JEE (Main) PHYSICS SOLVED PAPER

2023

24th Jan Shift 1

General Instructions :

1. *In Physics Section, there are 30 Questions (Q. no. 1 to 30).*
2. *In Physics, Section A consists of 20 multiple choice questions & Section B consists of 10 numerical value type questions. In Section B, candidates have to attempt any five questions out of 10.*
3. *There will be only one correct choice in the given four choices in Section A. For each question for Section A, 4 marks will be awarded for correct choice, 1 mark will be deducted for incorrect choice questions and zero mark will be awarded for not attempted question.*
4. *For Section B questions, 4 marks will be awarded for correct answer and zero for unattempted and incorrect answer.*
5. *Any textual, printed or written material, mobile phones, calculator etc. is not allowed for the students appearing for the test.*
6. *All calculations / written work should be done in the rough sheet is provided with Question Paper.*

Section A

Q. 1. A circular loop of radius r is carrying current I A. The ratio of magnetic field at the center of circular loop and at a distance r from the center of the loop on its axis is:

(1) $2\sqrt{2}:1$ **(2)** $1:3\sqrt{2}$
(3) $1:\sqrt{2}$ **(4)** $3\sqrt{2}:2$

Q. 2. The weight of a body at the surface of earth is 18 N. The weight of the body at an altitude of 3200 km above the earth's surface is (given, radius of earth R_e = 6400 km):

(1) 8 N **(2)** 4.9 N
(3) 9.8 N **(4)** 19.6 N

Q. 3. Two long straight wires P and Q carrying equal current 10 A each were kept parallel to each other at 5 cm distance. Magnitude of magnetic force experienced by 10 cm length of wire P is F_1. If distance between wires is halved and currents on them are doubled, force F_2 on 10 cm length of wire P will be:

(1) $\frac{F_1}{8}$ (2) $8\ F_1$
(3) $10\ F_1$ (4) $\frac{F_1}{10}$

Q. 4. Given below are two statements:

Statement I: The temperature of a gas is –73°C. When the gas is heated to 527°C, the root mean square speed of the molecules is doubled.

Statement II: The product of pressure and volume of an ideal gas will be equal to translational kinetic energy of the molecules.

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

Q. 5. The maximum vertical height to which a man can throw a ball is 136 m. The maximum horizontal distance upto which he can throw the same ball is:

(1) 272 m **(2)** 68 m
(3) 192 m **(4)** 136 m

Q. 6. Given below are two statements:

Statement I: If the Brewster's angle for the light propagating from air to glass is θ_B, then the Brewster's angle for the light propagating from glass to air is $\frac{\pi}{2}-\theta_B$.

Statement II: The Brewster's angle for the light propagating from glass to air is $\tan^{-1}(\mu_g)$ where μ_g is the refractive index of glass.

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

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

Q. 7. A 100 m long wire having cross-sectional area $6.25 \times 10^{-4}\ m^2$ and Young's modulus is $10^{10} Nm^{-2}$ is subjected to a load of 250 N, then the elongation in the wire will be:

(1) 4×10^{-3} m **(2)** 6.25×10^{-3} m
(3) 6.25×10^{-6} m **(4)** 4×10^{-4}m

Q. 8. If two charges q_1 and q_2 are separated with distance 'd' and placed in a medium of dielectric constant k. What will be the equivalent distance between charges in air for the same electrostatic force?

(1) $2d\sqrt{k}$ **(2)** $1.5\ d\sqrt{k}$
(3) $d\sqrt{k}$ **(4)** $k\sqrt{d}$

Q. 9. Consider the following radioactive decay process

$$^{218}_{84}A \xrightarrow{\alpha} A_1 \xrightarrow{\beta^-} A_2 \xrightarrow{\gamma} A_3 \xrightarrow{\alpha} A_4 \xrightarrow{\beta^+} A_5 \xrightarrow{\gamma} A_6$$

The mass number and the atomic number of A_6 are given by:

(1) 210 and 84
(2) 210 and 82
(3) 211 and 80
(4) 210 and 80

Q. 10. From the photoelectric effect experiment, following observations are made. Identify which of these are correct.

A. The stopping potential depends only on the work function of the metal.
B. The saturation current increases as the intensity of incident light increases.
C. The maximum kinetic energy of a photo electron depends on the intensity of the incident light.
D. Photoelectric effect can be explained using wave theory of light.

Choose the correct answer from the options given below:

(1) A, C, D only **(2)** B, C only
(3) B only **(4)** A, B, D only

Q. 11. Given below are two statements:

Statement I: An elevator can go up or down with uniform speed when its weight is balanced with the tension of its cable.

Statement II: Force exerted by the floor of an elevator on the foot of a person standing on it is more than his/her weight when the elevator goes down with increasing speed.

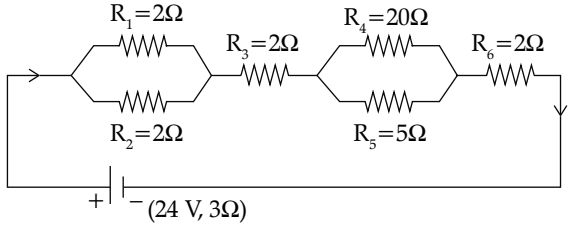
In the light of the above statements, choose the correct answer from the options given below:

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

Q. 12. 1 g of a liquid is converted to vapour at 3×10^5 P_a pressure. If 10% of the heat supplied is used for increasing the volume by 1600 cm^3 during this phase change, then the increase in internal energy in the process will be:

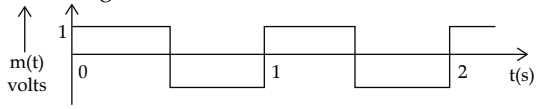
(1) 432000 J **(2)** 4320 J
(3) 4800 J **(4)** 4.32×10^8J

Q. 13. As shown in the figure, a network of resistors is connected to a battery of 24 V with an internal resistance of 3Ω. The currents through the resistors R_4 and R_5 are I_4, and I_5 respectively. The values of I_4 and I_5 are:



(1) $I_4 = \frac{2}{5}$ and $I_5 = \frac{8}{5}$A
(2) $I_4 = \frac{24}{5}$A and $I_5 = \frac{6}{5}$A
(3) $I_4 = \frac{8}{5}$A and $I_5 = \frac{2}{5}$A
(4) $I_4 = \frac{6}{5}$A and $I_5 = \frac{24}{5}$A

Q. 14. A modulating signal is a square wave, as shown in the figure.



If the carrier wave is given as c(t) = 2sin(8πt) volts, the modulation index is:

(1) $\frac{1}{4}$ **(2)** $\frac{1}{2}$
(3) 1 **(4)** $\frac{1}{3}$

Q. 15. A conducting circular loop of radius $\frac{10}{\sqrt{\pi}}$ cm is placed perpendicular to a uniform magnetic field of 0.5 T. The magnetic field is decreased to zero in 0.5 s at a steady rate. The induced emf in the circular loop at 0.25 s is:

(1) emf = 1mV **(2)** emf = 5mV
(3) emf = 100mV **(4)** emf = 10mV

Q. 16. In $\vec{E}$ and $\vec{K}$ represent electric field and propagation vectors of the EM waves in vacuum, then magnetic field vector is given by :

(ω - angular frequency):

(1) $\omega(\vec{E}\times\vec{K})$ **(2)** $\omega(\vec{K}\times\vec{E})$
(3) $\vec{K}\times\vec{E}$ **(4)** $\frac{1}{\omega}(\vec{K}\times\vec{E})$

Q. 17. Match List I with List II:

	LIST I		LIST II
A.	Planck's constant (h)	I.	$[M^1 L^2 T^{-2}]$
B.	Stopping potential (V_s)	II.	$[M^1 L^1 T^{-1}]$
C.	Work function (∅)	III.	$[M^1 L^2 T^{-1}]$
D.	Momentum (p)	IV.	$[M^1 L^2 T^{-3} A^{-1}]$

Choose the correct answer from the options given below:

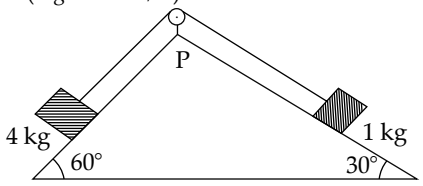
(1) A-I, B-III, C-IV, D-II
(2) A-III, B-I, C-II, D-IV
(3) A-II, B-IV, C-III, D-I
(4) A-III, B-IV, C-I, D-II

Q. 18. A travelling wave is described by the equation $y(x, t) = [0.05\sin(8x - 4t)]$m

The velocity of the wave is: [all the quantities are in SI unit]

(1) $8\ ms^{-1}$ **(2)** $4\ ms^{-1}$
(3) $0.5\ ms^{-1}$ **(4)** $2\ ms^{-1}$

Q. 19. As per given figure, a weightless pulley P is attached on a double inclined frictionless surfaces. The tension in the string (massless) will be (if $g = 10\ m/s^2$)



(1) $(4\sqrt{3}+1)\ N$ **(2)** $4(\sqrt{3}+1)\ N$
(3) $(4\sqrt{3}-1)\ N$ **(4)** $4(\sqrt{3}-1)\ N$

Q. 20. Given below are two statements: one is labelled as Assertion A and the other is labelled as Reason R Assertion

A: Photodiodes are preferably operated in reverse bias condition for light intensity measurement.

Reason: The current in the forward bias is more than the current in the reverse bias for a p - n junction diode.

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

(1) A is true but R is false
(2) A is false but R is true
(3) Both A and R are true and R is the correct explanation of A
(4) Both A and R are true but R is NOT the correct explanation of A

Section B

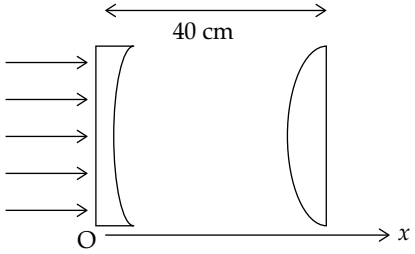
Q. 21. Vectors $a\hat{i}+b\hat{j}+\hat{k}$ and $2\hat{i}-3\hat{j}+4\hat{k}$ are perpendicular to each other when $3a + 2b = 7$, the ratio of a to b is $x/2$. The value of x is

Q. 22. Assume that protons and neutrons have equal masses. Mass of a nucleon is 1.6×10^{-27} kg and radius of nucleus is $1.5 \times 10^{-15}\ A^{1/3}$ m. The approximate ratio of the nuclear density and water density is $n \times 10^{13}$. The value of n is

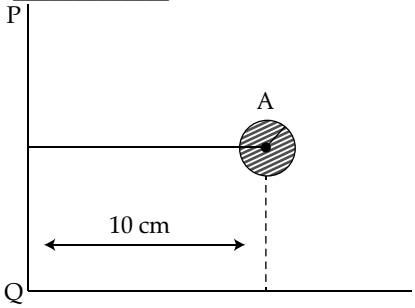
Q. 23. A hollow cylindrical conductor has length of 3.14 m, while its inner and outer diameters are 4 mm and 8 mm respectively. The resistance of the conductor is $n \times 10^{-3}\Omega$. If the resistivity of the material is $2.4 \times 10^{-8}\Omega m$. The value of n is

Q. 24. A stream of a positively charged particles having $\frac{q}{m} = 2 \times 10^{11}\frac{C}{kg}$ and velocity $\vec{v}_0 = 3 \times 10^7\ \hat{i}$ m/s is deflected by an electric field $1.8\hat{J}$ kV/m. The electric field exists in a region of 10 cm along x direction. Due to the electric field, the deflection of the charge particles in the y direction is ___mm

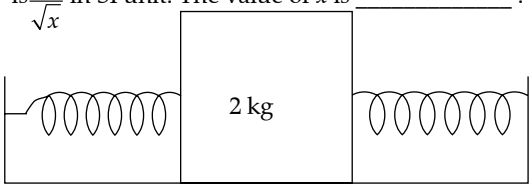
Q. 25. As shown in the figure, a combination of a thin plano concave lens and a thin plano convex lens is used to image an object placed at infinity. The radius of curvature of both the lenses is 30 cm and refraction index of the material for both the lenses is 1.75. Both the lenses are placed at distance of 40 cm from each other. Due to the combination, the image of the object is formed at distance = __cm, from concave lens.



Q. 26. Solid sphere A is rotating about an axis PQ. If the radius of the sphere is 5 cm then its radius of gyration about PQ will be $\sqrt{x}$ cm. The value of x is _____ .

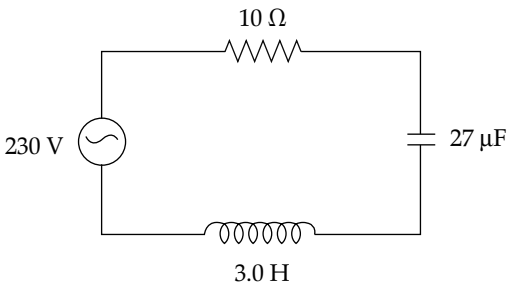


Q. 27. A block of a mass 2 kg is attached with two identical springs of spring constant 20 N/m each. The block is placed on a frictionless surface and the ends of the springs are attached to rigid supports (see figure). When the mass is displaced from its equilibrium position, it executes a simple harmonic motion. The time period of oscillation is $\frac{\pi}{\sqrt{x}}$ in SI unit. The value of x is _____ .



28. A hole is drilled in a metal sheet. At 27°C, the diameter of hole is 5 cm. When the sheet is heated to 177°C, the change in the diameter of hole is d $\times 10^{-3}$ cm. The value of d will be _____ if coefficient of linear expansion of the metal is 1.6×10^{-5}/°C.

29. In the circuit shown in the figure, the ratio of the quality factor and the band width is _____ S.



Q. 30. A spherical body of mass 2 kg starting from rest acquires a kinetic energy of 10000 J at the end of 5^{th} second. The force acted on the body is _____ N.

❐❐❐

Answer Key

Q. No.	Answer	Topic Name	Chapter Name
1	1	Magnetic Field Intensity due to Current Carrying Circular Coil	Moving Charges and Magnetism
2	1	Variation in Acceleration Due to Gravity	Gravitation
3	2	Force Between Two Current Carrying Straight Parallel Conductor	Moving Charges and Magnetism
4	3	RMS Speed	Kinetic Theory of Gases
5	1	Projectile Motion	Motion in a Plane
6	2	Total Internal Reflection	Ray Optics
7	1	Young's Modulus	Mechanical Properties of Solids
8	3	Coulomb's Law	Electric Charges and Fields
9	4	Radioactive Decay	Nuclei
10	3	Photoelectric Effect	Dual Nature of Radiation and Matter
11	3	Apparent Weight in Elevator/Lift	Laws of Motion
12	2	First Law of Thermodynamics	Thermodynamics
13	1	Equivalent Resistance	Current Electricity
14	2	Modulation	Communication Systems
15	4	Induced EMF	Electromagnetic Induction
16	4	Propogation of EMW	Electromagnetic Waves
17	4	Dimensions	Units and Measurements
18	3	Wave Equation	Waves
19	2	Motion of Connected Bodies	Laws of Motion
20	4	p-n Junction Diode	Semiconductor Electronics
21	[1]	Vectors	Mathematical Tools
22	[11]	Nuclear Density	Nuclei
23	[2]	Resistivity	Current Electricity
24	[2]	Electric Force	Electric Charges and Fields
25	[120]	Combination of Thin Lenses	Ray Optics
26	[110]	Moment of Inertia	System of Particles and Rotational Motion
27	[5]	SHM	Oscillations
28	[12]	Linear Expansion	Thermal Propoerties of Matter
29	[10]	LCR Circuit	Alternating Current
30	[40]	Kinetic Energy	Work, Energy and Power

JEE (Main) PHYSICS SOLVED PAPER

2023

24th Jan Shift 1

ANSWERS WITH EXPLANATIONS

Section A

1. Option (1) is correct.

Magnetic field at of a coil, $B_1 = \frac{\mu_0 I}{2r}$

magnetic field on axis of coil at a distance,

$$B_2 = \frac{\mu_0 I r^2}{2(r^2+x^2)^{3/2}}$$

$$\Rightarrow \quad B_2 = \frac{\mu_0 I r^2}{2(r^2+r^2)^{3/2}} \qquad (\text{as } d = r)$$

$$\Rightarrow \quad B_2 = \frac{\mu_0 I r^2}{2(2\sqrt{2}r^3)}$$

$$\Rightarrow \quad \frac{B_1}{B_2} = 2\sqrt{2} : 1$$

2. The correct option is (1)

Given, $mg = 18$ N,

At a height of h , $g' = g\frac{R^2}{(R+h)^2}$

$$\Rightarrow \quad g' = g\frac{6400^2}{(6400+3200)^2} = \frac{4}{9}g$$

Weight, $W = mg' = \frac{4}{9}mg$

$$\Rightarrow \quad W = \frac{4}{9} \times 18 = 8\text{N}$$

3. The correct option is (2)

Force per unit length between two parallel conductors is given by, $\frac{F}{l} = \frac{\mu_0 I_1 I_2}{2r}$

As l =constant, $I_1 = I_2 = I$, So $F \propto \frac{I^2}{r}$

$$\frac{F_1}{F_2} = \frac{\frac{I^2}{r}}{\frac{(2I)^2}{r/2}} = \frac{1}{8}$$

$\Rightarrow F_2 = F_1 = 8:1$

4. The correct option is (3)

Since, $V_{rms} = \sqrt{T}$

$$\frac{v_{rms1}}{v_{rms2}} = \frac{\sqrt{273+(-73)}}{\sqrt{273+(527)}} = \frac{\sqrt{200}}{\sqrt{800}} = \frac{1}{2}$$

$$\Rightarrow \quad v_{rms_2} = 2v_{rms_1}$$

Hence statement 1 is true.

Now, $KE_{trans} = \frac{3}{2}nRT = \frac{3}{2}PV$

Hence, Statement 2 is false.

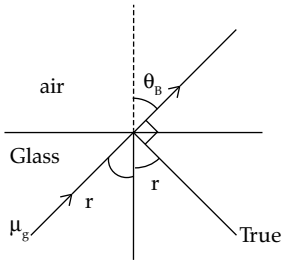
5. The correct option is (1)

Max height, $H = \frac{v^2}{2g} = 136$ m (given)

Max range, $R = \frac{v^2}{g} = 136 \times 2 = 272\text{m}$

6. The correct option is (2)

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



In reflection, $\angle I = \angle r = \theta_B$

In refraction, $r = \frac{\pi}{2} - \theta_B$

So, statement I is correct.

From glass to air, $\mu_g \sin i_B = \cos i_B$

$\Rightarrow \tan i_B = \frac{1}{\mu_g}$ or $i_B = \tan^{-1} = \left(\frac{1}{\mu_g}\right)$

Clearly, we can see statement II is incorrect.

7. The correct option is (1)

Given, $l = 100$ m, $A = 6.25 \times 10^{-4}$ m^2

$F = 250$ N

$Y = 10^{10}$ Nm^2

We know, Stress = Y strain

$$\Rightarrow \quad \frac{F}{A} = Y\frac{\Delta l}{l}$$

$$\Rightarrow \quad \frac{250}{6.25} \times 10^{-4} = 10^{10}\frac{\Delta l}{100}$$

$$\Rightarrow \quad \Delta l = 4 \times 10^{-3}\text{m}$$

8. The correct option is (3)

Force in air, $F_1 = \frac{kq_1q_2}{d^2}$

Force in dielectric, $F_2 = \frac{kq_1q_2}{Kr^2}$

As $F_1 = F_2$

$\Rightarrow$ $r = d\sqrt{K}$

9. The correct option is (4)

In α : A = –4 and z = –2

In β^-: z = +1 and β^+: z = –1

$^{218}_{84}A \xrightarrow{\alpha} A_1 \xrightarrow{\beta^-} A_2 \xrightarrow{\gamma} A_3 \cdot$

$\xrightarrow{\alpha} A_4 \xrightarrow{\beta^+} A_5 \xrightarrow{\gamma} A_6$

Mass number will be changed only due to α-particles.

$A_f = 218 - 2\alpha = 218 - 2 \times 4 = 210$

Atomic number will be changed due to α, β^+ and β^- particles.

$Z_f = 84 - 2\alpha - \beta^+ - \beta^{-1} = 84 - 2 \times 2 - (-1) - 1 = 80$

10. The correct option is (3)

Stopping potential or max KE depends upon frequency of light not on intensity. Wave theory cannot explain photoelectric effect. So statement A,C and D are false.

11. The correct option is (3)

When weight (force) is balanced a=0 and v = constant. Hence, statement I is true. When elevator goes down it means acceleration acts downwards. So $mg - N = ma$

Or $N = m(g - a)$, it means weight will reduce. Hence, statement II is false.

12. The correct option is (2)

Heat supplied,

$Q = P\Delta V = 3 \times 10^5 \times 1600 \times 10^{-6}$

$Q = 4800J$

From 1st law of thermodynamics

$Q = \Delta u + w$

$\Delta u = Q - \frac{Q}{10} = \frac{9}{10}Q$

$\Delta u = \frac{9}{10} \times 4800 = 4320J$

13. The correct option is (1)

$R_{eq} = R_1 \,||\, R_2 + R_3 + R_4 \,||\, R_5 + R_6 + r_{internal}$

$= \frac{2 \times 2}{2+2} + 2 + \frac{20 \times 5}{25} + 2 + 3 = 12\,\Omega$

$I_{eq} = \frac{V}{R_{eq}} = \frac{24}{12} = 2A$

$I_4 = \frac{5}{20+5} \times 2 = \frac{2}{5}A$

$I_5 = \frac{20}{20+5} \times 2 = \frac{8}{5}A$

14. The correct option is (2)

Given, $A_m = 1$, $A_C = 2$

Modulation index, $\mu = \frac{A_m}{A_c} = \frac{1}{2}$

15. The correct option is (4)

$\varepsilon = -\frac{d\phi}{dt} = -\frac{d(BA)}{dt}$

$\varepsilon = -A\frac{\Delta B}{\Delta t} = -\frac{\pi R^2(0 - B)}{\Delta t}$

$\varepsilon = -\frac{\pi\left(\frac{10}{\sqrt{\pi}} \times 10^{-2}\right)^2 \times 0.5}{0.5} = 10mV$

16. The correct option is (4)

Magnitude of $B = \frac{E}{C} = \frac{K}{\Omega}E$

In emw, $\vec{E}$, $\vec{B}$, and $\vec{K}$, all three are mutually perpendicular to each other. And B will be given by $\vec{K} \times \vec{E}$.

17. The correct option is (4)

Plank constant $h = \frac{E}{v} = \frac{[M^1L^2T^{-2}]}{[T^{-1}]} = [M^1L^2T^{-1}]$

Stopping potential, $[V] = \frac{[W]}{[q]} = [M^1L^2T^3A^{-1}]$

Work function , $[W] = [M^1L^2T^{-1}]$

Momentum, $[P] = [M^1L^2T^{-1}]$

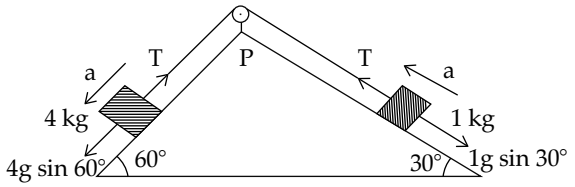
18. The correct option is (3)

On comparing given eq. with standard eq.

$y = A \sin(kx - \omega t)$, we get

$V = \frac{\omega}{k} = \frac{4}{8} = 0.5\ ms^{-1}$

19. The correct option is (2)



For 1 kg block

$T - mg \sin 30° = ma$

$T - 1 \times 10 \times \frac{1}{2} = a$

$T - 5 = a$ (i)

For 4 kg block

$mg \sin 60° - T = ma$

$4 \times 10\ \frac{\sqrt{3}}{2} - T = 4a$

$20\sqrt{3} - T = 4a$ (ii)

From Eqn. (i) and (ii)

$20\sqrt{3} - T = 4(T - 5)$

$20\sqrt{3} + 20 = 5T$

$T = 4(\sqrt{3} + 1)\ N$

20. The correct option is (4)

Photodiode detect light or optic signal and operate in reverse bias. In reverse bias current is very less as compare to forward bias unless breakdown occurs. Hence, both statements are correct.

Section B

21. The correct answer is [1]

As vectors are perpendicular so, $\vec{A}.\vec{B} = 0$

$(a\hat{i} + b\hat{j} + \hat{k}).(2\hat{i} - 3\hat{j} + 4\hat{k}) = 0$

$\Rightarrow$ 2a – 3b = –4 …(i)

Given 3a + 2b = 7 …(ii)

From (i) and (ii), a = 1 and b = 2

$\frac{a}{b} = \frac{1}{2} = \frac{x}{2} \Rightarrow x = 1$

22. The correct answer is [11]

$\rho_{nucleus} = \frac{M}{V} = \frac{mA}{\frac{4}{3}\pi R^3 A}$

$\rho_{nucleus} = \frac{3\times1.6\times10^{-27}}{4\times3.14\times(1.5\times10^{-15})^3} \sim 11\times10^{14}$ kg/m^3

$\rho_{water} = 10^3$ kg/m^3

Now, $\frac{\rho_{nucleus}}{\rho_{Water}} = 11\times10^{13}$, on comparing with $n\times10^{13}$, we get n = 11.

23. The correct answer is [2]

We know $R = \rho\ \frac{l}{A} = \rho\ \frac{l}{A} = \rho\frac{l}{\pi(r_2^2 - r_1^2)}$

$R = 2.4\times10^{-8}\ \frac{3.14}{3.14(4^2-2^2)} = 2\times10^{-3}\ \Omega$

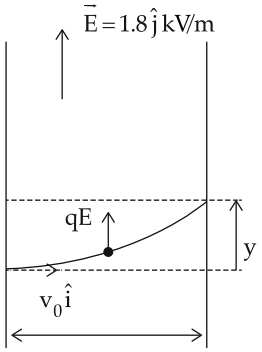
On comparing above value with $n\times10^{-3}$, we get n = 2

24. The correct answer is [2]

$Y = \frac{1}{2}at^2 = \frac{1}{2}\frac{qE}{m}t^2$

$\Rightarrow\ y = \frac{1}{2}\frac{qE}{m}\left(\frac{l}{v}\right)^2$ $(\because v = l/t)$

$\Rightarrow\ y = \frac{1}{2}\times2\times10^{11}\times1.8\times10^3\left(\frac{0.1}{3\times10^7}\right)^2 = 2$ mm



25. The correct answer is [120]

Focal length of the combination is given by,

$f = \frac{R}{\mu - 1} = \frac{30}{1.75 - 1} = 40$ cm

Focal length of concave surface f_1 = -40 cm

For the rays coming from infinity, it will form image at its focus. So, v_1 = -40 and it will become object for 2nd lens (convex).

Focal length of convex surface f_2 = + 40 cm

$\frac{1}{f} = \frac{1}{v_2} - \frac{1}{u}$

$\Rightarrow\ \frac{1}{40} = \frac{1}{v_2} - \frac{1}{-80}$

$\Rightarrow$ v_2 = 80 cm, image will form right side of convex lens.

Image will form at, v = 80 + 40 cm (distance between two lens) = 120 cm from concave lens.

26. The correct answer is [110]

$I_{PQ} = I_{CM} + md^2$

$\Rightarrow\ mk^2 = \frac{2}{5}mR^2 + md^2$

$\Rightarrow\ k = \sqrt{\frac{2}{5}5^2 + 10^2} = \sqrt{110}$cm

On comparing with $\sqrt{x}$, we get x = 110

27. The correct answer is [5]

$K_{eq} = k_1 + k_2 = 20 + 20 = 40$ N/m

Time period, $T = 2\pi\sqrt{\frac{m}{k_{eq}}}$

$T = 2\pi\sqrt{\frac{1}{20}} = \pi\sqrt{\frac{1}{5}}$

On comparing with $\frac{\pi}{\sqrt{x}}$, we get x = 5

28. The correct answer is [12]

Linear expansion, $l' = l(1 + \alpha\Delta T)$

$l' = 5(1 + 1.6\times10^{-5}\times(177 - 27))$

$l' = 12\times10^{-3}$ cm,

On comparing with $d\times10^{-3}$, we get

d = 12

29. The correct answer is [10]

Quality factor is given by, $Q = \frac{1}{R}\sqrt{\frac{L}{C}}$

Bandwidth of LCR circuit, $\omega = \frac{R}{L}$

Now, $\frac{Q}{\omega} = \frac{L}{R^2}\sqrt{\frac{L}{C}}$

$= \frac{3}{100}\sqrt{\frac{3}{27\times10^{-6}}} = 10$

30. The correct answer is [40]

Here, m = 2kg u = 0 ms^{-1}

T = 5s, KE = 10^4J

$v = \sqrt{\frac{2KE}{m}} = \sqrt{\frac{2\times10^4}{2}} = 100$ ms^{-1}

$a = \frac{v-u}{t} = \frac{100-0}{5} = 20$ ms^{-1}

Force acting on the body, F = ma = 2 × 20 = 40 N

❐❐❐