



JEE (Main)

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

2021

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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

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

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

$$m_{\alpha} = 2m_d$$

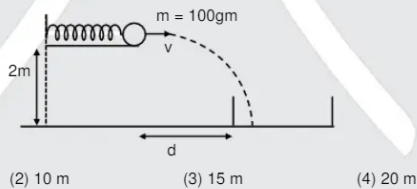
$$q_{\alpha} = 2q_d$$

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

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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

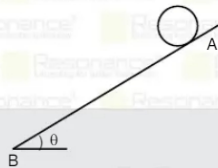
$$\frac{1}{2} kx^2 = \frac{1}{2} mv^2 \Rightarrow v = x \sqrt{\frac{k}{m}} \quad v = 0.5 \times \sqrt{\frac{100}{0.1}} = 5\sqrt{10} \text{ m/s}$$

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

Range of ball $s = ut$

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

3. When a disc slides on smooth inclined surface from rest, the time taken to move from A to B is 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.



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

$$\text{So } S = ut_2 + \frac{1}{2} a_2 t_2^2 = \frac{1}{2} \cdot \frac{2}{3} g \sin \theta \cdot t_2^2 \quad \dots(2)$$

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.

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

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

$$Q - 2q = 0$$

$$q = Q/2$$

$$\text{ratio} = 1 : 1$$

5. Four planks are arranged in a lift going upwards with an acceleration of 0.2 m/s^2 as shown in figure. Find the normal reaction applied by the lift on 10 kg block : ($g = 9.8 \text{ m/s}^2$)



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

Ans. (2)

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Sol.

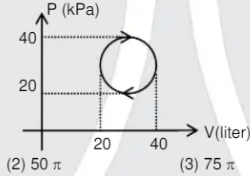


$$N - 70g = 70 \times 0.2$$

$$N = 70(g + 0.2)$$

$$N = 700$$

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



- Ans. (1) 25π (2) 50π (3) 75π (4) 100π

Sol.

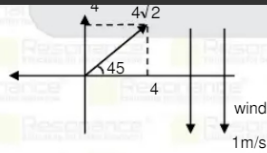
$$\Delta Q = W + \Delta U = W = \text{area enclosed by the curve}$$

$$\Delta Q = \pi ab$$

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

$$= 100\pi \text{ Joule}$$

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



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

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

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

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

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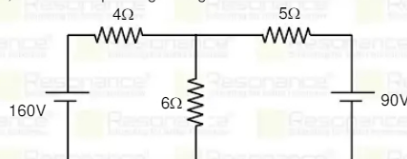
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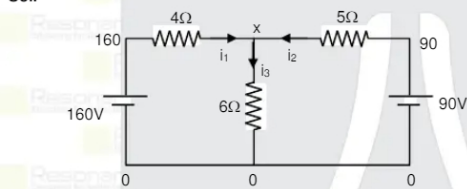
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8. In the given circuit, find current passing through 6Ω resistor



- Ans. (1) 15.67 (2) 16.50 (3) 18.47 (4) 10.46

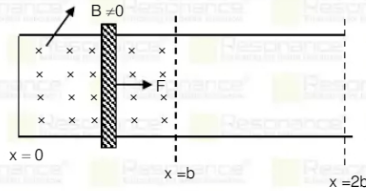


Let potential at junction point = x
 By KCL $\sum i_m = 0$
 $\Rightarrow \frac{160-x}{4} + \frac{90-x}{5} + \frac{0-x}{6} = 0$

$\Rightarrow 37x = 2400 + 1080$
 $x = 94.05$

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



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Column-I

Column-II

(a) Flux (ϕ)

(i)

(b) EMF (e)

(ii)

(c) Power (P)

(iii)

- (1) (a) - (iii), (b) - (i), (c) - (ii)
 (3) (a) - (iii), (b) - (ii), (c) - (i)

- (2) (a) - (ii), (b) - (iii), (c) - (i)
 (4) (a) - (i), (b) - (iii), (c) - (ii)

Ans.

Sol.

Flux = $\phi = B \cdot A$

$\Rightarrow B \times A \cos \theta$

Where $A = vt$

$\phi = B/vt$

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

When rod come back and when $x < b$ flux start decreasing so graph ϕ vs t



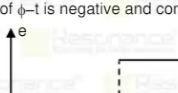
b \rightarrow (ii)

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

$e = -\text{slope of } \phi - t \text{ graph}$

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

In $t_2 - t_3$ slope of $\phi - t$ is negative and constant so $e =$ positive and zero



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

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

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



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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) $\frac{L_1 T_1 - L_2 T_2}{T_1 - T_2}$ (2) $\frac{L_2 T_1 - L_1 T_2}{T_2 - T_1}$ (3) $\frac{L_1 T_2 - L_2 T_1}{T_2 - T_1}$ (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 .

$$\text{As } \frac{T}{A} = Y \frac{\Delta l}{l}$$

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

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

Dividing

$$\frac{T_1}{T_2} = \frac{L_1 - L_0}{L_2 - L_0} ; T_1 L_2 - T_1 L_0 = T_2 L_1 - T_2 L_0 ; L_0 = \frac{L_1 T_2 - L_2 T_1}{T_2 - T_1}$$

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) $A + B$

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$$\Rightarrow AB \cos \theta = AB \sin \theta$$

$$\therefore \theta = 45^\circ$$

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

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

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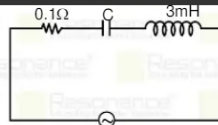
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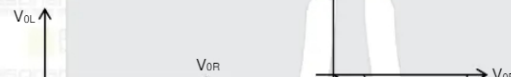
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- (1) 2.1 mF (2) 3.33 mF (3) 4.3 mF (4) 5.1 mF

Ans. (2)
 Sol.



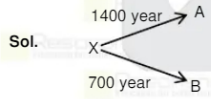
$$\tan 45^\circ = \frac{V_{0C} - V_{0L}}{V_{0R}} = \frac{X_C - X_L}{R}$$

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

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

$$\Rightarrow C = 3.33 \text{ mF (approx)}$$

- Ans. (1) 520 yr (2) 740 yr (3) 470 yr (4) 640 yr



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

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

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

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

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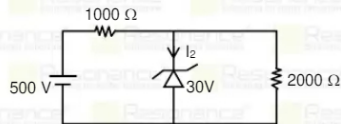
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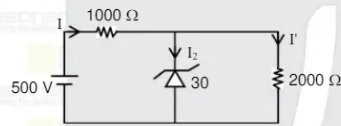
14. In the given circuit find current 'I' passing through Zener diode?



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

Ans. (1)

Sol.



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

$$I = I_2 + I'$$

$$I_2 = I - I' = 0.47 - 0.015 = 0.445 \text{ A}$$

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

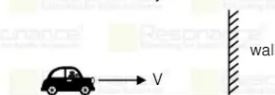
- (1) 5 → 2 (2) 5 → 3 (3) 3 → 1 (4) 4 → 2

Ans. (3)

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

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

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)

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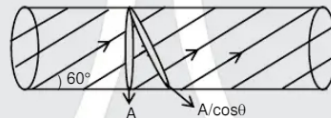
Sol. Frequency received by wall $f' = \left(\frac{v_s}{v_s - v} \right) f_0$

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

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

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

17. In a monophasic rod of area 2 cm^2 current $I = 5\text{ A}$ is flowing at angle of 60° from axis of rod. Resistivity of



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

Ans. (2)

Sol. $J = \sigma E$

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

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

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. $n = 4$

$\Delta T = 50\text{K}$

$\sim 5R$

As $W = 0$, it means isochoric process

$Q = \Delta U$

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

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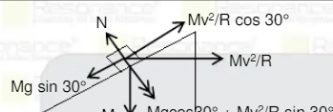
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19. A car is moving on a Banked rough road, the mass of car is 800 kg. The angle of Banking is 30° , car is moving with maximum speed given that $\mu_s = 0.2$. find the Normal Reaction (in Newton)?

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



$$30^\circ \quad Mg \sin 30^\circ + mv^2 \sin 30^\circ$$

Perpendicular to inclined plane

$$N = mg \cos 30^\circ + \frac{mv^2}{R} \sin 30^\circ$$

$$N - mg \cos 30^\circ = \frac{mv^2}{R} \sin 30^\circ \quad \dots(1)$$

along inclined plane

$$mg \sin 30^\circ + \mu_s N = \frac{mv^2}{R} \cos 30^\circ \quad \dots(2)$$

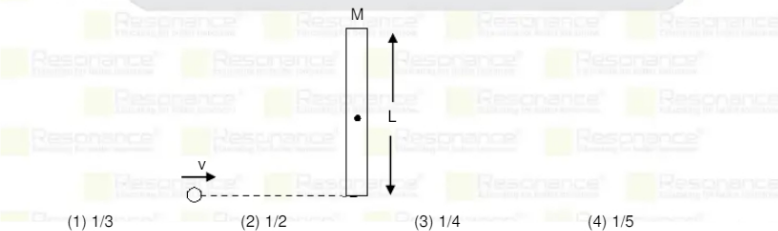
Dividing (1) by (2)

$$\frac{N - mg \cos 30^\circ}{mg \sin 30^\circ + \mu_s N} = \tan 30^\circ$$

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

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Ans. (3)

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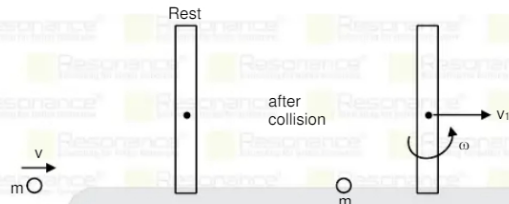
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Sol.



Conservation of angular momentum about centre of mass of rod

$$mv \left(\frac{L}{2} \right) = \frac{ML^2}{12} (\omega) \quad \dots(i)$$

$$mv = Mv_1 \quad \dots(ii)$$

$$1 = \frac{v_1 + \omega \frac{L}{2}}{v} \quad \dots(iii)$$

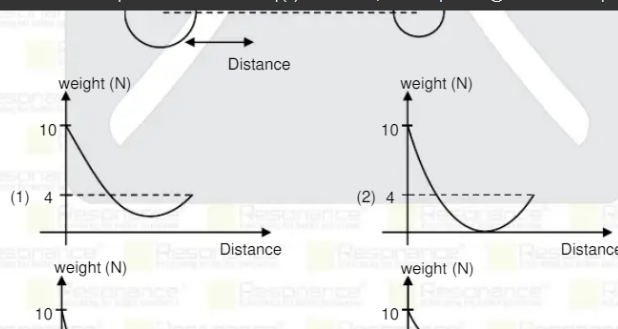
Putting v_1 from (ii) and ωL from (i) in (iii)

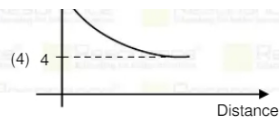
$$v = \frac{m}{M} v + \frac{6mv}{2M}$$

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

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 4 m/s^2 . Mass of the object is 1 kg .

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Ans. (2)

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Sol. \vec{g} (at any point) = $\vec{g}_{\text{Earth}} + \vec{g}_{\text{moon}}$. 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.



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

Ans. (1)

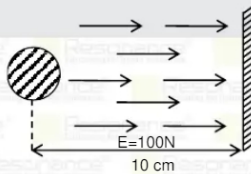
Sol. $\frac{n_2}{v} - \frac{n_1}{u} = \frac{n_2 - n_1}{R}$

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

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

$$\Rightarrow v = -41.67 \text{ cm}$$

23. A ball of charge to mass ratio $8\mu\text{C/g}$ 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)

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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.

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

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

$$t = \frac{1}{2} \text{ s}$$

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

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.



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

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

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

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

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

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25. Consider an equation $S = n^2 R / n \left(\frac{n k R}{-1} \right)$

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

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

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

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

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

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

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

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

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

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

represented by $y = \frac{1}{1+(1-x)^2}$, then speed of wave is :

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

Ans. (3)

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

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

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

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

By comparing

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

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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)

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

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

$$E_p = 12.08 \text{ eV}$$

For Gold plate

$$\phi = E_p - K_{E_{\max}}$$

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

$$= \frac{7 \times 10^{-3} \times 1.6 \times 10^{-19} \times 5 \times 10^{-4}}{9.1 \times 10^{-31}} = 6.15 \times 10^5$$

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

$$K.E. = \frac{1}{2} \times \frac{9.1 \times 10^{-31} \times (6.15 \times 10^5)^2}{1.6 \times 10^{-19}} \text{ eV} = 1.075 \text{ eV}$$

$$\phi = 12.05 - 1.075$$

$$\phi = 11.01 \text{ eV}$$

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in JEE (Advanced) 2020 from any Institute of Kota

5 AIRs in TOP-50 in JEE (Adv.) 2020 from Classroom

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Total Selections in JEE (Advanced) 2020	Eligible for JEE (Advanced) Through JEE (Main) 2020	NEET 2020
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