Resonance®
Educating for better tomorrow

JEE (Main)

PAPER-1 (B.E./B. TECH.)

2021

COMPUTER BASED TEST (CBT)

Memory Based Questions & Solutions

Date: 20 July, 2021 (SHIFT-1) | TIME : (9.00 a.m. to 12.00 p.m)

Duration: 3 Hours | Max. Marks: 300

SUBJECT: PHYSICS

Resonance Eduventures Ltd.
Reg. Office & Corp. Office : CG Tower, A-46 & 52, IPIA, Near City Mall, Jhalawar Road, Kota (Raj.) - 324005
Ph. No.: +91-744-2777777, 2777700 | **FAX No. :** +91-022-39167222
To Know more : sms **RESO** at **56677** | **Website :** www.resonance.ac.in | **E-mail :** contact@resonance.ac.in | **CIN : U80302RJ2007PLC024029**
Toll Free : 1800 258 5555 7340010333 facebook.com/ResonanceEdu twitter.com/ResonanceEdu www.youtube.com/resowatch blog.resonance.ac.in

PART : PHYSICS

1. A deuteron & α-particle both enters in a region of magnetic field perpendicular to it with same kinetic energy find the ratio of their radii ?

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

Ans. (3)

Sol. $r = \frac{mv}{qB} = \frac{\sqrt{2mK}}{qB}$

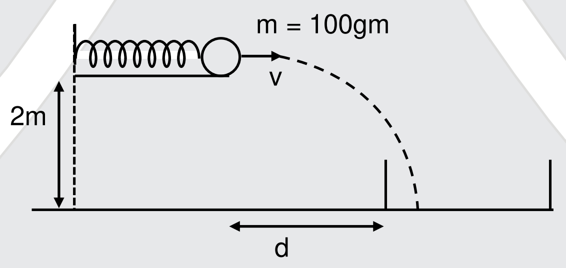
$r \propto \frac{\sqrt{m}}{q}$

$m_\alpha = 2m_d$

$q_\alpha = 2q_d$

$\frac{r_d}{r_\alpha} = \frac{\sqrt{m_d}}{q_d} \times \frac{2q_d}{\sqrt{2m_d}} = \sqrt{2}$

2. In the given arrangement, spring of spring constant 100 N/m is compressed by 0.5m. The height of the arrangement is 2m. A basket is placed at distance d such that after projection, ball will fall in the basket. If the mass of the ball is 100 gm, find maximum value of d ?



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

Ans. (2)

Sol. By energy conservation

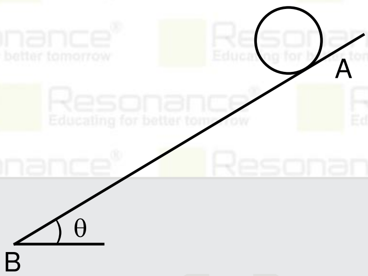
$\frac{1}{2}kx^2 = \frac{1}{2}mv^2 \Rightarrow v = x\sqrt{\frac{k}{m}}$ $v = 0.5 \times \sqrt{\frac{100}{0.1}} = 5\sqrt{10}\,m/s$

Time of flight of ball $T = \sqrt{\frac{2H}{g}} = \sqrt{\frac{2\times 2}{10}} = \frac{2}{\sqrt{10}}\,sec$

Range of ball s = ut

$d = 5\sqrt{10} \times \left(\frac{2}{\sqrt{10}}\right) = 10m$

3. When a disc slides on smooth inclined surface from rest, the time taken to move from A to B it t_1. When disc performs pure rolling from rest then time taken to move from A to B is t_2. If $\frac{t_2}{t_1} = \sqrt{\frac{3}{x}}$ find x.



Ans. 2

Sol. When disc slides $a_1 = g\sin\theta$ So $S = ut_1 + \frac{1}{2}a_1t_1^2 = \frac{1}{2}g\sin\theta.\, t_1^2$ ...(1)

When disc do pure rolling $a_2 = \frac{g\sin\theta}{1+k^2/R^2} = \frac{g\sin\theta}{1+1/2} = \frac{2}{3}g\sin\theta$

So $S = ut_2 + \frac{1}{2}a_2t_2^2 = \frac{1}{2}.\frac{2}{3}g\sin\theta.\, t_2^2$ ...(2)

From (1) & (2)

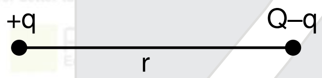
$\frac{t_2}{t_1} = \sqrt{\frac{3}{2}}$

4. We have a charge of magnitude Q. If we divide charge in two parts, what should be their ratio so that there will be max repulsion force between them ?

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

Ans. (1)

Sol.



$F = \frac{Kq_1q_2}{r^2} = \frac{K(q)(Q-q)}{r^2}$

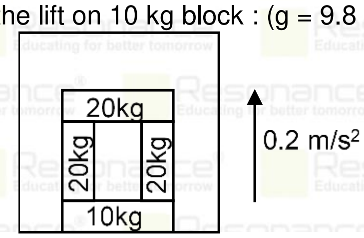
$\frac{dF}{dq} = 0$

$Q - 2q = 0$

$q = Q/2$

ratio = 1 : 1

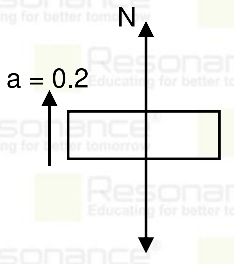
5. Four planks are arranged in a lift going upwards with an acceleration of 0.2 m/s² as shown in figure. Find the normal reaction applied by the lift on 10 kg block : (g = 9.8 m/s²)



(1) 500 (2) 700 (3) 672 (4) 800

Ans. (2)

Sol.

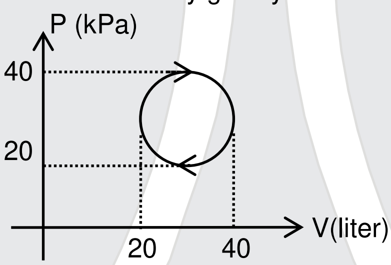


$N - 70g = 70 \times 0.2$

$N = 70(g + 0.2)$

$N = 700$

6. For given PV curve, Find net heat taken by gas system in cyclic process.



(1) 25π (2) 50π (3) 75π (4) 100π

Ans. (4)

Sol. $\Delta Q = W + \Delta U = W$ = area enclosed by the curve

$\Delta Q = \pi ab$

$= \left[\frac{40-20}{2} \times 10^3\right] \times \left[\frac{40-20}{2} \times 10^{-3}\right]$

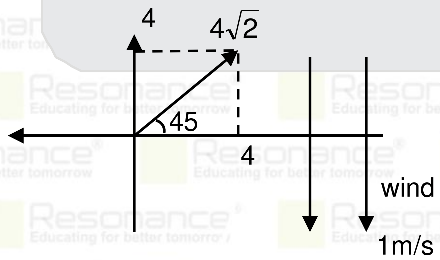
$= 100\pi$ Joule

7. A butterfly is flying in North–East with $4\sqrt{2}$ m/s w.r.t. wind. Wind is blowing at 1 m/s southwards. Displacement of butterfly in 3s is

(1) 10 meter (2) 15 meter (3) 20 meter (4) 5m

Ans. (2)

Sol.



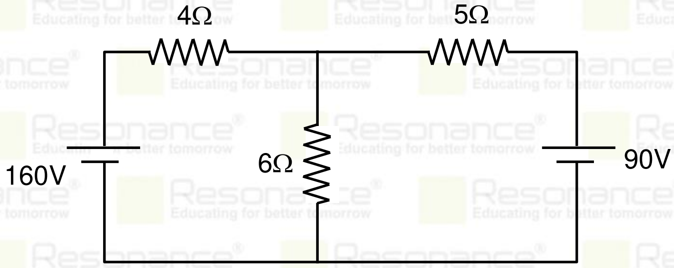
$\vec{D} = v_{F,G} \times T$

$= \{(4\hat{i} + 4\hat{j} + (-\hat{j})\} \times 3s$

$= (4\hat{i} + 3\hat{j}) \times 3s$

$|\vec{D}| = 15m$

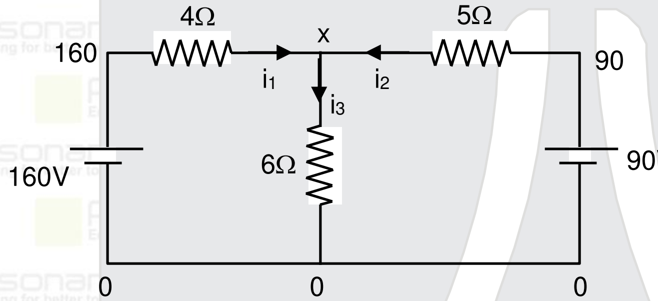
8. In the given circuit, find current passing through 6Ω resistor



(1) 15.67 (2) 16.50 (3) 18.47 (4) 10.46

Ans. (1)

Sol.



Let potential at junction point = x

By KCL $\sum i_{in} = 0$

$$\Rightarrow \frac{160-x}{4} + \frac{90-x}{5} + \frac{0-x}{6} = 0$$

$$\Rightarrow \frac{160 \times 15 - 15x + 90 \times 12 - 12x + 0 - 10x}{60} = 0$$

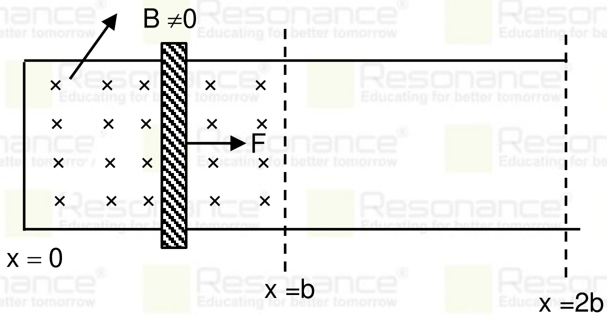
$\Rightarrow$ 37 x = 2400 + 1080

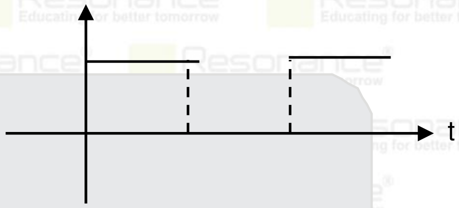
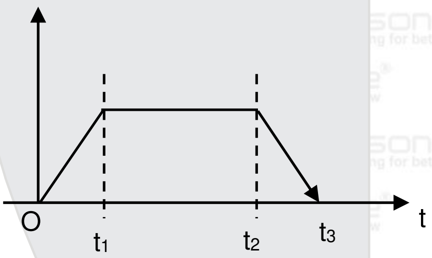
x = 94.05

So current $i_3 = \frac{x}{6}$

$$= \frac{94.05}{6} = 15.67$$

9. In the given system, uniform magnetic field exists from x = 0 to x = b. A rod is first moved from x = 0 to x = 2b uniformly and then moved reverse uniformly from x = 2b to x = 0. Match the quantities with proper curves



Column-I		**Column-II**	
(a)	Flux (ϕ)	(i)	
(b)	EMF (e)	(ii)	
(c)	Power (P)	(iii)	

(1) (a) – (iii), (b) – (i), (c) – (ii)
(2) (a) – (ii), (b) – (iii), (c) – (i)
(3) (a) – (iii), (b) – (ii), (c) – (i)
(4) (a) – (i), (b) – (iii), (c) – (ii)

Ans. (1)

Sol. Flux = ϕ = B.A

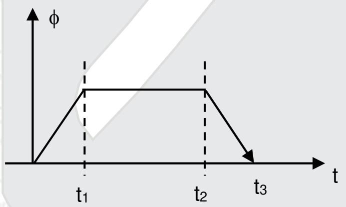
$\Rightarrow$ B × A cos0

Where A = ℓvt

$\phi = B\ell vt$

One rod go at x > b then ϕ stop changing this constant flux = Bℓb.

When rod come back and when x < b flux start decreasing so graph ϕv/st



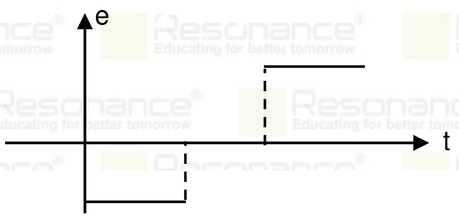
b → (ii)

$e = \frac{-d\phi}{dt}$

e = – slope of ϕ – t graph

In 0 – t_1 graph slope +ve and constant so e = negative and zero.

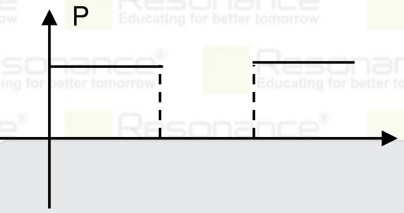
in t_2–t_3 slope of ϕ–t is negative and constant so e = positive and zero



Power = $\frac{e^2}{R}$

Resistance is only of rod so R of the circuit is constant

$P = \frac{B^2\ell^2v^2}{R} = \text{constant}$



10. A uniform rod of young's modulus Y is stretched by two tension T_1 and T_2 such that rods get expanded to length L_1 and L_2 respectively. Find initial length of rod ?

(1) $\frac{L_1T_1 - L_2T_2}{T_1 - T_2}$ (2) $\frac{L_2T_1 - L_1T_2}{T_2 - T_1}$ (3) $\frac{L_1T_2 - L_2T_1}{T_2 - T_1}$ (4) $\frac{L_1}{T_1} \times \frac{T_2}{L_2}$

Ans. (3)

Sol. Let initial length of rod be L_0 and Area A.

As $\frac{T}{A} = Y\frac{\Delta\ell}{\ell}$

So, $\frac{T_1}{A} = \frac{Y(L_1 - L_0)}{L_0}$

$\frac{T_2}{A} = \frac{Y(L_2 - L_0)}{L_0}$

Dividing

$\frac{T_1}{T_2} = \frac{L_1 - L_0}{L_2 - L_0}$; $T_1L_2 - T_1L_0 = T_2L_1 - T_2L_0$; $L_0 = \frac{L_1T_2 - L_2T_1}{T_2 - T_1}$

11. If $\vec{A}\cdot\vec{B} = |\vec{A}\times\vec{B}|$; Find $|\vec{A} - \vec{B}|$

(1) $\sqrt{A^2 + B^2 - \sqrt{2}AB}$

(2) $\sqrt{A^2 + B^2 + \sqrt{2}AB}$

(3) A – B

(4) A + B

Ans. (1)

Sol. $\vec{A}\cdot\vec{B} = |\vec{A}\times\vec{B}|$

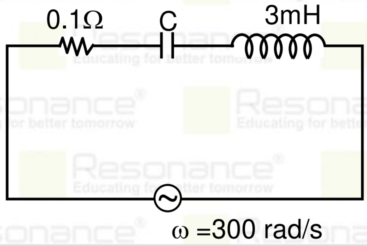
$\Rightarrow$ AB cos θ = AB sin θ

$\therefore$ θ = 45°

$\therefore$ $|\vec{A} - \vec{B}| = \sqrt{A^2 + B^2 - 2AB\cos 45^\circ}$

$= \sqrt{A^2 + B^2 - \sqrt{2}AB}$

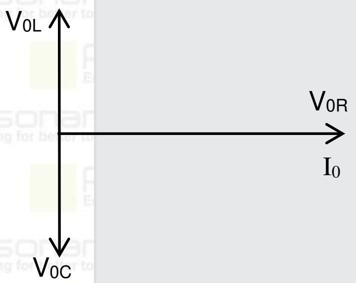
12. In the L-C-R series A.C. circuit shown fellow, current leads source voltage by 45°. Find capacitance of the capacitor.

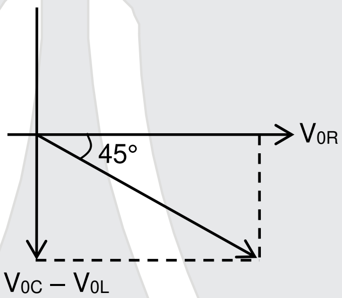


(1) 2.1 mF (2) 3.33 mF (3) 4.3 mF (4) 5.1 mF

Ans. (2)

Sol.





$$\tan 45° = \frac{V_{0C} - V_{0L}}{V_{0R}} = \frac{X_C - X_L}{R}$$

$$R = \frac{1}{\omega C} - \omega L$$

$$0.1\Omega = \frac{1}{300\,C} - 3 \times 10^{-3} \times 300$$

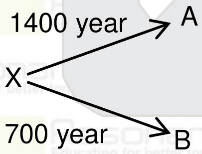
$\Rightarrow C = 3.33$ mF (approx)

13. A radioactive material having number of active nuclei N is decaying by two processes, one with half-life of 1400 yr and other with half-life of 700 yr. After how much time number of active nuclei will be N/3?

(1) 520 yr (2) 740 yr (3) 470 yr (4) 640 yr

Ans. (2)

Sol.



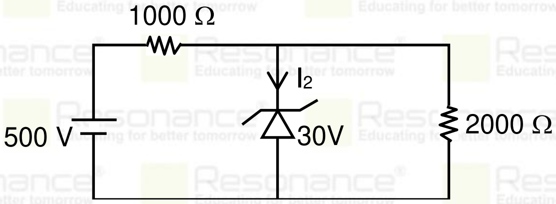
$$-\frac{dN_x}{dt} = \lambda_1 N_x + \lambda_2 N_x$$

$$\int_{N}^{N/3} \frac{dN_x}{N_x} = \int_0^t (\lambda_1 + \lambda_2)\,dt$$

$$\ln 3 = \left(\frac{\ln 2}{1400} + \frac{\ln 2}{700}\right)t$$

$$t = \frac{\ln 3}{\ln 2} \times \frac{1400}{3} = 740 \text{ year}$$

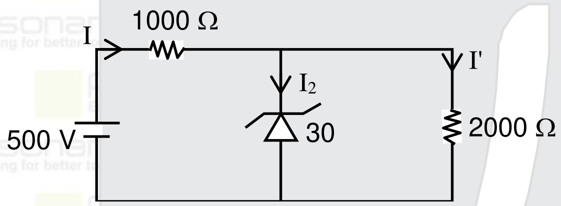
14. In the given circuit find current 'I' passing through Zener diode?



(1) 0.445 A (2) 0.345 A (3) 0.245 A (4) 0.145 A

Ans. (1)

Sol.



$I = \frac{500 - 30}{1000} = 0.47 \text{ A}$

$I' = \frac{30}{2000} = 0.015$

$I = I_z + I'$

$I_z = I - I = 0.47 - 0.015 = 0.445 \text{ A}$

15. The wave number of the spectral line in the emission spectrum of hydrogen will be equal to 8/9 times of the Rydberg's constant. Then the electron jumps from

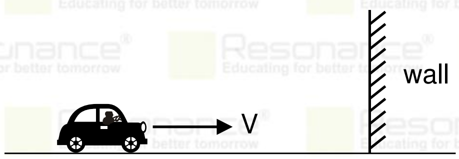
(1) $5 \rightarrow 2$ (2) $5 \rightarrow 3$ (3) $3 \rightarrow 1$ (4) $4 \rightarrow 2$

Ans. (3)

Sol. $\bar{\nu} = Rz^2\left(\frac{1}{n_L^2} - \frac{1}{n_H^2}\right)$

If $n_L = 1$, $n_H = 3$; $\bar{\nu} = R.1\left[\frac{1}{1} - \frac{1}{(3)^2}\right]$; $\bar{\nu} = \frac{8}{9}R$

16. A vehicle moving with velocity v and releasing sound of frequency 400 Hz. Listening the reflected sound from a wall of frequency 500 Hz. Find the velocity of vehicle v.



(1) 36.67 m/s (2) 30.12 m/s (3) 22.37 m/s (4) 20.25 m/s

Ans. **(1)**

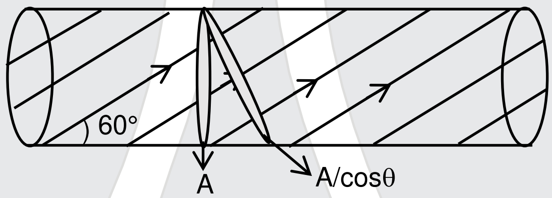
Sol. Frequency received by wall $f' = \left(\frac{v_s}{v_s - v}\right) f_0$

Reflected frequency received by man is $f'' = \left(\frac{v_s + v}{v_s}\right) f'$

$\Rightarrow \quad f'' = \left(\frac{v_s + v}{v_s}\right)\left(\frac{v_s}{v_s - v}\right) f_0 \Rightarrow \quad f'' = \left(\frac{v_s + v}{v_s - v}\right) f_0 \Rightarrow \quad 500 = \left(\frac{330 + v}{330 - v}\right) 400$

$\Rightarrow \quad v = \frac{330}{9} = 36.67$ m/s

17 In a magnesium rod of area 3m², current I = 5A is flowing at angle of 60° from axis of rod. Resistivity of material is 44 × 10⁻² ohm × m. Find electric field inside the rod?



(1) 0.567 (2) 0.367 (3) 0.667 (4) 0.767

Ans. (2)

Sol. $J = \sigma E$

$\frac{I}{A_{effective}} = \frac{E}{\rho}$

$E = \frac{\rho I}{A} \cos 60° = \frac{44 \times 10^{-2} \times 5}{3 \times 2}$; $E = 0.367$

18. Four moles of a diatomic gas is heated from 0°C to 50°C. Find the heat supplied to the gas if work done by it is zero.

(1) 700 R (2) 600 R (3) 500 R (4) 100 R

Ans. (3)

Sol. $n = 4$

$\Delta T = 50K$

$C_v = \frac{5R}{2}$

As W = 0. It means isochoric process

$Q = \Delta U$

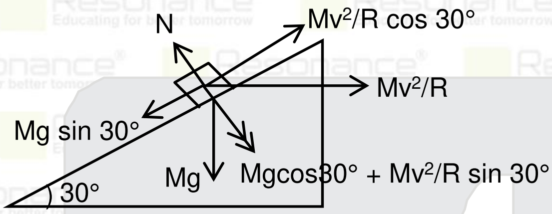
$= nC_v\Delta T = 4 \times \frac{5R}{2} \times 50 = 500$ R

19. A car is moving on a Banked rough road, the mass of car is 800 kg. The angle of Banking is 30°, car is moving with maximum speed given that μ_s = 0.2. find the Normal Reaction (in Newton)?

(1) 24000 (2) 5000 (3) 10000 (4) 9000

Ans. (3)

Sol.



Perpendicular to inclined plane

$$N = mg\cos30^\circ + \frac{mv^2}{R}\sin30^\circ$$

$$N - mg\cos30^\circ = \frac{mv^2}{R}\sin30^\circ \quad \ldots(1)$$

along inclined plane

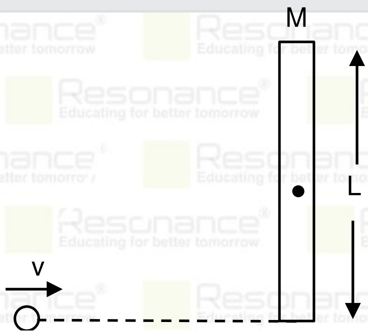
$$mg\sin30^\circ + \mu_s N = \frac{mv^2}{R}\cos30^\circ \quad \ldots(2)$$

Dividing (1) by (2)

$$\frac{N - mg\cos30^\circ}{mg\sin30^\circ + \mu_s N} = \tan30^\circ$$

Solving N = 10000 (Approx)

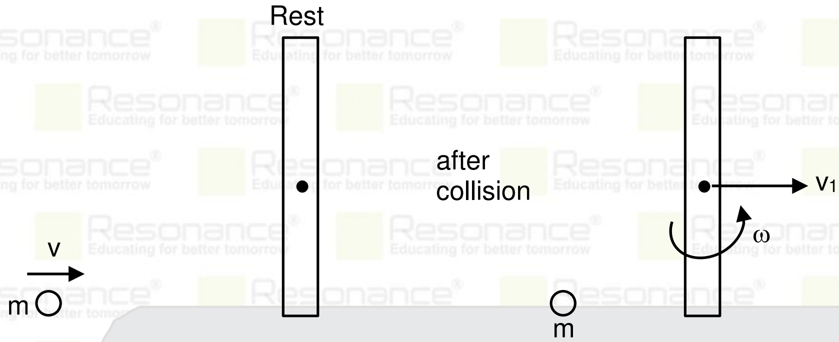
20. A particle of mass m moving with speed v collide elastically with the end of a uniform rod of mass M and length L perpendicularly as shown in figure. If the particle comes to rest after collision find the value of $\frac{m}{M}$.



(1) 1/3 (2) 1/2 (3) 1/4 (4) 1/5

Ans. (3)

Sol.



Conservation of angular momentum about centre of mass of rod

$$mv\left(\frac{L}{2}\right)=\frac{ML^2}{12}(\omega) \qquad \text{...(i)}$$

$$mv = Mv_1 \qquad \text{....(ii)}$$

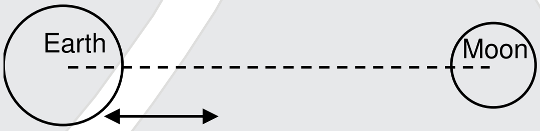
$$1=\frac{v_1+\omega\frac{L}{2}}{v} \qquad \text{....(iii)}$$

Putting v_1 from (ii) and ωL from (i) in (iii)

$$v=\frac{m}{M}v+\frac{6mv}{2M}$$

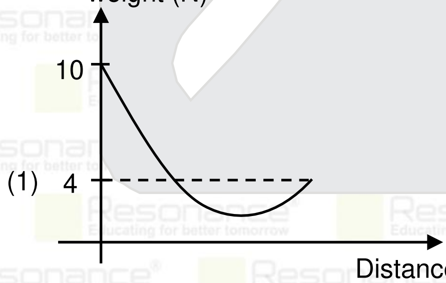
$$1=\frac{4m}{M} \quad ; m/M = 1/4$$

21. An object is moved from earth to moon. Choose the correct weight vs distance curve. Gravitational acceleration on earth surface is 10 m/s^2 and that on moon is 4m/s^2. Mass of the object is 1kg.

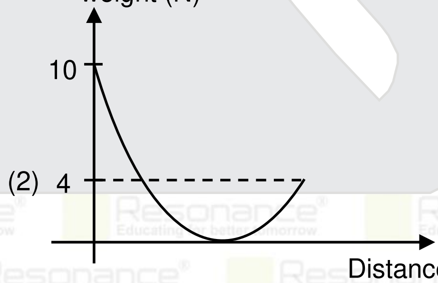


Distance

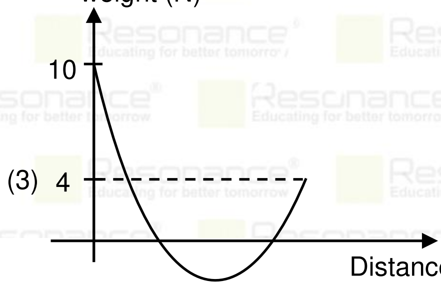
weight (N)



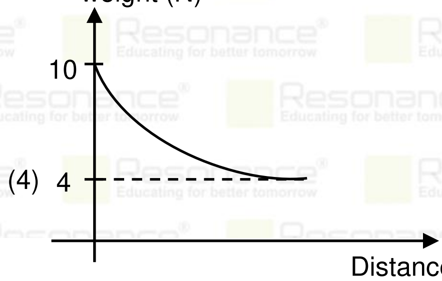
weight (N)



weight (N)



weight (N)



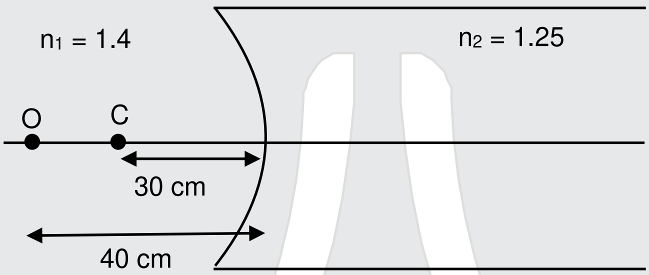
Ans. (2)

Sol. $\vec{g}$ (at any point) = $\vec{g}_{Earth} + \vec{g}_{moon}$. Since distance is large so $|\vec{g}| = |\vec{g}_E| = 10$.

As we move away from earth, It decrease to zero at a point where $\vec{g}_E + \vec{g}_M = 0$

Then it increase to $|\vec{g}| = |\vec{g}_M| = 4$ at moon surface.

22. For the spherical interface of radius of curvature R = 30 cm shown in figure. The two different media having refractive indices n_1 = 1.4 and n_2 = 1.25, an object is placed at 40 cm from the interface as shown in figure. Find position of image.



(1) 41.67 (2) 35.42 (3) 22.27 (4) 15.25

Ans. (1)

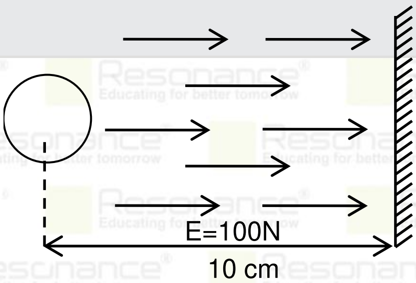
Sol. $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$

$\Rightarrow \frac{1.25}{v} - \frac{1.4}{-40} = \frac{1.25 - 1.4}{(-30)}$

$\Rightarrow \frac{1.25}{v} = 0.005 - 0.035$

$\Rightarrow$ v = –41.67 cm

23. A ball of charge to mass ratio 8μC/g is placed at a distance of 10 cm from a wall. An electric field 100 N/m is switched on in the direction of wall. Find time period of its oscillations? Assume all collisions elastic.



(1) 1 sec (2) 2 sec (3) 3 sec (4) 4 sec.

Ans. (1)

Sol. $a = \frac{qE}{m} = \frac{8 \times 10^{-6}}{10^{-3}} \times 100 = 0.8 \text{ m/s}^2$

As electric field is switched on, ball first strikes to wall and returns back.

one oscillation.

Thus $s = ut + \frac{1}{2}at_1^2$

$0.1 = \frac{1}{2} \times 0.8 t_1^2$

$t_1 = \frac{1}{2} s$

Thus time period $T = 2 \times \frac{1}{2} = 1$ sec.

24. A body of mass m emits a photon of frequency ν, then loss in its internal energy ?

(1) $h\nu$ (2) $h\nu\left(1 - \frac{h\nu}{2mc^2}\right)$ (3) $h\nu\left(1 + \frac{h\nu}{2mc^2}\right)$ (4) zero

Ans. (3)

Sol.

; $\nu = c/\lambda$

$mv = \frac{h}{\lambda} = \left(\frac{h\nu}{c}\right)$

Loss of energy $= \frac{1}{2}mv^2 + h\nu$

$= \frac{1}{2}\frac{p^2}{m} + h\nu$

$= \frac{1}{2m}\left(\frac{h\nu}{c}\right)^2 + h\nu$

$= h\nu\left(1 + \frac{h\nu}{2mc^2}\right)$

25. Consider an equation $S = \alpha^2\beta \ell n\left(\frac{nkR}{J\beta^2} - 1\right)$

Where S = Entropy
n = No. of moles
k = Boltzmann constant
R = Universal gas constant
J = Mechanical equivalent of heat

Find dimension of α and β respectively :

(1) $[M^0L^0T^0]$, $[M^1L^2T^2K^{-1}]$
(2) $[M^1L^2T^{-2}]$, $[M^1L^2T^{-2}K^{-1}]$
(3) $[M^1L^2T^{-2}K^{-1}]$, $[M^0L^0T^0]$
(4) None of these

Ans. (1)

Sol. $S = \frac{Q}{\Delta T}$

$[S] = \frac{ML^2T^{-2}}{K}$

$K = \frac{\text{Energy}}{T}$

$[K] = [S] = \frac{ML^2T^{-2}}{K}$

$[R] = \left[\frac{\text{Energy}}{nT}\right] = \frac{ML^2T^{-2}}{molK}$

$[J] = M^0L^0T^0$

Now, $[nKR] = [J\beta^2]$

$(mol) \times \frac{ML^2T^{-2}}{K} \times \frac{ML^2T^{-2}}{mol\,K} = [\beta^2]$

$[\beta] = ML^2T^{-2}K^{-1}$

$[\alpha^2] = \left[\frac{S}{\beta}\right] = \frac{ML^2T^{-2}}{K \times ML^2T^{-2}K^{-1}}$; $\alpha = M^0L^0T^0$

26. The shape of travelling wave at t = 0, is given by $y = \frac{1}{1+x^2}$. If after 3 sec shape of the wave pulse is represented by $y = \frac{1}{1+(1-x)^2}$, then speed of wave is :

(1) $\frac{1}{2}m/s$
(2) $\frac{4}{3}m/s$
(3) $\frac{1}{3}m/s$
(4) $\frac{5}{6}m/s$

Ans. (3)

Sol. $x \to (x - vt)$

$y = \frac{1}{1+(x-vt)^2}$

At t = 0 ; $y = \frac{1}{1+x^2}$

at t = 3 ; $y = \frac{1}{1+(x-3v)^2}$

By comparing

$V = \frac{1}{3}m/s$

27. In hydrogen atom these is photon emitted by transition of electron from n = 3 to n = 1, this photon is then incident on a gold plate from which electron is emitted which will make a radius of 7 mm in a uniform magnetic field of intensity 5×10^{-4} T find the work function of gold plate?

(1) 3.4 eV (2) 5.12 eV (3) 1.031 eV (4) 11.01 eV

Ans. (4)

Sol. $E_p = 13.6\left[\frac{1}{R_1^2} - \frac{1}{R_2^2}\right]eV$

$= 13.6\left[\frac{1}{1} - \frac{1}{9}\right]$

Ep = 12.08 eV

For Gold plate

$\phi = E_p - KE_{max}$

$v = \frac{RqB}{m}$

$= \frac{7\times10^{-3}\times1.6\times10^{-19}\times5\times10^{-4}}{9.1\times10^{-31}} = 6.15 \times 10^5$

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

$K.E = \frac{1}{2}\times\frac{9.1\times10^{-31}\times(6.15\times10^5)^2}{1.6\times10^{-19}}eV = 1.075 \text{ eV}$

$\phi = 12.05 - 1.075$

$\phi = 11.01$ eV