JEE MAIN 2023

Paper with Solution

PHYSICS | 30th Jan 2023 _ Shift-1

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

Most Promising **RANKS**
Produced by MOTION Faculties

NEET / AIIMS

AIR-1 to 10
25 Times

AIR-11 to 50
83 Times

AIR-51 to 100
81 Times

JEE MAIN+ADVANCED

AIR-1 to 10
8 Times

AIR-11 to 50
32 Times

AIR-51 to 100
36 Times

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 VIJAY (NV Sir)
Founder & CEO

SECTION - A

1. The magnetic moments associated with two closely wound circular coils A and B of radius $r_A = 10$ cm and $r_B = 20$ cm respectively are equal if : (Where N_A, I_A and N_B, I_B are number of turn and current of A and B respectively)

(1) $4\,N_A I_A = N_B I_B$ (2) $N_A = 2\,N_B$ (3) $N_A I_A = 4\,N_B I_B$ (4) $2\,N_A I_A = N_B I_B$

Sol. **(3)**

Magnetic moment m = IAN

Magnetic moment of coil A $\rightarrow$

$$m_A = I_A \pi r_A^2 N_A$$

$$m_A = I_A \pi N_A (10)^2 \qquad ...(1)$$

Magnetic moment of coil B $\rightarrow$

$$m_B = I_B N_B \pi r_B^2$$

$$m_B = I_B N_B \pi (20)^2 \qquad ...(2)$$

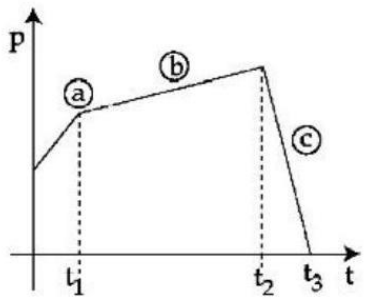
Now $m_A = m_B$

$$I_A . \pi N_A (100) = I_B N_B \pi 400$$

$$\boxed{I_A N_A = 4 I_B N_B}$$

2. The figure represents the momentum time (p-t) curve for a particle moving along an axis under the influence of the force. Identify the regions on the graph where the magnitude of the force is maximum and minimum respectively ?

If $(t_3 - t_2) < t_1$



(1) c and b (2) b and c (3) *a* and *b* (4) c and a

Sol. **(1)**

Slope of curve P-t will represent the force so

$$F = \frac{dP}{dt} = \text{slope}$$

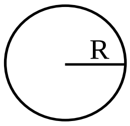
Maximum slope $\rightarrow$ (c)

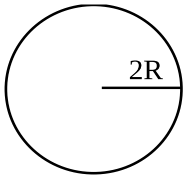
Minimum slope $\rightarrow$ (b)

3. Two isolated metallic solid spheres of radii R and 2R are charged such that both have same charge density σ. The spheres are then connected by a thin conducting wire. If the new charge density of the bigger sphere is σ'. The ratio $\frac{\sigma'}{\sigma}$ is :

(1) $\frac{4}{3}$ (2) $\frac{5}{3}$ (3) $\frac{5}{6}$ (4) $\frac{9}{4}$

Sol. **(3)**



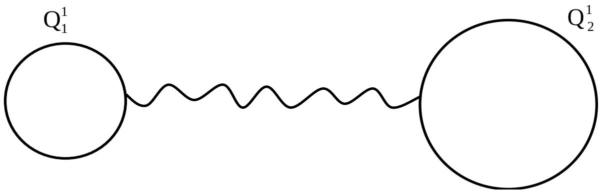


$Q_2 = \sigma 4\pi(2R)^2$

$Q_2 = \sigma 16\pi R^2$

$Q_1 = \sigma 4\pi R^2$

Now



Charge will flow until voltage of both sphere become equal so

$$c = 4\pi\varepsilon_0 R$$

$$v_1^1 = v_2^1$$

$$\frac{Q_1}{c_1} = \frac{Q_2}{c_2} \Rightarrow \frac{Q_1'}{4\pi\varepsilon_0 R} = \frac{Q_2'}{4\pi\varepsilon_0(2R)}$$

$$\Rightarrow \quad 2Q_1' = Q_2' \quad \ldots(1)$$

$$Q_1 + Q_2 = Q_1' + Q_2'$$

$$\sigma 20\pi R^2 = Q_2' + \frac{Q_2'}{2} = \frac{3}{2}Q_2' \Rightarrow Q_2' = \frac{\sigma 40\pi R^2}{3} \quad \ldots(2)$$

$$Q_2' = \frac{\sigma 40\pi R^2}{3}$$

Now $\sigma' 4\pi(2R)^2 = \dfrac{\sigma 40\pi R^2}{3}$

$$\sigma' 16\pi R^2 = \frac{\sigma 40\pi R^2}{3}$$

$$\frac{\sigma'}{\sigma} = \frac{40}{3} \times \frac{1}{16} = \frac{5}{6}$$

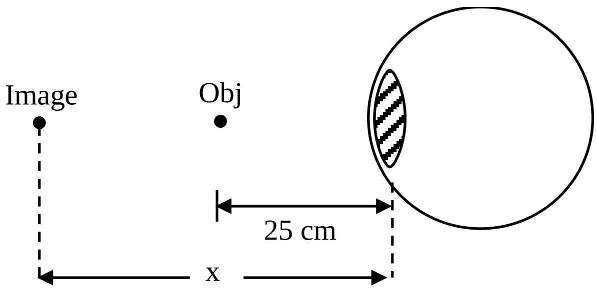
4. A person has been using spectacles of power −1.0 dioptre for distant vision and a separate reading glass of power 2.0 dioptres. What is the least distance of distinct vision for this person :

(1) 40 cm (2) 30 cm (3) 10 cm (4) 50 cm

Sol. **(4)**

Power convex lens = 2.0 D

Power of concave lens = –1.0 D



$x \rightarrow$ least distance of distinct vision

$$f = \frac{1}{2} \times 100 = 50\text{cm}$$

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

$$\frac{1}{50} = \frac{1}{(-x)} - \frac{1}{-25} \Rightarrow \frac{1}{50} - \frac{1}{25} = \frac{1}{(-x)}$$

$$\Rightarrow \frac{1-2}{50} = \frac{-1}{x}$$

$$\Rightarrow \boxed{x = 50\text{cm}}$$

5. A small object at rest, absorbs a light pulse of power 20 mW and duration 300 ns. Assuming speed of light as 3×10^8 m/s, the momentum of the object becomes equal to :

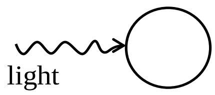
(1) 3×10^{-17} kg m/s (2) 2×10^{-17} kg m/s (3) 1×10^{-17} kg m/s (4) 0.5×10^{-17} kg m/s

Sol. **(2)**

Power = 20 mw

t = 300 nsec

energy absorbed $= 300 \times 10^{-9} \times 20 \times 10^{-3} = 6 \times 10^{3} \times 10^{-12} = 6 \times 10^{-9}$ J



$$\text{Pressure} = \frac{\text{Intensity}}{C} = \frac{\text{Power}}{\text{Area} \times C}$$

$$\text{Pressure} \times \text{Area} = \frac{\text{Power}}{C}$$

$$\text{Force} = \frac{\text{Power}}{C} = \frac{20 \times 10^{-3}}{3 \times 10^{8}}$$

$$F = \frac{20}{3} \times 10^{-11}\,\text{N}$$

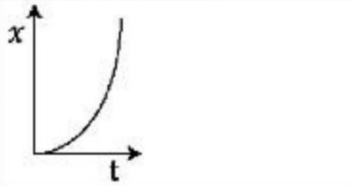
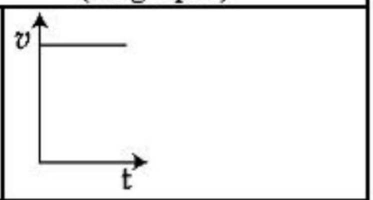
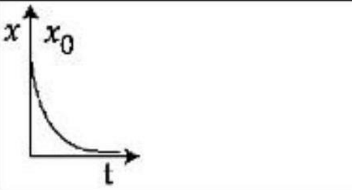
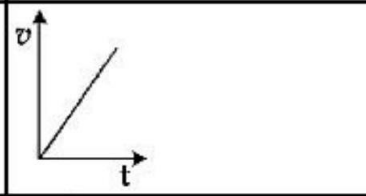
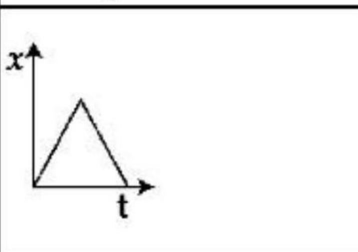
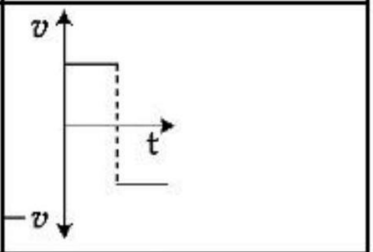
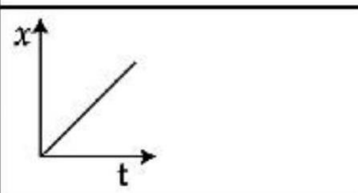
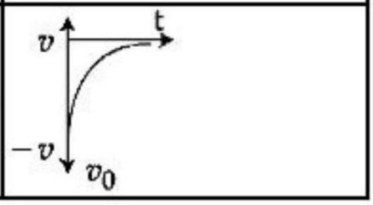
$$F\Delta t = \Delta P \ \text{(momentum)}$$

$$\frac{20}{3} \times 10^{-11} \times 300 \times 10^{-9} = P_f - P_i$$

$$20 \times 10^{-20} \times 100 = P_f$$

$$\boxed{2 \times 10^{-17} = P_f}$$

6. Match Column-I with Column-II :

	Column-I (x-t graphs)		Column-II (v-t graphs)
A.		I.	
B.		II.	
C.		III.	
D.		IV.	

Choose the correct answer from the options given below:

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

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

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

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

Sol. **(4)**

(A) $x \propto t^2$

$\frac{dx}{dt} \propto 2t \Rightarrow \boxed{V \propto t}$ $\quad A \to II$

(B) $x = x_0 e^{-\alpha t}$

$\frac{dx}{dt} = x_0 e^{-\alpha t}(-\alpha) = -\alpha(x_0 e^{-\alpha t})$

$V = -\alpha x_0 e^{-\alpha t}$ $\quad B \to IV$

(C) $x \propto t \;\to\; V = \text{const}$

$x \propto -t \;\to\; V = -\text{const}$ $\quad C \to III$

(D) $x \propto t \;\to\; V = \text{const}$ $\quad D \to I$

7. The pressure (P) and temperature (T) relationship of an ideal gas obeys the equation PT^2 = constant. The volume expansion coefficient of the gas will be :

(1) $\frac{3}{T^3}$ (2) $\frac{3}{T^2}$ (3) $3\,T^2$ (4) $\frac{3}{T}$

Sol. **(4)**

$PT^2 = \text{const.}$

$dV = V\gamma dT$

$\gamma = \frac{1}{V}\frac{dV}{dT}$ ...(1)

Using PV = nRT and PT^2 = cont.

$\frac{nRT}{V}.T^2 = \text{const}$

$V \propto T^3 \Rightarrow V = KT^3$ ...(2)

Now put in (1)

$\gamma = \frac{1}{KT^3} \times 3KT^2 = \frac{3}{T} \Rightarrow \gamma = \frac{3}{T}$

8. Heat is given to an ideal gas in an isothermal process.
A. Internal energy of the gas will decrease.
B. Internal energy of the gas will increase.
C. Internal energy of the gas will not change.
D. The gas will do positive work.
E. The gas will do negative work.
Choose the correct answer from the options given below :
(1) C and D only (2) C and E only (3) A and E only (4) B and D only

Sol. **(1)**

In isothermal process

$\Delta T = 0$

So $\Delta U = 0$

$\Delta Q = \omega + \Delta U$

$\boxed{\Delta Q = \omega}$

So heat will be used to do positive work

9. If the gravitational field in the space is given as $\left(-\frac{K}{r^2}\right)$. Taking the reference point to be at r = 2 cm with gravitational potential V = 10 J/kg. Find the gravitational potential at r = 3 cm in SI unit (Given, that K = 6Jcm/kg)
(1) 9 (2) 10 (3) 11 (4) 12

Sol. **(3)**

$\Delta V = -\int_2^3 \vec{E}.d\vec{r}$

$V(3) - V(2) = -\int_2^3 \frac{-K}{r^2}.dr$

$V(3) - 10 = -K\left(\frac{1}{r}\right)_2^3$

$V(3) - 10 = -6\left[\frac{1}{3} - \frac{1}{2}\right]$

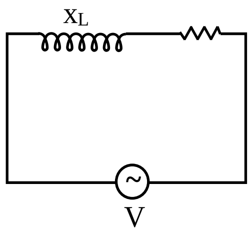
$V - 10 = -6\left[\frac{2-3}{6}\right] = 1$

$\boxed{V = 11}$

10. In a series LR circuit with $X_L = R$, power factor is P_1. If a capacitor of capacitance C with $X_C = X_L$ is added to the circuit the power factor becomes P_2. The ratio of P_1 to P_2 will be :

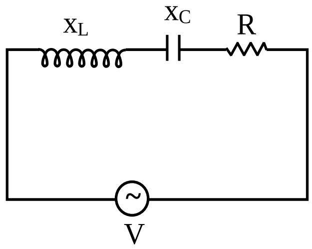
(1) 1:3 (2) 1: 2 (3) $1:\sqrt{2}$ (4) 1: 1

Sol. (3)



Power factor = $\cos\phi = \frac{R}{Z}$

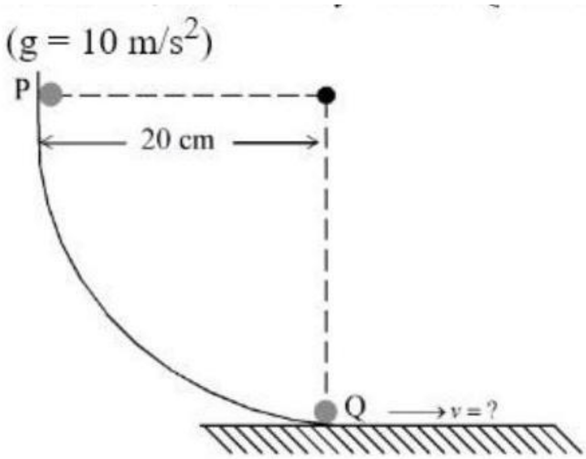
$$P_1 = \frac{R}{\sqrt{X_L^2 + R^2}} = \frac{R}{\sqrt{R^2 + R^2}} = \frac{R}{\sqrt{2}R} = \frac{1}{\sqrt{2}}$$



$$P_2 = \frac{R}{Z} = \frac{R}{\sqrt{(X_L - X_C)^2 + R^2}} = \frac{R}{R} = 1$$

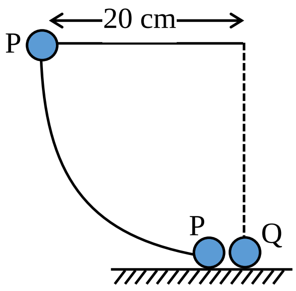
$$\frac{P_1}{P_2} = \frac{1}{\sqrt{2}}$$

11. As per the given figure, a small ball P slides down the quadrant of a circle and hits the other ball Q of equal mass which is initially at rest. Neglecting the effect of friction and assume the collision to be elastic, the velocity of ball Q after collision will be :



(1) 0 (2) 4 m/s (3) 2 m/s (4) 0.25 m/s

Sol. **(3)**



Energy conservation for 'P'

$$mgh = \frac{1}{2}mV^2$$

$$V = \sqrt{2gh}$$

$$V = \sqrt{2 \times 10 \times 0.2}$$

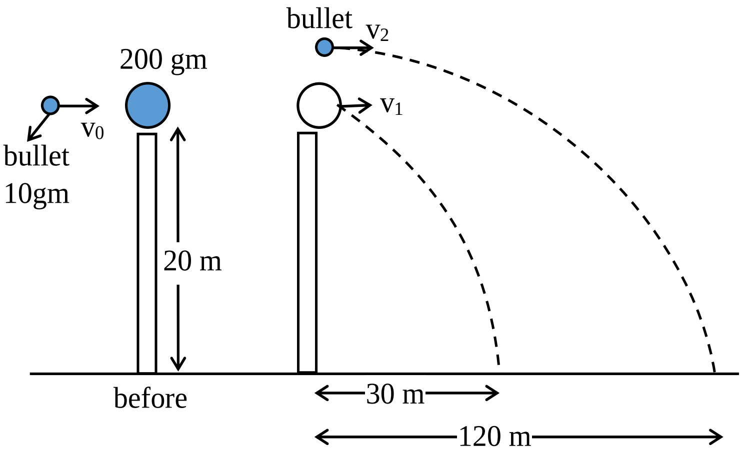
$$\boxed{V = 2m/sec}$$

Now collision between P and Q is elastic and both have same mass then P will transfer all velocity to then Q. So velocity Q will be 2 m/sec

12. A ball of mass 200 g rests on a vertical post of height 20 m. A bullet of mass 10 g, travelling in horizontal direction, hits the centre of the ball. After collision both travels independently. The ball hits the ground at a distance 30 m and the bullet at a distance of 120 m from the foot of the post. The value of initial velocity of the bullet will be (if $g = 10\ m/s^2$) :

(1)360 m/s (2) 400 m/s (3) 60 m/s (4) 120 m/s

Sol. **(1)**



Time to reach ground will be same for both

$$t = \sqrt{\frac{2h}{g}} = \sqrt{\frac{2 \times 20}{10}} = 2sec$$

Range of bullet = 120

$$120 = v_2(2) \Rightarrow \boxed{v_2 = 60m/sec}$$

Range of ball = 30

$30 = V_1(2) \Rightarrow \boxed{v_1 = 15m/sec}$

Now apply momentum conservation

$$P_i = P_f$$

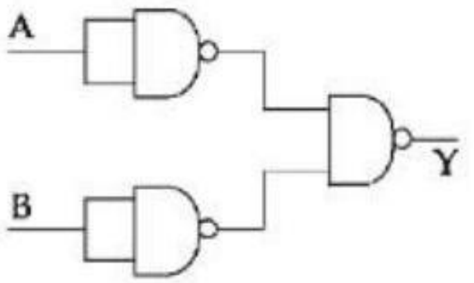
$$P_{ball} + P_{bullet} = P_{ball} + P_{bullet}$$

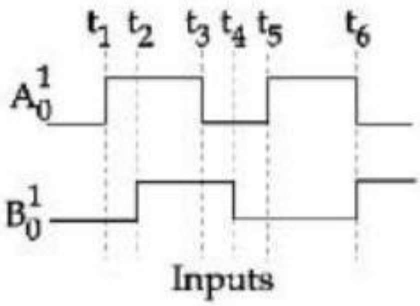
$$0 + \left(\frac{10}{1000}\right)v_0 = \left(\frac{200}{1000}\right)(15) + \left(\frac{10}{1000}\times 60\right)$$

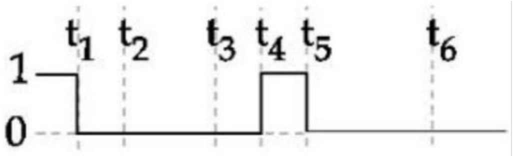
$$10v_0 = 3000 + 600$$

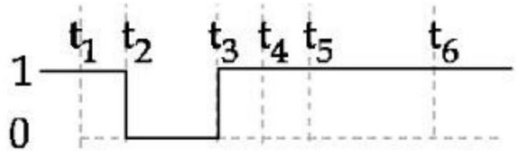
$$v_0 = \frac{3600}{10} \Rightarrow \boxed{v_0 = 360m/sec}$$

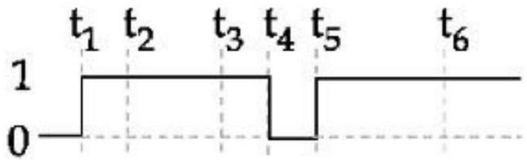
13. The output waveform of the given logical circuit for the following inputs A and B as shown below, is

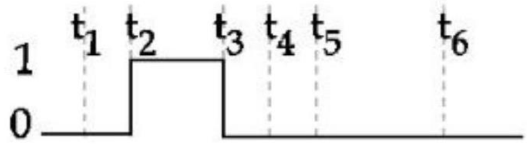




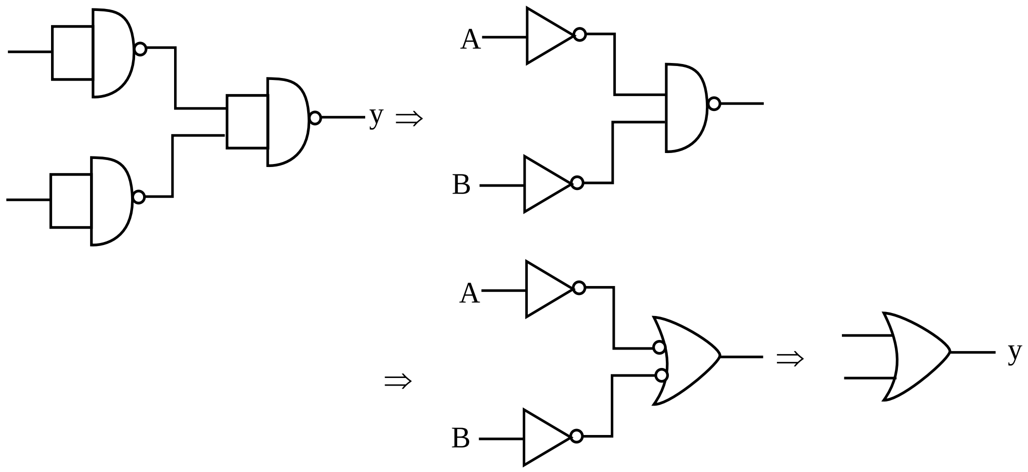
(1) 

(2) 

(3) 

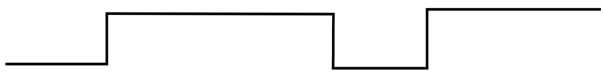
(4) 

Sol. **(3)**



y = A + B

A	0	1	1	0	0	1	0
B	0	0	1	1	0	0	1
y	0	1	1	1	0	1	1



14. The charge flowing in a conductor changes with time as $Q(t) = \alpha t - \beta t^2 + \gamma t^3$. Where α, β and γ are constants. Minimum value of current is :

(1) $\alpha - \frac{3\beta^2}{\gamma}$ (2) $\alpha - \frac{\gamma^2}{3\beta}$ (3) $\alpha - \frac{\beta^2}{3\gamma}$ (4) $\beta - \frac{\alpha^2}{3\gamma}$

Sol. **(3)**

$Q = \alpha t - \beta t^2 + \gamma t^3$

$I = \frac{dQ}{dt} = \alpha - 2\beta t + 3\gamma t^2$

$\frac{dI}{dt} = 0 = 0 - 2\beta + 6\gamma t \Rightarrow t = \frac{2\beta}{6\gamma} = \frac{\beta}{2\gamma}$

$I_{min} = \alpha - 2\beta\left(\frac{\beta}{3\gamma}\right) + 3\gamma\left(\frac{\beta}{3\gamma}\right)^2$

$= \alpha - \frac{2\beta^2}{3\gamma} + \frac{\beta^2}{3\gamma}$

$\boxed{I_{min} = \alpha - \frac{\beta^2}{3\gamma}}$

15. Choose the correct relationship between Poisson ratio (σ), bulk modulus (K) and modulus of rigidity (η) of a given solid object :

(1) $\sigma = \frac{3K + 2\eta}{6K + 2\eta}$ (2) $\sigma = \frac{3K - 2\eta}{6K + 2\eta}$ (3) $\sigma = \frac{6K + 2\eta}{3K - 2\eta}$ (4) $\sigma = \frac{6K - 2\eta}{3K - 2\eta}$

Sol. **(2)**

$Y = 2\eta[1+\sigma]$

and $Y = 3K[1-2\sigma]$

Now $2\eta(1+\sigma) = 3K(1-2\sigma)$

$2\eta\sigma + 2\eta = 3K - 6K\sigma$

$(2n + 6K)\sigma = 3K - 2n$

$\boxed{\sigma = \frac{3K - 2\eta}{2\eta + 6K}}$

16. Speed of an electron in Bohr's 7^{th} orbit for Hydrogen atom is 3.6×10^6 m/s. The corresponding speed of the electron in 3^{rd} orbit, in m/s is:

(1) (1.8×10^6) (2) (3.6×10^6) (3) (7.5×10^6) (4) (8.4×10^6)

Sol. **(4)**

We now

$V \propto \frac{z}{n}$

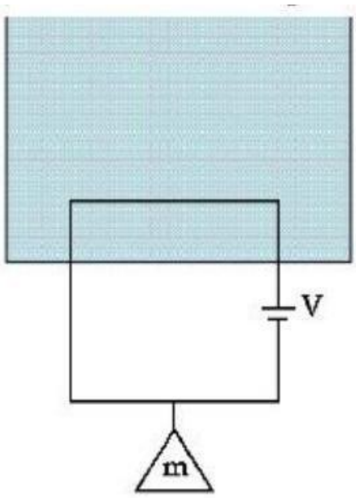
$\frac{V_3}{V_7} = \frac{7}{3}$

$V_3 = V_7 \times \frac{7}{3} = 3.6 \times 10^6 \times \frac{7}{3} = 1.2 \times 7 \times 10^6$

$\boxed{V_3 = 8.4 \times 10^6 \text{ m/s}}$

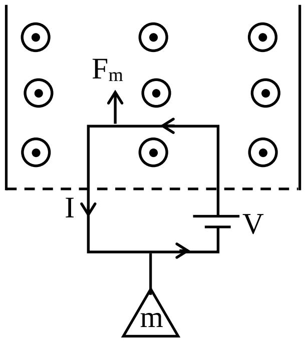
17. A massless square loop, of wire of resistance 10Ω, supporting a mass of 1 g, hangs vertically with one of its sides in a uniform magnetic field of 10^3G, directed outwards in the shaded region. A dc voltage V is applied to the loop. For what value of V, the magnetic force will exactly balance the weight of the supporting mass of 1 g ?

(If sides of the loop $= 10$ cm, $g = 10$ ms^{-2})



(1) $\frac{1}{10}$ V (2) 100 V (3) 10 V (4) 1 V

Sol. **(3)**



For balancing $\rightarrow$ $l = 10$ cm ,

$B = 10^3$ G $= 0.1$ T,

$m = 1$ g

$F_m = mg$

$I\ell B = mg$

$$\frac{V}{R}(0.1)(0.1) = \frac{1}{1000}\times 10$$

$$\frac{V}{100R} = \frac{1}{100}$$

$$\frac{V}{10} = 1 \Rightarrow \boxed{V = 10\text{Volt}}$$

18. Electric field in a certain region is given by $\vec{E} = \left(\frac{A}{x^2}\hat{i} + \frac{B}{y^2}\hat{j}\right)$. The SI unit of A and B are :

(1) Nm^3C^{-1}; Nm^2C^{-1} (2) Nm^2C^{-1}; Nm^3C^{-1} (3) Nm^3C; Nm^2C (4) Nm^2C; Nm^3C

Sol. **(2)**

$$\vec{E} = \frac{A}{x^2}\hat{i} + \frac{B}{y^3}\hat{j}$$

Unit of A $\rightarrow$ $\frac{N}{c}\times m^2 = Nm^2c^{-1}$

Unit of B $\rightarrow$ $\frac{N}{c}\times m^3 = Nm^3c^{-1}$

19. The height of liquid column raised in a capillary tube of certain radius when dipped in liquid A vertically is, 5 cm. If the tube is dipped in a similar manner in another liquid B of surface tension and density double the values of liquid A, the height of liquid column raised in liquid B would be m

(1) 0.05 (2) 0.10 (3) 0.20 (4) 0.5

Sol. **(1)**

$$h = \frac{2T\cos\theta}{r\rho g}$$

$$h \propto \frac{T}{\rho}$$

$$\frac{h_2}{h_1} = \frac{T_2}{T_1}\times\frac{\rho_1}{\rho_2}$$

$$\frac{h_2}{5cm} = \frac{2T}{T}\times\frac{\rho}{2\rho} = 1$$

$$\boxed{h_2 = 5cm = 0.05m}$$

20. A sinusoidal carrier voltage is amplitude modulated. The resultant amplitude modulated wave has maximum and minimum amplitude of 120 V and 80 V respectively. The amplitude of each sideband is :

(1) 20 V (2) 15 V (3) 10 V (4) 5 V

Sol. **(3)**

$V_{max} = V_m + V_c$

$120 = V_c + V_m$ ...(1)

$V_{min} = V_c - V_m$

$80 = V_c - V_m$ ...(2)

(1) + (2)

$200 = 2V_c \Rightarrow \boxed{V_c = 100}$

$V_M = 120 - 100 = 20 \Rightarrow \boxed{V_M = 20}$

$\mu = \frac{V_m}{V_c} = \frac{20}{100} = 0.2$

Amplitude of side bond = $\frac{\mu A_c}{2} = 0.2 \times \frac{100}{2} = 10V$

SECTION - B

21. The general displacement of a simple harmonic oscillator is $x = A\sin\omega t$. Let T be its time period. The slope of its potential energy (U) - time (t) curve will be maximum when $t = \frac{T}{\beta}$. The value of β is

Sol. **(8)**

$x = A\sin(\omega t)$

Potential energy $U = \frac{1}{2}kx^2$

$U = \frac{1}{2}.K.A^2\sin^2(\omega t)$

$\frac{dU}{dt} = \frac{KA^2}{2}.2\sin(\omega t)\cos(\omega t).\omega$

Slope $= \frac{dU}{dt} = \frac{\omega KA^2}{2}\sin(2\omega t)$

$\rightarrow$ Slope will be maximum for $\sin(2\omega t)$ will maximum

$2\omega t = \frac{\pi}{2}$

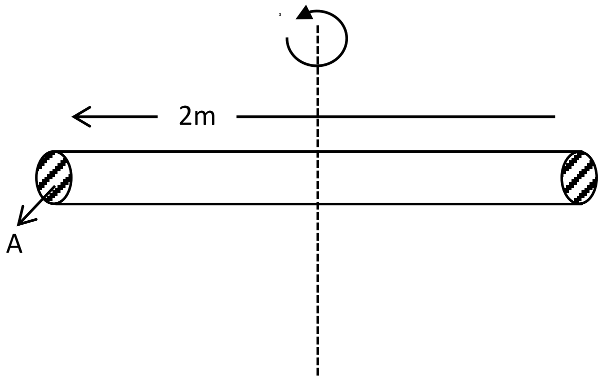
$2\omega.\frac{T}{\beta} = \frac{\pi}{2}$

$2\frac{2\pi}{T} \times \frac{T}{\beta} = \frac{\pi}{2} \Rightarrow \beta = 8$

Ans. = 8

22. A thin uniform rod of length 2 m, cross sectional area ' A ' and density ' d ' is rotated about an axis passing through the centre and perpendicular to its length with angular velocity ω. If value of ω in terms of its rotational kinetic energy E is $\sqrt{\frac{\alpha E}{Ad}}$ then value of α is

Sol. **(3)**



density $= d$

Area = A

mass $m = d.A\ell$

$m = dA(2) = 2Ad$ .... (1)

$K.E. = \frac{1}{2} I\omega^2$

$E = \frac{1}{2}.\frac{m\ell^2}{12}.\omega^2$

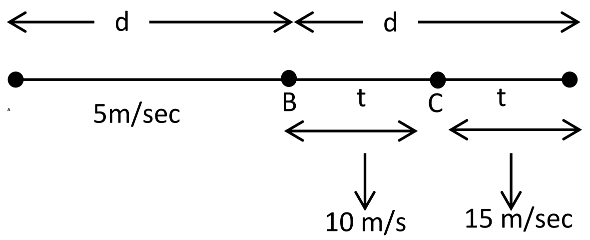
$E = \frac{1}{24}.2Ad.(2)^2\,\omega^2$

$\frac{24E}{8Ad} = \omega^2 \Rightarrow \omega = \sqrt{\frac{3E}{Ad}}$

Ans. $\alpha = 3$

23. A horse rider covers half the distance with 5 m/s speed. The remaining part of the distance was travelled with speed 10 m/s for half the time and with speed 15 m/s for other half of the time. The mean speed of the rider averaged over the whole time of motion is $\frac{x}{7}$ m/s. The value of x is

Sol. **(50)**



→ Kinematics

→ difficult

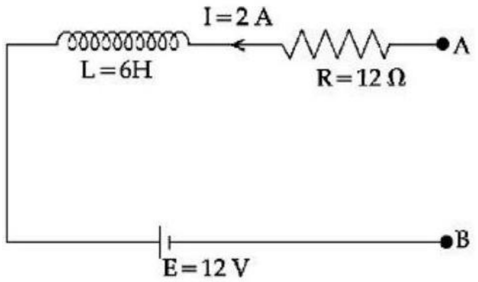
Avg. speed from B to D $\rightarrow V_{BD} = \frac{10+15}{2} = \frac{25}{2} m/sec$

Now, $\frac{2}{V_{ay}} = \frac{1}{5} + \frac{2}{25}$

$\frac{2}{V_{ag}} = \frac{7}{25} \Rightarrow V_{ag} = \frac{50}{7}$

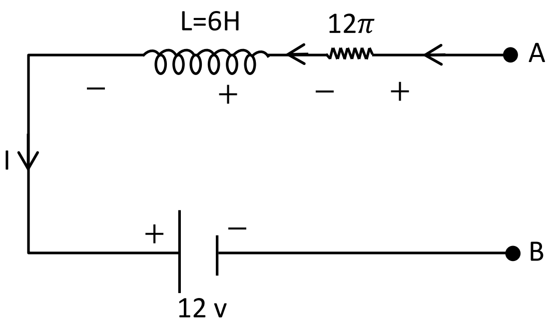
Ans. $x = 50$

24.



As per the given figure, if $\frac{dI}{dt} = -1$ A/s then the value of V_{AB} at this instant will be V.

Sol. **(30)**



$I = 2A$

$$\frac{dI}{dt} = -1A/sec$$

$$V_A - IR - L\frac{dI}{dt} - 12 = V_B$$

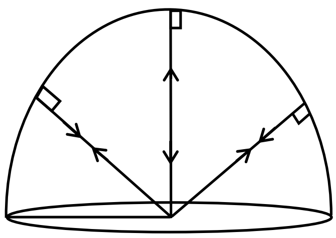
$$V_A - 2(12) + 6(1) - 12 = V_B$$

$$V_A - V_B = 24 + 12 - 6 = 24 + 6 = 30$$

Ans. 30

25. A point source of light is placed at the centre of curvature of a hemispherical surface. The source emits a power of 24 W. The radius of curvature of hemisphere is 10 cm and the inner surface is completely reflecting. The force on the hemisphere due to the light falling on it is ______ 10^{-8} N

Sol. **(4)**



$\theta = 0°$

Presses due reflecting surface $= \frac{2I}{C}$

Net force $= \frac{2I}{C}$ Area .... (1)

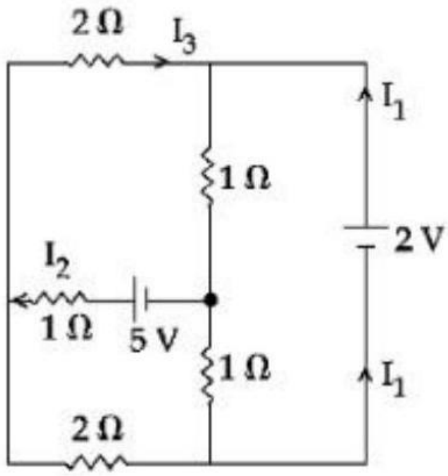
Now $I = \frac{Power}{Area} = \frac{Power}{4\pi r^2}$

From $F_{net} = \frac{2I}{C} \times$ Projected Area

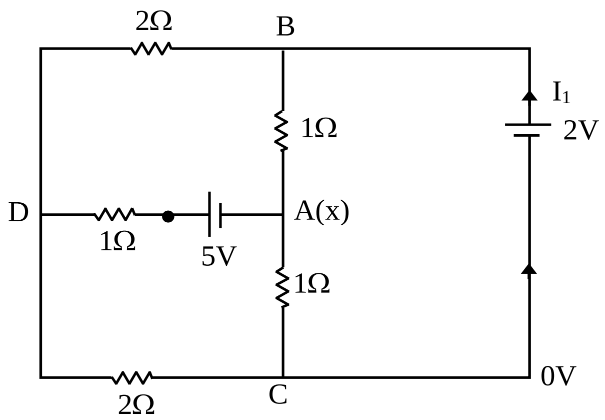
$$F_{net} = \frac{2}{C} \times \frac{Power}{4\pi r^2} \times \pi r^2$$

$$F_{net} = \frac{2 \times 24}{3 \times 10^8 \times 4} = 4 \times 10^{-8}$$

26. In the following circuit, the magnitude of current I_1, is _______ A.



Sol. **(1.5)**



Let at junction A $\rightarrow$ voltage = x

$V_A = x$

$V_D = y$

$V_C = 0$

$V_B = 2$

At junction 'A'

$$\frac{x-2}{1}+\frac{x-0}{1}+\frac{x+5-y}{1}=0$$

$3x-y+3=0$ ...(1)

At junction 'D'

$$\frac{y-0}{2}+\frac{y-2}{2}+\frac{y-x-5}{1}=0$$

$4y-2x=12$

$2y-x=6$ ...(2)

From (1) and (2)

$x = 0$; $y = 3$

So curent through 2V cell is

$I = \frac{3}{2} = 1.5$ A

27. In a screw gauge, there are 100 divisions on the circular scale and the main scale moves by 0.5 mm on a complete rotation of the circular scale. The zero of circular scale lies 6 divisions below the line of graduation when two studs are brought in contact with each other. When a wire is placed between the studs, 4 linear scale divisions are clearly visible while 46^{th} division the circular scale coincide with the reference line. The diameter of the wire is ________ $\times 10^{-2}$ mm

Sol. **(220)**

Pitch = 0.5 mm

$$\text{L.C.} = \frac{\text{pitch}}{\text{circular division}} = \frac{0.5\text{mm}}{100} = 0.005\text{mm}$$

Zero error = 6 × L.C. = 6 × (0.005) mm

Reading = main linear scale reading + n(L.C.) – zero error

= 4(0.5mm) + 46 (0.005) – 6(0.005)

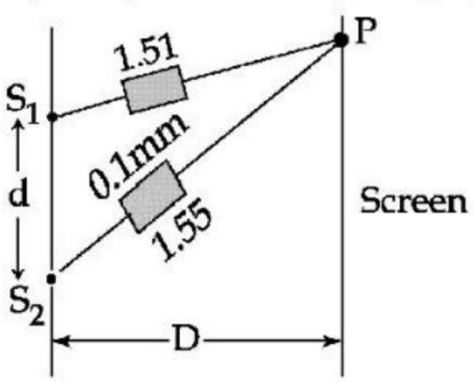
= 2 mm + 40 × 0.005 mm

$$= 2\text{ mm} + \frac{200}{1000}\text{ mm}$$

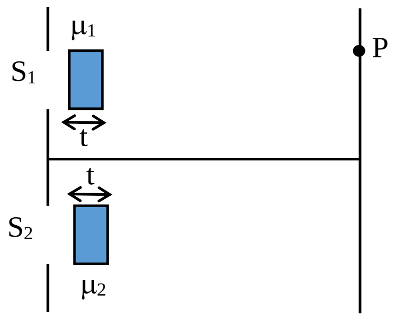
= 2.2 mm

Rading = 220×10^{-2} mm

28. In Young's double slit experiment, two slits S_1 and S_2 are ' d ' distance apart and the separation from slits to screen is D (as shown in figure). Now if two transparent slabs of equal thickness 0.1 mm but refractive index 1.51 and 1.55 are introduced in the path of beam ($\lambda = 4000Å$) from S_1 and S_2 respectively. The central bright fringe spot will shift by number of fringes.



Sol. **(10)**



$\mu_1 = 1.51$ $\quad$ $t = 0.1\text{mm}$

$\mu_2 = 1.55$ $\quad$ $\lambda = 4000Å$

Shifting central maxima

$$\Delta x = [S_1P + (\mu_1 - 1)t] - [S_2P + (\mu_2 - 1)t]$$

$$0 = (S_1P - S_2P) + (\mu_1 - 1)t - (\mu_2 - 1)t$$

$$0 = \frac{yd}{D} + (\mu_1 - \mu_2)t$$

$$(\mu_2 - \mu_1)t = \frac{yd}{D}$$

$$(1.55 - 1.51)(0.1\text{mm}) = y \times \frac{d}{D}$$

$$\frac{D}{d}(0.04 \times 0.1) \times 10^{-3} = y \qquad \ldots(1)$$

Now

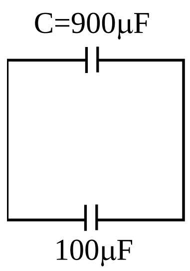
Fringe width $\Rightarrow \beta = \frac{\lambda D}{d}$

No. of fringes shifted $= \frac{y}{\beta} = \frac{4 \times 10^{-6}}{4000\text{Å}} = 10$

Ans. 10

29. A capacitor of capacitance $900\mu F$ is charged by a 100 V battery. The capacitor is disconnected from the battery and connected to another uncharged identical capacitor such that one plate of uncharged capacitor connected to positive plate and another plate of uncharged capacitor connected to negative plate of the charged capacitor. The loss of energy in this process is measured as $x \times 10^{-2}$ J. The value of x is

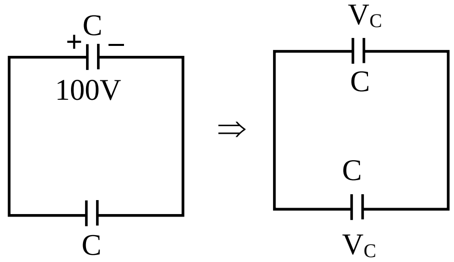
Sol. **(225)**



$Q = 900 \times 100\ \mu C$

$Q = 9 \times 10^{-2}\ C \qquad \ldots(1)$

Now



$$\Delta U = \frac{1}{2}\frac{C_1.C_2}{C_1 + C_2}(V_1 - V_2)^2$$

$$= \frac{1}{2} \times \frac{C \times C}{2C} \times (100 - 0)^2$$

$= \frac{C}{4} \times 100 \times 100$

$= \frac{900}{4} \times 10^{-6} \times 10^{4}$

$= \frac{9}{4} = 2.25J$

$\boxed{\Delta U = 225 \times 10^{-2} J}$

30. In an experiment for estimating the value of focal length of converging mirror, image of an object placed at 40 cm from the pole of the mirror is formed at distance 120 cm from the pole of the mirror. These distances are measured with a modified scale in which there are 20 small divisions in 1 cm. The value of error in measurement of focal length of the mirror is $\frac{1}{K}$ cm. The value of K is

Sol. **32**

$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$ $\qquad dv = du = \frac{1cm}{20} = 0.05cm$ (given)

$f^{-1} = v^{-1} + u^{-1}$

$(-1)f^{-2}df = (-1)v^{-2}dv - u^{-2}du$

$\frac{df}{f^2} = \frac{dv}{v^2} + \frac{du}{u^2}$ $\qquad \ldots(1)$

$\frac{1}{f} = \frac{1}{(-120)} + \frac{1}{-40}$

$\frac{1}{f} = \frac{1+3}{(-120)} = \frac{4}{-120} \Rightarrow \boxed{f = -30cm}$

Put value of f, du, dv in (1)

$\frac{df}{(30)^2} = \frac{0.05}{(120)^2} + \frac{0.05}{(40)^2}$

$df = \frac{1}{32} cm$ $\qquad$ so $\boxed{K = 32}$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भरोसा है।
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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