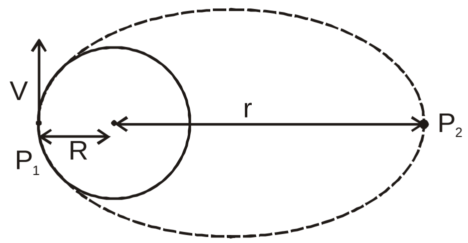
# PHYSICS PAPER - II (SOLUTION)

**1. (a)**




Ball will follow elliptical path as shown. Height is max at $P_2$. Velocity at $P_2$ is $v_2$

By angular momentum conservation

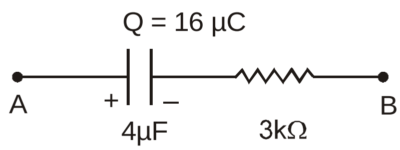
$$mvR = mV_2r$$

By energy conservation

$$\frac{-GM_e m}{R} + \frac{1}{2}mv^2 = -\frac{Gm_e m}{r} + \frac{1}{2}mv^2$$

Solving , we get $v = \sqrt{\frac{8}{5}gR}$

**2. (c)**




P. D. across capacitor V = $\frac{Q}{c} = 4V$

Hence P.D. across resistor, V = 15

Current flowing i = $\frac{15}{3 \times 10^3} = 5 \times 10^{-3}$ A

As capacitor is discharging [Current leaving through positive plate], it is delivering power.

$$P = \frac{dU}{dt} = \frac{d}{dt}\left(\frac{q^2}{2c}\right) = \frac{q}{c} \times \frac{dq}{dt} = \frac{q}{c}i = 20mw$$

**3. (b)**

As the upper half will have focal length twice that of lower half, rays coming from upper half will be focused at more distance from lense.

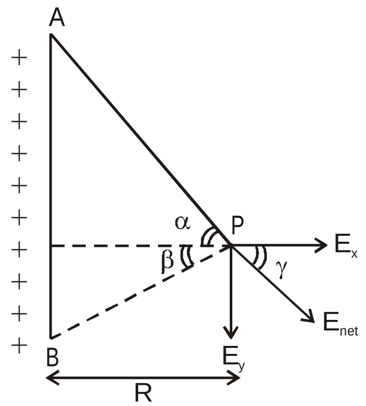
**4. (c)**

As the acceleration is horizontal, pressure variation in vertical will be as it happens in the case when container is at rest.

**5. (a)**

$$E_x = \frac{k\lambda}{R}[\sin\alpha + \sin\beta]$$

$E_y = \frac{k\lambda}{R}[\cos\beta - \cos\alpha]$




Angle of $\overrightarrow{E_{net}}$ with $\overrightarrow{E_x}$

$$\tan\gamma = \frac{E_y}{E_x} = \frac{\cos\beta - \cos\alpha}{\sin\alpha + \sin\beta}$$

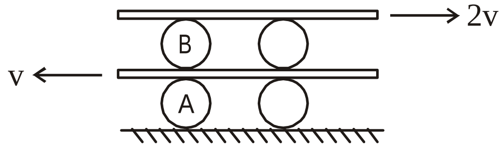
$$\gamma = \left(\frac{\alpha - \beta}{2}\right)$$

Angle of $\vec{E}$ with AP $\equiv$ $\alpha - \gamma = \frac{\alpha + \beta}{2}$

Hence $\vec{E}$ bisects angle APB

$\theta_1 = \theta_2$

**6. (b)**



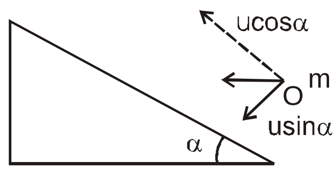

Top most point of A moves with V. Hence velocity of Com of A is $\frac{V}{2}$

$$\frac{V}{2} = R\omega_A \rightarrow \omega_A = \frac{V}{2R}$$

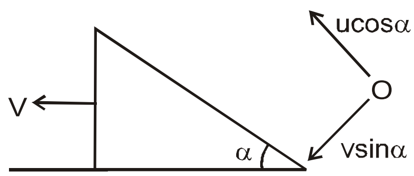
with respect to lower plank, upper plank moves with 3V. Hence $V_{cm}$ of B = $\frac{3V}{2}$ w.r.t. lower plank. $\frac{3V}{2} = \omega_B R \rightarrow \omega_B = \frac{3V}{2R}$

Ratio $\omega_B / \omega_A = 3$

**7. (c)**




For the ball, component of velocity parallel to wall ucos$\alpha$ does not change. Since collision is inelastic, $V_{separation} = 0$. That means components of velocities of wedge and ball perpendicular to the plane must be same.




as momentum is conserved in horizontal

$mu = mv + m(u\cos^2\alpha + v\sin^2\alpha)$

$\Rightarrow \quad v = \dfrac{mu\sin^2\alpha}{M + m\sin^2\alpha}$

**8. Ans. (a)**

Electric force between the balls is equal on each ball. So, the ball having less mass will rise higher than the ball having more mass.

**9. (c)**

$W_{mg}$ is same for both objects

Since fr = μ N here, linear acceleration will be same. Hence time taken to reach at ground and translational K.E. will be same for both

But $fr = I\alpha \qquad \alpha = \dfrac{f}{I}$

$w = \alpha t$

$= \dfrac{ft}{I}$

Rotational K.E. = $\dfrac{1}{2}Iw^2 = \dfrac{f^2t^2}{2I}$

$(K.E)_{rot} \propto \dfrac{1}{I}$

Since $I_{cylinder} > I_{sphere}$

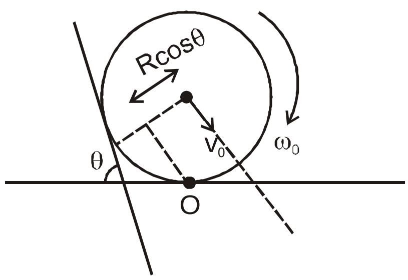
$(K.E)_{cylinder} < (K.E.)_{sphere}$

$W_{mg} - |W_{fr}| = \Delta k$

$|W_{fr}| = W_{mg} - \Delta k$

Hence $W_{fr}$ on cylinder is more.

**10. (a)**




Initial angular momentum about O = $\dfrac{2}{5}mR^2\omega + mv_0R\cos\theta$

Find angular momentum = $\dfrac{7}{5}mvR \Rightarrow v = \dfrac{5}{7}v_0\cos\theta + \dfrac{2}{7}\omega_0R$

**11. (c)**

As process A $\rightarrow$ B is isothermal,

$$W = pv\, \ln \frac{v_2}{v_1} = \left(\frac{u_2 - u_0}{2}\right)\ln 3$$

**12. (c)**

$U = U_0 + Pv$

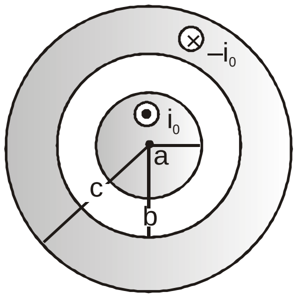
$dU = 0 + d(2p V) = 2R\, dT$

$C_v\, dt = 2\, RdT$

$\Rightarrow \quad C_v = 2R$

Mixture of monoatomic & diatomic

**13. (c)**




using ampere's law $\oint \vec{B}.\vec{dl} = \mu_0 i_{er}$

$B \times 2\pi r = \frac{\mu_0 i_0 r^2}{a^2}$, $\quad B = \frac{\mu_0 i_0 r}{2\pi a^2}$ $\quad$ as $\quad r = \frac{a}{2}$, $\quad B = \frac{\mu_0 i_0}{4\pi a}$

**14. (d)**

As $\quad 0 < r < a \quad B \propto r$

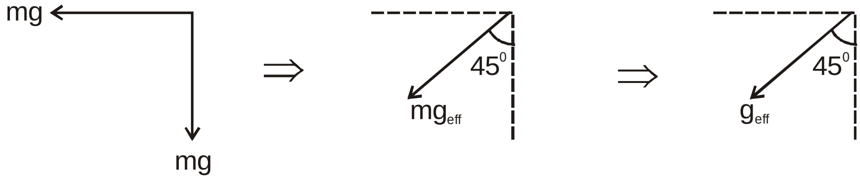
for a < r < b, field due to outer cylinder is zero, & inner cylinder behaves like a wire.

$$B = \frac{\mu_0 i}{2\pi r}$$

for b < r < c by ampere's law

$$B = \frac{\mu_0 i_0}{2\pi}\left(\frac{c^2 - r^2}{c^2 - b^2}\right)$$

**15. (c)**




Pressure increases along $I_{eff}$ and remain same perpendicular to it

Hence points with max pressure $\left(-\frac{R}{\sqrt{2}}, \frac{-R}{\sqrt{2}}\right)$

**16. (a)**

Perpendicular to $I_{eff}$. Pressure remains same.
Hence $P_A = P_B$

**17. (A) → r, (B) → s, (C) → q, (D) → p**

$E_y > E_{x\text{-rays}}$

y-rays and x-rays are high energy

rays

Hence $E_y = 1.08$ Mev

$E_x = 16$ kev

Energy absorbed by Hydrogen atom in ground state

$\Rightarrow$ 10.2 ev, 12.1 ev, 12.75 ev ........etc

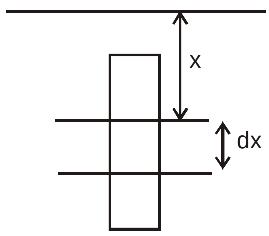
Hence D $\rightarrow$ 10.2 ev (A)

**18. (A) → q,r (B) → q, r (C) → p, (D) → p**

Motional emf $= \int (\vec{v} \times \vec{B}).\vec{dl}$

as $\vec{v}, \vec{B}$ & $\vec{dl}$ are mutually perpendicular

$$\varepsilon = v\int B dl$$




$$B = \frac{\mu_0 i}{2\pi x}$$

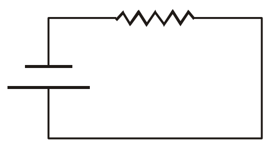
$$\varepsilon = v\int \frac{\mu_0 i}{2\pi x}\, dx$$

$x \rightarrow$ 1 to 2

$$\varepsilon = \frac{v \times \mu_0 i}{2\pi} \ln 2$$

$$\varepsilon \Rightarrow \frac{\mu_0}{2\pi} \ln 2$$

Rod behaves like a battery with internal resistance



$$i = \frac{\varepsilon}{R}$$

$$= \frac{\mu_0}{2\pi} \frac{\ln 2}{R} = \frac{\mu_0}{2\pi} \ln 2$$

Power developed in the circuit = $i^2R$

$$\Rightarrow \left(\frac{\mu_0}{2\pi} \ln 2\right)^2$$

Which must be equal to power of external force by lenz's law

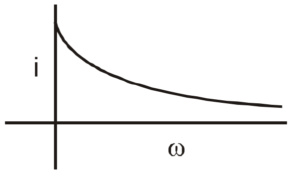
$$Fv = P \Rightarrow F = \frac{P}{V} = \left(\frac{\mu_0 \ln 2}{2\pi}\right)^2$$

**19. (A) $\rightarrow$ s, (B) $\rightarrow$ r, (C) $\rightarrow$ p, (D) $\rightarrow$ q**

For R – L , Impendence

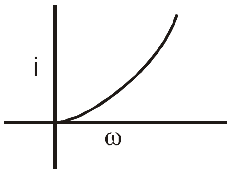
$Z = \sqrt{R^2 + (\omega L)^2}$

$I_{rms} = \frac{V_{rms}}{\sqrt{R^2 + \omega^2 L^2}}$



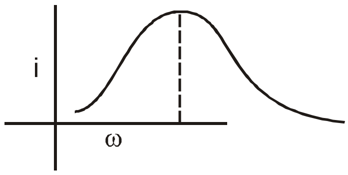

R– C

$i = \frac{V_{rms}}{\sqrt{R^2 + \frac{1}{\omega^2 L^2}}}$



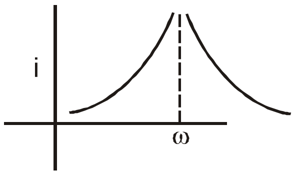

L– C – R

$i = \frac{V_{rms}}{\sqrt{R^2 + \left(\omega L - \frac{1}{\omega c}\right)^2}}$




L – C

$i = \frac{V_{rms}}{\sqrt{\left(\omega L - \frac{1}{\omega c}\right)^2}}$

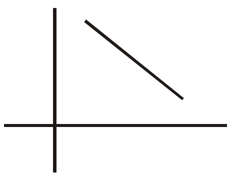



**20. Ans. (A) $\rightarrow$ q, (B) $\rightarrow$ r, (C)$\rightarrow$ s, (D) $\rightarrow$ s**

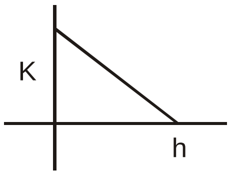
$W_{all} = \Delta k$

$K.E = \frac{1}{2} mu^2 = - mgh$

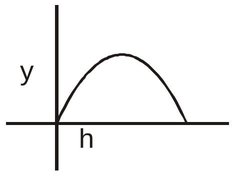
$K.E = \frac{1}{2} mu^2 - mgh$ as $K.E \neq 0$



For vertical motion K.E. = 0 at $H_{max}$



Trajectory of projectile




$$h = (u \sin \theta)\, t - \frac{1}{2g} t^2$$