$ B.M.
For $Mn^{2+} = 3d^5$, $\mu = \sqrt{5(5+2)} = \sqrt{35}$ B.M.

72. (c) :Cyanides, on hydrolysis, give acids
$RCN + 2H_2O \xrightarrow{H^+} RCOOH + NH_3$
while all other reactions give amines.

73. (b) :



2,4,6-triamino-1,3,5-triazine

74. (b) :
$2NaOH_{(dilute)} + Br_2 \xrightarrow{cold} NaBrO + NaBr + H_2O$
$3NaBrO \xrightarrow{300\ K} 3NaBrO$
Sodium hypobromide

On acidification, the final mixture gives bromine.

$$5NaBrO + NaBrO_3 + 6HCl \longrightarrow 6NaCl + 3Br_2 + 3H_2O$$

Thus, during the reaction, bromine is present in four different oxidation states *i.e.*, zero in Br_2, +1 in NaBrO, –1 in NaBr and +5 in $NaBrO_3$. The greatest difference between various oxidation states of bromine is 6 and not 5. On acidification of the final mixture, Br_2 is formed and disproportionation of Br_2 occurs during the reaction giving BrO^-, Br^- and BrO_3^- ions.

75. **(c)** : The complex $PtCl_4.5NH_3$ is designated as $[Pt(NH_3)_5Cl]Cl_3$ which ionizes to $[Pt(NH_3)_5Cl]^{3+}$ + $3Cl^-$ ions. Thus total ions produced are four but three moles of AgCl are produced from $3Cl^-$ ions with $AgNO_3$.

76. **(c)** : $\wedge^{\infty}_{HOAc} = \wedge^{\infty}_{NaOAc} + \wedge^{\infty}_{HCl} - \wedge^{\infty}_{NaCl}$

$= 91.0 + 426.2 - 126.5$ S cm^2 mol^{-1}

$= 390.7$ S cm^2 mol^{-1}

77. **(c)** : $Cu^+ = 1s^2\ 2s^2\ 2p^6 3s^2 3p^6 3d^{10}$.

Shells occupied =3, sub-shells occupied = 6, filled orbitals = 14. Unpaired $e^- = 0$.

78. **(c)** : There is no restriction that resonating structures should have +ve and –ve charges on atoms that are far apart.

79. **(d)** : Lattice energy $= -\frac{q_1 q_2}{r^2}$

where q_1 and q_2 are charges on ions and r is the distance between them. Since interionic distances in CaO and NaCl are similar, (larger cation has smaller anion and vice versa) therefore, r is almost the same. Therefore, lattice energy depends only on charge. Since the magnitude of charge on Na^+ and Cl^- ions is unity and that on Ca^{2+} and O^{2-} ions is 2 each, therefore, the lattice energy of CaO is four times the lattice energy of NaCl, *i.e.*, $4U$.

80. **(b)** : Since the phosphate of a metal is $MHPO_4$, therefore, metal M must be divalent, *i.e.*, M^{2+}. As a result, the formula of its chloride is MCl_2.

81. **(d)** : $P = \frac{1}{3}\frac{mnu^2}{V}$

$$\frac{P_X}{P_Y} = \frac{n_X u_X V_Y}{n_Y u_Y V_X} = \frac{(N_0/1000)}{(N_0/2000)} \times 2 \times \frac{2}{1} = 8$$

82. **(d)** : From thermodynamics, $dG = VdP - SdT$

At constant T, $dT = 0$ so that $\left(\frac{\delta G}{\delta P}\right)_T = V$

At constant P, $dP = 0$ so that $\left(\frac{\delta G}{\delta T}\right)_P = -S$

Also $\mu_{JT} = \left(\frac{\delta T}{\delta P}\right)_H$

83. **(c)** : Glycine $H_3N^+CH_2COO^-$ is more acidic than basic. Instead of K_b value, the second given K_a value is corresponding to the K_b value ($\because K_a \times K_b = 10^{-14}$). Hence, overall ionization constant,

$$K = K_{a_1} \times K_{a_2} = 4.5 \times 10^{-3} \times 1.7 \times 10^{-10} = 7.65 \times 10^{-13}$$

$$H^+ = \sqrt{KC} = \sqrt{7.65 \times 10^{-13} \times 0.01}$$

$$= \sqrt{0.765 \times 10^{-14}} = 0.87 \times 10^{-7}\ M$$

$pH = -\log(0.87 \times 10^{-7}) = 7.06$

84. **(c)** : Sequence (c) contains only representative elements.

85. **(c)** : $2H_2O_2 \longrightarrow 2H_2O + O_2$

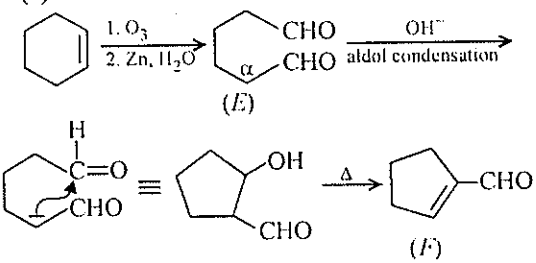
100 mL 1000 mL

or 1 mL of H_2O_2 will give 10 mL of O_2 at STP

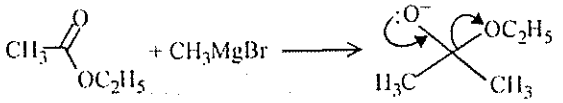
Thus its volume strength is 10 volume.

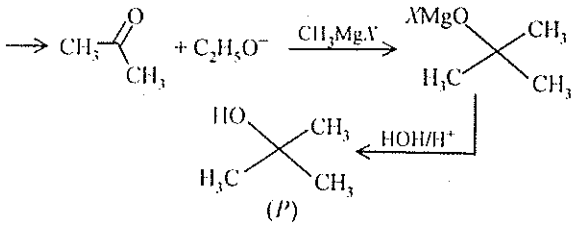
86. **(a)** : Be exhibits maximum covalency of four whereas Al shows maximum covalency of six.

87. **(a)** :



88. **(a)** :





(*P*)

89. (c) : Secondary (2°) amines (aliphatic as well as aromatic) react with nitrous acid (HNO_2) to form N-nitrosoamines.

$$\underset{(2^{\circ}\text{ amine})}{(C_2H_5)_2NH} + \underset{(\text{nitrous acid})}{HONO} \longrightarrow \underset{(\text{N-nitrosodiethylamine})}{(C_2H_5)_2N-N=O} + H_2O$$

90. (a) :

$$\underset{A}{C_3H_xO} \xrightarrow{K_2Cr_2O_7/H^+} \underset{B}{C_3H_6O} \xrightarrow{\text{ammo. } AgNO_3} \text{Silver mirror}$$

$$B \xrightarrow{H_2NCONHNH_2\cdot HCl} C$$

Reaction of *B* indicates that *B* is an aldehyde thus *B* should be C_2H_5CHO or CH_3CH_2CHO and therefore *C* should be $CH_3CH_2CH=NNHCONH_2$.

$$\underset{[A]}{CH_3CH_2CH_2OH} \xrightarrow{[O]} \underset{[B]}{CH_3CH_2CHO} \xrightarrow[\text{mirror test}]{\text{Silver}} CH_3CH_2COOH + 2Ag\downarrow$$

$$CH_3CH_2CHO + \underset{\text{semicarbazide}}{H_2NNHCONH_2} \longrightarrow \underset{\text{semicarbazone } [C]}{CH_3CH_2CH=NNHCONH_2}$$

91. (b) : $\Delta x \geq \dfrac{h}{(4\pi)(m\Delta v)}$

$$\Delta x \geq \frac{6.626\times10^{-34}}{(4\times3.14\times1050)(0.9)\left(\frac{1}{3600}\right)\left(\frac{1000}{1}\right)}$$

$\Delta x \geq 2\times10^{-37}$ m

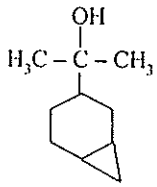
The uncertainty in the position of the car is far smaller than the uncertainty in the position of an electron in a hydrogen atom (3×10^{-10} m) and far too small a value to have any measurable consequences.

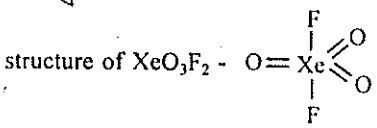
92. (b) : When a solute is present in very minute amounts (trace quantities), the concentration is expressed in ppm.

$$\text{ppm of } A = \frac{\text{mass of component } A}{\text{total mass of solution}}\times10^6$$

$$= \frac{0.025}{10^1}\times10^6 = 25 \text{ ppm}.$$

93. (a) : Degree of unsaturation of $C_{10}H_{18}O = 2$, but it contains no double or triple bond. Hence there are two rings – one six membered as indicated by product and the other three membered which is cleaved by HCl due to strain. Hence *A* has following structure.



94. (d) : The structure of XeO_3F_2 - 

No. of lone pair of Xe = 0 and no. of bond pair = 5

Hybridisation of Xe = sp^3d

Hence, shape of XeO_3F_2 should be trigonal bipyramidal and not octahedral.

95. (a) : For the desired reaction,

$$AgCl + 1e^- \rightarrow Ag + Cl^-, \quad E^\circ = \frac{-\Delta_r G^\circ}{(1)F}$$

The needed $\Delta_r G^\circ$ can be obtained by adding the values of $\Delta_r G^\circ$ for the reactions

$Ag^+ + 1e^- \rightarrow Ag$; $\Delta G^\circ = -nFE^\circ$

$AgCl \rightarrow Ag^+ + Cl^-$; $\Delta G^\circ = -RT \ln K_{sp}$, giving

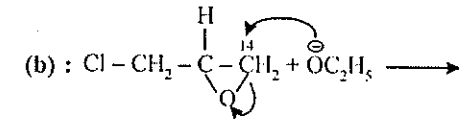
$\Delta_r G^\circ = -(1 \text{ mol})(9.648\times10^4 \text{ J mol}^{-1} \text{ V}^{-1})(0.7991 \text{ V})$

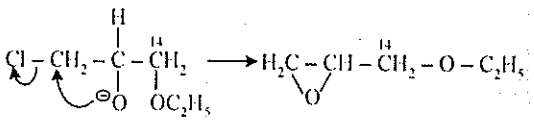
$-(8.314 \text{ JK}^{-1}\text{mol}^{-1})(298 \text{ K})\ln(1.56\times10^{-10})$

$= -77.10 \text{ kJ} + 55.95 \text{ kJ} = -21.15 \text{ kJ}$

The potential is $E^\circ = \dfrac{-(-21.15)}{(1)(96.485)} = +0.2192 \text{ V}$.

96. (d) : None of these acids evolve H_2 gas with alkali metals.

97. (b) : 



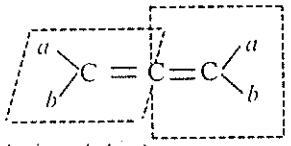
98. (a) : Given, $M_{HCl} = 0.1$ M, $V_{HCl} = 18.0$ mL

$M_{NaHCO_3} = 0.125$ M, $V_{NaHCO_3} = ?$

On applying, $M_{HCl} \times V_{HCl} = M_{NaHCO_3} \times V_{NaHCO_3}$
$\Rightarrow 0.1 \times 18 = 0.125 \times V_{NaHCO_3}$
$\Rightarrow M_{NaHCO_3} = 14.4$ mL
Thus, 14.4 mL of the 1.25 M $NaHCO_3$ solution is needed to neutralise 18.0 mL of the 0.100 M HCl solution.

99. **(b)** : $M^+ + X^- \rightarrow M + X$ is spontaneous because for the cell represented by $M|M^+ \| X^-|X$, the value of E° is positive *i.e.* (0.44 – 0.33) V = 0.11 V.

100. **(b)** : Allenes with even number of cumulative double bonds are optically active if both sides are disymmetric.



(horizontal plane) (vertical plane)
(no plane of symmetry)

101. **(c)** : NaCl and $CaCl_2$ are added to provide conductivity to the electrolyte and also to lower the fusion temperature of anhydrous $MgCl_2$.

102. **(b)** : The equilibrium constant is always fixed and is characteristic of a reaction at specified temperature. However final composition of a reaction mixture at equilibrium at constant temperature depends on the initial concentration of reactants and products.

103. **(a)** : PCl_5 is trigonal bipyramidal containing sp^3d hybridized P atom in liquid and gaseous states whereas in solid state it consists of tetrahedral PCl_4^+ cation and octahedral PCl_6^- anion.

104. **(a)**

105. **(a)** : $\overset{4}{CH_3}-\overset{3}{\underset{\underset{COOC_2H_5}{|}}{C}}=\overset{2}{CH}-\overset{1}{COOH}$

Here since —COOH is the principal functional group, it gets the lowest number than the secondary functional group (3-carbethoxy). So it is 3-carbethoxy-2-butenoic acid.

106. **(c)** : He contains fully filled $1s^2$ orbital which has more penetrating effect and is very close to the nucleus and hence has higher value of ionisation energy.

107. **(a)** : The nuclear isomerism in the nuclei of same mass number and same atomic number arises due to different radioactive properties. The reason for nuclear isomerism is the different energy states of two isomeric nuclei. One may be in the ground state and other in an excited state. The nucleus in the excited state will have different half-life.

108. **(b)** : When a silicon crystal is doped with a group-15 elements, such as P, As, Sb or Bi the structure of the crystal lattice is left unchanged but an occasional atom with five valence electrons occupies a site that would normally be occupied by a silicon atom. The foreign atom uses four of its electrons in covalent bonding but the remaining fifth electron becomes delocalised and is thus free to contribute to electrical conduction.

109. **(c)** : Reactions of higher order are rare because chances for larger number of molecules to come simultaneously for collision are less.

110. **(b)** : In actual practice transition metals react with acid very slowly and act as poor reducing agents. This is due to the protection of metal as a result of formation of thin oxide protective film. Further, their poor tendency as reducing agent is due to high ionisation energy, high heat of vapourization and low heat of hydration.

111. **(b)** : Both carbanions (formed in presence of base) and enol form (formed in presence of an acid) act as nucleophiles and hence add on the carbonyl group of aldehydes and ketones to give aldols.

112. **(a)** : The loss of one α-particle will reduce the mass number by four and atomic number by two. Subsequent two β-emissions will increase the atomic number by two without affecting the mass number. Hence, the new element will be only an isotope of the parent nucleide and hence its position in the periodic table remains unchanged.

113. **(d)** : Atomic mass and molecular mass are the ratios and have no units.

$$\text{Mol. mass} = \frac{\text{Wt. of one molecule of the substance}}{\frac{1}{12} \times \text{wt. of one atom of C} - 12}$$

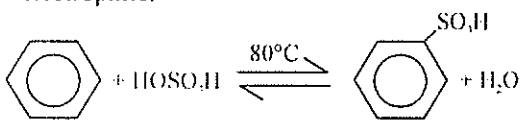
114. **(b)** : Bond dissociation energy is the energy required to break a particular bond in one mole of a gaseous molecule. Bond energy is the average values of dissociation energies of the same type of bond present in the molecule. Bond energy of C–H bond in methane is 99.2 kcal/mol. Thus for polyatomic molecules, average bond energy is taken as the dissociation bond energy.

115. **(b)** : The higher the charge on the metal ion, smaller is the ionic size and more is the complex forming ability. Thus, the degree of complex formation decreases in the order

$M^{4+} > MO_2^{2+} > M^{3+} > MO_2^{+}$

The higher tendency of complex formation of MO_2^{2+} as compared to M^{3+} is due to high concentration of charge on metal atom M in MO_2^{2+}.

116. **(a)** : Sulphonation of benzene is an electrophilic substitution reaction in which SO_3 acts as the electrophile.



117. **(a)** : Molality does not depend upon volume thus it does not depend on temperature.

118. **(d)** : In a Frenkel defect an ion leaves its position in the lattice and occupies normally vacant interstitial position.

119. **(a)** : $\left[(en)_2Co\begin{smallmatrix}NH\\OH\end{smallmatrix}Co(en)_2\right]^{3+}$ is named as tetrakis (ethylenediammine)-μ-hydroxo-μ-imido dicobalt (III) ion. For more than one bridging group the word μ is repeated before each bridging group.

120. **(c)** : Greater the number of hyperconjugating structures, greater is the stability of the compound.

BIOLOGY

121. **(c)** : Vitamin B_6, also called pyridoxine is widely distributed in cereal grains, yeast, liver, milk, etc. It is a constituent of a coenzyme (pyridoxal phosphate) involved in amino acid metabolism. Deficiency causes retarded growth, dermatitis, convulsions, and other symptoms.

122. **(d)** : All single-celled eukaryotes are placed under protista. Phylogenetically the kingdom protista acts as a connecting link between the prokaryotic kingdom— Monera and the complex multicellular kingdoms— Fungi, Plantae and Animalia.
Being eukaryotes, the protistan cell body contains a well defined nucleus and other membrane-bound organelles. It is surrounded by plasmalemma (cell membrane). Cilia and flagella occur in a number of forms. Nucleus has typical structure—porous nuclear envelope, chromatin, nucleolus and nucleoplasm.
Monerans lack nuclear membrane.

123. **(d)** : DPT vaccine is a combined vaccine against diphtheria, whooping cough (pertussis), and tetanus now replaced by the DTaP/IPV/Hib and DTaP/ IPV vaccines.

124. **(d)** : The vascular system consists of complex tissues, the phloem and the xylem. The xylem and phloem together constitute vascular bundles. In dicotyledonous stems, cambium is present between phloem and xylem. Such vascular bundles because of the presence of cambium possess the ability to form secondary xylem and phloem tissues, and hence are called open vascular bundles. In the monocotyledons, the vascular bundles have no cambium present in them. Hence, since they do not form secondary tissues they are referred to as closed.

125. **(c)**

126. **(a)**

127. **(a)** : Bryophytes are nonvascular terrestrial plants of moist habitats in which a multicellular diploid sporophyte lives as a parasite on an independent multicellular haploid gametophyte that develops multicellular jacketed sex organs. Whereas, in pteridophytes, the main plant body is a sporophyte which is differentiated into true root, stem and leaves and gametophyte is small or inconspicuous, it is usually independent.

128. **(b)** : Parietal cells are present in the epithelium of the gastric glands. They are large and are most numerous on the side walls of the glands.
They are also called oxyntic cells as they stain strongly with eosin. They secrete hydrochloric acid and Castle intrinsic factor.

129. **(a)** : A single species might show high diversity at the genetic level over its distributional range. India has more than 50,000 genetically different strains of rice, and 1,000 varieties of mango.

130. **(c)**

131. **(c)** : Gene related human disorders are determined by mutations in single gene. They are transmitted to the offspring as per Mendelian principles. The pattern of inheritance of such Mendelian disorders can be traced in a family by the pedigree analysis. Cystic fibrosis is an abnormal recessive disorder of infants, children and young adults that is due to an

abnormal recessive autosomal allele present on chromosome 7. In 70% of cases, it is due to deletion of three bases. The disease gets its name from the fibrous cysts that appear in the pancreas. It produces a defective glycoprotein. The defective glycoprotein causes formation of thick mucus in skin, lungs, pancreas, liver and other secretory organs. There is maldigestion of food with high fat content in stool. Liver may undergo cirrhosis.

Phenylketonuria is an inborn, autosomal, recessive metabolic disorder in which the homozygous recessive individual lacks the enzyme phenylalanine hydroxylase needed to change phenylalanine to tyrosine in liver. It results in hyperphenylalaninemia which is characterised by accumulation and excretion of phenylalanine, phenylpyruvic acid and related compounds. Lack of the enzyme is due to the abnormal autosomal recessive gene on chromosome 12.

132. **(d)** : In facilitated diffusion special proteins help move substances across membranes along the concentration gradient without expenditure of ATP energy. Facilitated diffusion is very specific, it allows cell to select substances for uptake. It is sensitive to inhibitors which react with protein side chains.

133. **(c)** : *Entamoeba histolytica* is a protozoan parasite in the large intestine of human which causes amoebiasis (amoebic dysentery).

Streptococcus pneumoniae and *Haemophilus influenzae* are responsible for the disease pneumonia in humans which infects the alveoli (air filled sacs) of the lungs. *Plasmodium*, a tiny protozoan is responsible for malaria. Typhoid fever could be confirmed by Widal test.

Wuchereria (*W. bancrofti* and *W. malayi*), the filarial worms cause a slowly developing chronic inflammation of the organs in which they live for many years, usually the lymphatic vessels of the lower limbs and the disease is called elephantiasis or filariasis.

134. **(b)** : The term ecology was coined by combining two Greek words, *oikos* (meaning 'house' or 'dwelling place') and *logos* (meaning 'the study of') to denote such relationships between the organisms and their environment. Thus, literally, ecology is the study of organisms 'at home'.

135. **(b)** : There are 64-triplet codons which code for 20 amino acids. This is due to the degeneracy of code as some amino acids are influenced by more than one codon. Only tryptophan and methionine are specified by single codons. All other amino acids are specified by two (*e.g.*, phenylalanine—UUU, UUC) to six (*e.g.*, arginine—CGU, CGC, CGA, CGG, AGA, AGG) codons.

136. **(c)**

137. **(a)**

138. **(c)** : The most recent model of plasma membrane is fluid-mosaic model which was proposed by Singer and Nicolson in 1972. According to this model, the membrane does not have a uniform disposition of lipids and proteins but is instead a mosaic of the two. Further, the membrane is not solid but is quasifluid.

139. **(c)** : *Penicillium notatum* restrict the growth of *Staphylococci*. *Acetobacter aceti* produces acetic acid. *Saccharomyces cerevisiae* is used for commercial production of ethanol. *Streptococcus* produces streptokinase which is modified by genetic engineering to be used as a 'clot buster' for removing clots from the blood vessels of patients who have undergone myocardial infarction leading to heart attack.Bacteria which produce methane are collectively called methanogens, and one such common bacterium is *Methanobacterium*. These bacteria are commonly found in the anaerobic sludge during sewage treatment.

140. **(d)** : Haemophilia B is due to deficiency of factor IX (Christmas factor). The patient may experience prolonged bleeding following any injury or wound, and in severe cases there is spontaneous bleeding into muscles and joints.

141. **(c)** : Virus is a nucleoprotein entity which is able to utilize the synthetic machinery of a living cell of another organism for its multiplication which does not involve growth and division.The nucleic acid is either DNA or RNA but never both. DNA containing viruses are called deoxyviruses while RNA containing viruses are termed as riboviruses.

142. **(c)**

143. **(a)** : AIDS or acquired immunodeficiency syndrome or acquired immune deficiency

syndrome (a death warrant) is a serious disease (also called slim disease) caused by a retrovirus HIV (human immunodeficiency virus). It is a set of symptoms and infections resulting from the damage to the human immune system by the virus, that depletes primarily the number of T-lymphocytes (CD-4 T cells or helper T-cells) and renders the patient susceptible to opportunistic infections *i.e.*, infection caused by non-pathogens.

144. **(d)** : The P-wave represents the electrical excitation (or depolarisation) of the atria, which leads to the contraction of both the atria. The QRS complex represents the depolarisation of the ventricles, which initiates the ventricular contraction. The T-wave represents the return of the ventricles from excited to normal state (repolarisation). So, by counting the number of QRS complexes that occur in a given time period, one can determine the heart beat rate of an individual.

145. **(b)** : Phosphorus is a major constituent of biological membranes, nucleic acids and cellular energy transfer systems. Many animals also need large quantities of this element to make shells, bones and teeth. The natural reservoir of phosphorus is rock, which contains phosphorus in the form of phosphates. When rocks are weathered, minute amounts of these phosphates dissolve in soil solution and are absorbed by the roots of the plants. Herbivores and other animals obtain this element from plants.

146. **(a)** : Gonadotropin releasing hormone (GnRH), stimulates the anterior lobe of the pituitary gland to secrete two gonadotropic hormones, follicle stimulating hormone (FSH) and luteinising hormone (LH). In male LH activates the Leydig's (interstitial) cells of the testis to secrete androgens.

147. **(c)** : Human beings have a significant ability to maintain and moderate the respiratory rhythm to suit the demands of the body tissues. A specialised centre present in the medulla region of the brain called respiratory rhythm centre is primarily responsible for this regulation. A chemosensitive area is situated adjacent to the rhythm centre which is highly sensitive to CO_2 and hydrogen ions. Increase in these substances can activate this centre, which in turn can signal the rhythm centre to make necessary adjustments in the respiratory process by which these substances can be eliminated.

148. **(b)**

149. **(a)** : Microvilli increases absorptive surface area. Typhlosolar region in earthworm is the middle region of the intestine in which the mid-dorsal wall of the intestine is thrown into a longitudinal fold which is known as typhlosole. The typhlosole increases the absorptive surface of the intestine.

150. **(b)** : In ciliated epithelium, the cells bear numerous delicate hair like outgrowths, the cilia, arising from basal granules. This epithelium lines most of the respiratory tract and Fallopian tubes (oviducts). It is also present in tympanic cavity of middle ear and auditory tube (Eustachian tube).

151. **(a)** : Cyclic photophosphorylation is a process of photophosphorylation in which an electron expelled by the excited photocentre is returned to it after passing through a series of electron carriers. Cyclic photophosphorylation is performed by photosystem I only. The electron is circulated within the photosystem and the phosphorylation occurs due to cyclic flow of electron. The excited electron does not pass on to $NADP^+$ but is cycled back to the PS I complex through the electron transport chain. The cyclic flow hence, results only in the synthesis of ATP, but not of $NADPH + H^+$.

152. **(c)** : Elephant has the longest gestation period among the given animals. The gestation period of an elephant is 624-641 days.

153. **(c)** : Plasmid is a structure in bacterial cells consisting of DNA that can exist and replicate independently of the chromosome. These are extrachromosomal circular dsDNA which provide genetic instructions for certain cell activities (*e.g.* resistance to antibiotic drugs). They can be transferred from cell to cell in a bacterial colony. Plasmids are widely used as vectors to produce recombinant DNA for gene cloning.

154. **(c)** : Concept of chemical evolution refers to origin of life from non living matter. First inorganic compounds and then organic compounds were formed in accordance with ever changing environmental conditions.

155. (c)

Crop	Variety	Resistance to diseases
Wheat	Himgiri	Leaf and stripe rust, hill bunt
Brassica	Pusa swarnim	White rust
Cowpea	Pusa komal	Bacterial blight
Chilli	Pusa sadabahar	Chilly mosaic virus

156. (b) : Processes of recombinant DNA technology involves isolation of DNA of a desired DNA fragment. In order to cut the DNA with restriction enzymes, it needs to be in pure form, free from other macro molecules. The DNA is enclosed within the membranes, we have to break the cell open to release DNA along with other macromolecules such as RNA, proteins, polysaccharides and also lipids. This can be achieved by treating the bacterial cells/plant or animal tissue with enzymes such as lysozyme (bacteria), cellulase (plant cells), chitinase (fungus). The RNA can be removed by treatment with ribonuclease whereas proteins can be removed by treatment with protease.

157. (d) : Genus comprises a group of related species which has more characters in common in comparison to species of other genera. In the other words, genera are aggregates of closely related species. For example, potato and brinjal are two different species but both belong to the genus *Solanum*.

158. (b) : *Panthera tigris* - Tiger
Mangifera indica - Mango
Musca domestica - Housefly
Periplaneta americana - Cockroach
Rana tigerina - Common Indian frog

159. (c)

160. (a) : Calvin pathway occurs in all photosynthetic plants which is CO_2 fixation cycle. Carbon dioxide combines with ribulose-1, 5-biphosphate to produce a transient intermediate compound. The intermediate compound splits up immediately in the presence of water to form the two molecules of 3-phosphoglycerate or PGA. It is the first stable product of photosynthesis.

161. (b) : Adrenaline (epinephrine) is a hormone produced by the medulla of the adrenal glands, that increases heart activity, improves the power and prolongs the action of muscles, and increases the rate and depth of breathing to prepare the body for 'fright, fight, or flight.It is secreted at the time of emergency. Hence it is also called emergency hormone.

162. (b) : Cork consists of dead and compactly arranged rectangular cells that possess suberised cell walls. The cork cells contain tannins. Hence, they appear brown or dark brown in colour. The cork cells of some plants are filled with air. Cork prevents the loss of water by evaporation. It also protects the interior against entry of harmful micro-organisms, mechanical injury and extremes of temperature. Cork is light, compressible, nonreactive and sufficiently resistant to fire. It is used as stopper for bottles, shock absorption and insulation.

163. (a) : The blood of cockroach, also called as haemolymph is a mobile connective tissue composed of corpuscles and a colourless fluid, the plasma. It does not contain any respiratory pigment and therefore plays no role in respiration.

The respiratory system consists of a network of trachea, that open through 10 pairs of small holes called spiracles present on the lateral side of the body. Thin branching tubes carry oxygen from the air to all the parts. The opening of the spiracles is regulated by the sphincters. Exchange of gases take place at the tracheoles by diffusion.

164. (a) : Virus infected cells secrete proteins known as interferons which protect non infected cells from further viral infection.

165. (d) : The descending limb of loop of Henle is permeable to water but almost impermeable to electrolytes. This concentrates the filtrate as it moves down.

166. (a) : Shrinkage of the protoplast of a cell under the influence of a hypertonic solution is called plasmolysis. Hypertonic solution causes exosmosis or withdrawal of water from cytoplasm and then the central vacuole of cell. The size of cytoplasm as well as central vacuole and hence protoplast

becomes reduced. The pressure on the wall is simultaneously reduced and the elastic wall contracts causing a reduction in cell size.

167. (a) : Inbreeding refers to the mating of closely related individuals within the same breed for 4-6 generations. Superior males and superior females of the same breed are identified and mated in pairs. The progeny obtained from such matings are evaluated and superior males and females among them are identified for further mating. Inbreeding increases homozygosity. Thus inbreeding is necessary if we want to evolve a pureline in any animal.

168. (d) : The process of delivery of the foetus (childbirth) is called parturition. Parturition is induced by a complex neuroendocrine mechanism. The signals for parturition originate from the fully developed foetus and the placenta which induce mild uterine contractions called foetal ejection reflex. This triggers release of oxytocin from the maternal pituitary. Oxytocin acts on the uterine muscle and causes stronger uterine contractions, which in turn stimulates further secretion of oxytocin. The stimulatory reflex between the uterine contraction and oxytocin secretion continues resulting in stronger and stronger contractions. This leads to expulsion of the baby out of the uterus through the birth canal.

169. (c)

170. (c) : Incomplete dominance is the phenomenon where none of the two contrasting alleles or factors is dominant. The expression of the character in a hybrid or F_1 individual is intermediate or a fine mixture of the expression of the two factors. The inheritance of flower colour in *Antirrhinum* is a good example to understand incomplete dominance. There are two types of flower colour in pure state, red and white. When the two types of plants are crossed, the hybrid or plants of F_1 generation have pink flowers. The pink colour apparently appears due to mixing of red and white colours (incomplete dominance).

171. (c) : Presence of large amounts of nutrients in water causes excessive growth of planktonic (free-floating) algae, called an algal bloom which imparts a distinct colour to the water bodies. Algal blooms cause deterioration of the water quality and fish mortality. Biomagnification refers to increase in concentration of the toxicant at successive trophic levels.

172. (d) : Bile (gall) is a bitter-tasting greenish-yellow alkaline fluid produced by the liver, stored in the gall bladder, and secreted into the duodenum of vertebrates. It assists the digestion and absorption of fats by the action of bile salts, which chemically reduce fatty substances and decrease the surface tension of fat droplets so that they are broken down and emulsified. Bile may also stimulate gut muscle contraction (peristalsis). Bile also contains the bile pigments, bilirubin and biliverdin, which are produced by the breakdown of the blood pigment haemoglobin.

173. (a) : The word "emphysema" means "inflation" or "full of air". Emphysema is an inflation or abnormal distension of the bronchioles or alveolar sacs of the lungs. It causes irreversible distension and loss of elasticity of alveoli. As a result, the alveolar sacs remain filled with air even after expiration. The exhalation becomes more difficult. The lungs remain inflated. Many of the septa between the alveoli are destroyed and much of the elastic tissue of the lungs is replaced by connective tissue. Major causes are cigarette smoking and the inhalation of other smoke or toxic substances over a period of time.

174. (b) : DNA fingerprinting involves identifying differences in some specific regions in DNA sequence called as repetitive DNA, because in these sequences, a small stretch of DNA is repeated many times. These sequences normally do not code for any proteins, but they form a large portion of human genome. These sequence show high degree of polymorphism and form the basis of DNA fingerprinting. As the polymorphisms are inheritable from parents to children, DNA fingerprinting is the basis of paternity testing in case of disputes.

175. (c) : Parasitism is a relationship between two living organisms of different species in which one organism called parasite obtains its food directly from another living organism called host.
Majority of the parasites harm the host; they may reduce the survival, growth and reproduction of the host and reduce its population density.
Pathogens are disease-causing microorganisms which get benefit by causing harm to host

organism. Pathogens such as viruses, bacteria, fungi, protozoans, helminths, insects etc., reproduce or multiply inside the host organism and therefore, they get the opportunity to complete the life cycle and spread their population.

176. (c) : CO_2 concentration of the atmosphere is 0.036% or 360 ppm (360 $\mu l \, . \, l^{-1}$). It is a limiting factor for C_3 as the available CO_2 concentration is lower than the optimum for photosynthesis. Increase in its concentration upto 0.05% increases the rate of photosynthesis in most C_3 plants. When CO_2 concentration is reduced, there comes a point at which illuminated plant parts stop absorbing carbon dioxide from their environment. It is known as CO_2 compensation point or threshold value. At this value CO_2 fixed in photosynthesis is equal to CO_2 evolved in respiration and photorespiration. The value is 25–100 ppm in C_3 plants and 0–10 ppm in C_4 plants. The reason for low compensation value for C_4 plants is the greater efficiency of CO_2 fixation through PEP-carboxylase.

177. (a) : Glucagon stimulates the liver to convert stored glycogen into glucose. Glucagon is also called an "anti-insulin" hormone. Insulin is antagonistic to glucagon. Insulin converts glucose into glycogen in the liver and muscles.
It promotes protein synthesis in tissue from amino acids.Insulin reduces catabolism of proteins. It is an anabolic hormone. It increase the synthesis of fat in the adipose tissue from fatty acids.
Insulin reduces the breakdown and oxidation of fat.

178. (d) : Auditory ossicles are three small bones present in the middle ear. These three ear ossicles are malleus, the incus and the stapes. These three bones are in the sequence of malleus, incus and stapes and are attached to each other. Their function is to increase the intensity of sound waves. The cavity of middle ear communicates with that of pharynx through the air filled tube called Eustachian tube. The Eustachian tube maintains the balance in the air pressure between two sides of the ear drum and thus allows it to vibrate freely when sound waves impinge on it.

179. (c) : Pharyngeal nephridia occur in three pairs of bunches in the 4th, 5th and 6th segments lying on each side of the alimentary canal. The ducts of the nephridia of the sixth segment open into the buccal cavity while the ducts from the nephridia bunches of the fourth and fifth segments open into the pharynx. These ducts carry excretory products from the pharyngeal nephridia into the gut. Enteronephric condition is an adaptation for the conservation of water which is absorbed by the inner lining of the alimentary canal.
Ectonephric nephridia discharge their contents directly to the outside which help the earthworm in keeping the skin moist for cutaneous respiration only. Integumentary nephridia are ectonephric nephridia while, pharyngeal and septal nephridia are enteronephric.

180. (d) : Pantothenic acid, formerly known as chick anti-dermatitis factor or filtrate factor is widely distributed in nature. It is a surprise to biochemists that despite the involvement of pantothenic acid (as coenzyme A) in a great number of metabolic reactions, its deficiency manifestations have not been reported in humans, presumably because of the wide occurrence of this vitamin in almost all foods and because small amount can be synthesized in the body. Folic acid deficiency is probably the most common vitamin deficiency.
The macrocytic anaemia (abnormally large RBC) associated with megaloblastic changes in bone narrow is a characteristic feature of folate deficiency.

GENERAL KNOWLEDGE

181. (a)	182. (c)	183. (a)	184. (b)	185. (c)
186. (a)	187. (a)	188. (c)	189. (c)	190. (c)
191. (b)	192. (d)	193. (d)	194. (c)	195. (b)
196. (c)	197. (b)	198. (c)	199. (d)	200. (b)

☺☺☺

Chapterwise Index - '11

Physics • Chemistry • Biology

Use the index for topicwise analysis of AIIMS paper and refer to these questions when you are practising MCQs chapterwise.

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