JEE MAIN 2023
Paper with Solution

PHYSICS | 30th Jan 2023 _ Shift-2

Umeed Rank Ki Ho Ya Selection Ki, JEET NISCHIT HAI!

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- AIR-1 to 10 — 25 Times
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JEE MAIN+ADVANCED

- AIR-1 to 10 — 8 Times
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Nation's Best SELECTION
Percentage (%) Ratio

Student Qualified in NEET

(2022)
4837/5356 = 90.31%
(2021)
3276/3411 = 93.12%

Student Qualified in JEE ADVANCED

(2022)
1756/4818 = 36.45%
(2021)
1256/2994 = 41.95%

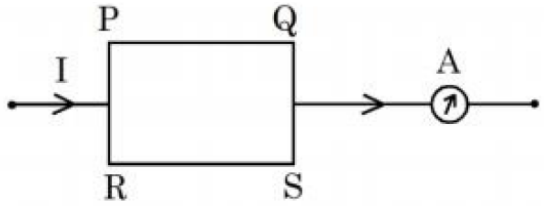
Student Qualified in JEE MAIN

(2022)
4818/6653 = 72.41%
(2021)
2994/4087 = 73.25%

NITIN VIIJAY (NV Sir)
Founder & CEO

SECTION - A

1. A current carrying rectangular loop $PQRS$ is made of uniform wire. The length $PR = QS = 5$ cm and $= RS = 100$ cm. If ammeter current reading changes from I to $2I$, the ratio of magnetic forces per unit length on the wire PQ due to wire RS in the two cases respectively $\left(f_{PQ}^{I} : f_{PQ}^{2I}\right)$ is:



(1) 1:2 (2) 1:3 (3) 1:4 (4) 1:5

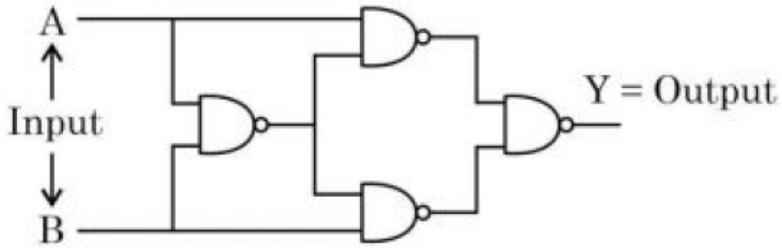
Sol. **(3)**

$F \propto I_1 I_2$

$\frac{F_1}{F_{2I}} = \frac{1}{4}$

Ans. (3)

2. The output Y for the inputs A and B of circuit is given by



Truth table of the shown circuit is:

(1)

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

(2)

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

(3)

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

(4)

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

Sol. **(3)**

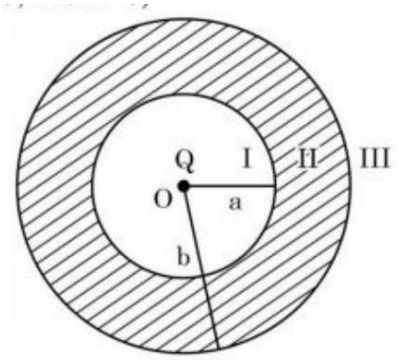
3. Given below are two statements: one is labelled as Assertion **A** and the other is labelled as Reason R
Assertion A: Efficiency of a reversible heat engine will be highest at $-273^{\circ}C$ temperature of cold reservoir.
Reason R: The efficiency of Carnot's engine depends not only on temperature of cold reservoir but it depends on the temperature of hot reservoir too and is given as $\eta = \left(1 - \frac{T_2}{T_1}\right)$.
In the light of the above statements, choose the correct answer from the options given below
(1) Both **A** and **R** are true but **R** is NOT the correct explanation of **A**
(2) Both **A** and **R** are true and **R** is the correct explanation of **A**
(3) A is false but **R** is true
(4) A is true but **R** is false

Sol. (2)

$$\eta = 1 - \frac{T_L}{T_H} = \frac{T_H - T_L}{T_H}$$

Efficiently of Carnot's engine will be highest at – 273º = 0K
Ans. (2)

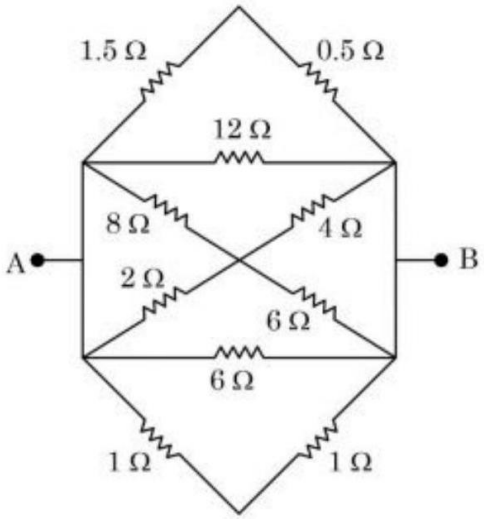
4. As shown in the figure, a point charge Q is placed at the centre of conducting spherical shell of inner radius a and outer radius b. The electric field due to charge Q in three different regions I, II and III is given by:
(I: $r < a$, II: $a < r < b$, III: $r > b$)



(1) $E_I = 0, E_{II} = 0, E_{III} = 0$
(2) $E_I = 0, E_{II} = 0, E_{III} \neq 0$
(3) $E_I \neq 0, E_{II} = 0, E_{III} \neq 0$
(4) $E_I \neq 0, E_{II} = 0, E_{III} = 0$

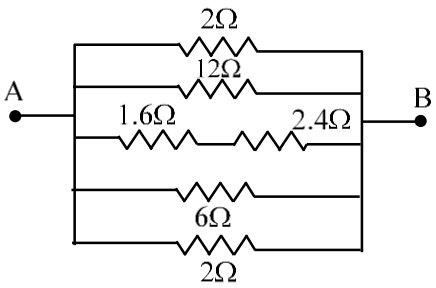
Sol. **Sol. (3)**
Electric field inside material of conductor is zero
Ans. (3)

5. The equivalent resistance between A and B is



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

Sol. **(4)**



$$\frac{1}{R_{eq}} = \frac{1}{2} + \frac{1}{12} + \frac{1}{4} + \frac{1}{6} + \frac{1}{2}$$

$$= \frac{18}{12} = \frac{3}{2}$$

$$R_{eq} = \frac{2}{3}\ \Omega$$

Ans. (4)

6. A vehicle travels 4 km with speed of 3 km/h and another 4 km with sped of 5 km/h, then its average speed is

(1) 3.50 km/h (2) 4.25 km/h (3) 4.00 km/h (4) 3.75 km/h

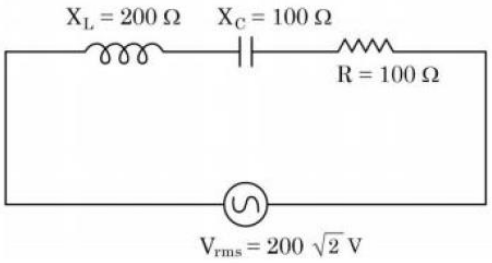
Sol. **(4)**

$$\frac{2}{V_{av}} = \frac{1}{3} + \frac{1}{5} = \frac{8}{15}$$

$$V_{av} = \frac{15}{4} = 3.75 \text{ km hr}^{-1}$$

Ans. (4)

7. In the given circuit, rms value of current (I_{rms}) through the resistor R is:



(1) $2\sqrt{2}$ A (2) 2 A (3) 20 A (4) $\frac{1}{2}$ A

Sol. **(2)**

$$Z = \sqrt{R^2 + (X_L - X_e)^2}$$

$$Z = \sqrt{(100)^2 + (200-100)^2}$$

$$Z = 100\sqrt{2}\ \Omega$$

$$I_{rms} = \frac{V_{rms}}{Z} = \frac{200\sqrt{2}}{100\sqrt{2}} = 2\ A$$

8. A point source of 100 W emits light with 5% efficiency. At a distance of 5 m from the source, the intensity produced by the electric field component is:

(1) $\frac{1}{2\pi}\frac{W}{m^2}$ (2) $\frac{1}{20\pi}\frac{W}{m^2}$ (3) $\frac{1}{10\pi}\frac{W}{m^2}$ (4) $\frac{1}{40\pi}\frac{W}{m^2}$

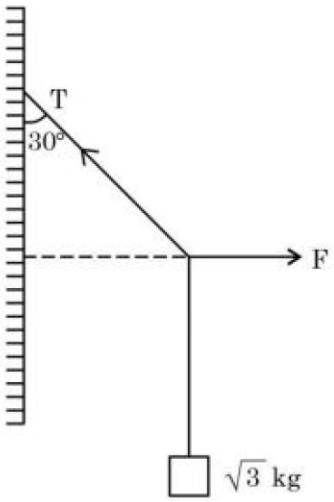
Sol. **(4)**

$$I_{EF} = \frac{1}{2} \times \frac{5}{4\pi(5)^2}$$

$$= \frac{1}{40\pi}\ w/m^2$$

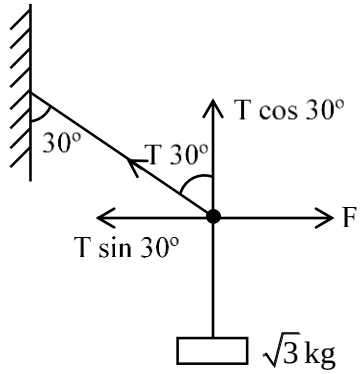
Ans: (4)

9. A block of $\sqrt{3}$ kg is attached to a string whose other end is attached to the wall. An unknown force F is applied so that the string makes an angle of 30° with the wall. The tension T is: (Given g = 10 ms^{-2})



(1) 20 N (2) 10 N (3) 15 N (4) 25 N

Sol. **(1)**



$F = T\sin 30°$

$\sqrt{3}g = T\cos 30°$

$\tan 30° = \frac{F}{\sqrt{3}g}$

$\frac{1}{\sqrt{3}} = \frac{F}{\sqrt{3}g}$

$F = 10$ N

$T = \frac{F}{\sin 30°} = 10 \times 2$

$T = 10 \times 2 = 20$ N

Ans: (1)

10. Match List I with List II:

List I	List II
A. Attenuation	I. Combination of a receiver and transmitter.
B. Transducer	II. process of retrieval of information from the carrier wave at receiver
C. Demodulation	III. converts one form of energy into another
D. Repeater	IV. Loss of strength of a signal while propogating through a medium.

Choose the correct answer from the options given below:

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

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

Sol. **(3)**

Theory

11. An electron accelerated through a potential difference V_1 has a de-Broglie wavelength of λ. When the potential is changed to V_2, its de-Broglie wavelength increases by 50%. The value of $\left(\frac{V_1}{V_2}\right)$ is equal to

(1) 3 (2) $\frac{3}{2}$ (3) 4 (4) $\frac{9}{4}$

Sol. **(4)**

$KE = \frac{P^2}{2m}$

$P = \frac{h}{\lambda}$

$eV_1 = \frac{\left(\frac{h}{\lambda}\right)^2}{2m}$

$eV_2 = \frac{\left(\frac{h}{1.5\lambda}\right)^2}{2m}$

$\frac{V_1}{V_2} = (1.5)^2 = \frac{9}{4}$

Ans: (4)

12. A flask contains hydrogen and oxygen in the ratio of 2:1 by mass at temperature 27°C. The ratio of average kinetic energy per molecule of hydrogen and oxygen respectively is:

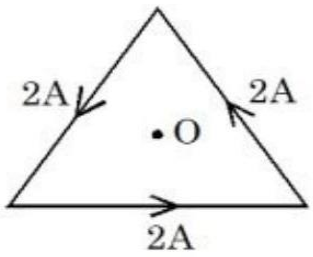
(1) 2 : 1 (2) 1 : 1 (3) 1 : 4 (4) 4 : 1

Sol. **(2)**

Average kinetic energy per molecule = $\frac{5}{2}KT$

Ratio = $\frac{1}{1}$

13. As shown in the figure, a current of 2 A flowing in an equilateral triangle of side $4\sqrt{3}$ cm. The magnetic field at the centroid 0 of the triangle is



(Neglect the effect of earth's magnetic field)

(1) $1.4\sqrt{3} \times 10^{-5}$ T (2) $4\sqrt{3} \times 10^{-4}$ T (3) $3\sqrt{3} \times 10^{-5}$ T (4) $\sqrt{3} \times 10^{-4}$ T

Sol. **(3)**

$d \tan 60° = 2\sqrt{3}$

$d = 2$ cm

$B = 3\left(\frac{\mu_0 I}{2\pi d}\right)\sin 60°$

$B = \frac{3 \times 2 \times 10^{-7} \times 2}{2 \times 10^{-2}} \times \frac{\sqrt{3}}{2}$

$B = 3\sqrt{3} \times 10^{-5}$ T

14. An object is allowed to fall from a height R above the earth, where R is the radius of earth. Its velocity when it strikes the earth's surface, ignoring air resistance, will be

(1) $\sqrt{2gR}$ (2) $\sqrt{\frac{gR}{2}}$ (3) $2\sqrt{gR}$ (4) $\sqrt{gR}$

Sol. **(4)**

Use work energy theorem

$\Delta KE = w_g$

$\frac{1}{2}mv^2 - 0 = -[u_f - u_i]$

$\frac{1}{2}mv^2 = -\left[-\frac{GMm}{R} - \left(-\frac{GMm}{2R}\right)\right]$

$\frac{1}{2}mv^2 = \frac{GMm}{R} - \frac{GMm}{2R}$

$= \frac{GMm}{R}\left(\frac{2-1}{2}\right)$

$\frac{1}{2}mv^2 = \frac{GMm}{2R}$

$V = \sqrt{\frac{GM}{R}}$

$V = \sqrt{gR}$ $(GM = gR^2)$

15. Match List I with List II:

List I	List II
A. Torque	I. $kg\ m^{-1}\ s^{-2}$
B. Energy density	II. $kg\ ms^{-1}$
C. Pressure gradient	III. $kg\ m^{-2}\ s^{-2}$
D. Impulse	IV. $kg\ m^2\ s^{-2}$

Choose the correct answer from the options given below:

(1) A – IV, B – I, C – III, D – II (2) A – IV, B – III, C – I, D – II

(3) A – IV, B – I, C – II, D – III (4) A – I, B – IV, C – III, D – II

Sol. **(1)**

Torque = N – m

$= kg\ \frac{m}{sec^2}\ m$

$= \frac{kg\ m^2}{sec^2}$

Energy Density = $\frac{N-m}{m^3} = \frac{N}{m^2}$

$= kg\ \frac{m}{sec^2} \times \frac{1}{m^2}$

Pressure gradient = $\frac{Pressure}{length} = \frac{F}{A - length}$

$= kg\ m^{-2}\ sec^{-2}$

Impulse = $\Delta P = kg\ m - s^{-1}$

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

Assertion A: The nuclear density of nuclides $^{10}_{5}$B, $^{6}_{3}$Li, $^{56}_{26}$Fe, $^{20}_{10}$Ne and $^{209}_{83}$Bi can be arranged as $\rho^{N}_{Bi} > \rho^{N}_{Fe} > \rho^{N}_{Ne} > \rho^{N}_{B} > \rho^{N}_{Li}$

Reason R: The radius R of nucleus is related to its mass number A as $R = R_0 A^{1/3}$, where R_0 is a constant.

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

(1) A is false but **R** is true

(2) A is true but **R** is false

(3) Both **A** and **R** are true but **R** is NOT the correct explanation of **A**

(4) Both **A** and **R** are true and **R** is the correct explanation of **A**

Sol. **(1)**

Nuclear density is independent of A

Ans: (1)

17. A force is applied to a steel wire 'A', rigidly clamped at one end. As a result elongation in the wire is 0.2 mm. If same force is applied to another steel wire 'B' of double the length and a diameter 2.4 times that of the wire 'A', the elongation in the wire ' B ' will be (wires having uniform circular cross sections)

(1) 6.06×10^{-2} mm (2) 2.77×10^{-2} mm

(3) 3.0×10^{-2} mm (4) 6.9×10^{-2} mm

Sol. **(4)**

$$Y = \frac{F\ell}{A\Delta\ell}$$

$$F = \frac{YA\Delta\ell}{\ell}$$

$$\left(\frac{A\Delta\ell}{\ell}\right)_1 = \left(\frac{A\Delta\ell}{\ell}\right)_2$$

$$\frac{\Delta\ell_2}{\Delta\ell_1} = \frac{A_1}{A_2} \times \frac{\ell_2}{\ell_1}$$

$$\frac{(\Delta\ell)_2}{0.2} = \frac{1}{2.4 \times 2.4} \times \frac{2}{1}$$

$(\Delta\ell)_2 = 6.9 \times 10^{-2}$ mm

Ans: (4)

18. A thin prism, P_1 with an angle 6th and made of glass of refractive index 1.54 is combined with another prism P_2 made from glass of refractive index 1.72 to produce dispersion without average deviation. The angle of prism P_2 is

(1) 1.3° (2) 6° (3) 4.5° (4) 7.8°

Sol. **(3)**

$\delta_1 = \delta_2$ [For no deviation]

$6(1.54 - 1) = A(1.72 - 1)$

$$A = \frac{18}{4} = 4.5^{\circ}$$

Ans: (3)

19. A machine gun of mass 10 kg fires 20 g bullets at the rate of 180 bullets per minute with a speed of 100 m s^{-1} each. The recoil velocity of the gun is

(1) 1.5 m/s (2) 0.6 m/s (3) 2.5 m/s (4) 0.02 m/s

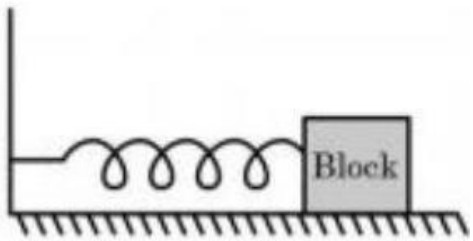
Sol. **(2)**

$20 \times 10^{-3} \times \frac{180}{60} \times 100 = 10$ V

V = 0.6 ms^{-1}

Ans: (2)

20. For a simple harmonic motion in a mass spring system shown, the surface is frictionless. When the mass of the block is 1 kg, the angular frequency is ω_1. When the mass block is 2 kg the angular frequency is ω_2. The ratio ω_2/ω_1 is



(1) $1/\sqrt{2}$ (2) $\sqrt{2}$ (3) 2 (4) 1/2

Sol. **(1)**

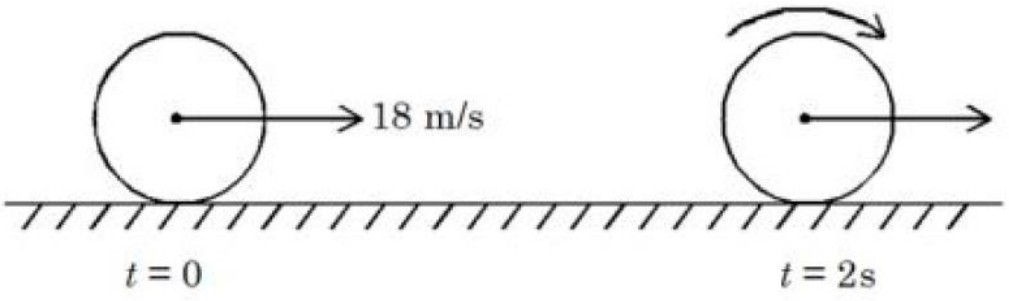
$\omega = \sqrt{\frac{k}{m}}$

$\frac{\omega_2}{\omega_1} = \sqrt{\frac{m_1}{m_2}} = \sqrt{\frac{1}{2}}$

Ans: (1)

SECTION - B

21. A uniform disc of mass 0.5 kg and radius r is projected with velocity 18 m/s at t = 0 s on a rough horizontal surface. It starts off with a purely sliding motion at t = 0 s. After 2 s it acquires a purely rolling motion (see figure). The total kinetic energy of the disc after 2 s will be _____ **J** (given, coefficient of friction is 0.3 and $g = 10$ m/s^2).



Sol. **(54)**

$a = -\mu_k g = -3$

$v = u + at$

$v = 18 - 3 \times 2 = 12\ ms^{-1}$

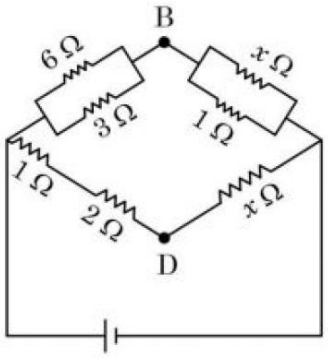
$KE = \frac{1}{2}mv^2 + \frac{1}{2}\left(\frac{mr^2}{2}\right)\left(\frac{v}{r}\right)^2$

$KE = \frac{3}{4}mv^2$

$KE = 3 \times 18 = 54\ J$

Ans: (54)

22. If the potential difference between B and D is zero, the value of x is $\frac{1}{n}\Omega$. The value of n is _____.



Sol. **(2)**

$\frac{2}{3} = \frac{x}{x+1}$

$\frac{2}{3} = \frac{1}{x+1}$

$x = 0.5 = \frac{1}{2}$

$n = 2$

Ans: (2)

23. A stone tied to 180 cm long string at its end is making 28 revolutions in horizontal circle in every minute. The magnitude of acceleration of stone is $\frac{1936}{x} ms^{-2}$. The value of x _____. (Take $\pi = \frac{22}{7}$)

Sol. **(125)**

$a = \omega^2 r$

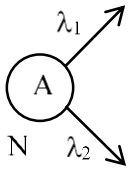
$a = \left(\frac{28 \times 2\pi}{60}\right)^2 \times 1.8$

$a = \frac{1936 \times 1.8}{225} = \frac{1936}{125} ms^{-2}$

$x = 125$

24. A radioactive nucleus decays by two different process. The half life of the first process is 5 minutes and that of the second process is 30 s. The effective half-life of the nucleus is calculated to be $\frac{\alpha}{11}$ s. The value of α is _____.

Sol. **(300)**



$$\frac{dN}{dt} = -(\lambda_1 + \lambda_2)N$$

$$\lambda_{eq} = \lambda_1 + \lambda_2$$

$$\frac{1}{t_{1/2}} = \frac{1}{300} + \frac{1}{30} = \frac{11}{300}$$

$$t_{1/2} = \left(\frac{300}{11}\right) \text{ sec}$$

Ans: (300)

25. A faulty thermometer reads 5°C in melting ice and 95°C in stream. The correct temperature on absolute scale will be _____ K when the faulty thermometer reads 41°C.

Sol. **(313)**

Ans: $\frac{41^\circ - 5^\circ}{95^\circ - 5^\circ} = \frac{R - 0}{100 - 0}$

$R = 40^\circ C$

$R = 313$ K

26. In an ac generator, a rectangular coil of 100 turns each having area 14×10^{-2} m^2 is rotated at 360rev/min about an axis perpendicular to a uniform magnetic field of magnitude 3.0 T. The maximum value of the emf produced will be _____ V.

$\left(\text{Take } \pi = \frac{22}{7}\right)$

Sol. **(1584)**

$E_{max} = NAB\omega$

$= 100 \times 14 \times 10^{-2} \times 3 \times \frac{360 \times 2\pi}{60}$

$= 1584$ V

Ans: (1584)

27. A body of mass 2 kg is initially at rest. It starts moving unidirectionally under the influence of a source of constant power P. Its displacement in 4 s is $\frac{1}{3}\alpha^2\sqrt{P}m$. The value of α will be _____.

Sol. **(4)**

$$\frac{1}{2}mv^2 = pt$$

$$V = \sqrt{\frac{2pt}{m}}$$

$$\frac{dx}{dt} = \sqrt{\frac{2pt}{m}}$$

$$\int dx = \sqrt{\frac{2p}{m}}\int \sqrt{t}dt$$

$$x = \sqrt{\frac{2p}{m}}\left[t^{3/2}\right]_0^4$$

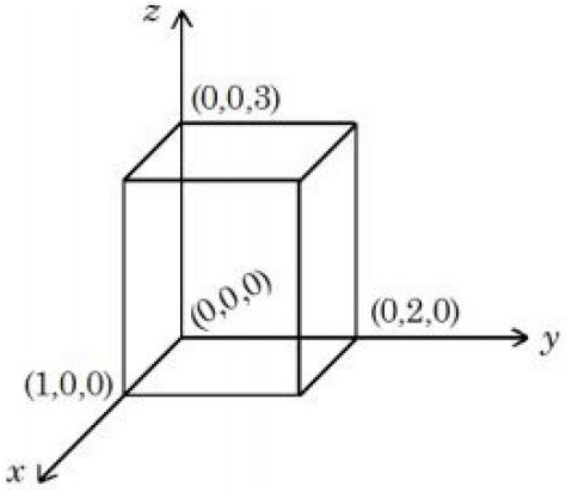
$$x = \frac{1}{3}\times 16\sqrt{p}$$

$$\propto = 4$$

Ans: (4)

28. As shown in figure, a cuboid lies in a region with electric field $= 2x^2\hat{\imath} - 4y\hat{\jmath} + 6\hat{k}$ N/C. The magnitude of charge within the cuboid is $n \in_0 C$.

The value of n is _____ (if dimension of cuboid is $1 \times 2 \times 3$ m^3).



Sol. **(12)**

$$\phi_{net} = -8 \times 3 + 2 \times 6$$

$$= -12$$

$$\phi_{net} = \frac{q_{inside}}{\in_0}$$

$$q_{inside} = -12 \in_0$$

Ans: (12)

29. In a Young's double slit experiment, the intensities at two points, for the path differences $\frac{\lambda}{4}$ and $\frac{\lambda}{3}$ (λ being the wavelength of light used) are I_1 and I_2 respectively. If I_0 denotes the intensity produced by each one of the individual slits, then $\frac{I_1+I_2}{I_0}$ = _____.

Sol. **(3)**

$I = 4I_0 \cos^2\frac{\phi}{2}$

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

$I_1 = 4I_0 \cos^2\frac{\pi}{4} = 2I_0$

$I_2 = 4I_0 \cos^2\frac{2\pi}{3} = I_0$

$\Rightarrow \frac{I_1 + I_2}{I_0} = 3$

Ans: (3)

30. The velocity of a particle executing SHM varies with displacement (x) as $4v^2 = 50 - x^2$. The time period of oscillations is $\frac{x}{7}s$. The value of x is _____.

$\left(\text{Take } \pi = \frac{22}{7}\right)$

Sol. **(88)**

$4v^2 = 50 - x^2$

$V = \frac{1}{2}\sqrt{50 - x^2}$

$\omega = \frac{1}{2}$

$T = \frac{2\pi}{\omega} = 4\pi = \frac{88}{7}$

$x = 88$

Ans: (88)

मोशन है, तो भरोसा है।

#RankBhiSelectionBhi

ADMISSION ANNOUNCEMENT

Session 2023-24 (English & हिन्दी Medium)

Target: JEE/NEET 2025
Nurture & प्रयास Batch
Class 10th to 11th Moving

Target: JEE/NEET 2024
Enthuse & प्रयास Batch
Class 11th to 12th Moving

Target: JEE/NEET 2024
Dropper & प्रयास Batch
Class 12th to 13th Moving

Target: PRE FOUNDATION
SIP, Evening & Tapasya Batch
Class 6th to 10th Students

MOTION®