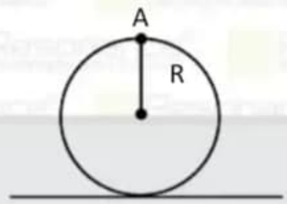
PART : PHYSICS

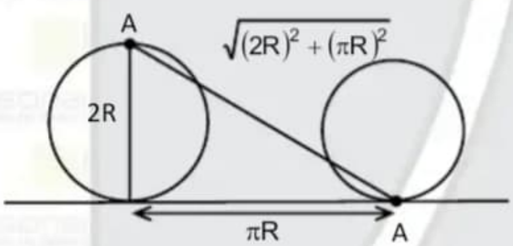
1. A disc having radius R is performing pure rolling on horizontal surface. Find displacement of point A after half revolution.



(1) 2R (2) πR (3) $(\pi + 2)$R (4) $R\sqrt{\pi^2+4}$

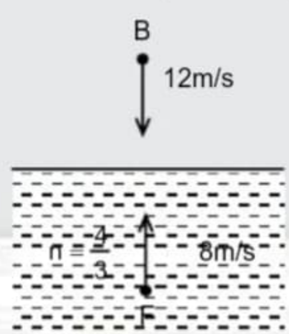
Ans. (4)

Sol.



Displacement = $R\sqrt{\pi^2+4}$

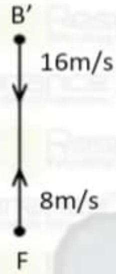
2. Find velocity of Bird observed by Fish w.r.t. itself ($n_{water} = 4/3$)



(1) 4 m/s (2) 20 m/s (3) 16 m/s (4) 24 m/s

Ans. (4)

Sol. $v_1 = \frac{v_0}{n_{rel.}} = \frac{12}{1} \times \frac{4}{3} = 16$ m/s



Velocity of Bird observed by Fish = 16 + 8 = 24 m/s

3. If mass of earth change from M to 9M and radius changes from R to 9R then how many times will be the escape speed?

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

Ans. (1)

Sol. $v_e = \sqrt{\frac{2GM}{R}}$

$v'_e \sqrt{\frac{2G \times 9m}{4R}} = \frac{3}{2} v_e$

4. If a wire of resistance R is connected with a source of voltage V_0, then the power consumed is P_0. The wire is cut into two equal parts and each part is connected with the source V_0 individually, then total power consumed by them is P, if $\frac{P_0}{P}$ is $\frac{1}{x}$ find the value of x.

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

Ans. (1)

Sol. $P_0 = \frac{V_0^2}{R}$ $P = \frac{V_0^2}{R/2} + \frac{V_0^2}{R/2} = \frac{4V_0^2}{R}$

and $\frac{P_0}{P} = \frac{1}{4}$

5. Ratio of K.E of particles having equal momentum is $\frac{16}{9}$. Find the ratio of their masses.

(1) 4 : 3 (2) 9 : 16 (3) 5 : 4 (4) 5 : 9

Ans. (2)

Sol. $k = \frac{p^2}{2m}$

$\frac{k_2}{k_1} = \frac{m_1}{m_2}$

$\frac{9}{16} = \frac{m_1}{m_2} \Rightarrow \frac{m_1}{m_2} = \frac{9}{16}$

6. In SHM displacement of particle at an instant y = A cos30°. Where A = 40 cm & kinetic energy is 200 J. If force constant 1×10^x N/m, then x will be

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

Ans. **(4)**

Sol. $\frac{1}{2}k(A^2 - y^2) = 200$

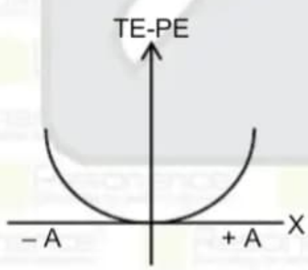
$\frac{1}{2}(k)\left[(.4)^2 - (.4)^2\left(\frac{3}{4}\right)\right] = 200$

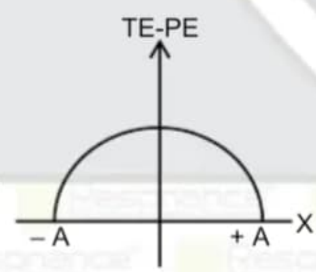
$\frac{1}{2}\,k\left[(.4)^2\left(1 - \frac{3}{4}\right)\right] = 200$

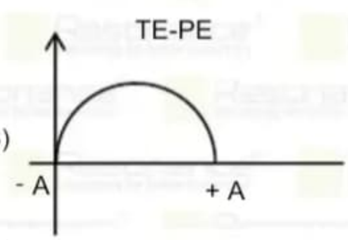
$k\,(.4)^2\,\frac{1}{8} = 200$

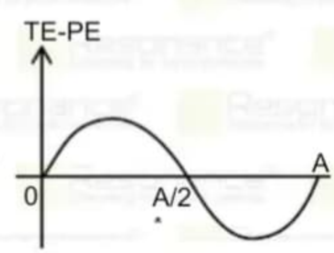
$k = \frac{200 \times 8}{.4 \times .4} = 100 \times 100 = 1 \times 10^4$

7. A partial is executing SHM. Choose the correct graph of TE–PE verses position.

(1) 

(2) 

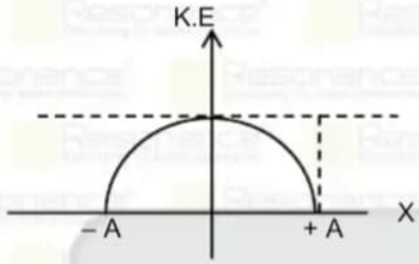
(3) 

(4) 

Ans. **(2)**

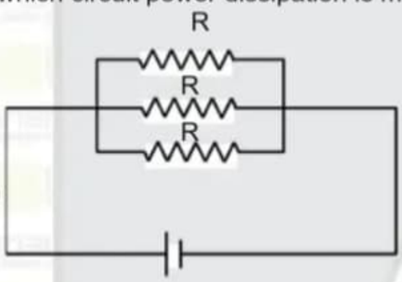
Sol. TE – P.E = K.E

$K.E = K = \frac{1}{2}mv^2 = \frac{1}{2}m.\omega^2(A^2 - x^2)$



8. In which circuit power dissipation is maximum :

(1)



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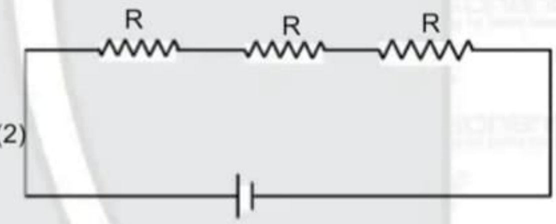

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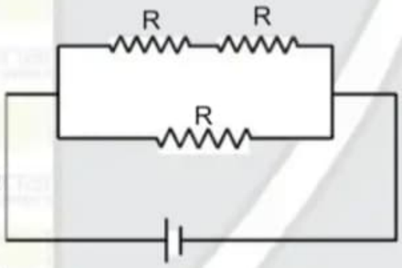

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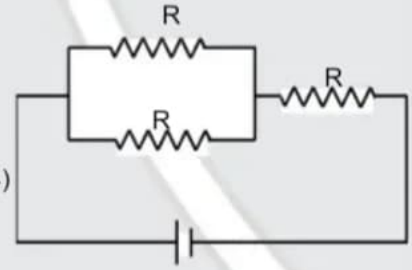
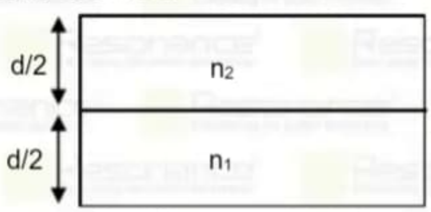


Ans. (1)

Sol. $P = \frac{v^2}{R_{eq}}$

In parallel combination R_{eq} is minimum so power dissipation will be maximum :

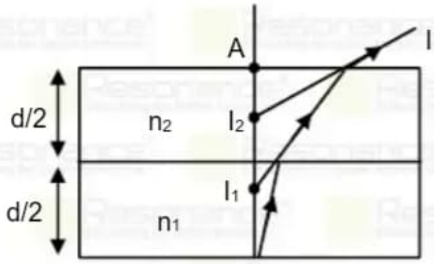
9. Find apparent depth of vessel :



(1) $d\left(\frac{1}{n_1} + \frac{1}{n_2}\right)$ (2) $\frac{d}{2}\left(\frac{1}{n_1} - \frac{1}{n_2}\right)$ (3) $\frac{d}{2}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)$ (4) $\frac{d}{2(n_1 + n_2)}$

Ans. (3)

Sol.



$$AI_1 = \frac{d/2}{n_1} + \frac{d/2}{n_2} = \frac{d}{2}\left(\frac{1}{n_1} + \frac{1}{n_2}\right)$$

10. Find ratio of radius of 2nd orbit of He^+ & 4th orbit of Be^{+3}.

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

Ans. **(1)**

Sol. $r = a_0\frac{n^2}{z}$

$$\frac{r_{He^+}}{r_{Be^{+3}}} = \left(\frac{2}{4}\right)^2 \times \frac{4}{2} = \frac{4}{16} \times \frac{4}{2} = \frac{1}{2}$$

11. Two metals A & B have work functions ϕ_A = 9ev & ϕ_B = 4.5 eV. Find difference between their threshold wavelength. (hc = 1242 eV.nm)

(1) 250 nm (2) 138 nm (3) 100 nm (4) 50 nm

Ans. **(2)**

Sol. $\phi = \frac{hc}{\lambda_{th}}$

$\Rightarrow \lambda_{th} = \frac{hc}{\phi}$

So difference of λ_{th} is

$$= \frac{1242}{4.5} - \frac{1242}{9} = 1242\left[\frac{1}{4.5} - \frac{1}{9}\right] = 1242\left[\frac{2}{9} - \frac{1}{9}\right] = \frac{1242}{9} = 138$$

12. Length of a tunnel is L = 60ℓ. Two trains A & B of length ℓ and 4ℓ respectively are moving with speed 108Km/h and 72Km/h respectively in opposite directions. If train A takes 35 sec. less than the train B to cross the tunnel then find value of L.

(1) 2000 m (2) 1800 m (3) 2500 m (4) 3000 m

Ans. **(2)**

Sol. According to question

$$\frac{64\ell}{20} - \frac{61\ell}{30} = 35$$

$\Rightarrow \ell = 30$ m

So, $L = 60\ell = 60 \times 30 = 1800$ m

13. A solid sphere is in pure rotational motion about a fixed axis. The ratio of its angular momentum & kinetic energy is $\frac{\pi}{22}$. Find angular velocity of the sphere. $\left(\pi = \frac{22}{7}\right)$

(1) 10 rad/s (2) 7 rad/s (3) 14 rad/s (4) 21 rad/s

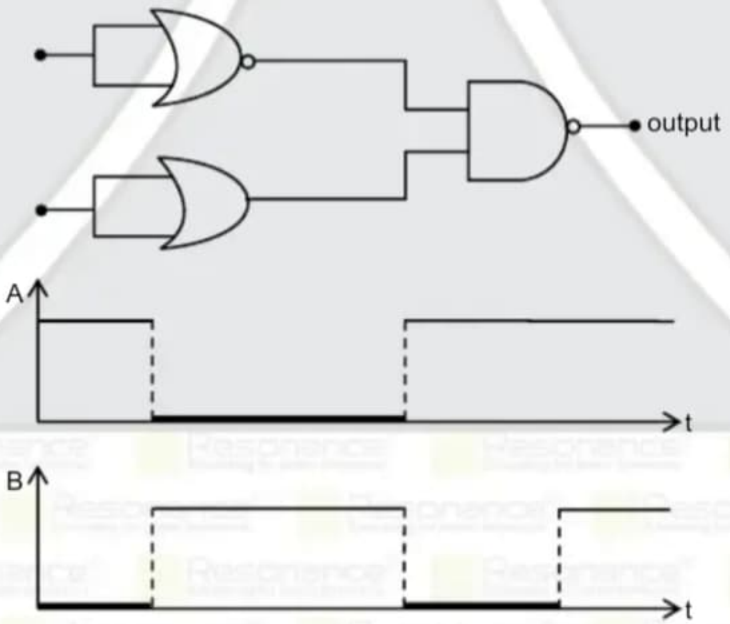
Ans. (3)

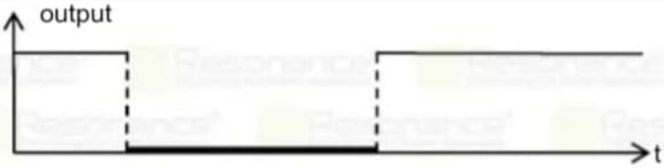
Sol. $L = I\omega = \frac{2}{5}mR^2\omega$ & $K = \frac{1}{2}\left(\frac{2}{5}mR^2\right)\omega^2$

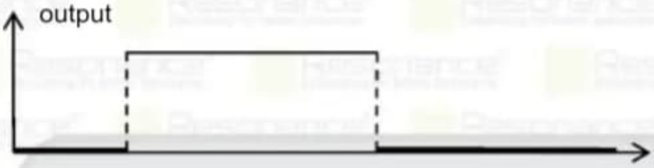
$$\frac{L}{K} = \frac{2}{\omega} = \frac{\pi}{22} \Rightarrow \omega = \frac{2\times 22}{\pi}$$

$\Rightarrow \omega = 14$ rad/s

14. If the digital inputs A and B are as shown, then find the output as a function of time.



(1) 

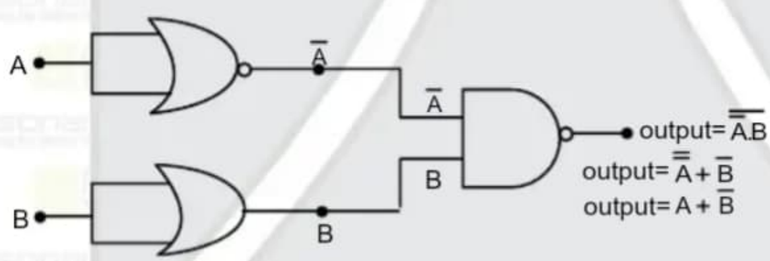
(2) 

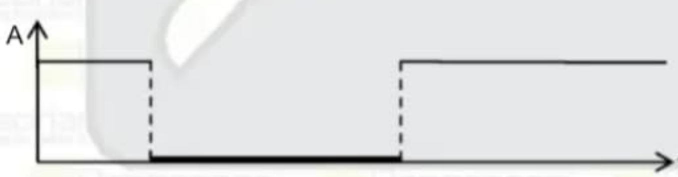
(3) 

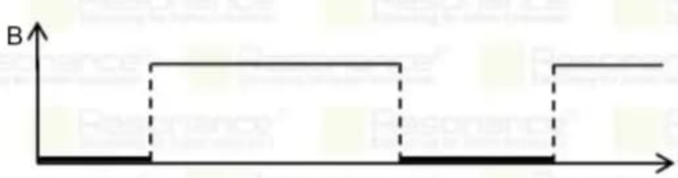
(4) 

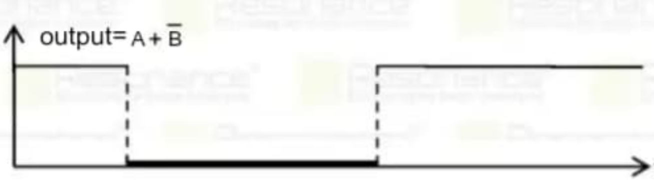
Ans. (1)

Sol.









15. A dipole made of charge 0.01 C which are separated by a distance of 0.4 mm, is placed at an angle of 30° with the external electric field of strength 10 dyne /C. Find the torque exerted on the dipole in the field

(1) 2×10^{-9} N–m (2) 1×10^{-10} N–m (3) 2×10^{-10} N–m (4) 1×10^{-9} N–m

Ans. (3)

Sol. $\tau = PE \sin\theta$ $P = 0.01 \times 0.4 \times 10^{-3}$

$= 0.4 \times 10^{-5}$

$\tau = 0.4 \times 10^{-5} \times 10 \times 10^{-5} \times \frac{1}{2}$

$= \tau = 2 \times 10^{-10}$ N–m

16. In H–atom, the energy of electron in 1st and 3rd orbit are respectively E_1 and E_3, and $E_3 = xE_1$, then the value of x will be:- **[Modern Physics]**

(1) $\frac{1}{8}$ (2) $\frac{1}{27}$ (3) $\frac{1}{64}$ (4*) $\frac{1}{9}$

Ans. (4)

Sol. $E_n = -13.6 \text{ eV} \frac{z^2}{n^2} \Rightarrow E_n \propto \frac{1}{n^2}$

$\frac{E_3}{E_1} = \left(\frac{1}{3}\right)^2 = \frac{1}{9}$

17. An ideal gas is undergone through a process whose equation is given by $P = KV^{-3}$. Find bulk modulus for this process.

(1*) 3P (2) –3P (3) $\frac{P}{3}$ (4) $-\frac{P}{3}$

Ans. (1)

Sol. $pv^3 = \text{Constant} \Rightarrow \frac{dp}{p} + 3\frac{dv}{v} = 0 \Rightarrow \frac{dp}{dv} = -3\frac{p}{v}$

$B = -v\frac{dP}{dv} = -(v)\left(-3\frac{p}{v}\right)$

$B = 3P$

18. For an ideal gas $\left(1+\frac{1}{x}\right)^{1/2} V_{Average.} = V_{rms}$

find value of x.

(1) $\frac{8}{3\pi - 8}$ (2) $\frac{3}{3\pi - 8}$ (3) $\frac{8}{\pi + 8}$ (4) $\frac{4}{3\pi - 8}$

Ans. (1)

Sol. $\sqrt{1+\frac{1}{x}}\sqrt{\frac{8Rt}{\pi M}} = \sqrt{\frac{3RT}{M}}$

$\Rightarrow \sqrt{1+\frac{1}{x}}\sqrt{\frac{8}{\pi}} = \sqrt{3}$

$\Rightarrow \left(1+\frac{1}{x}\right)\frac{8}{\pi} = 3$

$\Rightarrow 1 + \frac{1}{x} = \frac{3\pi}{8}$

$\Rightarrow \frac{1}{x} = \frac{3\pi}{8} - 1 \Rightarrow x = \frac{8}{3\pi - 8}$

19. ${}_{92}U^{238} \rightarrow {}_{90}Th^{234} + {}_{2}He^{4} + Q$

In the given nuclear reaction, the atomic mass of U, Th and He are respectively 238.029 amu, 234.021 amu and 4.003 amu. Find the Q–value (Energy released) for this reaction. **[Nuclear Physics]**

(1) 3.28 MeV (2) 2.28 MeV (3*) 4.65 MeV (4) 8.28 MeV

Ans. (3)

Sol. $\Delta m_{loss} = (238.029) - (234.021 + 4.003)$

$\Delta m_{loss} = 0.005$ amu

Energy released = $(931 \times \Delta m)$ MeV

$= 931 \times 0.005 = 4.65$ MeV

20. Mass of a block is (5 ± 0.2) Kg and its speed is (20 ± 0.4) m/sec. Find the maximum possible error in the measurement & its Kinetic Energy. **[Measurement and Error]**

(1) 100 J (2*) 80 J (3) 180 J (4) 60 J

Ans. (2)

Sol. K.E. $= \frac{1}{2}mv^2 = \frac{1}{2} \times 5 \times (20)^2 = 1000$ J

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

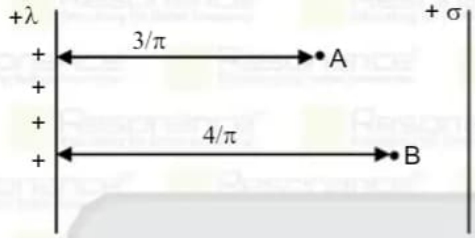
$\frac{d(KE)}{KE} = \frac{dm}{m} + 2\frac{dv}{v}$

$\frac{d(KE)}{KE} = \frac{0.2}{5} + 2\frac{0.4}{20}$

$\frac{d(KE)}{1000} = 0.08$

$\Rightarrow d(KE) = 80$ J

21. A line charge of linear large density λ and a large non conducting sheet of surface charge density σ are placed parallel to each other as shown in figure. Find ratio of resultant electric field at A & B.



(1) $\frac{4}{3}\left(\frac{\lambda-3\sigma}{\lambda-4\sigma}\right)$ (2) $\frac{4}{3}\left(\frac{\lambda-2\sigma}{\lambda-4\sigma}\right)$ (3) $\frac{3}{8}\left(\frac{\lambda-3\sigma}{\lambda-4\sigma}\right)$ (4) $\frac{3}{8}\left(\frac{\lambda-2\sigma}{\lambda-4\sigma}\right)$

Ans. (1)

Sol. $E_A = \frac{\lambda}{2\pi\varepsilon_0 r_A} - \frac{\sigma}{2\varepsilon_0} \quad \left\{r_A = \frac{3}{\pi}\right\}$

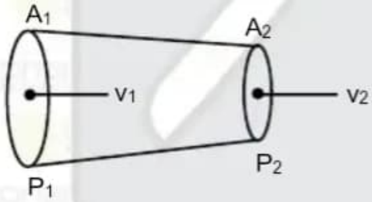
$= \frac{1}{2\varepsilon_0}\left[\frac{\lambda}{3} - \sigma\right]$

$E_B = \frac{\lambda}{2\pi\varepsilon_0 r_A} - \frac{\sigma}{2\varepsilon_0} \quad \left\{r_B = \frac{4}{\pi}\right\}$

$= \frac{1}{2\varepsilon_0}\left[\frac{\lambda}{4} - \sigma\right]$

$\frac{E_A}{E_B} = \frac{4}{3}\left(\frac{\lambda-3\sigma}{\lambda-4\sigma}\right)$

22. A water is flowing in a conical tube as shown in figure.

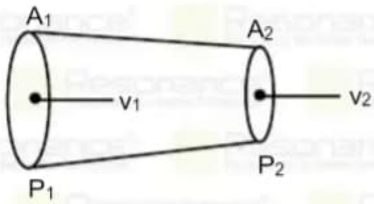


Velocity of water at area A_2 is given as 60cm/s. The value of A_1 and A_2 is $10cm^2$ & $5\ cm^2$ respectively. Find the pressure difference at both the cross-sections.

(1) $135N/m^2$ (2) $230\ N/m^2$ (3) $200\ N/m^2$ (4) $105\ N/M^2$

Ans. (1)

Sol.



$A_1V_1 = A_2V_2$

$\Rightarrow 10V_1 = 5V_2$

$\Rightarrow V_2 = 2V_1$

$P_1 + \frac{1}{2}\rho V_1^2 = P_2 + \frac{1}{2}\rho v_2^2 \Rightarrow P_1 - P_2 = \frac{1}{2}\rho\left(V_2^2 - V_1^2\right)$

$= \frac{1}{2}\rho\, 3V_1^2$

$\Rightarrow P_1 - P_2 = \frac{1}{2} \times 1000 \times 3 \times 30 \times 30 \times 10^{-4}$

$= 13.5 \times 10 = 135\ N/m^2$

$V_1 = \frac{V_2}{z}$

$\frac{60}{2}$

$= 30$ cm