AIPMT - 2012
(Physics, Chemistry and Biology)
Prelims Answer Key and Solution
Code D

Answers

1	(4)	2	(3)	3	(1)	4	(4)	5	(1)	6	(1)	7	(4)	8	(1)	9	(1)	10	(3)
11	(1)	12	(2)	13	(1)	14	(2)	15	(3)	16	(4)	17	(4)	18	(1)	19	(3)	20	(4)
21	(3)	22	(3)	23	(1)	24	(2)	25	(2)	26	(1)	27	(2)	28	(2)	29	(4)	30	(4)
31	(1)	32	(3)	33	(1)	34	(1)	35	(3)	36	(3)	37	(3)	38	(2)	39	(3)	40	(2)
41	(3)	42	(1)	43	(1)	44	(2)	45	(4)	46	(1)	47	(4)	48	(3)	49	(4)	50	(4)
51	(1)	52	(3)	53	(3)	54	(4)	55	(4)	56	(1)	57	(3)	58	(4)	59	(4)	60	(2)
61	(4)	62	(3)	63	(2)	64	(1)	65	(4)	66	(2)	67	(1)	68	(4)	69	(4)	70	(1)
71	(1)	72	(1)	73	(3)	74	(3)	75	(3)	76	(1)	77	(4)	78	(1)	79	(2)	80	(4)
81	(1)	82	(2)	83	(2)	84	(4)	85	(1)	86	(2)	87	(3)	88	(3)	89	(3)	90	(1)
91	(4)	92	(3)	93	(3)	94	(2)	95	(1)	96	(2)	97	(4)	98	(4)	99	(4)	100	(4)
101	(4)	102	(4)	103	(4)	104	(4)	105	(4)	106	(2)	107	(1)	108	(1)	109	(3)	110	(1)
111	(4)	112	(2)	113	(1)	114	(2)	115	(2)	116	(4)	117	(2)	118	(1)	119	(4)	120	(4)
121	(3)	122	(2)	123	(2)	124	(4)	125	(4)	126	(3)	127	(4)	128	(3)	129	(1)	130	(3)
131	(2)	132	(2)	133	(3)	134	(3)	135	(3)	136	(4)	137	(4)	138	(1)	139	(1)	140	(4)
141	(2)	142	(2)	143	(2)	144	(4)	145	(4)	146	(1)	147	(1)	148	(1)	149	(2)	150	(3)
151	(3)	152	(2)	153	(2)	154	(1)	155	(1)	156	(4)	157	(1)	158	(4)	159	(1)	160	(1)
161	(Bonus)	162	(3)	163	(3)	164	(3)	165	(4)	166	(1)	167	(4)	168	(2)	169	(2)	170	(3)
171	(1)	172	(1)	173	(2)	174	(3)	175	(4)	176	(2)	177	(4)	178	(4)	179	(1)	180	(1)
181	(1)	182	(2)	183	(3)	184	(3)	185	(2)	186	(4)	187	(2)	188	(2)	189	(1)	190	(1)
191	(2)	192	(2)	193	(2)	194	(2)	195	(1)	196	(4)	197	(4)	198	(1)	199	(2)	200	(3)

Physics

1. For the third excited state, n = 4; for the second excited state, n = 3 and for the first excited state, n = 2.

   When the electron jumps from the third excited state to the second, the energy is

   $$\Delta E = \frac{hc}{\lambda_1}$$

   Now, using the Rydberg's formula, we get

   $$\Delta E = \frac{hc}{\lambda_1} = 13.6\left(\frac{1}{3^2} - \frac{1}{4^2}\right) \qquad \text{...... (1)}$$

   When the electron jumps from the second excited state to the first, the energy is

   $$\Delta E = \frac{hc}{\lambda_2}$$

   Now, using the Rydberg's formula, we get

   $$\Delta E = \frac{hc}{\lambda_2} = 13.6\left(\frac{1}{2^2} - \frac{1}{3^2}\right) \qquad \text{...... (2)}$$

   Dividing equations (1) and (2), we get

   $$\frac{\lambda_1}{\lambda_2} = \frac{\left(\frac{1}{2^2} - \frac{1}{3^2}\right)}{\left(\frac{1}{3^2} - \frac{1}{4^2}\right)} = \frac{\left(\frac{1}{4} - \frac{1}{9}\right)}{\left(\frac{1}{9} - \frac{1}{16}\right)}$$

   $$\therefore \frac{\lambda_1}{\lambda_2} = \frac{\frac{5}{36}}{\frac{7}{144}} = \frac{5}{36} \times \frac{144}{7} = \frac{20}{7}$$

2. The total length of the string is

   $$\ell = \ell_1 + \ell_2 + \ell_3 \qquad \text{...... (1)}$$

   The fundamental frequency of the string is

   $$\nu = \frac{1}{2\ell}\sqrt{\frac{T}{\mu}}$$

   $$\Rightarrow \nu \propto \frac{1}{\ell} \qquad \text{...... (2)}$$

   Here, ℓ is the length, T is the tension in the string and μ is the mass per unit length of the string.

   Hence, from equations (1) and (2), we get

   $$\frac{1}{\nu} = \frac{1}{\nu_1} + \frac{1}{\nu_2} + \frac{1}{\nu_3}$$

3. Let us assume that n photons have been emitted per second. Hence, the total energy emitted is

$$E = n\frac{hc}{\lambda}$$

Now, energy is related to power as

P = E/t

Hence, for t = 1 second,

P = E

Now, power of the sodium lamp is 200 W and it is 25% efficient. So, we have

$$n\frac{hc}{\lambda} = 200 \times \frac{25}{100} = 50$$

$$\therefore n = \frac{50 \times \lambda}{hc} = \frac{50 \times 0.6 \times 10^{-6}}{6.63 \times 10^{-34} \times 3 \times 10^{8}}$$

$$\therefore n = 1.5 \times 10^{20}$$

4. The circuit has diode D_1 in forward bias and diode D_2 in reverse bias. Hence, only D_1 will conduct.

So, the current supplied by the battery is

$$I = \frac{V}{R} = \frac{5}{10} = 0.5 \text{ A}$$

5. The angular momentum of a mass rotating about a fixed point is

$$\vec{L} = \vec{r} \times \vec{p}$$

Hence, the angular momentum will always be directed perpendicular to the radius vector and the momentum vector of the mass.

So, we can say that it is perpendicular to the plane of rotation.

6. The torque of the dipole is

$$\vec{\tau} = \vec{p} \times \vec{E} = pE\sin\theta$$

Similarly, the potential energy of the dipole is

$$\vec{U} = -\vec{p} \cdot \vec{E} = -pE\cos\theta$$

7. It is given that output voltage across the collector is V_o = 2 V.

The resistance across the collector is $R_c = 2\text{ k}\Omega = 2 \times 10^{3}\Omega$.

Hence, the current through the collector is $V_o = I_c R_c$

$$\Rightarrow I_c = \frac{V_o}{R_c} = \frac{2}{2 \times 10^{3}} = 1 \times 10^{-3} \text{ A}$$

Now, it is given that current gain across the transistor is 100. So, we have

$$\beta = \frac{I_c}{I_b}$$

$$\therefore I_b = \frac{I_c}{\beta} = \frac{1\times10^{-3}}{100} = 1\times10^{-5}\ \text{A}$$

Therefore, we will get the input voltage as

$$V_i = I_b R_b$$

$$\therefore V_i = 1 \times 10^{-5} \times 1 \times 10^{3}$$

$$\therefore V_i = 1\times 10^{-2}\ \text{V} = 10\times 10^{-3}\ \text{V} = 10\ \text{mV}$$

8. The flux linked with the coil is

$$\phi = 50t^2 + 4$$

Now, the emf induced in the coil is

$$\varepsilon = -\frac{d\phi}{dt} = -2 \times 50t = -100t$$

Hence, the induced current at time t = 2 s is

$$i = \left|\frac{\varepsilon}{R}\right| = \frac{100t}{R} = \frac{100 \times 2}{400} = 0.5\ \text{A}$$

9. The process ABCD is a cyclic process.
Now, the change in internal energy of a cyclic process is zero.

$$\Delta U = 0$$

According to the first law of thermodynamics, we have

$$\Delta Q = \Delta U + \Delta W$$

$$\Rightarrow \Delta Q = \Delta W$$

Now, work done is equal to the area under the curve for the process.
From the graph given, we get

$$\Delta Q = \text{Area under the cycle ABCD}$$

$$= AB\times AD$$

$$= (3V - V)\times(2P - P)$$

$$= 2V \times P$$

$$= 2PV$$

Hence, the heat rejected by the gas during the cycle is 2PV.

10. The nuclear radius in terms of atomic mass number is

$$R = R_0 (A)^{\frac{1}{3}}$$

It is given that $R(^{27}Al) = 3.6$ fm

A = 27 for Al and A = 64 for Cu

So, we get

$$\frac{R_{Cu}}{R_{Al}} = \left(\frac{A_{Cu}}{A_{Al}}\right)^{\frac{1}{3}} = \left(\frac{64}{27}\right)^{\frac{1}{3}} = \frac{4}{3}$$

$$\therefore R_{Cu} = \frac{4}{3} R_{Al} = \frac{4}{3} \times 3.6 = 4 \times 1.2 = 4.8 \text{ fm}$$

11. The two coils carrying current I and 2I are placed concentrically perpendicular to each other.

Now, the magnetic field around the current-carrying coil is given by the right-hand thumb rule.

So, both fields will be perpendicular to each other.

Now, the magnetic field at the centre of a coil due to current I flowing in the coil is

$$B_1 = \frac{\mu_0 I}{2R}$$

So, for the other coil with the same radius and current 2I, we have

$$B_2 = \frac{\mu_0 (2I)}{2R}$$

Therefore, the net magnetic field is

$$B = \sqrt{B_1^2 + B_2^2}$$

$$= \sqrt{\left(\frac{\mu_0 I}{2R}\right)^2 + \left(\frac{\mu_0 2I}{2R}\right)^2}$$

$$= \sqrt{\left(\frac{\mu_0}{2R}\right)^2 (I^2 + 4I^2)}$$

$$= \sqrt{\left(\frac{\mu_0}{2R}\right)^2 (5I^2)}$$

$$= \frac{\sqrt{5}\mu_0 I}{2R}$$

12. The potential energy of a particle is

$$U = \frac{A}{r^2} - \frac{B}{r}$$

Now, for equilibrium, we have

$$\frac{dU}{dr} = 0$$

$$\therefore \frac{-2A}{r^3} + \frac{B}{r^2} = 0$$

$$\Rightarrow \frac{B}{r^2} = \frac{2A}{r^3}$$

$$\therefore r = \frac{2A}{B}$$

For stable equilibrium, the condition which needs to be satisfied is $\frac{d^2U}{dr^2} > 0$.

After differentiating for the second time, it can be seen that $\frac{d^2U}{dr^2} > 0$.

Hence, we have the distance of the particle as $r = \frac{2A}{B}$.

13. From the lens makers formula, we get

$$\frac{1}{f} = \left(\frac{\mu_2}{\mu_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right)$$

Here, μ_2 is the refractive index of glass and μ_1 is the refractive index of liquid.

It is given that after dipping in the liquid, the biconvex lens acts as a plane glass. So, we have

$$f = \infty$$

$$\Rightarrow \frac{1}{f} = 0$$

$$\therefore \left(\frac{\mu_2}{\mu_1} - 1\right)\left(\frac{1}{R_1} - \frac{1}{R_2}\right) = 0$$

$$\Rightarrow \frac{\mu_2}{\mu_1} - 1 = 0$$

$$\Rightarrow \frac{\mu_2}{\mu_1} = 1$$

$$\Rightarrow \mu_1 = \mu_2$$

14. The horizontal range of the projectile is

$$R = \frac{u^2}{g}\sin 2\theta \qquad ......\ (1)$$

The height of the projectile is

$$H = \frac{u^2}{2g}\sin^2\theta \qquad ......\ (2)$$

Dividing equations (1) and (2), we get

$$\frac{H}{R} = \frac{u^2}{2g}\sin^2\theta \times \frac{g}{u^2 \sin 2\theta}$$

$$= \frac{\sin^2\theta}{2\sin 2\theta} = \frac{\sin^2\theta}{4\sin\theta\cos\theta} = \frac{1}{4}\tan\theta$$

Therefore, when H = R, we get

$$\frac{R}{R} = \frac{1}{4}\tan\theta$$

$$\tan\theta = 4$$

$$\theta = \tan^{-1} 4$$

15. When the inductor is removed from the circuit, the phase difference between the resistor and capacitor is given from the phasor diagram as

$$\tan\frac{\pi}{3} = \frac{X_C}{R}$$

$$\Rightarrow X_C = R\tan\frac{\pi}{3}$$

Similarly, when the capacitor is removed from the circuit, the phase difference between the resistor and inductor is given from the phasor diagram as

$$\tan\frac{\pi}{3} = \frac{X_L}{R}$$

$$\Rightarrow X_L = R\tan\frac{\pi}{3}$$

Hence, we see that $X_L = X_C$.

This is the condition of resonance.

Now, the power factor of the circuit is

$$\cos\phi = \frac{R}{Z} = \frac{R}{\sqrt{R^2 + (X_L - X_C)^2}} = \frac{R}{R} = 1$$

16. The rate of energy production is given from Stefan's law as

$$Q = \sigma e T^4 \times A$$

Now for a black body, we have e = 1.

We also know that A = $4\pi R^2$. Therefore, we have

$$Q = 4\pi R^2 \sigma T^4$$

$$\therefore T^4 = \frac{Q}{4\pi R^2 \sigma}$$

$$\therefore T = \left(\frac{Q}{4\pi R^2 \sigma}\right)^{\frac{1}{4}}$$

17. The voltage across an inductance is

$$|V| = \left|-L\frac{di}{dt}\right| = L\frac{di}{dt}$$

Now, from the graph, it can be seen that $\frac{di}{dt}$ is constant and positive for the first half of the cycle.

So, V is constant and positive.

Similarly, from the graph, it can be seen that $\frac{di}{dt}$ is constant and negative for the second half of the cycle.

So, V is constant and negative.

Hence, the graph will be as shown in option (4).

18. The range of a millivoltmeter is 25 mV. So, we have V = 25 × 10^{-3} V.

Now, this millivoltmeter is to be converted to an ammeter of range 25 A.

To do this, a shunt is to be connected across the millivoltmeter.

Let the resistance of the millivoltmeter be R and the shunt resistance be S.

Therefore, its resistance should be

$$\frac{1}{R_{eq}} = \frac{1}{R} + \frac{1}{S} = \frac{R+S}{RS}$$

$$\therefore R_{eq} = \frac{RS}{R+S}$$

Now, the ammeter will have resistance in accordance to Ohm's law as

$$R_{eq} = \frac{V}{I} = \frac{RS}{R+S}$$

$$\therefore \frac{25 \times 10^{-3}}{25} = \frac{RS}{R+S} = 0.001$$

Now, we know that the shunt to be connected should have a very low resistance as compared to the original resistance.

So, we get

$S << R$

$$\therefore \frac{RS}{R+S} \approx \frac{RS}{R}$$

$\therefore S = 0.001\ \Omega$

19. The boat is in still water. After the man moves towards the other, there is no net force acting on the boat. Hence, the centre of mass does not shift.

20. The number of nuclei after time t in any given radioactive sample is

$$N = \frac{N_0}{(2)^{\frac{t}{T}}}$$

Here, N_0 is the initial number of nuclei and T is the half-life of the radioactive nuclei.

Hence, we have

$$N_1 = \frac{N_{01}}{(2)^{\frac{t}{20}}}$$

$$N_2 = \frac{N_{02}}{(2)^{\frac{t}{10}}}$$

It is given that N_{01} = 40 g, N_{02} = 160 g and $N_1 = N_2$.

Therefore, we get

$N_1 = N_2$

$$\therefore \frac{N_{01}}{(2)^{\frac{t}{20}}} = \frac{N_{02}}{(2)^{\frac{t}{10}}}$$

$$\therefore \frac{40}{(2)^{\frac{t}{20}}} = \frac{160}{(2)^{\frac{t}{10}}}$$

$$\therefore \frac{(2)^{\frac{t}{10}}}{(2)^{\frac{t}{20}}} = \frac{160}{40} = 4 = 2^2$$

$$\therefore (2)^{\frac{t}{10} - \frac{t}{20}} = 2^2$$

$$\Rightarrow \frac{t}{10} - \frac{t}{20} = 2$$

$$\therefore \frac{2t - t}{20} = 2$$

$\therefore t = 40$ s

21. The electronic configuration of ^{6}C
is $^{6}C = 1s^2, 2s^2\ 2p^6$

Similarly, the electronic configuration of ^{14}Si is
$^{14}Si = 1s^2, 2s^2\ 2p^8, 3s^2\ 3p^2$

From the electronic configuration, we see that although both atoms have 4 bonding electrons, the electrons in C lie in the 2^{nd} orbit and those of Si lie in the 3^{rd} orbit. So, it can be concluded that C is an insulator and Si is an intrinsic semiconductor.

22. The acceleration due to gravity at a height h is

$$g' = \frac{g}{\left(1+\frac{h}{R}\right)^2}$$

$$\therefore mg' = \frac{mg}{\left(1+\frac{h}{R}\right)^2}$$

It is given that $mg = \frac{mg}{16}$

Hence, we get

$$\frac{mg}{16} = \frac{mg}{\left(1+\frac{h}{R}\right)^2}$$

$$\therefore \left(1+\frac{h}{R}\right)^2 = 16$$

$$\therefore 1+\frac{h}{R} = 4$$

$$\therefore \frac{h}{R} = 3$$

$$\therefore h = 3R$$

23. The electron jumps from the 5^{th} energy level to the ground level. A photon is emitted in the process.

Now, the wavelength of the emitted photon for hydrogen atom is

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

Hence, we get

$$\frac{1}{\lambda} = R\left(\frac{1}{1^2} - \frac{1}{5^2}\right) = R\left(\frac{1}{1} - \frac{1}{25}\right)$$

$$\therefore \frac{1}{\lambda} = R\left(\frac{25-1}{25}\right) = \frac{24R}{25}$$

The de Broglie wavelength of the photon is related to momentum as

$\lambda = \frac{h}{p} = \frac{24hR}{25}$

Now, momentum is $p = mv$

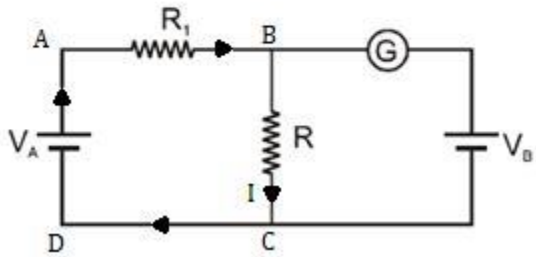
Hence, the velocity of the atom is

$$v = \frac{p}{m} = \frac{24hR}{25m}$$

24. At the geomagnetic poles, the magnetic field is in the vertical direction.

The needle is however allowed to rotate freely along the horizontal plane only. Hence, the needle can stay along any direction.

25. The galvanometer shows no deflection when $V_A = 12$ V, $R_1 = 500\Omega$ and $R = 100\Omega$. Hence, there is no current flowing through the galvanometer.



Therefore, the current through the loop ABCD is

$$I = \frac{V_A}{R_{total}} = \frac{V_A}{R_1 + R}$$

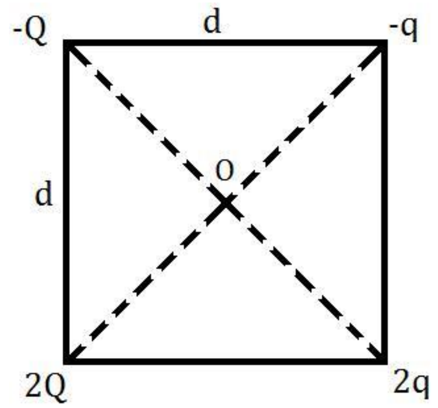
$$\therefore I = \frac{12}{500 + 100} = \frac{12}{600} \text{ A}$$

So, the voltage across the resistor R will be

$$V_R = IR = \frac{12}{600} \times 100 = 2 \text{ V}$$

Now, this voltage will be the same across the supply V_B. So, we have $V_B = 2$ V.

26. The four charges are placed as shown in the figure below:



The potential at the centre O is zero.
The potential at O will be due to the sum of potentials of four charges.

Now, all the four charges are placed at a distance x such that $x^2 + x^2 = d^2$

$$\therefore x^2 = \frac{d^2}{2}$$

$$\therefore x = \frac{d}{\sqrt{2}}$$

Now, the potential at O is

$$V_O = V_{-Q} + V_{-q} + V_{2q} + V_{2Q}$$

$$0 = \frac{k(-Q)}{x} + \frac{k(-q)}{x} + \frac{k(2q)}{x} + \frac{k(2Q)}{x}$$

$$0 = \frac{k(-Q)}{\frac{d}{\sqrt{2}}} + \frac{k(-q)}{\frac{d}{\sqrt{2}}} + \frac{k(2q)}{\frac{d}{\sqrt{2}}} + \frac{k(2Q)}{\frac{d}{\sqrt{2}}}$$

$$0 = \frac{k\sqrt{2}}{d}\left(-Q - q + 2q + 2Q\right)$$

$$0 = \frac{k\sqrt{2}}{d}\left(Q + q\right)$$

Therefore, we have

$$Q + q = 0$$

$$\Rightarrow Q = -q$$

27. For a banked road with angle of banking θ, the velocity with which a car can travel safely is

$$\tan\theta = \frac{v^2}{Rg}$$

$$\Rightarrow v = \sqrt{Rg\tan\theta}$$

Here, R is the radius of the banked curve.

Substituting the values, we get

$$v = \sqrt{90 \times 10 \tan 45}$$

$$= \sqrt{900}$$

$$= 30\ ms^{-1}$$

28. The cylinder is rolling towards the spring. Hence, its kinetic energy will be

$$KE = \frac{1}{2}mv^2 + \frac{1}{2}I\omega^2$$

Now, this cylinder compresses a spring. At maximum compression of the spring, the cylinder will stop. Let the compression be x.

Hence, from the conservation of energy, we get

Loss in kinetic energy of cylinder = gain in potential energy of the spring

$$\frac{1}{2}mv^2 + \frac{1}{2}I\omega^2 = \frac{1}{2}kx^2$$

$$\therefore mv^2 + I\omega^2 = kx^2$$

$$\therefore mv^2 + \frac{mR^2}{2}\left(\frac{v}{R}\right)^2 = kx^2$$

$$\therefore mv^2 + \frac{1}{2}mv^2 = kx^2$$

$$\therefore \frac{3}{2}mv^2 = kx^2$$

$$\therefore x^2 = \frac{3mv^2}{2k} = \frac{3 \times 3 \times 4^2}{2 \times 200} = \frac{144}{400}$$

$$\therefore x = \frac{12}{20} = \frac{6}{10} = 0.6\ m$$

29. The process starts from A and ends at B.

Now, the first process starts at A and isothermally expands the system from V to 3V. Now, this process is correctly shown in options (2) and (4).

The second process is an isobaric process which is correctly shown in option (4).

30. The sphere A is initially at rest. Hence, its velocity is 0.

Sphere B is initially moving at velocity v along the x axis. So, we have

$v_{A1} = 0$

$v_{B1} = v\hat{x}$

After collision, B moves with velocity v/2 along the perpendicular direction, i.e. along y. Therefore, we have

$$v_{B2} = \frac{v}{2}\hat{y}$$

Let A be moving along an angle θ with velocity v_{A2}.

Using the conservation of linear momentum along the x and y axes, respectively, we get

$$m_2 v = m_1 v_{A2} \cos\theta \ldots\ldots \qquad (1)$$

$$0 = m_1 v_{A2} \sin\theta + m_2 \frac{v}{2}$$

$$\Rightarrow -m_2 \frac{v}{2} = m_1 v_{A2} \sin\theta \qquad \ldots\ldots (2)$$

Dividing equations (1) and (2), we get

$$\frac{m_1 v_{A2} \sin\theta}{m_1 v_{A2} \cos\theta} = \frac{-m_2 \frac{v}{2}}{m_2 v}$$

$$\therefore \tan\theta = -\frac{1}{2}$$

$$\therefore \theta = \tan^{-1}\left(-\frac{1}{2}\right)$$

Hence, the correct option is (4), i.e. sphere A will move in the direction $\theta = \tan^{-1}\left(-\frac{1}{2}\right)$ to the x axis.

31. Liquid oxygen is initially at 50 K. It is then heated till 300 K. So, its temperature will increase gradually till 300 K. Hence, option (4) is incorrect.

Now, once it reaches 300 K, there will be a change of phase from the liquid to the gaseous state.

This will occur at constant temperature.

After that, the temperature will start increasing again.

So, the correct graph is as represented in option (3).

32. The cyclotron with frequency ν between the dees of radius R is used to accelerate protons of mass m.

The time period of the orbit of protons is

$$T = \frac{1}{\nu} = \frac{2\pi m}{eB}$$

$$\Rightarrow B = \frac{2\pi m\nu}{e} \quad \text{...... (1)}$$

Here, e is the charge on the proton and B is the magnetic field in the cyclotron.

So, equation (1) is the requisite equation for the magnetic field.

Now, the radius of the dees is related to the magnetic field as

$$R = \frac{mv}{eB}$$

Here, v is the velocity of the proton inside the dees.

Momentum is p = mv, so we get

$$R = \frac{p}{eB}$$

$$\therefore\ p = eRB \quad \text{...... (2)}$$

Now, kinetic energy and momentum are related as

$$K = \frac{p^2}{2m} \quad \text{...... (3)}$$

Substituting equations (1) and (2) in equation (3), we get

$$K = \frac{(eRB)^2}{2m} = \frac{e^2R^2 \times \left(\frac{2\pi m\nu}{e}\right)^2}{2m}$$

$$\therefore\ K = \frac{e^2R^2 \times 4\pi^2 m^2 \nu^2}{2me^2} = 2\pi^2 mR^2 \nu^2$$

Hence, the correct option is (3).

33. The gravitational force on mass m due to planet of mass M_P is given from Newton's law of gravitation as

$$\frac{}{R_P^2} \quad \frac{}{\left(\frac{D}{2}\right)^2} \quad \frac{}{D_P^2}$$

Now, this force is the weight experienced by the mass. Therefore, we get the acceleration due to gravity as

$$F = mg = \frac{4GM_P m}{D_P^2}$$

$$\therefore g = \frac{4GM_P}{D_P^2}$$

34. The ray of light emerges normally from the second face of the prism.
Hence, the angle of emergence is zero.

$e = 0$

Therefore, $r_2 = 0$.

Now, we know that for a prism

$A = r_1 + r_2$

$\therefore A = r_1 + 0 = r_1$

The refractive index of the prism will be given from Snell's law as

$$\mu = \frac{\sin i}{\sin r} = \frac{\sin i}{\sin r_1} = \frac{\sin i}{\sin A}$$

Now, for small angles, we know that $\sin\theta \approx \theta$

$$\therefore \mu = \frac{i}{A}$$

$\therefore i = \mu A$

35. The damping force on an oscillator is directly proportional to the velocity, i.e.

$F \propto v$

$\Rightarrow F = kv$

Here, k is the constant of proportionality.

Therefore, we have

$$k = \frac{F}{v} = \frac{ma}{v} = \frac{kg\ ms^{-2}}{ms^{-1}} = kgs^{-1}$$

36. The ray of light is incident from infinity on the convex lens. It has focal length f_2.
So, these rays will refract from the lens and pass through the focus of the lens.

Now, it is given that the rays after reflection through the mirror travel back to infinity. So, the rays have to emerge parallel from the lens again. For which they need to travel back to the focus of the lens.

This will happen only if the rays after refraction from the lens travel to the mirror and the mirror reflects in the same direction.

A concave mirror reflects light incident on it from the centre of curvature back to the same direction.

So, the total distance between the lens and the mirror combination will be
$d = f_2 + C = f_2 + 2f_1$

37. According to Kepler's third law of planetary motion, the square of the orbital period of a planet is directly proportional to the cube of the radius of its orbit.
$T^2 \propto r^3$

Hence, for the two satellites, we get

$$\frac{T_1^2}{T_2^2} = \frac{r_1^3}{r_2^3}$$

It is given that the first satellite is a geostationary satellite. Hence, T1 = 24 hours.
$r_1 = 5R + R = 6R$ and $r_2 = 2R + R = 3R$

Therefore, we get

$$\frac{24^2}{T_2^2} = \frac{(6R)^3}{(3R)^3}$$

$$\therefore T_2^2 = \frac{24^2 \times (3R)^3}{(6R)^3} = \frac{24^2 \times 27R^3}{216R^3}$$

$$\therefore T_2^2 = \frac{24 \times 24 \times 27}{216} = 72 = 36 \times 2$$

$\therefore T_2 = 6\sqrt{2}$ hours

38. From the characteristic curve, we see that if a transistor is used as a switch, then it will turn ON if operated in region I and turn OFF if operated in region III. That is we can conclude that for transistor as a switch, it has to be used in the cut-off region and the saturation region only. It will work as a regular amplifier in region II.
So, the correct option is (2).

39. The power consumed by the bulb is

$$P = \frac{V^2}{R}$$

Hence, the change in power rating will be

$$\frac{\Delta P}{P} = \frac{2\Delta V}{V} + \frac{\Delta R}{R}$$

Now, because the same bulb is used, the resistance does not change. So, we get

$$\frac{\Delta P}{P} = \frac{2\Delta V}{V} = 2 \times \frac{\Delta V}{V}$$

Hence, the percentage drop will be written as

$$\frac{\Delta P}{P} \times 100 = 2 \times \frac{\Delta V}{V} \times 100 = 2 \times 2.5 = 5\%$$

40. According to the kinematic equation of motion, we get

$$v = u + at$$

In vector notation, we have

$$\vec{v} = \vec{u} + \vec{a}t$$

Substituting the values, we get

$$\vec{v} = \left(2\vec{i} + 3\vec{j} \right) + \left(0.3\vec{i} + 0.2\vec{j} \right) \times 10$$

$$= 2\vec{i} + 3\vec{j} + 3\vec{i} + 2\vec{j}$$

$$= 5\vec{i} + 5\vec{j}$$

Therefore, the magnitude of velocity is

$$v = |\vec{v}| = \sqrt{5^2 + 5^2} = \sqrt{2 \times 5^2} = 5\sqrt{2} \text{ units}$$

41. When an electron jumps from the first excited state to the ground state, a photon of energy equal to the energy difference of the two levels is emitted.

This energy is equal to 10.2 eV.

Now, according to Einstein's photoelectric equation, we have

$$KE = E - \phi$$

Here, KE is the kinetic energy of the emitted photoelectrons, E is the energy of the photons and ϕ is the work function of the material.

Hence, we get

$$KE = 10.2 - 3.57$$

$$= 6.63 \text{ eV}$$

$$= 6.63 \times 1.6 \times 10^{19} \text{ J}$$

Therefore, the threshold frequency will be

$$KE = h\nu_0 = 6.63 \times 1.6 \times 10^{19} \text{ J}$$

$$\nu = \frac{KE}{h} = \frac{6.63 \times 1.6 \times 10^{19}}{6.63 \times 10^{34}} = 1.6 \times 10^{15} \text{ Hz}^0$$

42. ABC is an equilateral triangle. O is its centre.

Hence, the perpendicular distance from the centre to all the three sides is the same, say 'x'.

Now, considering the counterclockwise torque on the system, we get

$\tau_1 + \tau_2 - \tau_3 = 0$

$\Rightarrow \tau_1 + \tau_2 = \tau_3$

Torque is the product of force and perpendicular distance from the central axis.

$F_1 x + F_2 x = F_3 x$

$\Rightarrow F_1 + F_2 = F_3$

43. From the given output figure, the following truth table can be made.

A (input)	B (input)	C (output)
0	0	0
1	0	1
1	1	1
0	1	1

Judging from the table, we can say that the gate is an OR gate.

44. The charge q is placed at one of the corners of the cube.

Now, this charge q can be surrounded by 8 cubes in all such that it becomes the centre of the larger cube.

Now, the flux through the entire cube will be

$\phi = \frac{q}{\varepsilon_0}$

This flux will be divided into 8 parts. So, the flux through the given small cube is

$\phi = \frac{q}{8\varepsilon_0}$

45. The alpha particle of charge q = 2e moves in a circular orbit of radius R in a magnetic field B.

Now, the radius of the orbit is

$R = \frac{mv}{qB} = \frac{p}{2eB}$

$\therefore p = 2eBR$ ...... (1)

The de Broglie wavelength associated with the alpha particle is

$\lambda = \frac{h}{p}$ ...... (2)

Substituting equation (1) in (2), we get

$$\lambda = \frac{h}{R \cdot 2eB}$$

$$\therefore \lambda = \frac{6.63 \times 10^{-34}}{2 \times 1.6 \times 10^{-19} \times 0.25 \times 0.83 \times 10^{-2}}$$

$$\therefore \lambda = 10 \times 10^{-13}\ m = 10^{-12}\ m = 0.01 \times 10^{-10}\ m$$

$$\therefore \lambda = 0.01\ \mathring{A}$$

46. An electromagnetic wave is represented by the equation $\vec{E} = E_0 \cos(kz - \omega t)\hat{i}$

It is given that $\vec{E} = 40\cos(kz - 6 \times 10^8\ t)\hat{i}$

Comparing the above two, we get $\omega = 6 \times 10^8$ Now, the wave velocity is

$$v = \frac{\omega}{k}$$

$$\therefore k = \frac{\omega}{v}$$

Substituting the values, we get the wave vector as

$$k = \frac{6 \times 10^8}{3 \times 10^8} = 2\ m^{-1}$$

47. The motion of a particle along a straight line is described by equation

$x = 8 + 12t - t^3$

Hence, the velocity of the particle is

$$v = \frac{dx}{dt} = 0 + 12 - 3t^2$$

It is given that velocity becomes zero after time t. So, we get

$0 + 12 - 3t^2 = 0$

$\therefore 3t^2 = 12$

$\therefore t^2 = 4$

$\therefore t = 2\ s$

Hence, after two seconds, the velocity of the particle will be zero.

Therefore, the retardation of the particle will be

$$a = \frac{dv}{dt} = 0 - 6t = -6t$$

$\therefore\ a = -6\times = -12\ ms^{-2}$

The negative sign indicates retardation, so its magnitude is a = 12 ms^{-2}.

48. The magnifying power of the telescope is

$$m = \frac{\text{Focal length of objective}}{\text{Focal length of eyepiece}} = \frac{f_o}{f_e} = 9$$

$\Rightarrow f_o = 9f_e$

It is given that $f_o + f_e = 20$ cm.

Hence, we get

$f_o + f_e = 20$

$\therefore\ 9f_e + f_e = 20$

$\therefore 10f_e = 20$

$\therefore\ f_e = 2$ cm

Hence, the focal length of the objective is

$f_o = 9f_e$

$\therefore\ f_o = 9 \times 2 = 18$ cm

49. The equation of a progressive wave is $y = a\sin\omega t$

Therefore, for the two progressive waves, we get

$y_1 = a_1 \sin\omega_1 t$

$y_2 = a_2 \sin\omega_2 t$

The given progressive waves are

$y_1 = 4\sin 600\pi t$

$y_2 = 5\sin 608\pi t$

Comparing the equations with the given waves, we get

$\omega_1 = 2\pi f_1 = 600\pi$

$\therefore\ f_1 = \frac{600}{2} = 300$ Hz

$\omega_2 = 2\pi f_2 = 608\pi$

$\therefore\ f_2 = \frac{608}{2} = 304$ Hz

Hence, the number of beats generated will be

$\text{Beats} = |f_1 - f_2| = |300 - 304| = 4$

So, 4 beats will be generated.

Now, the maximum and minimum intensities are related to amplitudes as

$I_{max} = (a_1 + a_2)^2$

$I_{min} = (a_1 - a_2)^2$

Hence, the intensity ratio is

$$\frac{I_{max}}{I_{min}} = \frac{(a_1 + a_2)^2}{(a_1 - a_2)^2}$$

$$\frac{I_{max}}{I_{min}} = \frac{(4+5)^2}{(4-5)^2} = \frac{81}{1}$$

Hence, the correct option is (4).

50. The resistance of a wire depends on its length.

Hence, when two points A and B are considered for connecting a conductor, the length of the upper and lower parts of the ring would be different.

These two parts will be parallel to each other. So, we have

$$R_{eq} = \frac{R_1 R_2}{R_1 + R_2} \quad \text{...... (1)}$$

Now, we know that the resistance of a wire can be given in its resistance per unit length ρ and length ℓ as

$$R = \frac{\text{Resistance}}{\text{Unit length}} \times \text{length} \; \ell = \rho\ell$$

Therefore, the resistance of the two parts of the wire will be

$R_1 = \rho\ell_1$ ...... (2)

$R_2 = \rho\ell_2$ ...... (3)

Substituting equations (2) and (3) in (1), we get

$$R_{eq} = \frac{\rho\ell_1 \times \rho\ell_2}{\rho\ell_1 + \rho\ell_2} = \rho\frac{\ell_1\ell_2}{\ell_1 + \ell_2}$$

It is given that $R_{eq} = \frac{8}{3}$, so we get

$$R_{eq} = \rho\frac{\ell_1\ell_2}{\ell_1 + \ell_2} = \frac{8}{3} \quad \text{...... (4)}$$

Now, it is given that the initial resistance of the wire is R0 = 12Ω.

That is

$R_0 = \rho\ell_1 + \rho\ell_2 = 12$

$\therefore \rho(\ell_1 + \ell_2) = 12$ ...... (5)

Dividing equations (4) and (5), we get

$$\frac{\rho\frac{\ell_1\ell_2}{\ell_1+\ell_2}}{\rho(\ell_1+\ell_2)} = \frac{\frac{8}{3}}{12} = \frac{8}{36} = \frac{2}{9}$$

$$\therefore \frac{\ell_1\ell_2}{(\ell_1+\ell_2)^2} = \frac{2}{9}$$

$$\therefore \frac{\ell_1\ell_2}{\ell_2^2\left(\frac{\ell_1}{\ell_2}+1\right)^2} = \frac{2}{9}$$

$$\therefore \frac{\ell_1}{\ell_2\left(\frac{\ell_1}{\ell_2}+1\right)^2} = \frac{2}{9}$$

$$\left(\frac{\ell_1}{\ell_2}+1\right)^2 = \frac{9}{2}\frac{\ell_1}{\ell_2}$$

Expanding the above equation, we get

$$\left(\frac{\ell_1}{\ell_2}\right)^2 + 2\frac{\ell_1}{\ell_2} + 1 - \frac{9}{2}\frac{\ell_1}{\ell_2} = 0$$

$$\left(\frac{\ell_1}{\ell_2}\right)^2 - \frac{5}{2}\frac{\ell_1}{\ell_2} + 1 = 0$$

This is of the form $ax^2 + bx + c = 0$. Hence, the solution is

$$\frac{\ell_1}{\ell_2} = \frac{\frac{5}{2} \pm \sqrt{\frac{25}{4} - 4}}{2} = \frac{\frac{5}{2} \pm \sqrt{\frac{25-16}{4}}}{2}$$

$$\frac{\ell_1}{\ell_2} = \frac{\frac{5}{2} \pm \frac{3}{2}}{2}$$

$$\therefore \frac{\ell_1}{\ell_2} = \frac{\frac{5}{2} + \frac{3}{2}}{2} \quad \text{OR} \quad \frac{\ell_1}{\ell_2} = \frac{\frac{5}{2} - \frac{3}{2}}{2}$$

$$\therefore \frac{\ell_1}{\ell_2} = 2 \text{ OR } \frac{1}{2}$$

Hence, the correct option is (4).

Biology

51. Within the Anopheles mosquito, the gametocytes mature into male and female gametes, fertilisation occurs and a motile zygote is formed within the lumen of the mosquito's gut.

52. The hindbrain in humans comprises pons, cerebellum and medulla oblongata.

53. Above the cochlea, receptors such as crista and macula are present in the vestibular apparatus which plays a significant role in maintaining body balance and posture.

54. Heterotrophic bacteria are major decomposers which help in curdling of milk, production of antibiotics and nitrogen fixation.

55. The viability of the sperm is several days, not 24 hours.

56. The process of evolution of different species in a given geographical area starting from a point and radiating to the other area of geography is called adaptive radiation. Examples: Darwin's finches and Australian marsupials

57. The figure shown is tubectomy in which the fallopian tubes are cut and ligated through a small incision in the abdomen or vagina.

58. High concentration of DDT disturbs calcium metabolism in birds which causes thinning of eggshell and their premature breaking.

59. In pBR322,

Ori – site of origin of replication

rop – proteins taking part in replication of plasmid

Hind III, ECORI – recognition sites of restriction endonucleases

amp^R and tet^R – antibiotic-resistant gene part

60. Common bottle cork – *Quercus robur* which contains suberin. Phellogen forms cork towards the outside and phelloderm towards the inside.

61. The Widal test is a test of blood serum which uses an agglutination reaction to diagnose typhoid fever.

62. The apical meristem comprises actively dividing cells which do not have a well-established vascular system for virus movement. The virus cannot move from cell to cell through plasmodesmata So, it is advisable to use the meristem for virus-free plants in micropropagation.

63. The upper part of the atmosphere is the stratosphere which produces a good ozone layer which protects the Earth from harmful ultraviolet radiations from the Sun.

64. Companion cells are connected with sieve elements by complex plasmodesmata.

65. The virus when cause pneumonia infects only the alveoli but common cold affects the nose, throat and sinuses.

66. Pheretima (earthworm) derives nutrition from decaying fallen leaves and soil organic matter.

67. RNA polymerase III forms tRNA in eukaryotes.

68. During daytime, the stomata remain closed in C4 plants. So, photorespiration is absent in C4 plants such as maize, sugarcane and millets.

69. Restriction fragment length polymorphism (RFLP) analysis is used to identify a change in the genetic sequence which occurs at a site where a restriction enzyme cuts.

Polymerase chain reaction (PCR) is used in amplification of DNA.
Both are used in DNA fingerprinting.

70. Adequate manganese (Mn) is required as it facilitates the photolysis of water molecules and provides energy for photosynthesis.

71. Biological oxygen demand (BOD) is a measure of organic matter present in water. It refers to the amount of oxygen consumed by microbes to decompose all the organic matter in one litre of water at 20°C for 5 days.

72. Transcription unit consists of promoter, structural gene and terminator.

73. The doctor friend offered blood group O as an individual with blood group O is a universal donor.

74. Golden rice is a vitamin A-rich variety developed by recombinant DNA technology and used in the treatment of vitamin A deficiency.

75. All the essential nutrients and 70–80% of electrolytes and water are reabsorbed by proximal convoluted tubules.

76. Self-pollination, autogamy and geitonogamy are prevented in dioecious flowers (male and female flowers are present on different plants). Examples: Papaya, mulberry, willow

77. Parietal placentation – Mustard

Free central placentation – Dianthus and
Primula Marginal placentation – Pea

Axial placentation – Tomato, China rose

78. Epinephrine and norepinephrine are secreted by the adrenal medulla in response to stress of any kind and during emergencies and are called emergency hormones or hormones of flight.

79. Phosphorus moves in a cycle through rocks, water, soil and sediments and organisms. Therefore, the phosphorus cycle is a sedimentary cycle.

80. A probe is a 15–30 long radioactive or non-radioactive segment of DNA or RNA which is used in hybridisation with the DNA segment.

81. Divergent evolution produces homologous structures. The bones of forelimbs of vertebrates are homologous structures.

Unrelated animals converging on the same form or structure, because that form is very adaptive in their common environment. This special case of evolution is called convergent evolution. Example: Eyes in octopus and mammals

82. Sporopollenin is the fatty substance present in the pollen wall and provides resistance against extreme conditions such as high temperature, acids and bases.

83. Motile sperms are found in both Cycas and Adiantum. The gymnosperms possess seeds and cambium which are absent in pteridophytes.

84. The significant trend in evolution in modern man is his increasing brain capacity. The brain size has significantly increased from Neanderthal man to modern man.

85. The main axis ends in a flower as the peduncle stops growing in the flowers of Solanum.

The flowers of Sesbania, Trifolium and Brassica show racemose inflorescence in which the main axis shows continuous growth and it does not end with a flower.

86. Ribosomal RNA is synthesised in the nucleolus and is combined with proteins from the cytoplasm which are imported into the nucleolus where they form ribosomes.

87. The enzyme recombinase is involved in the pachytene stage of meiosis I. It catalyses the process of crossing over leading to the recombination of genetic material on the two chromosomes.

88. The food chain has to continue with primary, secondary and tertiary consumers. The primary consumers are herbivores (insects), the secondary consumers are the carnivores frog (consumes insects) and cobra (consumes the frog) and the tertiary consumer is the eagle (consumes the cobra).

89. Phyllode is a modification of leaf (petiole) which bears an axillary bud. Example: *Acacia melanoxylon*

90. The level 'primary consumers' (PC) is 'insects' and the level 'secondary consumers' (SC) is 'small insectivorous birds'.

91. *Monascus purpureus* is yeast used in the production of statins which are blood cholesterol-lowering agents.

92. The first stage of photorespiration involves the formation of glycolate in the chloroplasts. Further reactions of the glycolate pathway occur in the mitochondria and peroxisomes, and eventually, a compound is formed which is returned to the chloroplasts, where the process began.

93. The active transport of nutrients takes place with the utilisation of ATP. The apoplastic movement of water occurs exclusively through the cell wall without crossing any membrane, while the symplastic movement occurs from cell to cell through the plasmodesmata.

94. Man with normal vision – XY

His colour blind father – X^cY

Women's colourblind father – X^cY

In colourblindness, the genes are present on the X chromosome. As males have only one X chromosome, it is expressed in them and the females can be carriers in the heterozygous condition (X^cX) and suffers in the homozygous condition (X^cX^c).

Gametes	X	Y
X_c	X_cX	X_cY
X	XX	XY

Of the two daughters, one is a colourblind carrier (X^cX) and the other is normal (XX). So, the chance of the first daughter or any daughter of this couple being colourblind is 0%.

95. Signals for parturition originate from the fully developed foetus and the placenta involving a complex neuroendocrine mechanism. This is also called the foetal ejection reflex.

96. Myocardial infarction occurs because of thrombosis (blood clotting) which forms inside the coronary artery. The clot-busting medicine streptokinase can be given that eliminates the clots clearing the blood vessel.

97. Cancer cells do not show the property of contact inhibition (the tendency of the cells to end growth and division when in contact with other cells).

98. Michelia flower has several pistils each consisting of a single carpel.

99. Stratification refers to formation or deposition of layers as of rock or sediments. It is not a unit of the ecosystem.

100. Pregnancy can be confirmed by detecting the presence of human chorionic gonadotropin (HCG) in blood or urine of the pregnant woman. The main function of HCG is to maintain the corpus luteum to allow the secretion of progesterone and oestrogen. Progesterone enriches the uterus with a thick lining of blood vessels and capillaries so that it can sustain the growing foetus.

101. There are three biodiversity hotspots in India—Western Ghats, Eastern Himalayas and Indo- Burma region.

102. Bryophytes bear protonemal and leafy stage.
Female gametophyte is not free-living.

Antheridiophores and archegoniophores are present in Marchantia (bryophyte). Origin of seed habit was first seen in Selaginella.

103. Cell membrane does not differ in *E. coli* and *Chlamydomonas*.

104. Cyanobacteria are said to be blue-green algae because they looked like green algae when they were discovered. Cyanobacteria contain the photosynthetic pigments chlorophyll (green) and photocyanin (blue).

105. Zygote intrafallopian transfer (ZIFT) is an assisted reproductive procedure similar to *in vitro* fertilisation and embryo transfer, the difference being that the fertilised embryo is transferred into the fallopian tube instead of the uterus.

106. Vector DNA – site for cloning

107. The fungus represents about 80,000 known species which include yeast, rust, smut, mildews, moulds and mushrooms.

108. Polymorphonuclear leucocytes and monocytes are examples of cellular barriers providing innate immunity.

109. Phosphorus is a constituent of cell membranes, all nucleic acids and certain proteins.

110. The anxiety of eating and consuming spicy food may result in indigestion.

111. Leydig cells are thought to be a source of androgens. In males, the interstitial cells of Leydig, located in the connective tissue surrounding the sperm-producing tubules of the testes, are responsible for the production and secretion of testosterone.

112. Erythrocytes in mammals are enucleate when mature, i.e. they lack a cell nucleus. In comparison, the erythrocytes of frog do contain a nucleus.

113. Pila (gastropod/snail) are Molluscs which possess radula. All molluscs have an unsegmented body.

114. Ribosomes contain both rRNA and proteins which form 62% RNA and 38% protein formed into two complexes.

115. Cirrhosis is an abnormal liver condition in which there is irreversible scarring of the liver. The main causes are sustained excessive alcohol consumption.

116. DNA polymerase used in PCR is Taq Polymerase obtained from *Thermus aquaticus* which remains active at high temperature inducing denaturation of double-stranded DNA.

117. All viruses do not possess helical symmetry.

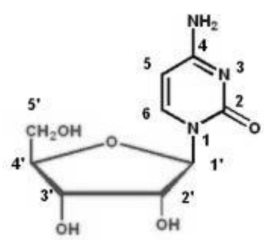
118. A short modified underground stem surrounded by usually fleshy modified leaves which contain stored food is the onion bulb.

119. Fig – Developed by hypanthodium inflorescence (The receptacle becomes spherical with a cavity inside. It opens to the outside with a small opening.)

Pineapple – Developed by spike inflorescence (Simple inflorescence which does not have a pedicel.)

Mulberry – Developed by catkin inflorescence (An inflorescence consisting of a spike, usually hanging, of much reduced flowers of either sex.)

120. The given figure is that of a nucleoside (nucleotide + sugar). The figure is a nucleotide and 'X' denotes a sugar. A ribose and nitrogenous base are covalently joined by a glycosidic bond to form a nucleoside molecule:



121. Glomus which is an endomycorrhiza helps in the absorption of nutrition (phosphorus from soil).

122. Neanderthal man who lived 1, 00,000 to 4, 00,000 years ago had short stature, heavy eyebrows, large jaws with heavy teeth and stocky bodies.

123. Sequence of DNA – ATCTG

Sequence of RNA – UAGAC

124. Intracellular receptors are used specifically by steroid hormones such as cortisol, aldosterone, testosterone, oestrogen and progestogen. Steroid hormones are lipid-soluble; therefore, they diffuse through the cell membrane and gain direct access to the cell. Inside, they bind to steroid receptors. This forms a hormone–receptor complex. This complex then binds to parts of DNA in the nucleus of the cell called hormone-responsive elements. The binding process changes the physical shape of the

DNA in the nucleus and means that the pattern of gene expression is altered in that cell.

125. Nuclear membrane is absent in Nostoc as it is a prokaryote. *Penicillium*, *Agaricus* and *Volvox* are eukaryotes.

126. Collagen, a structural protein, is found in multiple tissues in multiple species.

127. The diplontic life cycle is present in all seed-bearing plants (gymnosperms and angiosperms). Mosses have a haplodiplontic life cycle. A multicellular fungus forms a separate kingdom as they are not part of Plantae such as algae and bryophytes (mosses). The multicellular fungi are heterotrophic in nature, whereas others are photosynthetic.

128. Paramoecium and Plasmodium belong to Kingdom Protozoa, whereas Penicillium belongs to Kingdom Fungi (Ascomycetes).

Lichen is a composite organism formed by symbiotic association between algae and fungi.

Saccharomyces cerevisiae is yeast (Baker's yeast) used in making bread and ethanol.
Nostoc and Anabaena are examples of cyanobacteria which help in nitrogen fixation.

129. Seed setting is assured in Commelina without the presence of pollination.

130. Yeast (*Saccharomyces cerevisiae*) is used in making bread and beer by the process of fermentation.

131. The formula of amino acid comprises

(i) a carboxyl group – –COOH

(ii) an amine group – $-NH_2$

(iii) an atom of hydrogen – H

(iv) a variable radical – –R (functional group)

So, an amino acid is a carboxylic acid which has an amine group attached to it.

132. The pyramid of number for a forest is partially upright. In a forest, a limited number of producers support a greater number of herbivores, which in turn support lesser number of carnivores.

133. Glucagon is secreted by the alpha cells of the islets of Langerhans and stimulates glycogenolysis.

Secretion of thymosin is stimulated with the onset of puberty. FSH binds with specific receptors on the ovarian cell membrane.

FSH stimulates secretion of oestrogen, progesterone and testosterone.

134. Closed bundles lack cambium and are unable to continue growth laterally.

135. Workers in mines are prone to dust from grinding. They suffer from lung fibrosis.

136. As DNA is transcribed into RNA, it needs to be edited to remove non-coding regions or introns and to join the coding regions (exons). This process is called RNA splicing.

137. The F_2 generation with both genotypic and phenotypic ratio of 1:2:1 can be a monohybrid cross with incomplete dominance.

If we cross two heterozygous plants – tall plant (TT), medium (Tt) and short plant (tt), the genotypic ratio will be 1:2:1 (TT – 25%, Tt – 50% and tt – 25%) and the phenotypic ratio will also be 1:2:1.

Parents Tt × Tt

Gametes T t T t

F_1 progeny

	T	t
T	TT	Tt
t	Tt	tt

138. The following diagram shows the stage of Prophase I of Meiosis I. In Prophase I, the duplicated homologous chromosomes pair and crossing over occurs.

Crossing-over is the process which can give rise to genetic recombination. At this point, each homologous chromosome pair is visible as a bivalent (tetrad), each consisting of two sister chromatids. The sites of crossing-over are seen as criss-crossed non-sister chromatids and are called chiasmata.

139. People living at high altitudes develop more RBCs in the bone marrow which reduces oxygen haemoglobin affinity. So, these people will have polycythaemia (more number of RBC in blood) after six months.

140. The particle bombardment method starts with coating tungsten or gold particles (microprojectiles) with plasmid DNA. The coated particles are then coated on a macrocarrier, which is accelerated with air pressure and shot into the plant tissue on a Petri plate.

141. An important source of available nitrogen in flooded rice fields is the water fern Azolla which associates with the cyanobacterium Anabaena. The Azolla–Anabaena association can fix as much as 0.5 kg of atmospheric nitrogen per hectare per day.

142. Muscular dystrophy – appears in infancy and middle age

Osteoporosis – appears at advance age, leading to fractures and decrease in bone mass Myasthenia gravis – neuromuscular disease characterised by varying degree of weakness of skeletal muscles of the body

Gout – stiffness and swelling of joints because of deposition of uric acid

143. As maize is a monocot plant, the vascular bundles contain water-containing cavities.

144. Na^+ and K^+ ions move across the cell membrane by active transport.
Proteins make up roughly half the cellular mass of the cell membrane.
The phospholipid molecules are arranged in two layers in the plasma membrane with the heads of the molecules facing outwards.
Singer and Nicolson proposed the fluid mosaic model of the cell membrane.

145. Gymnosperms also called softwood spermatophytes because they lack thick walled tracheids or xylem fibres

146. Coconut water and the edible part of the coconut form the inner part of the pericarp, i.e. the endocarp layer which is fleshy and nutritious.

147. Vexillary aestivation is the arrangement of petals in which the standard petal is large and overlaps other petals. This type of aestivation is found in Family Fabaceae (peas, beans etc).

148. Trichoderma species are used to manage certain plant pathogens. Trichoderma is used to treat the spread of fungal and bacterial growth on tree wounds.

149. Male cockroaches (*Periplaneta americana*) possess a pair of short thread-like anal styles.

150. Nutritional consumption or intake is mostly by Monera.

Chemistry

151. Aluminium is extracted from alumina (Al_2O_3) by electrolysis of a molten mixture of $Al_2O_3 + Na_3AlF_6 + CaF_2$

152.

pH=12

pH+pOH=14

$\therefore$ pOH=2

pOH= $-\log_{10}[OH^-]$

2= $-\log[OH^-]$

$\log[OH^-] = -2$

$\therefore [OH^-] = Al(-2) = 0.01 = 10^{-2}$

Now, $Ba(OH)_2 \rightarrow Ba^{+2} + 2OH^-$

s 2s

$K_{sp} = s \times (2s)^2 = s \times 4s^2 = 4s^3$

$2s = 10^{-2}$

$\therefore s = 5 \times 10^{-3}$

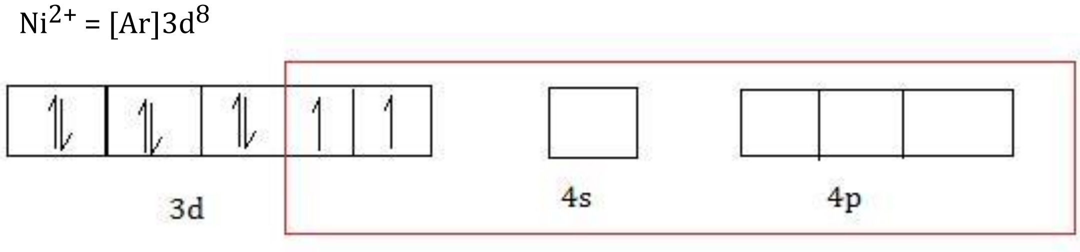
$K_{sp} = 4s^3 = 4(5\times10^{-3})^3 = 500 \times 10^{-9} = 5 \times 10^{-7}$

153. $Cl_2 + NaOH \rightarrow NaCl + NaClO_3$

154. Subshell 4f can hold 14 electrons.

155. $_{28}Ni = [Ar]\ 3d^8\ 4s^2$

$Ni^{2+} = [Ar]3d^8$



sp^3d^2

$[Ni(NH_3)_6]^{2+}$ is a weak ligand with two unpaired electrons.

156. $R = k[A]^x[B]^y$ ....(i)

$2R = k[A]^x[B]^{2y}$....................(ii)

$8R = k[A]^{2x}[B]^{2y}$.................(iii)

From eqns. (ii) and (iii),

$x = 2$

From eqns. (i) and (ii),

$y = 1$

Hence, rate = $k[A]^2[B]^1$

157. Because disorder increases, entropy increases. ΔS = +ve

The reaction is exothermic, so ΔH = −ve

We also know that

$\Delta G = \Delta H - T\Delta S$ ΔG

= −ve − T(+ve)

Hence, as the temperature increases, the value of ΔG decreases.

158. Magnetite is a mineral of iron.

159. In the Freundlich adsorption isotherm, the value of 1/n is always between 0 and 1.

160. The pH value is the highest for $BaCl_2$ solution because it is a salt of the strong acid HCl and the strong base $Ba(OH)_2$. As a result, the aqueous solution of the neutral salt has pH 7.

161.

UsingGraham'slawof effusion

$$\frac{r_1}{r_2} = \sqrt{\frac{M_{W2}}{M_{W1}}} = \frac{V_B\,T_A}{T_B.V_A}$$

$$\sqrt{\frac{M_{W2}}{M_{W1}}} = \frac{V_1 x t_2}{t_1 x V_2}$$

$$\sqrt{\frac{36}{M_{W1}}} = \frac{4}{3}$$

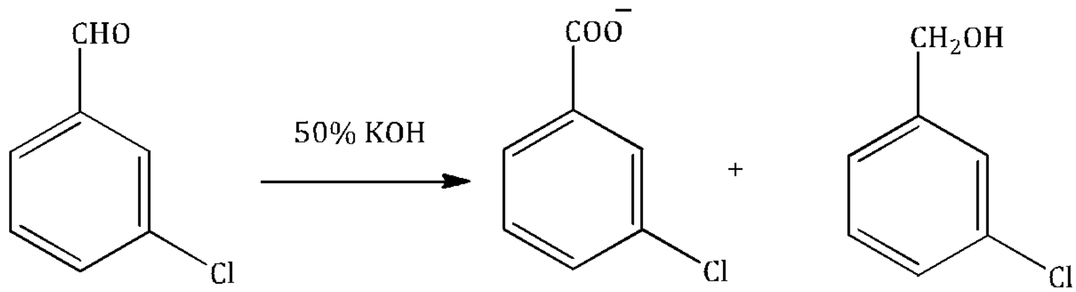
$$M_{W1} = \frac{36x9}{} = 20.25$$

162. $_{37}Rb = [Kr]5s^1$

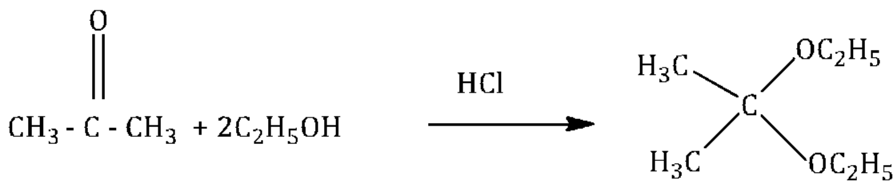
$n = 5, l = 0, m = 0, s = +1/2$

163. In N_3H, the oxidation number of N is −1/3.

164.



165.



166. For fcc,

$$r = \frac{a}{2\sqrt{2}}$$

Sothediameter= $\frac{a}{\sqrt{}} = \frac{408}{} = 288.5pm$

167. Enzymes are the least reactive at optimum temperature.

168. Change in temperature = 100 − 10 =
90°C Hence, n = 9

So, when the temperature is increased from 10°C to
100°C, the rate = $2^n = 2^9$ = 512 times.

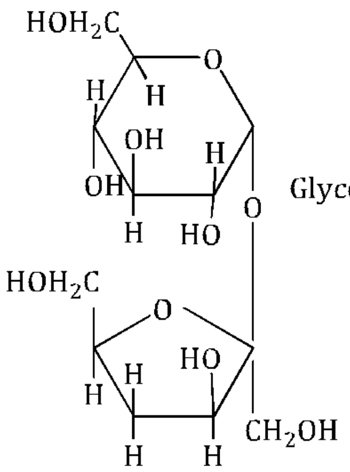
169. Deficiency of vitamin B1 causes beri-beri.

170. Toluene is more reactive towards electrophilic nitration because of the +R effect of the methyl group.

171. Buffer solutions have constant acidity and alkalinity because these give unionised acid or base on reaction with added acid or alkali.

172. CF_3COOH > CCl_3COOH > HCOOH > CH_3COOH
The presence of electron-withdrawing group (-I effect) makes the acid more acidic.

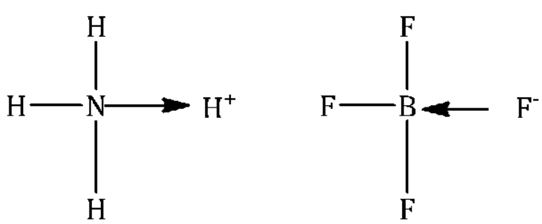
173. α -D-glucopyranose and β -D-fructofuranose



174.

$$\Delta S = \frac{\Delta H}{T} = \frac{1.435x1000}{273} = 5.26 cal/(molK)$$

175.



176. Bond order of 1.5 is shown by O_2^-

177. Neoprene is a polymer of chloroprene ($CH_2=C(Cl)\ CH=CH_2$). So, it is an addition polymer.

178. $CH_3\text{-}Br \xrightarrow{KCN} CH_3CN \xrightarrow{H_3O+} CH_3COOH \xrightarrow[ether]{LiAlH_4} CH_3CH_2OH$

179. The correct name should be 3 bromo prop-1-ene.

180. Number of octahedral voids = number of atoms in the closed packed structure Number of atoms = 1

So, number of octahedral voids = 1

181. $2Cu_2O + Cu_2S \rightarrow 6Cu + SO_2$

182. Steel contains iron and carbon.

183. $C_2O_4H_2 + KClO_3 + H_2SO_4 \rightarrow K_2SO_4 + CO_2 + Cl_2 + H_2O$
Maximum change in oxidation number is observed for chlorine from +5 to 0.

184. Lithium on heating in air forms
Li_2O. $4Li + O_2 \rightarrow 2Li_2O$

185. As the size of alkali metal ions increases, the adsorption of hydrated metal ions on an ion-exchange resin decreases.

So, the ease of adsorption follows the

order $Rb^+ < K^+ < Na^+ < Li^+$

186. Photochemical smog causes irritation in the eyes and throat.

187. $C_6H_5CH_2CHO$ does not give an iodoform test. CH_3CHO on treating with NaOH and I_2 gives yellow crystals of iodoform.

$CH_3CHO + 3I_2 + 4NaOH \rightarrow CHI_3 + HCOONa + 3NaI + 3H_2O$

$C_6H_5CH_2CHO + I_2 + NaOH \rightarrow$ No reaction

188. $Na_2Cr_2O_7$ is not preferred over $K_2Cr_2O_7$ in volumetric analysis because $Na_2Cr_2O_7$ is hygroscopic in nature.

189. $H_2O_{(l)} \rightarrow H_2O_{(g)}$

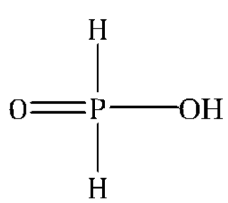
$H = E + nRT$

$40.66 = E + 1 \times 8.314 / 1000 \times 373$

$E = 37.5$ kJ

190. Among isoelectronic species, the ionic radius increases with an increase in –ve charge or decrease in +ve charge.

191.



H_3PO_2 has only one replaceable hydrogen atom, so it is a monoprotic acid.

192. The protecting power of a lyophilic colloidal sol is expressed in gold number.

193. $Fe_2(SO_4)_3 \rightarrow Fe_2O_3 + 3SO_3$

194. $P = P'_A + P'_B$..................(I)
We know $P'_A = P_AX_A$

$P'_B = P_B X_B$

Substituting the values in equation (I),

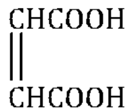
$P = P_A X_A + P_B X_B$

Since $X_A + X_B = 1$

$P = P_A X_A + P_B(1 - X_A) = P_A X_A + P_B - P_B X_A$

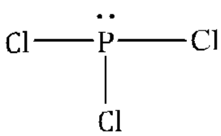
So, $P = P_B + X_A(P_A - P_B)$

195.



Maleic acid has no chiral centre and so is optically inactive. Hence, it does not exhibit optical isomerism.

196. PCl_3 contains three bond pairs and one lone pair.



197. $\Lambda^0_m (NH_4Cl) + \Lambda^0_m (NaOH) - \Lambda^0_m (NaCl)$

198. Bond order of O_2^{2-}, B_2 is 1.

199. Nylon-66 is a fibre and not an elastomer.

200.