PHYSICS

1. A bullet of mass 10 grams is moving with horizontal velocity v, hits the ball placed on the tower of height 20 m from ground. After collision, bullet hits the ground 120 m and ball hits the ground 30 m from the foot of tower. Find velocity v (in m/sec).

Ans. **360**

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

for 200 grams

$30 = v_2 \times 2$

$v_2 = 15$ m/s

for 10 gm

$120 = v_1 \times 2$

$v_1 = 60$ m/s

Using linear momentum conservation

$10\,v = 200 \times 15 + 10 \times 60$

$v = 360$ m/s

2. For a polytropic process PT^2 = constant where P is pressure and T is temperature. Find coefficient of volume expansion.

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

Ans. **(3)**

Sol. $PT^2 = K$

$\frac{nRT}{V}T^2 = K$

$T^3 = KV$

$3T^2\Delta T = K\Delta V$

$\frac{3\Delta T}{T} = \frac{\Delta V}{V}$

$\frac{3}{T} = \frac{\Delta V}{V\Delta T}$ $\left[\therefore \Delta V = \gamma V\Delta T \text{ or } \gamma = \frac{\Delta V}{V\Delta T}\right]$

$\gamma = \frac{3}{T}$

3. A uniform rod of length 2m and cross sectional area A having density d is rotated with uniform angular velocity ω about the axis passing through centre of rod. If rotational kinetic energy of rod is E, then $\omega = \sqrt{\frac{\alpha E}{Ad}}$. Find α?

Ans. **3**

Sol. $KE = \frac{1}{2} I\omega^2$

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

$E = \frac{1}{2}\frac{dA\ell^3}{12}\omega^2$

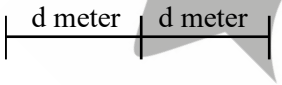
$\omega = \sqrt{\frac{24E}{dA2^3}}$

$\omega = \sqrt{\frac{3E}{dA}} = 3$ **Ans.**

4. A particle is moving with velocity 5m/s for first half distance and remaining half distance for equal time interval its travels with speed 10 m/s and 15 m/s. If average speed $\frac{50}{x}$ m/s find x.

Ans. **7**

Sol.



$t_1 = \frac{d}{5}s \qquad d_2 = \frac{10t}{2}m \qquad d_3 = \frac{15t}{2}m$

$d_2 + d_3 = d = \frac{t}{2}(10 + 15)$

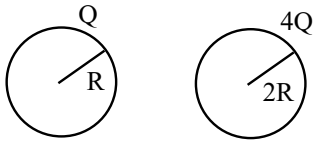
$\langle v \rangle = = \frac{2d}{\frac{d}{5} + \frac{2d}{25}} = \frac{2 \times 25}{(5+2)} = \frac{50}{7} m/s$

Ans. x = 7

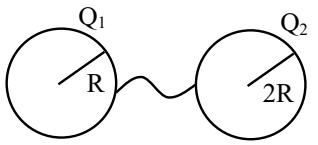
5. Two isolated solid conducting sphere of radius R and 2R having same surface charge density initially. Now the spheres are connected by thin conducting wire and the surface charge density on the two sphere are σ and σ' respectively. Find $\frac{\sigma'}{\sigma}$.

(1) 1 (2) 1/2 (3) 1/4 (4) 1/8

Ans. (2)



Sol.



$Q_1 + Q_2 = 5Q$ …. (i)

$\frac{KQ_1}{R} = \frac{KQ_2}{2R} \Rightarrow Q_2 = 2Q_1$ …. (ii)

From (i) and (ii)

$Q_1 = \frac{5Q}{3}, Q_2 = \frac{10Q}{3}$

$\sigma (4\pi R^2) = Q_1$ …. (iii)

$\sigma' (4\pi (2R)^2) = Q_2$ …. (iv)

(iii)/(iv) $\frac{\sigma}{4\sigma'} = \frac{Q_1}{Q_2} = \frac{1}{2}$

$\frac{\sigma}{\sigma'} = 2$

$\frac{\sigma'}{\sigma} = \frac{1}{2}$

6. When heat is absorbed by gas in Isothermal process then which of the following statement is correct.

S-1 → Work done by gas is negative

S-2 → Work done by gas is positive

S-3 → Internal energy is constant

S-4 → Internal energy increases

S-5 → Internal energy decreases

(1) S – 1 and S – 3 is true (2) S – 1 and S – 4 is true

(3) S – 2 and S – 3 is true (4) S – 2 and S – 5 is true

Ans. (3)

Sol. Temp. = constant

$U = \frac{f}{2}\pi RT = \text{constant}$

$\Delta U = \Delta$

$\Delta Q = \Delta U + W$

$+ve = 0 + W$

So work done by gas is positive.

7. In a hydrogen atom, velocity of electron in 7^{th} orbit is 0.308×10^6 m/s. Find velocity of electron in 3^{rd} orbit.

(1) 0.719×10^6 m/s (2) 0.819×10^6 m/s (3) 1.719×10^6 m/s (4) 0.619×10^6 m/s

Ans. (1)

Sol. $v \propto \frac{z}{n}$

$\frac{0.308\times10^6}{v_3} = \frac{n_3}{n_7}$

$\frac{0.308\times10^6}{v_3} = \frac{3}{7}$

$v_3 = 0.719\times10^6 \text{ m/s}$

8. A point object is placed at 40 cm in front of converging mirror & its real image is obtained at 120 cm. Scale used to measure distances has 20 divisions in 1 cm. Error in focal length is $\frac{1}{K}$ cm.

Find K ?

Ans. **32**

Sol. $\frac{1}{v} + \frac{1}{u} = \frac{1}{f}$

$\therefore -\frac{1}{120} - \frac{1}{40} = \frac{1}{f} \Rightarrow f = -30 \text{ cm}$

Now,

$\frac{-1}{v^2}dv - \frac{1}{u^2}du = -\frac{1}{f^2}df$ & $dv = du = \frac{1}{20}$ cm

$$\therefore \frac{\frac{1}{20}}{(120)^2}+\frac{\frac{1}{20}}{(40)^2}=\frac{df}{(30)^2}$$

$$\therefore \frac{1}{20}\times\frac{1}{40}\times\frac{1}{40}\left[\frac{1}{9}+1\right]=\frac{df}{30\times30}$$

$$\therefore df=\frac{1}{32}\text{ cm}$$

$$\therefore k=32$$

9. A capacitor of capacitance 900 μF is charged to voltage 100 volt. Now it is connected with identical uncharged capacitor. Find out heat produced (in J)

Ans. **2.25 J**

Sol. $$\Delta H=\frac{1}{2}\left(\frac{C_1C_2}{C_1+C_2}\right)(V_1-V_2)^2$$

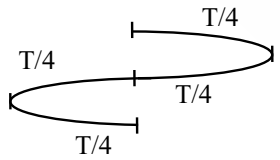
$$\Delta H=\frac{1}{2}\times\frac{C\times C}{C+C}(100-0)^2$$

$$=\frac{1}{2}\times\frac{900\times10^{-6}}{2}\times10^4=\frac{9}{4}\text{J}=2.25\text{ J}$$

10. A particle with x = A sin (ωt) is performing SHM with time period 'T'. Its potential energy is maximum for first time at $t=\frac{T}{\beta}$, then value of β is :

Ans. **4**

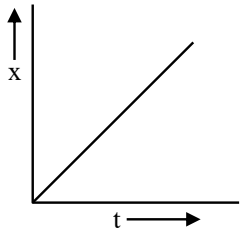
Sol. P.E. is maximum at $x_{max}=A$

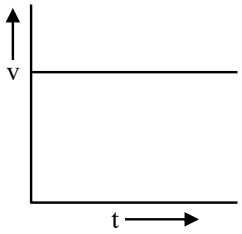


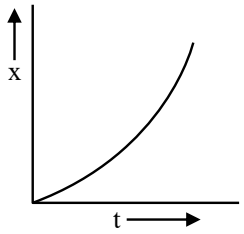
$$\Rightarrow \quad t'=\frac{T}{4}$$

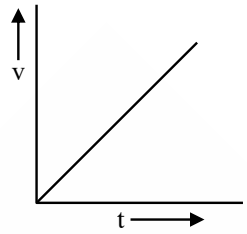
$$\beta=4$$

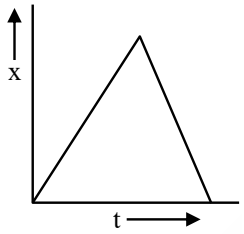
11. Matrix match correct

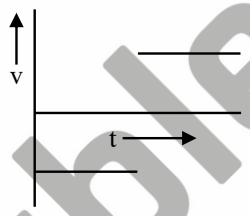
(1) 

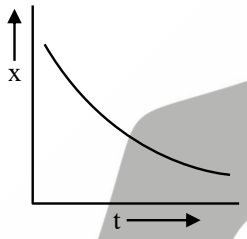
(P) 

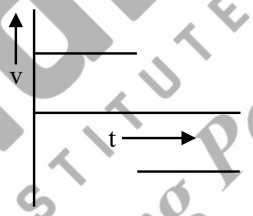
(2) 

(Q) 

(3) 

(R) 

(4) 

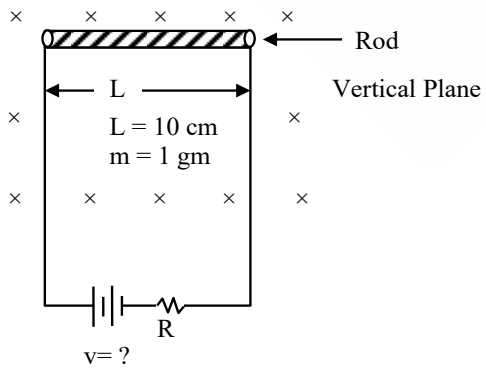
(S) 

Ans. **(1)**

Sol. Slope of x-t curve = velocity

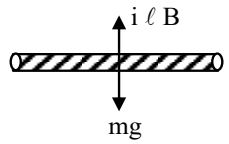
12. Find the potential (in volt) of battery so that rod is in equilibrium.

(Given B = 10^{-3}T, R = 5Ω)



Ans. 500 V

Sol.



$i\ell B = mg$

$\frac{V}{R}\ell B = mg$

$V = \frac{mgR}{\ell B}$

$= \frac{1\times10^{-3}\times10\times5}{10^{-1}\times10^{-3}} = 500V$

13. The heat passing through the cross section of a conductor varies with time 't' as $Q(t) = \alpha t - \beta t^2 + \gamma t^3$. Find maximum heat current through the conductor is

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

Ans. **(2)**

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

$\frac{dI}{dt} = 0 - 2\beta + 6\gamma t = 0 \Rightarrow t = \frac{\beta}{3\gamma}$

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

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

14. If in a region the value of gravitational field is $g = \frac{-k}{x^2}\left(K = \frac{6J}{kg}cm\right)$. If potential at x = 2 cm is 10 J/kg. Find potential at x = 3cm.

(1) 9 J/kg (2) 11 J/kg (3) 12 J/kg (4) 8 J/kg

Ans. **(2)**

Sol. $\int_V dv = -\int_V \vec{g}.\overrightarrow{dr}$

$$\int_{10}^{} dv = -\int_{2cm}^{3cm} \frac{K}{x^2}.dx$$

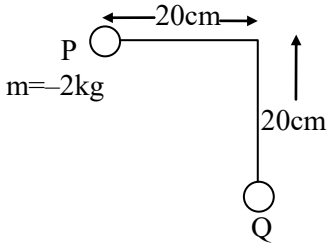
$$V-10 = \frac{-K}{x}\Big]_{2cm}^{3cm}$$

$$= -K\left[\frac{1}{3}-\frac{1}{2}\right]$$

$$= \frac{K}{6} = 1$$

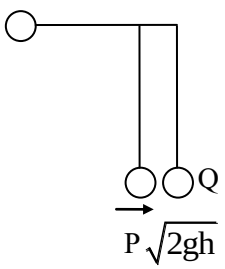
$\therefore$ V = 11 V

15. Two identical mass P and Q are attached by two different strings from same point. If P is released from horizontal position and Q is vertical position. All the collisions are elastic, find velocity of Q just after collision.



Ans. **2 m/s**

Sol. If collision is elastic with same masses velocity get exchange just after collision.



$V_Q = \sqrt{2gh} = 2m/s$

16. An inductor and resistor are connected to A.C. battery source such that $X_L = R$ and power factor is P_1. If a capacitor is connected in series to this circuit such that $X_L = X_C$ and Power factor is P_2. The ratio $\frac{P_1}{P_2} = \frac{1}{\sqrt{x}}$. Find x

Ans. **2**

Sol. $P_1 = \cos\phi = \frac{R}{z} = \frac{R}{\sqrt{R^2 + (x_L)^2}} = \frac{R}{\sqrt{2R^2}} = \frac{1}{\sqrt{2}}$

$P_2 = \cos\phi = \frac{R}{z} = \frac{R}{\sqrt{R^2 + (x_L - x_C)^2}} = \frac{R}{R} = 1$

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

17. In A.M. wave, maximum amplitude 120 volt and minimum 80 volt. Find amplitude of carrier and modulating wave?

(1) 100 V, 20 V (2) 20 V, 100 V (3) 120 V, 80 V (4) 80 V, 120 V

Ans. **(1)**

Sol. $120 = A_c + A_m$ … (i)

$80 = A_c - A_m$ … (ii)

Using equation (i) and (ii)

$A_c = 100$ volt

$A_m = 20$ volt

18. Surface tension of liquid A and B is T and 2T respectively. Density of liquid A and B are ρ and 2ρ respectively. Height raised by liquid A is 5 cm in capillary tube. Find the height raised by liquid B in same capillary tube is ? (Assume contact angle for both liquids are same)

Ans. **5 cm**

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

$5 = \frac{2T\cos\theta}{\rho g r}$

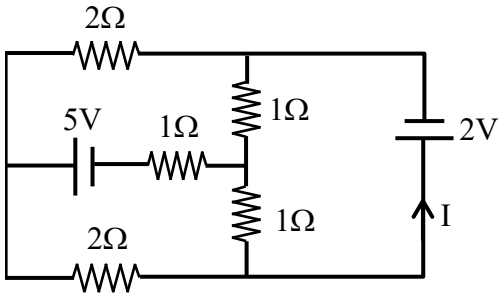
$h_B = \frac{2(2T)\cos\theta}{2\rho g r} = 5\text{cm}$

19. The relation between bulk modulus K, modulus of rigidity and passion's ratio σ is:

(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) $\sigma = \frac{6k+2\eta}{3k-2\eta}$

Ans. (2)

20.



Find the value of I in ampere?

Ans. (1.5)

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

3x + 3 = y …(1)

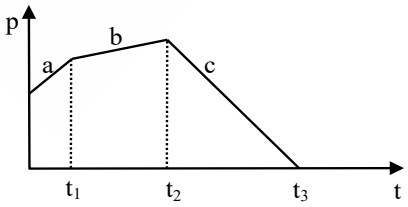
$\frac{y-0}{2} + \frac{y-5-x}{1} + \frac{y-2}{2} = 0$

$4y - 2x = 12$

$\therefore x = 0$ and $y = 3$

Hence $i = \frac{3}{2} = 1.5$ A

21. If the graph between momentum and time is shown below. Find the region of maximum and minimum force. Given : $t_3 - t_2 < t_1$



(1) a, b (2) b, c (3) a, c (4) c, b

Ans. (4)

Sol. $F = \frac{dp}{dt}$ (using graph)

22. If the expression of electric field of wave can be written as $E = \frac{A}{x^2}\hat{j} + \frac{B}{y^3}\hat{j}$.

Find unit of A, B

(1) $A = Nm^2\ C,\ B = Nm^3\ C$

(2) $A = \frac{Nm^2}{C},\ B = \frac{Nm^3}{C}$

(3) $A = \frac{N}{C}m^3,\ B = \frac{N}{C}m^2$

(4) None

Ans. **(2)**

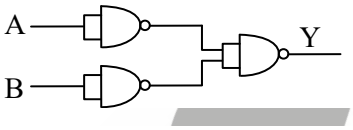
Sol. $\frac{A}{x^2} = \frac{N}{C}$

$A = \frac{N - m^2}{C}$

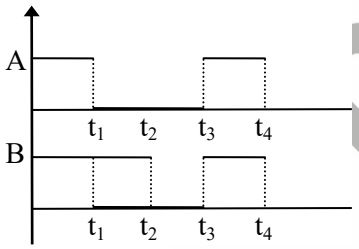
$\frac{B}{y^3} = \frac{N}{C}$

$B = \frac{N - m^3}{C}$

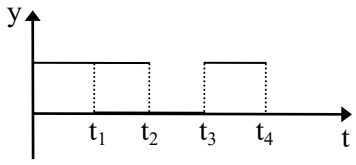
23.



Find out output wave from for input A and B.



(1)



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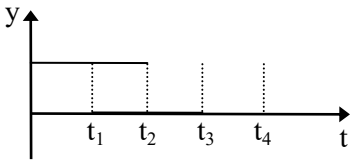

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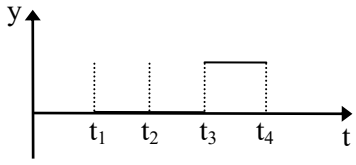

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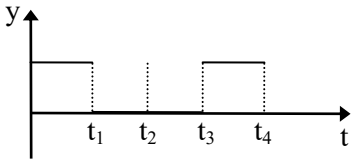


Ans. **(1)**

Sol. De-morgain's law

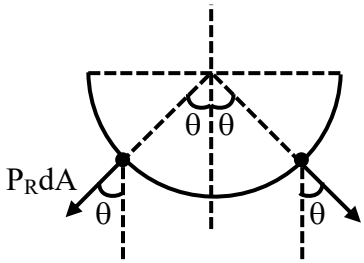
$\overline{\overline{A}\overline{B}} = \overline{\overline{A}} + \overline{\overline{B}} = A + B$

24. A point source of light of power P = 20 mW is placed at the centre of hemispherical surface of radius r = 10 cm. The inner surface of hemisphere is perfectly reflecting. Find the force on hemisphere due to light falling on it?

(1) $\frac{5}{3}\times10^{-11}$N (2) $\frac{20}{3}\times10^{-11}$N (3) $\frac{10}{3}\times10^{-11}$N (4) $\frac{40}{3}\times10^{-11}$N

Ans. (3)

Sol.



$\mathbf{F} = \int (P_R) dA\cos\theta$

$= \frac{2I}{c}\int dA\cos\theta$

$= \frac{2I}{C}\pi R^2 = 2\left(\frac{P}{4\pi R^2}\right)\frac{\pi R^2}{c}$

$= \frac{P}{2c} = \frac{20\times10^{-3}}{2\times3\times10^8} = \frac{10}{3}\times10^{-11}$N

25. Coil A of radius 10 cm has N_A number of turns and I_A current is flowing through it. Coil B of radius 20 cm has N_B number of turns and I_B current is flowing through it. If magnetic dipole moment of both the coils is same then

(1) $I_A N_A = \frac{1}{2} I_B N_B$ (2) $I_A N_A = 2 I_B N_B$ (3) $I_A N_A = \frac{1}{4} I_B N_B$ (4) $I_A N_A = 4 I_B N_B$

Sol. (4)

I_A, N_A, r $I_B, N_B, 2r$

$\vec{M}_1 = \vec{M}_2$ $(\vec{M} = i\vec{A})$

$N_A I_A \pi r^2 = N_B I_B \pi (2r)^2$

$N_A I_A = 4 I_B N_B$