

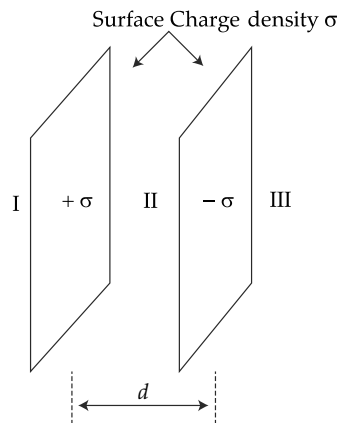
JEE (Main) PHYSICS SOLVED PAPER

2023
01st Feb Shift 1

Section A

- Q. 1.** A child stands on the edge of the cliff 10 m above the ground and throws a stone horizontally with an initial speed of 5 m s^{-1} . Neglecting the air resistance, the speed with which the stone hits the ground will be $__ \text{ m s}^{-1}$ (given, $g = 10 \text{ m s}^{-2}$).
- (1) 15 (2) 20 (3) 30 (4) 25

- Q. 2.** Let σ be the uniform surface charge density of two infinite thin plane sheets shown in figure. Then the electric fields in three different regions E_I , E_{II} and E_{III} are:



- (1) $\vec{E}_I = \frac{2\sigma}{\epsilon_0} \hat{n}, \vec{E}_{II} = 0, \vec{E}_{III} = \frac{2\sigma}{\epsilon_0} \hat{n}$
- (2) $\vec{E}_I = \frac{2\sigma}{2\epsilon_0} \hat{n}, \vec{E}_{II} = 0, \vec{E}_{III} = \frac{2\sigma}{2\epsilon_0} \hat{n}$
- (3) $\vec{E}_I = -\frac{\sigma}{\epsilon_0} \hat{n}, \vec{E}_{II} = 0, \vec{E}_{III} = \frac{\sigma}{\epsilon_0} \hat{n}$
- (4) $\vec{E}_I = 0, \vec{E}_{II} = \frac{\sigma}{\epsilon_0} \hat{n}, \vec{E}_{III} = 0$

- Q. 3.** A mercury drop of radius 10^{-3} m is broken into 125 equal size droplets. Surface tension of mercury is 0.45 N m^{-1} . The gain in surface energy is:
- (1) $28 \times 10^{-5} \text{ J}$ (2) $17.5 \times 10^{-5} \text{ J}$
(3) $5 \times 10^{-5} \text{ J}$ (4) $2.26 \times 10^{-5} \text{ J}$

- Q. 4.** If earth has a mass nine times and radius twice to that of a planet P. Then $\frac{V_e}{3} \sqrt{x} \text{ ms}^{-1}$ will be the minimum velocity required by a rocket to pull out of gravitational force of P, where V_e is escape velocity on earth. The value of x is:
- (1) 1 (2) 3 (3) 18 (4) 2

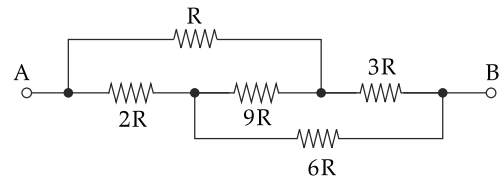
- Q. 5.** A sample of gas at temperature T is adiabatically expanded to double its volume. The work done by the gas in the process is (given, $\gamma = \frac{3}{2}$):

- (1) $W = \frac{T}{R} [\sqrt{2} - 2]$ (2) $W = RT [2 - \sqrt{2}]$
(3) $W = TR [\sqrt{2} - 2]$ (4) $W = \frac{R}{T} [2 - \sqrt{2}]$

- Q. 6.** $\left(P + \frac{a}{V^2}\right)(V - b) = RT$ represents the equation of state of some gases. Where P is the pressure, V is the volume, T is the temperature and a, b, R are the constants. The physical quantity, which has dimensional formula as that of $\frac{b^2}{a}$, will be:

- (1) Compressibility (2) Energy density
(3) Modulus of rigidity (4) Bulk modulus

- Q. 7.** The equivalent resistance between A and B of the network shown in figure:



- (1) $\frac{8}{3} R$ (2) $21R$ (3) $14R$ (4) $11 \frac{2}{3} R$

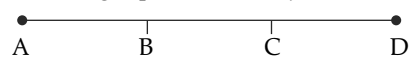
- Q. 8.** Match List I with List II:

List I	List II
A. AC generator	I. Presence of both L and C
B. Transformer	II. Electromagnetic Induction
C. Resonance phenomenon to occur	III. Quality factor
D. Sharpness of resonance	IV. Mutual Induction

Choose the correct answer from the options given below:

- (1) A-IV, B-III, C-I, D-II
(2) A-IV, B-II, C-I, D-III
(3) A-II, B-IV, C-I, D-III
(4) A-II, B-I, C-III, D-IV

- Q. 9.** An object moves with speed v_1, v_2 and v_3 along a line segment AB, BC and CD respectively as shown in figure. Where $AB = BC$ and $AD = 3AB$, then average speed of the object will be:



- (1) $\frac{(v_1 + v_2 + v_3)}{3v_1v_2v_3}$ (2) $\frac{(v_1 + v_2 + v_3)}{3}$
(3) $\frac{3v_1v_2v_3}{(v_1v_2 + v_2v_3 + v_3v_1)}$ (4) $\frac{v_1v_2v_3}{3(v_1v_2 + v_2v_3 + v_3v_1)}$

Q. 10. 'n' polarising sheets are arranged such that each makes an angle of 45° with the preceding sheet. An unpolarised light of intensity I is incident into this arrangement. The output intensity is found to be $I/64$. The value of n will be:

- (1) 4 (2) 3 (3) 5 (4) 6

Q. 11. Match List I with List II:

List I	List II
A. Microwaves	I. Radioactive decay of the nucleus
B. Gamma rays	II. Rapid acceleration and deceleration of electron in aerials
C. Radio waves	III. Inner shell electrons
D. X-rays	IV. Klystron valve

Choose the correct answer from the options given below:

- (1) A-I, B-III, C-IV, D-II
 (2) A-IV, B-I, C-II, D-III
 (3) A-IV, B-III, C-II, D-I
 (4) A-I, B-II, C-III, D-IV

Q. 12. A proton moving with one tenth of velocity of light has a certain de-Broglie wavelength of λ . An alpha particle having certain kinetic energy has the same de-Broglie wavelength λ . The ratio of kinetic energy of proton and that of alpha particle is:

- (1) 2 : 1 (2) 1 : 2 (3) 1 : 4 (4) 4 : 1

Q. 13. A block of mass 5 kg is placed at rest on a table of rough surface. Now, if a force of 30 N is applied in the direction parallel to surface of the table, the block slides through a distance of 50 m in an interval of time 10 s. Coefficient of kinetic friction is (given, $g = 10 \text{ m s}^{-2}$):

- (1) 0.60 (2) 0.25 (3) 0.75 (4) 0.50

Q. 14. Given below are two statements:

Statement I: Acceleration due to gravity is different at different places on the surface of earth.
Statement II: Acceleration due to gravity increases as we go down below the earth's surface.

In the light of the above statements, choose the correct answer from the options given below

- (1) Statement I is false but Statement II is true
 (2) Statement I is true but Statement II is false
 (3) Both Statement I and Statement II are false
 (4) Both Statement I and Statement II are true

Q. 15. Which of the following frequencies does not belong to FM broadcast.

- (1) 64 MHz (2) 89 MHz
 (3) 99 MHz (4) 106 MHz

Q. 16. The mass of proton, neutron and helium nucleus are respectively $1.0073u$, $1.0087u$ and $4.0015u$. The binding energy of helium nucleus is:

- (1) 28.4 MeV (2) 56.8 MeV
 (3) 14.2 MeV (4) 7.1 MeV

Q. 17. A steel wire with mass per unit length $7.0 \times 10^{-3} \text{ kg m}^{-1}$ is under tension of 70 N. The speed of transverse waves in the wire will be:

- (1) 100 m s^{-1} (2) 10 m s^{-1}
 (3) 50 m s^{-1} (4) $200\pi \text{ m s}^{-1}$

Q. 18. Match List I with List II:

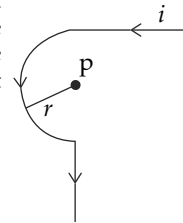
List I	List II
A. Intrinsic semiconductor	I. Fermi-level near the valence band
B. n-type semiconductor	II. Fermi-level in the middle of valence and conduction band

C. p-type semiconductor	III. Fermi-level near the conduction band
D. Metals	IV. Fermi-level inside the conduction band

Choose the correct answer from the options given below:

- (1) A-II, B-III, C-I, D-IV
 (2) A-I, B-II, C-III, D-IV
 (3) A-II, B-I, C-III, D-IV
 (4) A-III, B-I, C-II, D-IV

Q. 19. Find the magnetic field at the point P in figure. The curved portion is a semicircle connected to two long straight wires.



- (1) $\frac{\mu_0 i}{2r} \left(1 + \frac{2}{\pi}\right)$ (2) $\frac{\mu_0 i}{2r} \left(\frac{1}{2} + \frac{1}{2\pi}\right)$
 (3) $\frac{\mu_0 i}{2r} \left(1 + \frac{1}{\pi}\right)$ (4) $\frac{\mu_0 i}{2r} \left(\frac{1}{2} + \frac{1}{\pi}\right)$

Q. 20. The average kinetic energy of a molecule of the gas is:

- (1) proportional to absolute temperature
 (2) proportional to pressure
 (3) proportional to volume
 (4) dependent on the nature of the gas

Section B

Q. 21. A small particle moves to position $5\hat{i} - 2\hat{j} + \hat{k}$ from its initial position $2\hat{i} + 3\hat{j} - 4\hat{k}$ under the action of force $5\hat{i} + 2\hat{j} + 7\hat{k}$ N. The value of work done will be _____ J.

Q. 22. A certain pressure 'P' is applied to 1 litre of water and 2 litre of a liquid separately. Water gets compressed to 0.01% whereas the liquid gets compressed to 0.03%. The ratio of Bulk modulus of water to that of the liquid is $\frac{3}{x}$.

The value of x is _____.

Q. 23. A light of energy 12.75 eV is incident on a hydrogen atom in its ground state. The atom absorbs the radiation and reaches to one of its excited states. The angular momentum of the atom in the excited state is $\frac{x}{\pi} \times 10^{-17} \text{ e V}$. The value of x is _____ (use $h = 4.14 \times 10^{-15} \text{ e V s}$, $c = 3 \times 10^8 \text{ m s}^{-1}$).

Q. 24. A charged particle of $2 \mu\text{C}$ accelerated by a potential difference of 100 V enters a region of uniform magnetic field of magnitude 4 m T at right angle to the direction of field. The charge particle completes semicircle of radius 3 cm inside magnetic field. The mass of the charge particle is _____ $\times 10^{-18} \text{ kg}$.

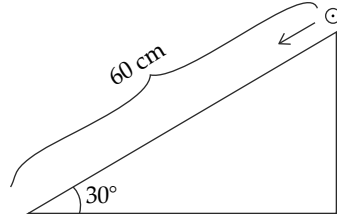
Q. 25. The amplitude of a particle executing SHM is 3 cm. The displacement at which its kinetic energy will be 25% more than the potential energy is _____ cm.

Q. 26. In an experiment to find emf of a cell using potentiometer, the length of null point for a cell of emf 1.5 V is found to be 60 cm. If this cell is replaced by another cell of emf E, the length-of

null point increases by 40 cm. The value of E is $\frac{x}{10}$ V. The value of x is _____.

- Q. 27. A thin cylindrical rod of length 10 cm is placed horizontally on the principle axis of a concave mirror of focal length 20 cm. The rod is placed in such a way that mid point of the rod is at 40 cm from the pole of mirror. The length of the image formed by the mirror will be $\frac{x}{3}$ cm. The value of x is _____.

- Q. 28. A solid cylinder is released from rest from the top of an inclined plane of inclination 30° and length



60 cm. If the cylinder rolls without slipping, its speed upon reaching the bottom of the inclined plane is _____ ms^{-1} .
(Given $g = 10 \text{ ms}^{-2}$)

- Q. 29. A series LCR circuit is connected to an AC source of 220 V, 50 Hz. The circuit contain a resistance $R = 100 \Omega$ and an inductor of inductive reactance $X_L = 79.6 \Omega$. The capacitance of the capacitor needed to maximise the average rate at which energy is supplied will be _____ μF .
- Q. 30. Two equal positive point charges are separated by a distance $2a$. The distance of a point from the centre of the line joining two charges on the equatorial line (perpendicular bisector) at which force experienced by a test charge q_0 becomes maximum is $\frac{a}{\sqrt{x}}$. The value of x is _____.

Answer Key

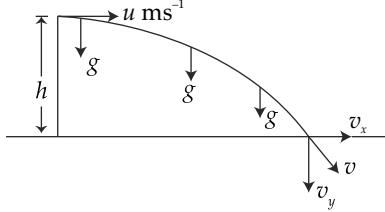
Q. No.	Answer	Topic Name	Chapter Name
1	(1)	Kinematics in two dimension	Kinematics
2	(3)	Electric field	Electrostatics
3	(4)	Properties of liquid	Properties of solid and liquid
4	(4)	Motion of satellites and escape velocity	Gravitation
5	(2)	Work done by gas	Thermodynamics
6	(1)	Dimensional analysis	Physics and measurement
7	(1)	Electric resistance	Current electricity
8	(3)	Electromagnetic induction and LCR circuit	Electromagnetic induction and Alternating current
9	(3)	Motion in straight line	Kinematics
10	(4)	Wave optics	Optics
11	(2)	Em waves	Em waves
12	(3)	Matter waves	Atoms and Nuclei
13	(4)	Frictional forces	Laws of motion
14	(2)	Gravitational forces	Gravitation
15	(1)	Spectrum	Principle of communication
16	(1)	Radio Activity	Atoms and Nuclei
17	(1)	Wave Motion	Oscillations and waves
18	(1)	Types of semiconductor	Electronic devices
19	(2)	Magnetic effect of current	Magnetic effects of current and magnetism
20	(1)	Degree of freedom and specific heat capacities of gases	Kinetic theory of gases
21	[40]	Work energy and power	Work energy and power
22	[1]	Elasticity	Properties of solids and liquids
23	[828]	Bohrs Atomic model	Atoms and Nuclei
24	[144]	Magnetic effect of current	Magnetic effect of current and magnetism
25	[2]	Simple harmonic motion	Oscillation and waves
26	[25]	Kirchoffs law and electrical instruments	Current electricity
27	[32]	Rectilinear propagation of light	Optics
28	[2]	Rotational motion	Rotational motion
29	[40]	LCR Circuit	Electromagnetic induction and alternating current
30	[2]	Magnetic effect of current	Magnetic effect of current and magnetism

SOLUTIONS

Section A

1. Option (1) is correct.

Resolving motion of ball in two directions



In horizontal direction $a_x = 0$

So $v_x = u_x = \text{constant}$

In vertical direction $a_y = g$

So $v_y = u_y + gt$ But $u_y = 0, v_y = gt$

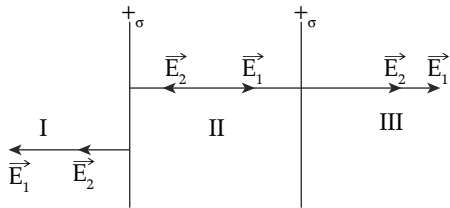
Also $h = u_y t + \frac{1}{2} a_y t^2 \therefore h = \frac{1}{2} g t^2$

Also $v_y^2 = u_y^2 + 2gh \therefore v_y^2 = 2gh$

at the point of hitting on ground,

$$v = \sqrt{u^2 + 2gh} = \sqrt{25 + 200} = 15 \text{ m s}^{-1}$$

2. Option (3) is correct.



Let \hat{n} is unit vector along Normal towards right of sheet.

$$\text{At region I, } E_1 = \frac{\sigma}{2\epsilon_0} \Rightarrow E_2 = \frac{\sigma}{2\epsilon_0}$$

$$E_I = E_1 + E_2 = \frac{(\sigma)}{\epsilon_0}$$

$$\vec{E}_I = \frac{\sigma}{\epsilon_0} (-\hat{n})$$

$$E_{II} = E_1 - E_2 = \frac{\sigma}{2\epsilon_0} - \frac{\sigma}{2\epsilon_0} = 0$$

$$E_{III} = E_1 + E_2 = \frac{\sigma}{2\epsilon_0} + \frac{\sigma}{2\epsilon_0} = \frac{\sigma}{\epsilon_0} \Rightarrow \vec{E}_{III} = \frac{\sigma}{\epsilon_0} \hat{n}$$

3. Option (4) is correct.

Gain in surface energy = Surface tension \times increase in surface area

Let initial radius is R and radius of each small droplet

is r .

$$V_i = V_f \Rightarrow \frac{4}{3} \pi R^3 = n \frac{4}{3} \pi r^3$$

$$R^3 = 125 r^3 \therefore r = R/5$$

$$\text{Initial surface area} = 4\pi R^2$$

$$\text{Final surface area} = n4\pi r^2$$

$$\text{Increase in area} = 4\pi n r^2 - 4\pi R^2$$

$$= 4\pi \times 125 \times \frac{R^2}{25} - 4\pi R^2 = 16\pi R^2$$

$$\Delta U = 0.45 \times 16 \frac{25}{\pi} \times 10^{-6}$$

$$= 0.45 \times 3.14 \times 16 \times 10^{-6} = 2.26 \times 10^{-5} \text{ J}$$

4. Option (4) is correct.

Escape velocity of any body from surface of any planet is given by

$$V_e = \sqrt{\frac{2GM}{R}} \Rightarrow V_e \propto \sqrt{\frac{M}{R}}$$

$$M = \frac{1}{9} \text{ times of earth, } R = \frac{1}{2} \text{ times of earth}$$

$$V_e' \propto \sqrt{\frac{2}{9}} \propto \frac{\sqrt{2}}{3}, V_e \text{ from planet} = \frac{\sqrt{2}}{3} V_e \text{ from earth}$$

So, value of $x = 2$

5. Option (2) is correct.

Work done in Adiabatic process is given by

$$\Delta W = U_1 - U_2 = nC_v (T_1 - T_2)$$

By $TV^{\gamma-1} = \text{constant}$

$$T_1 V^{\gamma-1} = T_2 (2V)^{\gamma-1} \Rightarrow T_1 V^{\gamma-1} = T_2 2^{\gamma-1} V^{\gamma-1}$$

$$T_2 = T_1 / \sqrt{2} \Rightarrow T_1 = T \Rightarrow T_2 = T/\sqrt{2}$$

$$\therefore \Delta W = n \frac{R}{\gamma-1} (T_1 - T_2)$$

$$= \frac{nR}{\left(\frac{1}{2}\right)} \left(T - \frac{T}{\sqrt{2}}\right) = 2nR \left(\frac{\sqrt{2}-1}{\sqrt{2}}\right) T$$

$$= \sqrt{2} nR (\sqrt{2}-1) T = nRT (2 - \sqrt{2})$$

if $n = 1$ then $\Delta W = RT(2 - \sqrt{2})$

6. Option (1) is correct.

Dimensional formula for $(b) = [V]$

$$\text{Dimensional formula for } \left(\frac{a}{b^2}\right) = [P]$$

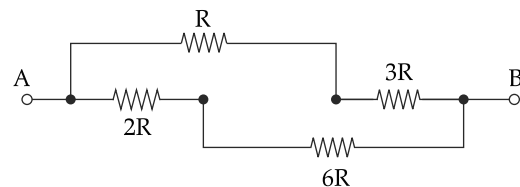
$$\text{Now, Dimensional formula for } \left(\frac{b^2}{a}\right) = \frac{1}{[P]} = \frac{1}{[B]} = K$$

Here, B in the bulk modulus and K in the compressibility

7. Option (1) is correct.

As $\frac{R}{3R} = \frac{2R}{6R}$, this a balanced wheat stone bridge.

and $9R$ will be non effective, and it can be removed.



R and $3R$ are in series and $2R$ and $6R$ are in series and their equivalent are in parallel

$$\therefore R_{AB} = \frac{4R \times 8R}{12R} = \frac{8R}{3}$$

8. Option (3) is correct.

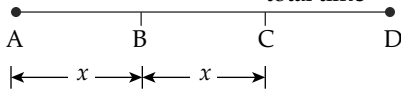
- (A) AC generator are based on Electromagnetic Induction.
 (B) Transformer are based on Mutual Induction.
 (C) Resonance phenomenon takes place in the presence of L and C both.

(D) Sharpness of Resonance curve is directly proportional to quality factor.

9. **Option (3) is correct.**

Average speed is given by

$$v_{av} = \frac{\text{total distance}}{\text{total time}}$$



$$CD = AD - (AB + BC)$$

$$= 3AB - AB - BC = 3x - 2x = x$$

$$v_{av} = \frac{3x}{\frac{x}{v_1} + \frac{x}{v_2} + \frac{x}{v_3}} = \frac{3v_1v_2v_3}{v_2v_3 + v_1v_3 + v_1v_2}$$

10. **Option (4) is correct.**

According to Malus law, if transmission axis of polarising sheet makes an angle θ with the electric field vector of light, then intensity of light emerging from the sheet is given by

$$I' = I \cos^2 \theta$$

where, I = Incident intensity on polarising sheet. If there are n sheets then,

$$I_{out} = \frac{I_0}{2} \cos^2 45^\circ \times \cos^2 45^\circ \times \cos^2 45^\circ \times \dots (n-1) \text{ times}$$

As after passing first sheet, Intensity remains half of Intensity of incident unpolarised light.

$$\frac{I_0}{64} = \frac{I_0}{2} \times \left(\frac{1}{2}\right)^{n-1} \Rightarrow \frac{1}{32} = \frac{1}{2^{n-1}} \Rightarrow n = 6$$

11. **Option (2) is correct.**

(A) **Microwaves:** Klystron value.

(B) γ (**Gamma**) Rays are electromagnetic Radiation emitted in radioactive decay.

(C) **Radio waves:** Rapid acceleration, deceleration of electron in aerials

(D) **X-Rays** are emitted when inner k shell electron is knocked out.

12. **Option (3) is correct.**

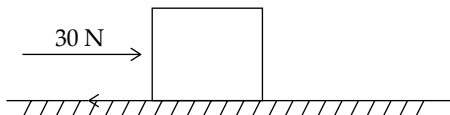
de-Broglie wave length

$$\lambda = \frac{h}{p} \text{ By } p = \sqrt{2m(KE)} \quad \therefore \quad = \frac{h}{\sqrt{2m(KE)}}$$

$$\Rightarrow \frac{h}{\sqrt{2m(KE_p)}} = \frac{h}{\sqrt{8m(KE_\alpha)}}$$

$$\Rightarrow \frac{1}{KE_p} = \frac{1}{4KE_\alpha} \Rightarrow \frac{KE_\alpha}{KE_p} = \frac{1}{4}$$

13. **Option (4) is correct.**



$$\text{acc. of block} = \frac{30 - \mu N}{5} \Rightarrow N = 50$$

$$a = \frac{30 - 50\mu}{5} \text{ by } s = \frac{1}{2}at^2 \Rightarrow 50 = \frac{1}{2}(6 - 10\mu)100^2$$

$$6 - 10\mu = 1 \Rightarrow \mu = \frac{1}{2} = .50$$

14. **Option (2) is correct.**

Acceleration due to gravity depends on shape of Earth also, that's why its value is different at different places.

Inside the Earth, value of gravitational acceleration is directly proportional to distance from centre of Earth. So if we go down below the surface of Earth, acceleration due to gravity decreases.

So, Statement I is true and Statement II is false.

15. **Option (1) is correct.**

Frequency range of FM broadcast is from 88 MHz to 108 MHz

16. **Option (1) is correct.**

Binding Energy of a nucleus is given by $E = (\Delta m)c^2$

where, Δm = mass defect

and if (Δm) is in amu.

$$E = (\Delta m) \times 931 \text{ Me V}$$

In Helium nucleus ${}^4_2\text{He}$ there are 2 Protons and 2 neutrons

$$\text{So, } \Delta m = [2(1.0073 + 1.0087) - 4.0015]$$

$$E = (0.0305) \times 931 \text{ Me V} \approx 28.4 \text{ Me V}$$

17. **Option (1) is correct.**

Speed of transverse wave of a stretched string is given by

$$v = \sqrt{\frac{T}{\mu}} \Rightarrow v = \sqrt{\frac{70}{7 \times 10^{-3}}} \Rightarrow v = 100 \text{ m s}^{-1}$$

18. **Option (1) is correct.**

(A) In intrinsic semiconductor fermi level is between conduction band and valence band.

(B) In n -type semiconductor the 5th electron is almost free and has energy close to conduction band that's why in n type semiconductor fermi level is near conduction band.

(C) In p -type semi conductor fermi level is near valence band

(D) In metals, fermi level is inside the conduction band.

19. **Option (2) is correct.**

Magnetic field at P due to section AB of wire,

$$B_2 = \frac{\mu_0 i}{4\pi r} \odot T$$

Magnetic field at P due to semicircular section,

$$B_2 = \frac{\mu_0 i}{4r} \odot T$$

Due to Straight part CD, $B = 0$

as current carrying straight wire does not produce magnetic field along its length.

So, Net magnetic field at P,

$$B = \frac{\mu_0 i}{4\pi r} + \frac{\mu_0 i}{4r} \Rightarrow B = \frac{\mu_0 i}{2r} \left(\frac{1}{2\pi} + \frac{1}{2} \right)$$

20. **Option (1) is correct.**

Average K.E. of an ideal gas molecule is given by,

$$KE = \frac{3}{2}KT \quad \text{Hence, } KE \propto T$$

Section B

21. **The correct answer is [40]**

Work done is given by, $W = \vec{F} \cdot \vec{d}$

$$\vec{d} = 5\hat{i} - 2\hat{j} + \hat{k} - (2\hat{i} + 3\hat{j} - 4\hat{k}) = 3\hat{i} - 5\hat{j} + 5\hat{k}$$

$$\vec{W} = (5\hat{i} + 2\hat{j} + 7\hat{k}) \cdot (3\hat{i} - 5\hat{j} + 5\hat{k})$$

$$= 15 - 10 + 35 = 40 \text{ J}$$

22. The correct answer is [1]

Bulk modulus of elasticity is given by,

$$B = \frac{\Delta P}{-\left(\frac{\Delta V}{V}\right)} \Rightarrow -\frac{\Delta V}{V} = \frac{\Delta P}{B}$$

$$-\left(\frac{\Delta V}{V}\right) \times 100 = \frac{\Delta P}{B} \times 100 \Rightarrow \frac{0.01}{0.03} = \frac{B_{\text{Liquid}}}{B_{\text{Water}}}$$

$$\frac{B_W}{B_{Liq}} = \frac{3}{1} = \frac{3}{x}$$

On comparison, we get $x = 1$

23. The correct answer is [828]

We know that different energies of hydrogen atom are as

$$E_1 = -13.6 \text{ eV}, E_2 = -3.4 \text{ eV}$$

$$E_3 = -1.51 \text{ eV}, E_4 = 0.85 \text{ eV}$$

and $E_4 - E_5 = 12.75 \text{ eV}$

It means electron will reach to 4th excited state (i.e. $n = 4$)

According to Bohr's theory, angular momentum is given by,

$$L = \frac{nh}{2\pi} \Rightarrow L = \frac{4 \times 4.14 \times 10^{-15}}{2\pi} \text{ eV}$$

$$= \frac{8.28 \times 10^{-15}}{\pi} \text{ eV} = \frac{828}{\pi} \times 10^{-17} \text{ eV}$$

$$x = 828$$

24. The correct answer is [144]

$$r = \frac{mv}{qB} \Rightarrow r = \frac{m\sqrt{\frac{2qV}{m}}}{qB} \Rightarrow r = \frac{\sqrt{2mqV}}{qB} \Rightarrow r^2 = \frac{2mV}{qB^2}$$

$$m = \frac{qB^2r^2}{2V} \Rightarrow m = \frac{2 \times 10^{-6} \times 16 \times 10^{-6} \times 9 \times 10^{-4}}{2 \times 100V}$$

$$m = 144 \times 10^{-18} \text{ kg}$$

25. The correct answer is [2]

$$PE + KE = \frac{1}{2}m\omega^2A^2 \Rightarrow PE + \frac{5}{4}PE = \frac{1}{2}m\omega^2A^2$$

$$\frac{9}{4} \frac{1}{2} m \Omega^2 x^2 = \frac{1}{2} m \Omega^2 A^2 \Rightarrow x^2 = \frac{4}{9} A^2$$

$$x = \pm \frac{2}{3} \times 3 \text{ (given } A = 3) \Rightarrow x = \pm 2 \text{ cm}$$

26. The correct answer is [25]

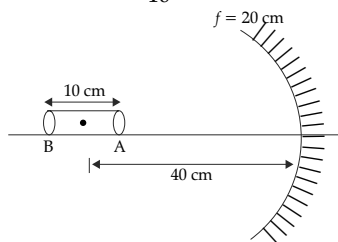
$$E \propto \frac{1}{l}$$

$$\frac{E_1}{E_2} = \frac{l_1}{l_2} \Rightarrow \frac{1.5}{E_2} = \frac{60}{100 \text{ cm}}$$

$$E_2 = \frac{7.5}{3} \Rightarrow E_2 = 2.5 = \frac{25}{10} \text{ V}, x = 25$$

27. The correct answer is [32]

Here, to find length of image, we will find position of image at extreme points of object i.e. (A and B).



For A,

$$u = -35 \text{ cm}$$

$$\frac{1}{v_A} = \frac{-1}{20} + \frac{1}{35} \Rightarrow \frac{1}{v_A} = \frac{-35 + 20}{20 \times 35}$$

$$v_A = \frac{-140}{3} \text{ cm}$$

For B, $\frac{1}{v_B} = \frac{-1}{20} + \frac{1}{45}$

$$\frac{1}{v_B} = \frac{-45 + 20}{45 \times 20} = \frac{-25}{45 \times 20} = -36 \text{ cm}$$

28. The correct answer is [2]

For solid Cylinder,

$$I = \frac{1}{2}mR^2 \Rightarrow Mk^2 = \frac{1}{2}mR^2 \Rightarrow \frac{k^2}{R^2} = \frac{1}{2}$$

and velocity of body at bottom when it roll down the inclined plane without slipping

$$v = \frac{\sqrt{2gh}}{\sqrt{1 + \left(\frac{k^2}{R^2}\right)}} \Rightarrow v = \frac{\sqrt{2 \times 10 \times 30 \times 10^{-2}}}{\sqrt{1 + \frac{1}{2}}} = \frac{\sqrt{6}}{\sqrt{\frac{3}{2}}} = 2 \text{ m s}^{-1}$$

29. The correct answer is [40]

For maximum power, current in circuit should be maximum and for that impedance should be minimum. Hence

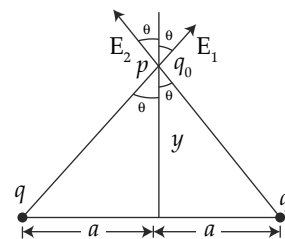
$$X_L = X_C$$

$$79.6 = \frac{1}{\omega C} \Rightarrow C = \frac{1}{2\pi \times 50 \times 79.6}$$

$$C = \frac{1}{314 \times 79.6} \Rightarrow C \cong 40 \mu\text{F}$$

30. The correct answer is [2]

For force on q_0 to be maximum, electric field at Point P should be maximum.



$$\text{At } P, E_1 = \frac{kq}{a^2 + y^2} \Rightarrow E_2 = \frac{kq}{a^2 + y^2}$$

$$E_p = E_1 \cos \theta + E_2 \cos \theta = \frac{2kqy}{(a^2 + y^2)^{3/2}}$$

For E_p to be maximum

$$\frac{d}{dy} E_p = 0 \Rightarrow \frac{d}{dy} \frac{2kqy}{(a^2 + y^2)^{3/2}} = 0$$

$$y = \pm \frac{a}{\sqrt{2}}$$

On comparison $x = 2$

