

AIPMT / NEET – 2016
(Physics, Chemistry and Biology)
Code – A
Answer Key and Solution

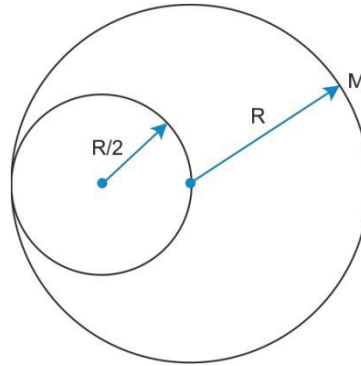
Answer Key

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

Physics

1. $I = \frac{13MR^2}{32}$

From a disc of radius R and mass M , a circular hole of diameter R is cut, whose rim passes through the centre of the given disc.



The moment of inertia of the remaining part of the disc about a perpendicular axis passing through the centre is given by

$$I = \frac{MR^2}{2} - 3\sigma \cdot \pi \left(\frac{R}{2}\right)^2 \left(\frac{R}{2}\right)^2$$

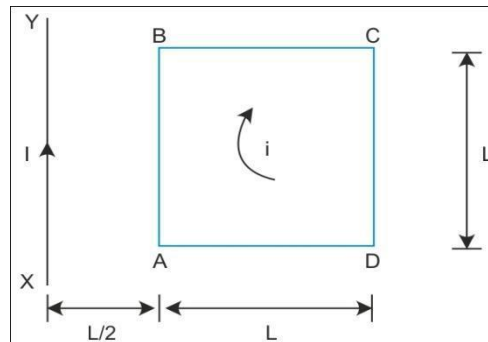
Where $\sigma = \frac{M}{\pi R^2}$

$$I = \frac{MR^2}{2} - \frac{3MR^2}{32}$$

$$\frac{32}{32}$$

2. $F_{net} = \frac{2\mu_0 I i}{3\pi}$

A square loop ABCD carrying a current i , is placed such that it is near and coplanar with a long straight conductor XY carrying a current I , the net force on the loop will be derived as follows:



Force F_1 towards I along length $\left(\frac{L}{2}\right)$ is

$$F_1 = \frac{\mu_0 I i l}{2\pi \left(\frac{l}{2}\right)} = \frac{\mu_0 I i}{\pi}$$

Similarly, F_2 is given by $F_2 = \frac{\mu_0 I i l}{2\pi \left(\frac{3l}{2}\right)} = \frac{\mu_0 I i}{3\pi}$

Net force is the difference of forces.

$$\therefore F_{\text{net}} = F_1 - F_2$$

$$F_{\text{net}} = \frac{2\mu_0 I i}{3\pi}$$

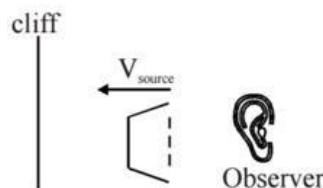
3. Diamagnetic material only.

Only a diamagnetic substance has negative magnetic susceptibility.

4. 838 Hz

A siren emitting a sound frequency of 800 Hz is moving away from the observer towards a cliff with the speed of 15 m/s.

Velocity of sound in air (V_a) = 330 m/s



Let f_0 be the sound frequency of the siren.

$$f_0 = 800\text{Hz}$$

V_{Source} be the velocity of movement of the siren.

$$V_{\text{source}} = 15\text{m / s}$$

Therefore, the sound frequency which the observer hears is f_a .

$$f_a = \frac{V_a}{V_a - V_{\text{source}}} \times f_0$$

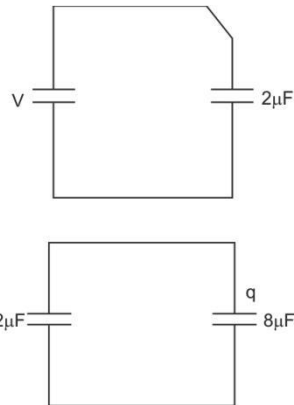
$$f_a = \frac{330}{330 - 15} \times 800$$

$$f_a = \frac{330}{315} \times 800$$

$$f_a = 838\text{Hz}$$

5. 80%

A 2 μF capacitor is charged as shown in the diagram.



We know that charge Q is

$$Q = CV$$

$$C = 2\mu\text{F}$$

The energy stored in the capacitor is

$$U = \frac{1}{2} \frac{Q^2}{C}$$

$$U_i = \frac{1}{2} \times \frac{(2V)^2}{2} = V^2$$

Potential across capacitor

$$V = \frac{1}{2} \cdot \frac{64V^2}{25 \times 8}$$

Final stored energy

$$U_f = \frac{5V^2}{25} = \frac{V^2}{5}$$

$$\frac{2V}{2} = \frac{q}{8}$$

$$q = \frac{8V}{5}$$

$$\text{Therefore, energy dissipated} = \frac{4V^2}{5}$$

$$\text{The above is expressed in \% as } \frac{4V^2}{5V^2} \times 100$$

$$= 80\%$$

$$6. \theta = \sin^{-1} \left(\frac{3}{4} \right)$$

In a diffraction pattern due to a single slit of width 'a', the first minimum is observed at an angle 30° and wavelength 5000 Armstrong unit. The first secondary maximum will be observed at an angle which is calculated as follows:

The diffraction relation is

$$a \sin 30 = \lambda$$

$$a \sin \theta = \frac{3}{2} \lambda$$

By dividing, we get

$$\frac{\sin \theta}{\sin 30} = \frac{3}{2}$$

Substituting $\sin 30 = \frac{1}{2}$, we get

$$\theta = \sin^{-1} \left(\frac{3}{4} \right)$$

$$7. h = 2600 \text{ km}$$

Gravitational potential (V) = $-5.4 \times 10^7 \text{ J kg}^{-2}$; acceleration due to gravity $g = 6 \text{ m/s}^2$; radius of the Earth = 6400 km, we need to find height 'h' from the surface.

Gravitational potential is

$$V = \frac{GM}{R+h} = -5.4 \times 10^7$$

Acceleration due to gravity is $g = \frac{GM}{(R+h)^2} = 6$

$$\therefore \frac{5.4}{6} \times 10^7 = R+h$$

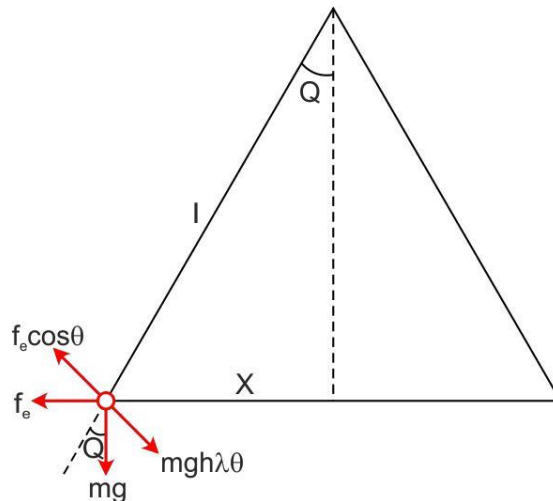
$$\therefore a \times 10^6 = 6.4 \times 10^6 + h$$

$$\therefore h = 2600 \text{ km}$$

8. An accelerating charge produces an electromagnetic wave.

$$9. v \propto x^{-\frac{1}{2}}$$

Two identical charged spheres are suspended from the same point by two mass less strings of length l . The initial distance between them is d ($d \ll l$). v is the velocity through which the spheres approach. The variation of v with respect to distance x is derived by



By the geometry of the above figure, we get

$$\theta = \frac{x}{l}$$

$$f_e \cos \theta = mgh\lambda\theta$$

$$f_e = mg \cdot \left(\frac{x}{l}\right)$$

$$kx^2 = mgx$$

$$kx^2 = \frac{mg}{2l} \cdot x^3$$

$$q \propto x^2$$

Differentiating w.r.t. time, we get

$$\frac{dq}{dt} \propto 2x \cdot \frac{dx}{dt}$$

The above implies to

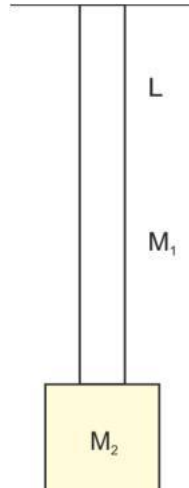
$$x^2 \cdot v = \text{constant}$$

$$\therefore v \propto x^{-2}$$

10. $\lambda_2 = \sqrt{\frac{M_1 + M_2}{M_1}} \cdot \frac{1}{f}$

A rope of length L and mass M_1 hangs vertically from a rigid support as shown below.

A block of mass of M_2 is attached to the free end of the rope. A transverse pulse of wavelength λ_1 is produced at the lower end.



Wavelength of the same pulse at the top is λ_2
 At the bottom of the rope, the pulse velocity is

$$\lambda_2 = \sqrt{\frac{M_1 + M_2}{M_1}} \cdot \frac{1}{f}$$

$$v_1 = \sqrt{\frac{M_2 g l}{M_1}}$$

$$\therefore \lambda_1 = \sqrt{\frac{M_2 g l}{M_1}} \cdot \frac{1}{f}$$

At the top of the rope, the ratio of pulse wavelengths is

$$\frac{\lambda_2}{\lambda_1} = \sqrt{\frac{M_1 + M_2}{M_2}}$$

$$\therefore v_1 = \sqrt{\frac{M_1 + M_2}{M_2}} \cdot \frac{1}{f}$$

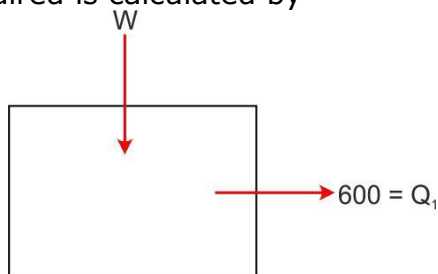
$$\lambda_2 = \sqrt{\frac{(M_1 + M_2) g l}{M_2}} \cdot \frac{1}{f}$$

11. $w = 236.5$

The working range of a refrigerator is from 4°C to 30°C . In order to keep the temperature of the refrigerated space constant, it is required to remove 600 calories of heat per second.

Let $t_1 = 4^\circ\text{C}$ and $t_2 = 30^\circ\text{C}$ and heat $Q = 600$ calories.

Therefore, the power required is calculated by



Analysing the above heat system,

$$\frac{Q + w}{600} = \frac{t_2}{277}$$

$$Q + w = 600 \times \frac{t_2}{277}$$

Substituting the given values (converting the temperature to Kelvin),

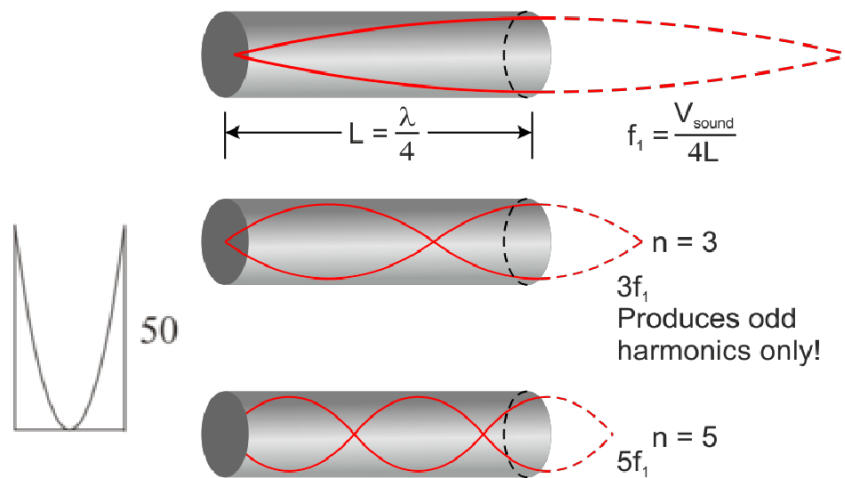
$$\frac{600 + w}{600} = \frac{303}{277}$$

$$1 + \frac{w}{600} = \frac{303}{277}$$

$$w = 600 \times \frac{26}{277} \times 4.2$$

12. 150 cm.

An air column which is closed at one end and open at the other, resonates with a tuning fork when the smallest length of the column is 50 cm. The following larger length of the column resonating with the same tuning fork is to be found.



By geometry of the resonating waves, we see that the next largest resonating length is thrice that of the smallest resonating wave; therefore, the largest resonating column length with the same fork is 150 cm.

13. 10^{-2}

For an ideal diode, the potential is +4 V at point A and is -6 V at point B, and a resistor of 1 kΩ is used; therefore, the current through AB is

$$V_a - V_b = 4 - (-6) = 10$$

Therefore, the current using Ohm's law,

$$\therefore i = \frac{10}{1000} = 10^{-2}$$

14. $H = \frac{a^3 R}{3b}$

The variation of charge through resistance R with respect to time is $Q = at - bt^2$, the heat produced can be expressed as

$$Q = at - bt^2$$

Therefore, $t \in]0, \left[\frac{a}{2b} \right[$

Current is $i = \frac{dq}{dt} = a - 2bt$

It is clear that current i is positive when $t \in \left] 0, \frac{a}{2b} \right[$ and is negative when $t \in \left] \frac{a}{2b}, a \right[$

$$\in \left] \frac{a}{2b}, a \right[$$

Current in the same direction is positive current and that in the opposite direction is negative current.

Hence, using the heating equation of current

$$\therefore dH = i^2 r dt$$

$$= (a - 2bt)^2 R dt$$

Integrating the above,

$$H = \int_0^{\frac{a}{2b}} (a - 2bt)^2 R dt$$

Integrating the above definite integral,

$$H = \left[\frac{(a - 2bt)^3 R}{3 \cdot -2b} \right]_0^{\frac{a}{2b}}$$

$$\frac{1}{-6b} [(-a)^3 - a^3] R$$

$$\therefore H = \frac{a^3 R}{3b}$$

15. $\therefore U_2 > U_1$

Temperature of a black body is 5670 K. At wavelength 250 nm the energy of radiation emitted by the body is U_1 , at wavelength 500 nm the energy of radiation emitted by the body is U_2 and the energy of radiation emitted by the body at wavelength 1000 nm is U_3 . Wien's constant, $b = 2.88 \times 10^6$ nmK.

Therefore the relationship between the energies is established using the black body radiation equation.

By Wien's displacement law

$$\lambda T = b$$

$$\therefore \lambda = \frac{2.88 \times 10^6}{5760}$$

$$\lambda = 500 \text{ nm}$$

Therefore, the energy of radiation with wavelength 500 nm is the largest.

$$\therefore U_2 > U_1$$

16. $\alpha_1 l_1 = \alpha_2 l_2$

Given that the difference in lengths ($l_2 - l_1$) is the same. So, the increase in the lengths is also the same.

$$\Delta l_1 = \Delta l_2$$

Increase in length is given as

$$l_1 \alpha_1 \Delta T = l_2 \alpha_2 \Delta T$$

$$\rightarrow l_1 \alpha_1 = l_2 \alpha_2$$

17. 4, 3.84

Given that $\alpha = 0.96$

Using the relation between the current gains of common base and common emitter, we get

$$\beta = \frac{\alpha}{1 - \alpha} = \frac{0.96}{1 - 0.96}$$

$$\therefore \beta = 24 \dots\dots\dots \text{(Equation 1)}$$

Voltage gain for common emitter configuration is

$$A_v = \beta \frac{R_L}{R_i}$$

Here $R_L = 800\Omega$ and $R_i = 192\Omega$

$$\therefore A_v = 24 \times 192 \frac{800}{192}$$

$$\therefore A_v = 100 \dots\dots\dots \text{(Equation 2)}$$

Voltage gain for common base configuration is

$$A_v = \alpha \frac{R_L}{R_p}$$

$$\therefore A_v = 0.96 \times 192 \frac{800}{192}$$

$$\therefore A_v = 4 \dots\dots\dots \text{(Equation 3)}$$

Power gain for the common emitter configuration is

$$P_v = \beta A_v$$

$$\therefore P_v = 24 \times 100 = 2400$$

Power gain for common base configuration is

$$P_v = \alpha A_v$$

$$\therefore P_v = 0.96 \times 4 = 3.84 \dots\dots\dots \text{(Equation 4)}$$

18. $\frac{I_0}{2}$

In Young's double slit experiment, $I_{\max} = I_0$

Path difference in front of one shift is

$$\left(\frac{y}{D} \right)$$

Here, $y = \frac{d}{2}$

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

Given that $D = 10d$ and $d = 5\lambda$

$$\therefore \Delta x = \frac{d^2}{2(10d)} = \frac{d}{20}$$

$$\rightarrow \Delta x = 20 \frac{5\lambda}{20}$$

$$\therefore \Delta x = 4\lambda \dots\dots\dots \text{(Equation 1)}$$

$$\phi = \frac{2\pi}{\lambda} \cdot \Delta x$$

$$\rightarrow \phi = \frac{2\pi}{\lambda} \times 4\lambda$$

$$\therefore \phi = 2\pi \dots\dots\dots \text{(Equation 2)}$$

Intensity at that point is $I = I_{\max} \cos^2 (\phi / 2)$

Substituting the value from equation 2 and $I_{\max} = I_0$, we

get π

$$\text{or } I = \frac{I_0}{2}$$

19. 8.0

Let us assume that the point is located at the periphery of the disc. The particle will have both radial and tangential acceleration.

Given: $R = 50 \text{ cm}$, $\alpha = 2 \text{ rad s}^{-2}$, $t = 2 \text{ s}$

Tangential acceleration is $a_t = R\alpha$

$$\rightarrow a_t = 0.5 \times 2 = 1 \text{ m/s}^2$$

At the end of 2 sec, $\omega = \omega_0 + \alpha t$

$$\rightarrow \omega = 0 + 2 \times 2$$

$$\rightarrow \omega = 4 \text{ rad/sec}$$

Particle acceleration towards the centre

$$\text{is } a_c = R\omega^2$$

$$\rightarrow a_c = 0.5 \times (4)^2$$

$$\rightarrow a_c = 8 \text{ m/s}^2$$

Total acceleration, $a_{\text{total}} = \sqrt{a_t^2 + a_c^2}$

$$\therefore a_{\text{total}} = \sqrt{1^2 + 8^2}$$

$$\therefore a_{\text{total}} = 8 \text{ m/s}$$

20. $\frac{1}{\lambda} = \frac{1}{h} \sqrt{2mE}$

de-Broglie wavelength

For electron: $\lambda_e = \frac{h}{p} = \frac{h}{\sqrt{2mE}}$

For photon: $\lambda_p = \frac{h}{p} = \frac{h}{E/c} = \frac{hc}{E}$

$$\frac{\lambda_e}{\lambda_p} = \frac{h}{\sqrt{2mE}} \times \frac{E}{hc}$$

$$\therefore \frac{\lambda_e}{\lambda_p} = \frac{1}{c} \sqrt{\frac{E}{2m}}$$

21. Sphere.

Acceleration of the object on rough inclined plane is $a = \frac{g \sin \theta}{1 + \frac{K^2}{R^2}}$,

which is independent of mass and radius.

For sphere, $\frac{K^2}{R^2} = \frac{1}{2} = 0.5$

For disc, $\frac{K^2}{R^2} = \frac{2}{5} = 0.4$

Thus, $a_{\text{sphere}} > a_{\text{disc}}$

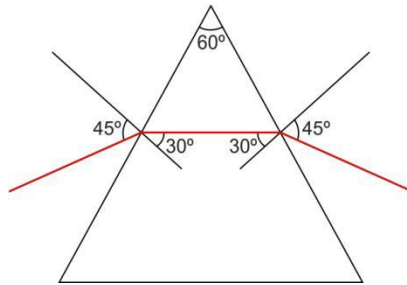
\therefore The sphere reaches first.

22. $30^\circ, \sqrt{2}$

Given that $i = 45^\circ$ and $A = 60^\circ$

Angle of minimum deviation, $\delta_m = 2i - A = 2(45^\circ) - 60^\circ$

$\therefore \delta_m = 30^\circ$



Refractive index of the material of the prism is

$$\mu = \frac{\sin \left(\frac{A + \delta}{2} \right)}{\sin \frac{A}{2}}$$

$$\mu = \frac{\sin \left(\frac{60^\circ + 30^\circ}{2} \right)}{\sin \left(\frac{60^\circ}{2} \right)}$$

$$\mu = \frac{\sin 45^\circ}{\sin 30^\circ} = 2$$

$$\mu = \sqrt{2}$$

23. m^{-1}

At closest approach the total kinetic energy of the α particle changes to potential energy,

$$\text{so } \frac{1}{2} mv^2 = \frac{kQq}{r}$$

$2r$

Given that $Q = ze$ and $q = 2e$

$$\rightarrow \frac{1}{2} mv^2 = \frac{k(ze) \times 2e}{r}$$

$$\rightarrow r = \frac{4kze^2}{mv^2}$$

$$\Rightarrow r \propto m^{-1}$$

24. 0.1 m/s^2

Given that $m = 0.01 \text{ kg}$, $r = 6.4 \text{ cm}$ and $\text{KE} = 8 \times 10^{-4} \text{ J}$

$$8 \times 10^{-4} \text{ J} = \frac{1}{2} \times 0.01 \times v^2$$

$$\therefore v^2 = 16 \times 10^{-2}$$

Speed, $v^2 = 2a_t s$ (Equation 1)

where $a_t = \text{Tangential acceleration}$

Here, $s = 2(2\pi r)$

Substituting the above in equation (1), we get

$$\therefore v^2 = 2a_t \times 4\pi r$$

$$\rightarrow a_t = \frac{v^2}{8\pi r}$$

$$(16 \times 10^{-2})$$

$$\rightarrow a_t = \frac{16 \times 10^{-2}}{8\pi \times 6.4 \times 10^{-2}}$$

$$\rightarrow a_t = 0.1 \text{ m/s}^2$$

25. $\frac{400}{\sqrt{3}}$

Given that $v_1 = 200 \text{ m/s}$, $T_1 = 300 \text{ K}$, $P_2 = 0.05 \times 10^5 \text{ N/m}^2$, $T_2 = 400 \text{ K}$ and $P_1 = 0.05 \times 10^5 \text{ N/m}^2$

$$v_{\text{rms}} = \sqrt{\frac{3RT}{M}}$$

$$\rightarrow \frac{v_1}{v_2} = \sqrt{\frac{T_1}{T_2}}$$

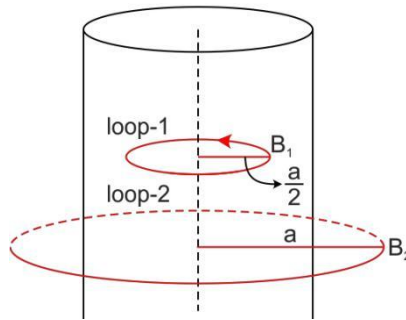
$$\rightarrow v_2 = v_1 \times \sqrt{\frac{T_2}{T_1}} \quad T^1$$

$$\therefore v_2 = v_1 \times \sqrt{\frac{T_2}{T_1}} \quad T^1$$

$$\therefore v_2 = 200 \text{ m/s} \times \sqrt{\frac{400 \text{ K}}{300 \text{ K}}}$$

$$\therefore v_2 = \frac{400}{\sqrt{3}} \text{ m/s}$$

26. 1



By Ampere's law:

For points outside the wire, $B = \frac{\mu_0 I}{2\pi r}$ ($r \geq R$)

$$\rightarrow B' = \frac{\mu_0 I}{2\pi(2a)} = \frac{\mu_0 I}{4\pi a}$$

For points inside the wire, $B = \frac{\mu_0 I r}{2\pi R^2}$ ($r \leq R$)

$$\rightarrow B = \frac{\mu_0 I (a/2)}{(2a)^2} = \frac{\mu_0 I}{4\pi a}$$

Taking ratio of B and B', we get

$$\frac{B}{B'} = \frac{\frac{\mu_0 I}{4\pi a}}{\frac{\mu_0 I}{4\pi a}} = \frac{1}{1}$$

27. Velocity is perpendicular to r and acceleration is directed towards the origin.

Velocity of the particle, $v = \frac{dr}{dt} = -\omega \sin \omega t \hat{x} + \omega \cos \omega t \hat{y}$ (Equation 2)

Acceleration of the particle, $a = \frac{dv}{dt} = -\omega^2 \cos \omega t \hat{x} - \omega^2 \sin \omega t \hat{y}$
 or $a = -\omega^2 r$ (Equation 3)

So, the direction of r and a are opposite.

From equation (1) and (2), we get

$$\therefore v \cdot r = 0 \Rightarrow v \perp r$$

28. $\sqrt{5gR}$

The particle will complete a full vertical loop no matter from where it enters the vertical loop when its minimum speed is $\sqrt{5gR}$.

29. 3λ

Using Einstein's potential energy equation,

$$\text{Case I: } eV = \frac{hc}{\lambda} - \frac{hc}{\lambda_0} \dots\dots\dots (\text{Equation 1})$$

$$\text{Case II: } e(V/4) = \frac{hc}{2\lambda} - \frac{hc}{\lambda_0} \dots\dots\dots (\text{Equation 2})$$

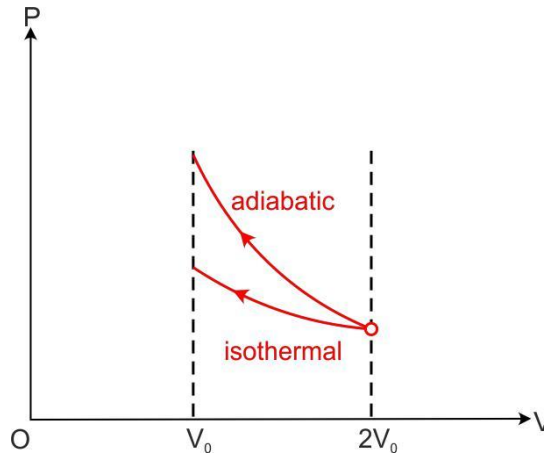
Subtracting equation (1) from (2), we get

$$\frac{hc}{\lambda} - \frac{2hc}{\lambda} = -\frac{4hc}{\lambda_0} + \frac{hc}{\lambda_0}$$

$$\therefore -\frac{hc}{\lambda} = -\frac{3hc}{\lambda_0}$$

$$\rightarrow \lambda_0 = 3\lambda$$

30. Compressing the gas through an adiabatic process will require more work to be done.



The adiabatic curve lies above the isothermal curve. So, in an adiabatic process, more work is done. That is

$W_{\text{ext}} = \text{negative area along the volume axis.}$

$$W_{(\text{adiabatic})} > W_{(\text{isothermal})}$$

31. 3:2

When the two cells connected in series support each other, the balancing length is 50 cm.

Now, the total emf of the cell is proportional to the balancing length.

$$E_1 + E_2 = xL_1 = 50x$$

Similarly, when the cells oppose each other, the balancing length is 10 cm.

$$E_1 - E_2 = xL_2 = 10x$$

$$\therefore \frac{E_1 + E_2}{E_1 - E_2} = \frac{50}{10} = 5$$

$$\therefore E_1 + E_2 = 5E_1 - 5E_2$$

$$\therefore 6E_2 = 4E_1$$

$$\therefore \frac{E_1}{E_2} = \frac{6}{4} = \frac{3}{2}$$

32. 54.0 cm

The object is placed at a distance of $u = -200$ cm from the objective.
Hence,

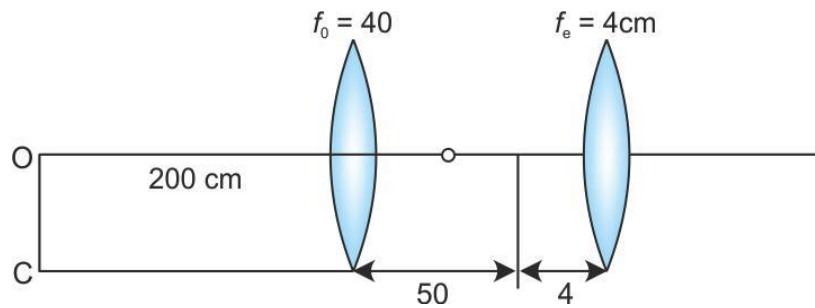
$$\frac{1}{v_o} - \frac{1}{u_o} = \frac{1}{f_o}$$

$$\therefore \frac{1}{v_o} = \frac{1}{f_o} + \frac{1}{u_o}$$

$$\therefore \frac{1}{v_o} = \frac{1}{40} - \frac{1}{200} = \frac{5-1}{200} = \frac{4}{200} = \frac{1}{50}$$

$$\therefore v_o = 50 \text{ cm}$$

Hence, the image is formed 50 cm from the lens.



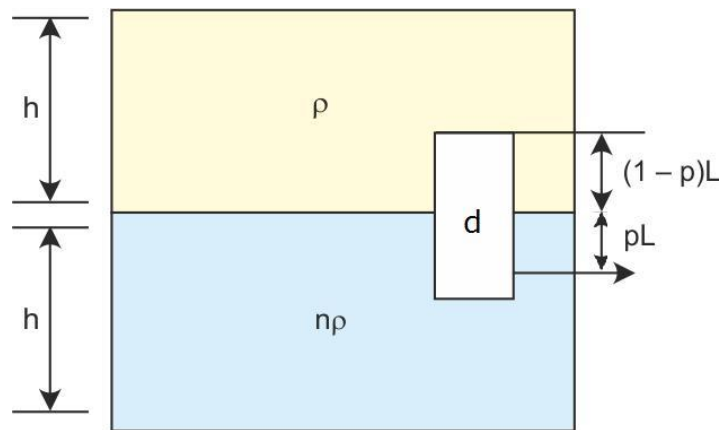
Now, the separation between the lens is

$$L = v_o + f_e$$

$$\therefore L = 50 + 4 = 54 \text{ cm}$$

33. $\rho [1 + p(n-1)]$

The container with the liquids and a cylinder in it is represented as



The cylinder is not moving inside the liquids, so the total weight of the cylinder is equal to the upthrust on it.

Weight of cylinder = Total upthrust

$\therefore Mg = \text{upthrust by rarer liquid} + \text{upthrust by denser liquid}$

$$\therefore ALdg = A(L - pL)\rho g + ApLn\rho g$$

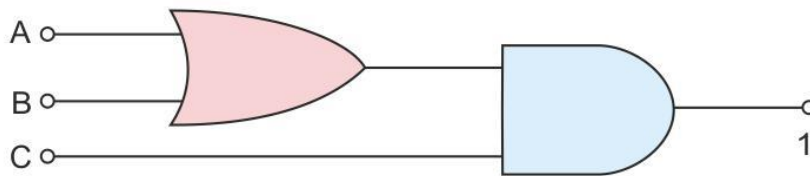
$$\therefore ALdg = AL\rho g - ApL\rho g + ApLn\rho g$$

$$\therefore d = \rho - p\rho + pn\rho = \rho(1 - p + np)$$

$$\therefore d = \rho \left[\frac{1 + p(n-1)}{1} \right]$$

34. A = 1, B = 0, C = 1

The given circuit is



The truth table for the circuit is

A	B	A+B	C	$Y = (A + B) \cdot C$
0	0	0	0	0
0	1	1	0	0
1	0	1	0	0
1	1	1	0	0
0	0	0	1	0
0	1	1	1	1
1	0	1	1	1
1	1	1	1	1

From the above truth table, we see that the output is 1 when either of A or B is 1 and C is 1. Hence, the correct option is A = 1, B = 0 and C = 1.

35. 136 km

The piece of ice is at a certain height h. At this height, it possesses energy equal to the potential energy mgh.

It is given that quarter of this energy goes in melting the ice. Now, the energy required to melt the ice is called latent heat mL.

$$\therefore \frac{1}{4} mgh = mL$$

$$\therefore h = \frac{4L}{g} = \frac{4 \times 3.4 \times 10^5}{10} = 1.36 \times 10^5 \text{ m}$$

$$\therefore h = 136 \times 10^3 \text{ m} = 136 \text{ km}$$

36. $1 : 2\sqrt{2}$

The escape velocity for an object on the Earth is

$$V_E = \sqrt{\frac{2GM_E}{R_E}}$$

Similarly, for a planet, the escape velocity is

$$V_P = \sqrt{\frac{2GM_P}{R_P}}$$

Therefore, the ratio is

$$\frac{V_E}{V_P} = \frac{\sqrt{\frac{2GM_E}{R_E}}}{\sqrt{\frac{2GM_P}{R_P}}} = \sqrt{\frac{M_E R_P}{M_P R_E}}$$

Now, we know that mass is the product of volume and density.

So,

$$\frac{V_E}{V_P} = \sqrt{\frac{\rho_E \times \frac{4}{3} \pi R_E^3 \times R_P}{\rho_P \times \frac{4}{3} \pi R_P^3 \times R_E}}$$

$$\rho_P = 2\rho_E \text{ and } R_P = 2R_E$$

$$\therefore \frac{V_E}{V_P} = \sqrt{\frac{\rho_E \times R_E^3 \times 2R_E}{2\rho_E \times 8R_E^3 \times R_E}} = \sqrt{\frac{1}{8}} = \frac{1}{\sqrt{4 \times 2}} = \frac{1}{2\sqrt{2}}$$

37. 90°

The magnitude of the sum of two vectors is equal to the magnitude of the difference of those two vectors. So,

$$|A + B| = |A - B|$$

$$\therefore A^2 + B^2 + 2AB \cos \theta = A^2 + B^2 - 2AB \cos \theta$$

$$\therefore 2AB \cos \theta + 2AB \cos \theta = 0$$

$$\therefore 4AB \cos \theta = 0$$

$$\therefore \cos \theta = 0$$

$$\therefore \theta = 90^\circ$$

38. $0.25 \times 10^7 \text{ m}^{-1}$

From Rydberg's formula, the wave number is

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

For the last line of the Balmer series, $n_i = \infty$ and $n_f = 2$.

$$\frac{1}{\lambda} = R \left(\frac{1}{2^2} - \frac{1}{\infty} \right) = R \times \frac{1}{4} = 0.25 \times 10^7 \text{ m}^{-1}$$

39. $(2t^3 + 3t^5) \text{ W}$

The acceleration of the body is

$$\mathbf{a} = \mathbf{\bar{m}} = 2t^2 \hat{i} + 3t^3 \hat{j}$$

Therefore, the velocity is obtained by integrating acceleration as

$$\mathbf{v} = \int_0^t \mathbf{a} dt = \int_0^t (2t^2 \hat{i} + 3t^3 \hat{j}) dt$$

$$\therefore \mathbf{v} = t^3 \hat{i} + t^4 \hat{j}$$

So, the power developed by the force is

$$P = \mathbf{F} \cdot \mathbf{v} = (2t^3 \hat{i} + 3t^5 \hat{j}) \cdot (t^3 \hat{i} + t^4 \hat{j})$$

$$\therefore P = 2t^3 \times t^3 + 3t^5 \times t^4$$

$$\therefore P = (2t^6 + 3t^9) \text{ W}$$

40. 0.51 W

The net impedance of the circuit is

$$Z = \sqrt{R^2 + (X_L - X_C)^2} = \sqrt{R^2 + \left(\omega L - \frac{1}{\omega C} \right)^2}$$

$$\therefore Z = \sqrt{40^2 + \left(340 \times 20 \times 10^{-3} - \frac{1}{340 \times 50 \times 10^{-6}} \right)^2}$$

$$\therefore Z = \sqrt{1600 + 6.8 - 58.8^2} = \sqrt{1600 + 2704} = \sqrt{4304} = 65.6 \Omega$$

Now, the mean voltage is $v_0 = 10 \text{ V}$.

Therefore, the r.m.s. value of current through the circuit is

$$i_m = \frac{V_m}{Z} = \frac{V_0}{\sqrt{2} Z} = \frac{10}{65.6 \times \sqrt{2}}$$

Therefore, the maximum power loss in the circuit is

$$P = i_m^2 R$$

$$\therefore P = \frac{10^2}{(65.6)^2} \times 2 \times 40 = 0.46 \text{ W}$$

Therefore, the closest answer to the above obtained result is 0.51 W .

41. $2\frac{3}{2} A + \frac{7}{3} B$

The velocity of the particle is

$$v = At + Bt^2$$

Hence, the distance travelled is obtained by integrating velocity over time t.

$$x = \int_0^t v = \int_0^t At + Bt^2$$

$$\therefore x = A \left[\frac{t^2}{2} \right]_0^t + B \left[\frac{t^3}{3} \right]_0^t$$

$$\therefore x = \frac{At^2}{2} + \frac{Bt^3}{3}$$

Hence, for t = 1 s

$$x = \frac{A}{2} + \frac{B}{3}$$

$$x_2 = \frac{A(2)^2}{2} + \frac{B(2)^3}{3} = 2A + \frac{8}{3} B$$

Hence, the distance travelled between 1 s and 2 s is

$$x_2 - x_1 = 2A - \frac{A}{2} + \frac{8}{3} B - \frac{B}{3} = \frac{3}{2} A + \frac{7}{3} B$$

42. 1 H

The flux linked with a solenoid of N turns is

$$N\phi = LI$$

where L is the self-inductance of the solenoid coil and I is the current flowing through it.

$$\therefore L = \frac{N\phi}{I}$$

$$\therefore L = \frac{1000 \times 4 \times 10^{-3}}{4}$$

$$\therefore L = 1 \text{ H}$$

43. Over a full cycle, the capacitor C does not consume any energy from the voltage source.

In a capacitor, the current leads the voltage by 90°. Hence, options (1), (3) and (4) are incorrect.

Now, the average power dissipated in a capacitor over a complete cycle is zero.

So, the capacitor does not consume any energy from the voltage source.

44. A → B and c, B → b and c, C → b and d, D → a and d
 The magnification for a mirror is

$$m = \frac{-v}{u}$$

Now, for column (1) option (A), $m = -2$

So,

$$-2 = \frac{-v}{u}$$

$$\therefore v = 2u$$

Hence, the sign of the image and the object is the same, i.e. the image is on the same side as the object. So, the image is real.

Now, we know that a convex mirror always forms a virtual image. Hence, the correct options for option (A) in column (2) are b and c.

Now, for column (1) option (B), $m = -1/2$

Here too, the correct options are b and c.

Now, for column (1) option (C), $m = +2$

So,

$$+2 = \frac{-v}{u}$$

$$\therefore v = -2u$$

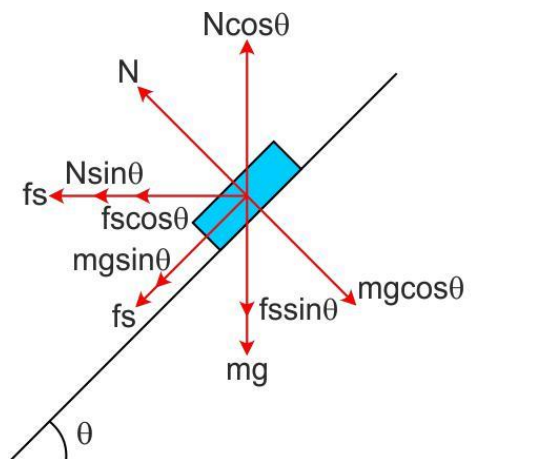
Now, the image is virtual, but it is also enlarged. A convex mirror always forms a diminished image. So, the correct options are b and d.

Finally, for column (1) option (D), $m = +1/2$

Hence, the correct options are a and d.

45.
$$\sqrt{gR \frac{\mu_s + \tan \theta}{1 - \mu_s \tan \theta}}$$

The forces on the car are as shown in the figure below.



From the diagram, the forces which balance each other are

$$\frac{mv^2}{R} = N \sin \theta + \mu_s N \cos \theta$$

$$\therefore \frac{mv^2}{R} = N \sin \theta + \mu_s N \cos \theta = N (\sin \theta + \mu_s \cos \theta)$$

$$\text{And } mg = N \cos \theta - \mu_s N \sin \theta = N (\cos \theta - \mu_s \sin \theta)$$

Therefore, we get

$$\frac{mv^2}{R} = \frac{N (\sin \theta + \mu_s \cos \theta)}{N (\cos \theta - \mu_s \sin \theta)}$$

$$Rmg = \frac{N (\sin \theta + \mu_s \cos \theta)}{N (\cos \theta - \mu_s \sin \theta)}$$

$$\therefore v^2 = Rg \left| \frac{\sin \theta + \mu_s \cos \theta}{\cos \theta - \mu_s \sin \theta} \right| = Rg \left| \frac{\mu_s + \tan \theta}{1 - \mu_s \tan \theta} \right|$$

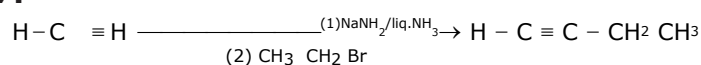
$$\left(\cos \theta - \mu_s \sin \theta \right) \quad \left(1 - \mu_s \tan \theta \right)$$

Chemistry

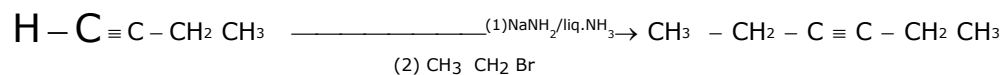
46.

Bond Angle	Molecule
104.5°	H ₂ O
107°	NH ₃
109°28'	CH ₄

47.



1 – Butyne (x)



3 – Hexyne (y)

48. As the number of oxygen atoms attached to chlorine increases, the acid strength increases.

49.

$$K = \frac{2.303}{t} \log \frac{a_0}{a_t}$$

$$\frac{2.303 \times 0.3010}{t^{1/2}} = \frac{2.303}{t} \log \frac{a_0}{a_t}$$

$$\frac{0.3010}{t^{1/2}} = \frac{1}{10} \log a_0 \times \frac{3}{4}$$

$$\frac{0.3010}{t} = \frac{1}{10} \log \frac{4}{3}$$

$$\frac{0.3010^{1/2}}{t^{1/2}} = \frac{1}{10} \times 0.125$$

$$t_{1/2} = 24.1 \text{ s}$$

50. For the adsorption process,

$\Delta H = -ve$; the adsorption process is exothermic.

$\Delta S = -ve$; the adsorption process is feasible.

$\Delta G = -ve$; the adsorption process is accompanied by a decrease in entropy.

- 51.** Ionisation enthalpy of N is greater than O because of its stable electronic configuration. Hence, the order $B < C < N < O$ is incorrect.
- 52.** Calcium plays an important role in neuromuscular function, interneuronal transmission and cell membrane integrity and blood coagulation.
- 53.** Hydrogen has three isotopes—protium, deuterium and tritium. Tritium is radioactive and very rare. Dihydrogen acts as a reducing agent.
- 54.** A carbonyl compound with a hydrogen atom on its alpha-carbon rapidly equilibrates with its corresponding enol, and this process is known as keto-enol tautomerism.

55.

$$\text{Solubility of MY} = \sqrt[3]{K_{sp}} \quad \text{of NY}_3 = \sqrt[4]{K_{sp}}$$

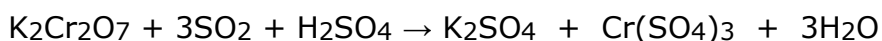
So, the solubility of NY_3 is greater than that of MY .

56. Amino acids are joined by peptide bonds in proteins.

57. Natural rubber is cis polyisoprene.

58. The cyanide process is used to extract gold (Au) in hydrometallurgy. The froth flotation process is used for dressing of sulphide ores (ZnS). Electrolytic reduction is used to extract aluminium (Al). The zone refining process is used for obtaining ultrapure germanium (Ge).

59. The reaction is



(green)

60. The electronic configurations of Eu, Gd and Tb are
 Eu ($Z = 63$) [Xe] $4f^7, 6s^2$
 Gd ($Z = 64$) [Xe] $4f^7, 5d^1, 6s^2$
 Tb ($Z = 65$) [Xe] $4f^9, 6s^2$

61. Electrons occupying the same orbital have different spin quantum numbers.

62. When copper is heated with concentrated nitric acid, it produces copper(II) nitrate and nitrogen dioxide. The reaction is

$$\text{Cu} + 4\text{HNO}_3 \rightarrow \text{Cu}(\text{NO}_3)_2 + 2\text{NO}_2 + 2\text{H}_2\text{O}$$
 (conc.)

63. Acetone usually condenses with the cis hydroxyl groups on the adjacent carbon atoms. Thus, it is used to distinguish cis-cyclopenta-1, 2-diol from the trans isomer. The reaction is

64. $\Delta G = \Delta H - T\Delta S$

ΔG will always be negative when ΔH is negative and ΔS is positive.

Hence, the thermodynamic conditions for the spontaneous reaction at all temperatures are $\Delta H < 0$ and $\Delta S > 0$.

65.

$$d = \frac{Z \times M}{a^3 \times N_A}$$

$$a^3 = \frac{2 \times 6.94}{53 \times 10^{-3} \times 6.02 \times 10^{23}}$$

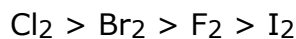
$$= \frac{0.53 \times 6.02 \times 10^{23}}{2 \times 6.94}$$

$$= 43.5 \times 10^{-24} \text{ cm}^3$$

$$a = 3.52 \times 10^{-8} \text{ cm}$$

$$= 352 \text{ pm}$$

66. The correct order of bond dissociation enthalpy of halogens is



This is due to the anomalous behaviour of large electron–electron repulsion among the lone pairs in the F_2 molecule compared to the Cl_2 and Br_2 molecules.

67. Novalgin is an analgesic. It is used for the treatment of pain. Penicillin and streptomycin are antibiotics, and chloromycetin is useful for the treatment of several bacterial infections.

68.

$$\frac{n_{\text{O}_2} / t_1}{H_2 / 2} = \sqrt{\frac{M_{\text{H}_2}}{M_{\text{O}_2}}}$$

$$\text{Now, } t_1 = t_2 \text{ and } n_{\text{H}_2} = \frac{1}{2},$$

$$\Rightarrow \frac{2n_{\text{O}_2}}{1} = \sqrt{\frac{2}{32}}$$

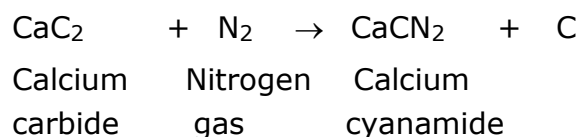
$$\Rightarrow n_{\text{O}_2} = \frac{1}{8}$$

69.

On addition of a large amount of KHSO_4 , the concentration of HSO_4^- increases. Hence, the equilibrium shifts backward.

70. According to the VSEPR theory, the overall order of repulsion is lone pair–lone pair > lone pair–bond pair > bond pair–bond pair

71.



72.

$$P = Ae^{-\frac{H_{\text{vap}}}{RT}}$$

$$\ln P = \ln A - \frac{H_{\text{vap}}}{RT}$$

$$\frac{d}{dT} \ln P = \frac{H_{\text{vap}}}{RT^2}$$

$$\therefore \frac{d \ln P}{dT} = \frac{H_{\text{vap}}}{RT^2}$$

73.

Column I		Hybridisation	Column II	
(a)	XeF ₆	sp ³ d ³	(i)	distorted octahedral
(b)	XeO ₃	sp ³	(iii)	pyramidal
(c)	XeOF ₄	d ² sp ³	(iv)	square pyramidal
(d)	XeF ₄	sp ³ d ²	(ii)	square planar

74. The metal carbon bond in metal carbonyls possesses both σ and π character.

The M-C π bond is formed by donation of a pair of electrons from the filled orbital of metal into vacant antibonding π orbital of CO.

Greater the negative charge on the metal, greater will be the ease of electron transfer from the metal to the π^* orbital of CO. Accordingly, the M-C bond order increases and the C-O bond order decreases.

75.

Pt, H_{2(g)} / H⁺ Hydrogen electrode E^o_{H₂ / H⁺} = 0.0 Volt

H_{2(g)} → 2H_{+(aq)} + 2e⁻ [H₊] = 10⁻⁷ M at 25°C (for Pure water)

$$E = -0.0591 \log \left(\frac{[H^+]^2}{P_{H_2}} \right)$$

$$E = 0 = \log \frac{[H^+]^2}{P_{H_2}} = 0$$

$$\therefore [H^+]^2 = P_{H_2}$$

$$\therefore P_{H_2} = 10^{-14} \text{ atm}$$

76. Activation energy is the minimum energy required to form an activated complex at the transition state. A catalyst lowers the activation energy.

77. Radius ratio of

$$\left(\frac{A^+}{B^-} \right) = \frac{0.98 \times 10^{-10} \text{ m}}{1.81 \times 10^{-10} \text{ m}} = 0.54$$

The co-ordination number is 6 if the radius ratio is between 0.414 and 0.732.

78. Phosphinic acid is hypophosphorous acid H_3PO_2 which is a monobasic acid.

Phosphonic acid is phosphorous acid H_3PO_3 which is a dibasic acid.

79. It is a colloidal solution in which a liquid is dispersed in gas.

80. Let A = Benzene, B = Toluene

$$= 12.8 \times 0.5 + 3.85 \times 0.5$$

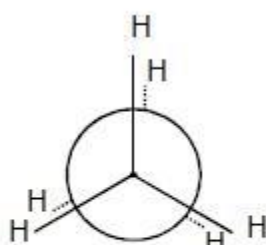
$$= 6.2 + 1.925$$

$$= 8.125$$

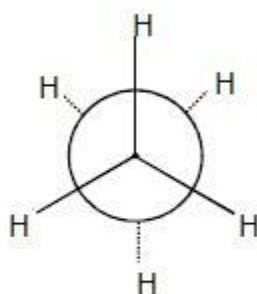
Also, the mole fraction of benzene
$$Y_A = \frac{P_A X_A}{P_T} = \frac{6.2}{8.125} = 0.75$$

and the mole fraction of toluene
$$Y_B = 1 - 0.75 = 0.25$$

81. The staggered conformation of ethane is more stable than the eclipsed conformation because the staggered conformation has no torsional strain.



Eclipsed



Staggered

85. (a) is an elimination reaction, (b) is a substitution reaction and (c) is an addition reaction.

86. 101°C

$$\frac{P^0 - P}{P^0} = \frac{m \times M}{1000}$$

$$\frac{-28}{\frac{18}{1000}} = \frac{m}{760}$$

$$m = 2$$

$$\Delta T_b = K_b \times m = 0.52 \times 2 = 1.04 \approx 1$$

$$\text{Boiling point of solution} = 100 + 1 = 101^\circ\text{C}$$

87. The sugar component in RNA is ribose, and the sugar component in DNA is 2'-deoxyribose.

88. Arylamines are generally less basic than alkyl amines because the nitrogen lone pair electrons are delocalised by interaction with the aromatic ring π electron system.

The basic strength decreases because the lone pair is in conjugation with the double bond.

89. It is a non-reducing sugar.

90. If we look at the carbanion, the carbon has 1 sigma, 2 pi bonds and one lone pair. Hence, C is sp hybridised.

Biology

- 91.** Gause's principle of competitive exclusion states that two closely related species competing for the same resources cannot coexist indefinitely. The competitively inferior species will be eliminated in the long run. Therefore, when two closely related species with similar requirements occur in the same environment, they either use different food or become active at different time periods or occupy different niches to avoid competition.
- 92.** The protein human insulin consists of two polypeptide chains—A and B—linked together covalently by two disulphide bonds. The A chain consists of 21 amino acid residues, while the B chain consists of 30 amino acid residues.
- 93.** In nuclear type of endosperm, the first division of the primary endosperm nucleus (PEN) and few subsequent nuclear divisions are not accompanied by cell wall formation. The primary endosperm cell divides repeatedly and forms a triploid endosperm tissue. It consists of reserve food materials which are used for the nourishment of the developing embryo. The PEN undergoes successive nuclear divisions to give rise to free nuclei. Subsequently, cell wall formation occurs and the endosperm becomes cellular. In coconut, cell wall formation of the endosperm is never found complete. Hence, coconut water from a tender coconut represents free nuclear endosperm, and the surrounding white kernel is the cellular endosperm.
- 94.** Viroids are infectious agents smaller than viruses. They lack a capsid and do not have any proteins associated with them. The infectious substance present in viroids is a free RNA of low molecular weight. Viroids have been known to cause some very important plant diseases such as potato spindle tuber disease and *Citrus exocortis* disease.
- 95.** Arthropoda is the largest phylum and includes about 80% of the total animals on the Earth. It includes characteristics such as
- Thick, tough chitinous exoskeleton
 - Jointed appendages which are differently modified to perform different functions
 - Heteronomous metamerism where the anterior segments show clear cephalisation and are modified into head-bearing specific sense organs
- The presence of unjointed appendages called parapodia or suckers is a characteristic feature of Phylum Annelida. These parapodia serve as organs of locomotion in annelids.

- 96.** Haemophilia is a Mendelian disorder in which the blood lacks the capacity to coagulate. It is caused by a recessive gene located on the X chromosome. This gene controls the synthesis of a protein required for the clotting of blood. The gene for haemophilia being located on the X chromosome can produce the defect because there is no homologue of this gene on the Y chromosome to curb its expression. Haemophilia follows a criss-cross pattern of inheritance because a haemophilic father passes on the haemophilic gene to his carrier daughters who transmit haemophilia to their sons.
- 97.** Emerson and Lewis observed that the quantum yield of photosynthesis decreased very sharply towards 680 nm (red region) and longer wavelengths. The fall in photosynthetic yield beyond the red region of the spectrum is called Emerson's first effect or red drop. Later, Emerson and his co-workers found that monochromatic light of longer wavelength (far red light) supplemented with light of shorter wavelength (red light) enhanced photosynthetic yield. This is called Emerson enhancement effect or Emerson's second effect. The discovery of Emerson's effect clearly indicates the existence of two distinct photochemical processes believed to be associated with two different pigment groups called pigment/photosystem I and pigment/photosystem II. Each photosystem has all the pigments, except for chlorophyll a. These pigments form the light harvesting complex called antennae and the single chlorophyll a molecule forms the reaction centre.
- 98.** The essential elements which are used in relatively large amounts by plants for their growth are called macronutrients. Carbon, oxygen, hydrogen, nitrogen, sulphur, phosphorus, potassium, magnesium and calcium are macronutrients. The essential elements which are required in minute quantities by plants for plant growth are called micronutrients. Iron, boron, manganese, zinc, copper, molybdenum, chlorine and nickel are micronutrients.
In the given choices, none of the options represents three macronutrients as asked in the question. All the options are a combination of macro and micronutrients.
- 99.** Emphysema is a chronic respiratory disorder caused mainly by cigarette smoking. Smoking of cigarettes stimulates the release of proteinases and inactivates anti-proteinases. This decreases the repairing capacity of damaged interstitial proteins.

- 100.** Ley farming is a system of rotating crops with legume or grass pastures to improve soil structure and fertility and to disrupt the life cycles of pests and other disease-causing agents.

Contour farming is the practice of growing crops on the level across or perpendicular to a slope rather than up and down the slope.

Strip farming is the practice of growing different crops on alternate strips of ground so as to minimise soil erosion.

Shifting agriculture is a system of cultivation in which a plot of land is cleared and cultivated for a short period of time, then abandoned and allowed to revert for producing its normal vegetation, while the cultivator moves on to another plot.

- 101.** Mitochondria and chloroplasts are semi-autonomous organelles. They have the complete protein synthesising machinery including DNA, RNA, ribosomes and ATP for the synthesis of the required proteins. For some other proteins, these organelles depend on nuclear DNA and cytoplasmic ribosomes.

- 102.** Amniocentesis is a prenatal test in which a small amount of amniotic fluid is removed from the sac surrounding the foetus for testing.

- It is usually done when a woman is about 14–16 weeks pregnant.
- It is used for prenatal sex determination.
- It can be used for the detection of congenital defects such as Down syndrome.
- Because ultrasound is performed at the time of amniocentesis, it may detect birth defects such as cleft palate, cleft lip, club foot or heart defects.

In the given choices, all the options in the context of amniocentesis are correct.

- 103.** In photosynthesis, proton accumulation is towards the inside of the membrane, i.e. in the lumen. Therefore, in a chloroplast, the highest number of protons is found in the lumen of thylakoids. In the lumen, protons are produced because of splitting of water which occurs on the inner side of the membrane.

- 104.** The photoreceptors or visual cells in eyes are of two types—rods and cones. Rods have a visual purple pigment called rhodopsin, while cones have a visual violet pigment called iodopsin. Light induces the photopigments of photoreceptors to dissociate into opsin (protein) and retinal (aldehyde of vitamin A).

105. Small disc-shaped structures called kinetochores serve as sites of attachment of spindle fibres to the chromosomes which are moved into position at the centre of the cell. Spindle fibres which connect the poles to the chromosomes at the kinetochores are called chromosomal fibres or tractile fibres.

106. River Dolphin is the national aquatic animal of India. This mammal is also said to represent the purity of the holy River Ganga as it can only survive in pure and freshwater.

107. In an inducible system, the genes are induced or switched on to produce mRNA needed for the synthesis of required enzymes. The substance which induces the gene to transcribe specific mRNA is called inducer or activator. The substrate lactose acts as an inducer for the synthesis of the enzyme β -galactosidase and the genes associated with the enzymes of lactose metabolism form the lac inducible system.

108.

Parathormone	Increases calcium in the blood
Calcitonin	Decreases calcium in the blood

Insulin	Stimulates the liver and most other body cells to absorb glucose.
Glucagon	Stimulates the liver to release glucose

Aldosterone	Stimulates sodium retention
Atrial Natriuretic Factor	Stimulates sodium loss

Relaxin	Loosens pelvic ligaments, dilates and relaxes muscles of the uterus
Inhibin	Inhibits FSH and GnRH secretion

109. Microtubules are hollow, unbranched cylinders. They are found only in eukaryotic cellular structures such as cilia, flagella, centriole, basal body, astral fibres, spindle apparatus and sperm tail. Microtubules form part of the cytoskeleton and provide mechanical support, aid in locomotion and feeding.

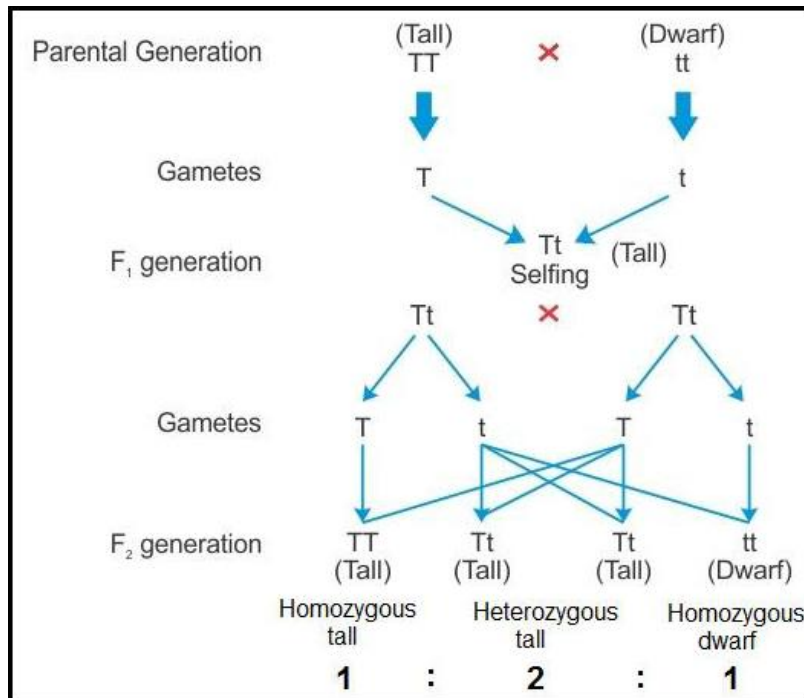
110. Polyribosome or polysome is a cluster of ribosomes connected by a strand of mRNA and function as a unit in protein synthesis.

- 111.** Fertilisation in humans occurs in the ampulla of the fallopian tube. For successful fertilisation, it is necessary that the ovum and the sperms are transported simultaneously to the ampullary isthmic junction of the fallopian tube.
- 112.** Mast cells play a significant role in the pathophysiology of asthma because of their ability to release a host of pleiotropic autacoid mediators, proteases and cytokines in response to activation by both immunoglobulin (IgE-dependent) and diverse non-immunological stimuli.
- 113.** The *Avena* curvature test is used for the bioassay of auxins. The most important auxin found in plants is indole-3-acetic acid (IAA). *Avena* coleoptile curvature test is based on the ability of auxins to stimulate shoot growth (or inhibit root growth).
- 114.** Papilionaceous corolla is a butterfly-shaped irregular corolla consisting of five petals. The posterior largest petal is called standard or vexillum.
- 115.**

Floral families	Type of gynoecium
Liliaceae	Tricarpellary, trilocular, syncarpous
Solanaceae	Bicarpellary, bilocular, syncarpous
Fabaceae/Leguminosae	Monocarpellary, unilocular
Poaceae	Monocarpellary, unilocular

- 116.** Chitin is a neutral heteropolysaccharide and a polymer of N-acetyl glucosamine units interlinked by β (1 \rightarrow 4) glycosidic bonds. It is commonly found in the cell wall of most fungi and is also called fungal cellulose.
- 117.** During the follicular phase of the menstrual cycle, the anterior pituitary lobe secretes FSH. FSH stimulates the ovarian follicle to secrete oestrogen. The oestradiol inhibits the secretion of FSH and stimulates the secretion of LH from the anterior pituitary. At about the 14th day of the menstrual cycle, both FSH and LH attain a peak level.
- 118.** The phenomenon of crossing over occurs during the pachytene stage of meiosis I. The exchange of genes or crossing over between two non-sister chromatids of homologous chromosomes occurs at points called recombination nodules which appear at intervals on the synaptonemal complex. Crossing over is regulated by enzyme recombinase.

119.



120. Destruction of natural habitats and fragmentation are the main causes of loss of biodiversity and extinction of wildlife. Human activities such as cutting down trees, burning forests and filling wetlands are the main causes of habitat loss. Fragmentation includes diversion of forest land into croplands, orchards, exotic plantations or construction of buildings and roads. Because of fragmentation of large forest tracts, tigers, lions and bears are greatly threatened.

121. Cropland ecosystem is a Cropland ecosystem has equal type of crop plants. So, it has less diversity and high productivity.

122. Gonadotropic-releasing hormone (GnRH) is regulated by follicle-stimulating hormone and luteinising hormone. So, FSH stimulates follicle cells to secrete oestrogen and LH secretes progesterone and oestradiol, respectively.

123. Plasmid is double-stranded, circular, self-replicating and extra chromosomal DNA in bacterial cells.

124.

- The body cavity of *Periplaneta Americana* (cockroach) consists of schizocoelom which is formed by splitting of the mesoderm in the embryonic condition.
- During embryonic development of cockroach, determinate cleavage is seen (indeterminate cleavage in deuterostomes and determinate cleavage in protostomes).
- The exoskeleton is formed of chitin which is a polysaccharide of N-acetylglucosamine molecules.
- Linear series of body segments (metamerism) is found in cockroach.

125. Autoimmune disease is a group of disorder in which the cells of the acquired immunity loses the ability to differentiate between self and non-self.

126.

Column I	Column II
(a) Dominance	(ii) In a heterozygous organism, only one allele expresses itself.
(b) Codominance	(iii) In a heterozygous organism, both alleles express themselves fully.
(c) Pleiotropy	(iv) A single gene influences many characters.
(d) Polygenic inheritance	(i) Many genes govern a single character.

127. Originating in the early 1970s, the concept of joint forest management (JFM) is the official and popular term in India which was introduced to protect forest cover in India.

128.

- Haemophilia is a sex-linked recessive disease because of the problem in the clotting of blood.
- Down syndrome is an aneuploid trisomic disease which is caused by the presence of an extra chromosome 21.
- Phenylketonuria is an autosomal recessive disorder caused by mutations in both alleles of the gene for phenylalanine hydroxylase (PAH) found on chromosome 12.
- Sickle cell anaemia is an autosomal hereditary disease.

129. Eubacteria means true bacteria which includes all bacteria except for Archaeobacteria.

- 130.** The proximal end of the filament of the stamen is attached to the thalamus or petal and the distal end is attached to the anther.
- 131.** Vasectomy is a permanent contraceptive method in which a small part of the vas deferens is removed or tied up (by a small incision on the scrotum). It prevents the entry of sperm into the semen, thus preventing fertilisation.
- 132.** Taq polymerase is a thermostable DNA polymerase named after the thermophilic bacterium *Thermus aquaticus*.
- 133.** *Inhibin* is a hormone secreted by the granulosa cells in the ovaries of women. It acts primarily to inhibit the secretion of follicle-stimulating hormone.
- 134.** *Meloidogyne incognita* cause root-knot disease in tobacco plant.
- 135.** Measles and oral polio vaccines contain attenuated (weakened) viruses which are administered into the body.
- 136.** Lysosomes are roughly spherical bodies enclosed by a single membrane, whereas mitochondria, chloroplasts and nuclei are enclosed by double membrane.
- 137.** A sustained muscle contraction because of the lack of relaxation between successive stimuli is called tetanus.
- 138.** Pitcher of *Nepenthes* is the modification of leaf lamina, whereas thorns of citrus, tendrils of cucumber and flattened structures of *Opuntia* are modifications of the stem.
- 139.** Anthocyanins are water-soluble vacuolar flavonoid pigments ranging from red to blue to purple shades which provide colour in certain flowers and fruits (red, blue and purple tints in apples, berries, eggplant and radishes).
- 140.**
- Gymnosperms are only heterosporous as the spores differ in size and sex.
 - *Pinus* and *Salvinia* are gymnosperms, whereas *Ginkgo* is an angiosperm.
 - The giant Sequoia is the world's tallest tree which is a gymnosperm. It can reach 130–150 metres in height.
- 141.** Zinc fingers are small protein domains in which zinc plays a structural role contributing to the stability of the domain. It does not have any role in DNA fingerprinting.

142.

- The walls of hollow organs such as stomach, intestine and ureter contain smooth muscle.
- Tendon is dense, regular, white, fibrous connective tissue and areolar tissue is loose connective tissue.
- The tip of the nose is made of elastic cartilage.
- The stomach is lined with columnar epithelium.

143. C4 plants such as maize can fix CO₂ at high temperature and high intensity of light. Its productivity is high at higher intensity. Photorespiration is absent in these plants.

144. The flipper of a whale is homologous to the wing of a bird because they are similar in structure but perform different functions.

145.

- Chondrichthyes have an endoskeleton made of cartilage.
- All mammals are viviparous except platypus which is oviparous.
- All chordates possess a mouth with an upper and a lower jaw except organisms such as Agnatha which are without jaws.
- All reptiles have a three-chambered heart except crocodile and tortoise in which the heart is four-chambered.

146. Telomerase is also found in high levels in cancer cells. This enables cancer cells to be immortal and continue replicating themselves. If telomerase activity was switched off in cancer cells, their telomeres would shorten until they reached a 'critical length'. This would prevent the cancer cells from dividing uncontrollably to form tumours.

147. Tryptophan is the precursor for the synthesis of melatonin and serotonin.

148. Both statements are true.

149. The decrease in blood pH is likely the direct cause of lower haemoglobin affinity for oxygen which is called Bohr effect.

150. Development of similar adaptive functional structures in unrelated groups of organisms is called convergent evolution. Example: Wings of insect, bird and bat show convergent evolution as they are analogous structures.

151. Hind II was the discovered restriction endonuclease isolated from Haemophilus influenza Rd. It recognises a specific sequence of 6 base pairs on the DNA and cuts the DNA to produce blunt ends.

152. A. G. Tansley coined the term ecosystem for the first time in 1935.

153. Methionine, cysteine and homocysteine are the three sulphur-containing amino acids, while glycine consists of a single hydrogen atom as its side chain.

154. In algae, bryophytes and pteridophytes, water serves as the medium for gamete transfer.

155.

$$\frac{dN}{dT} = rN \left(1 - \frac{N}{K} \right)$$

Given that $\frac{N}{K}$ is exactly equal to 1.

$$\therefore \frac{dN}{dT} = rN(1 - 1)$$

$$\Rightarrow \frac{dN}{dT} = rN(0)$$

$$\Rightarrow \frac{dN}{dT} = 0$$

156. In a typical anther, the epidermis, endodermis and middle layer function in dehiscence and provide protection to the young anther. The tapetum functions in nourishment to the developing microspore mother cells and pollen grains, production of Ubisch granules and secretion of callase enzyme.

157. Lichens appear as the pioneer organisms on a bare rock as they can tolerate desiccation and extreme heating during summers and cooling during winters. They can also erode the rock and extract mineral nutrients and survive in extreme conditions.

158. AUG and GUG are the two start codons.

159. Birds lay eggs and hence are oviparous unlike mammals which give birth to young ones (viviparous).

160. A scientific name of an organism cannot be written in any language. When a name is derived from any other language, it must be Latinised.

161. The blood pressure in the pulmonary artery is more than that in the pulmonary vein as blood pressure in the arteries is more than that in the veins.

- 162.** Maize is a monocot. Monocots have a single cotyledon and are called scutellum.
- 163.** Parietal cells of the gastric glands of the stomach secrete the gastric acid HCl.
- 164.** Ozone found in the ozone layer is responsible for absorbing the harmful UV-B rays which cause skin cancer. Depletion of ozone reduces the amount of UV-B absorbed, thus increasing the incidence of skin cancer.
- 165.** Chrysophytes, Euglenoids, Dinoflagellates and Slimes are eukaryotic unicellular organisms and are included in Kingdom Protista.
- 166.** In plants, both photosynthesis and transpiration occur at the same time and water vapour and CO₂ both move out and inside the cell as the diffusion coefficient of the two is different and each moves along its concentration gradient.
- 167.** In humans, urea and other waste materials are produced in the liver. Because the hepatic vein carries blood out of the liver, it carries the highest amount of urea.
- 168.** Apomixis is the process of seed formation in plants without undergoing fertilisation. In this type of reproduction, the zygote is formed without the fusion of gametes. The two common ways by which apomixis occurs is recurrent agamospermy and adventitious embryony.
- 169.** Lipase is obtained from *Candida lipolytica* and *Geotrichum candidum*. It is used in detergents to remove oily stains from clothes.
- 170.** In a testcross involving the F₁ dihybrid, if more of the parental type offspring are obtained as compared to the recombinant type, then it is indicative that the genes are linked and present on the same chromosomes due to which they fail to segregate and the same parental type is retained in the progeny.
- 171.** As compared to large animals, small animals have a high metabolic rate, and as a result, more energy is available. Hence, smaller animals can run uphill faster than larger animals.
- 172.** Synapsis is the crossing over of two homologous chromosomes. Crossing over occurs only during recombination, which is a feature of meiosis and does not occur during mitosis.

- 173.** More than one pollen tube from the pollen grain of the same species may grow into the style of the gynoecium.
- 174.** In certain species of plants, the guard cells are surrounded by the subsidiary cells. These cells help maintain the turgidity of the cells and thus help regulate the opening and closing of the stomata.
- 175.** The opening of the hepatopancreatic duct into the duodenum is guarded by the sphincter of Oddi.
- 176.** In xerophytes, the leaves are highly reduced to form spines, and the stems are modified into flattened green structures called phylloclades, which carry out the functions of the leaves.
- 177.** Methanogens belong to the group of Archaeobacteria, Kingdom Monera, are responsible for the production of biogas from dung.
- 178.** Domestic sewage rich in organic waste increases the number of algae in the river. This results in algal blooms. The algae on the surface use up most oxygen dissolved in the water, reducing the availability of oxygen for other aquatic organism, thus killing them.
- 179.** Polyploidy is caused by an increased number of chromosomes because of chromosome duplication without cell division.
- 180.** A typical fat molecule is made of one glycerol molecule and three fatty acid molecules.