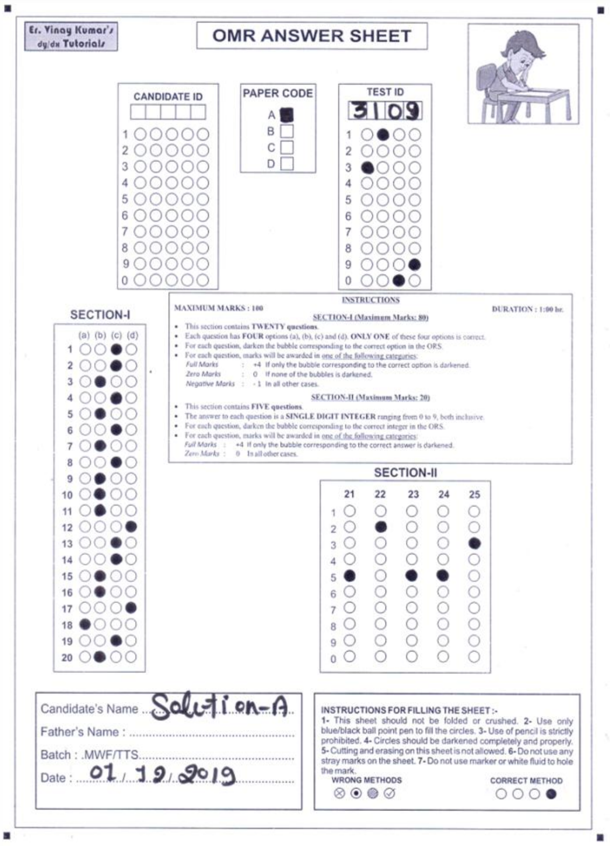
SET-A



Er. Vinay Kumar's dy/dx Tutorials

OMR ANSWER SHEET

CANDIDATE ID | PAPER CODE: A | TEST ID: 3109

SECTION-I | SECTION-II

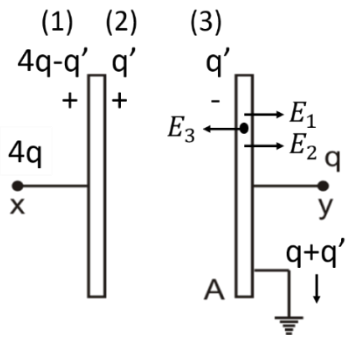
Candidate's Name: Solution-A

Father's Name:

Batch: MWF/TTS

Date: 01/12/2019

Q1.



$E_1 + E_2 = E_3$

$$\frac{4q-q'}{\epsilon_0 A}+\frac{q'}{\epsilon_0 A}=\frac{q'}{\epsilon_0 A}$$

$\Rightarrow \quad 4q - q' + q' = q'$

$\Rightarrow \quad q' = 4q$

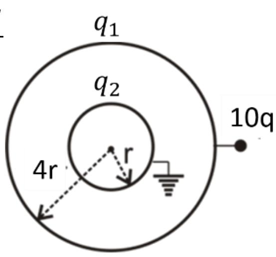
Charge flown to the earth:

$= q + q' \ = \ q + 4q$

$= +5q$

Q2. $\dfrac{q_1}{q_2}=\dfrac{4r}{r} \quad \Rightarrow \quad \dfrac{10q}{q_2}=\dfrac{4r}{r}$

$\Rightarrow \quad q_2 = \dfrac{10}{4}q$



$\Rightarrow \quad q_2 = 2.5q$ (negative)

Q3. $\Delta V \quad \Rightarrow \quad V_B - V_A \quad \Rightarrow \quad (-)$

low pot. high pot.

$\Delta V = E\Delta r = -ER$

Distance parallel to the field

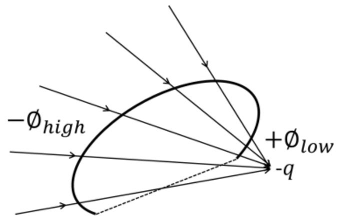
$W_o = q_o \Delta V \quad \Rightarrow \quad (-q_o)(-ER) = q_o ER$

Q4. Flux entering is high

$\Rightarrow \quad -\phi_{high}$

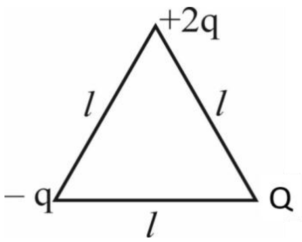
Flux emitting is high

$\Rightarrow \quad +\phi_{low}$



$\phi_{net} = -\phi_{high} + \phi_{low} \Rightarrow \quad (-)$

Q6.



$$U=\frac{1}{4\pi\epsilon_0}\left[\frac{2qQ}{l}+\frac{(2q)\ (-q)}{l}+\frac{(-q)\ Q}{l}\right]$$

for equilibrium U = 0

$2qQ - 2q^2 - qQ = 0$

$qQ = 2q^2 \quad \Rightarrow \quad Q = 2q$

Q7. no effect on potential difference due to change of charge on outer sphere.

Q8. For circular plate :

$I_1 = \dfrac{mr^2}{4}$

For square

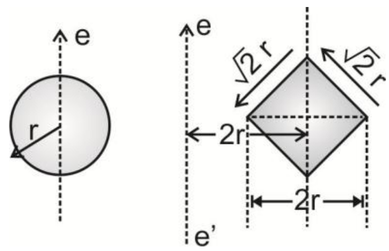


plate : $I_2 = \dfrac{m(\sqrt{2}r)^2}{12} + m(2r)^2$

$= \dfrac{mr^2}{6} + 4mr^2 = \dfrac{25}{6}mr^2$

$$I = I_1 + I_2 = \frac{mr^2}{4} + \frac{25mr^2}{6} = \frac{53}{12}mr^2$$

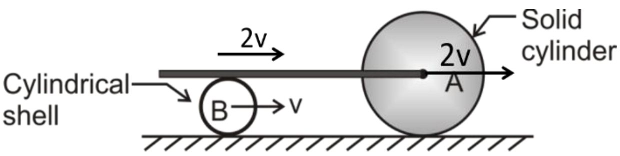
Q9. $KE_t = \dfrac{KE}{\left[1+\dfrac{1}{mr^2}\right]} \quad \Rightarrow \quad \dfrac{1}{2}mv^2 = \dfrac{mg\left(\dfrac{7v^2}{10g}\right)}{\left(1+\dfrac{I}{mr_2}\right)}$

$\Rightarrow \quad \dfrac{1}{2}\left(1+\dfrac{I}{mr_2}\right) = \dfrac{7}{10}$

$\Rightarrow \quad 1+\dfrac{I}{mr_2} = \dfrac{7}{5} \quad \Rightarrow \quad \dfrac{I}{mr_2} = \dfrac{7}{5} - 1$

$\Rightarrow \quad \dfrac{I}{mr_2} = \dfrac{2}{5}$ $\quad \Rightarrow$ this object is solid sphere

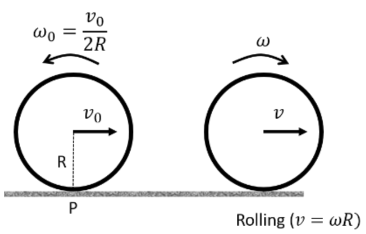
Q10. $KE = KE_A + KE_{plank} + KE_B$



$$KE = \frac{1}{2}m(2v)^2\left[1+\frac{1}{2}\right] + \frac{1}{2}m(2v)^2 + \frac{1}{2}mv^2(1+1)$$

$$= 3mv^2 + 2mv^2 + mv^2 = 6mv^2$$

Q11.



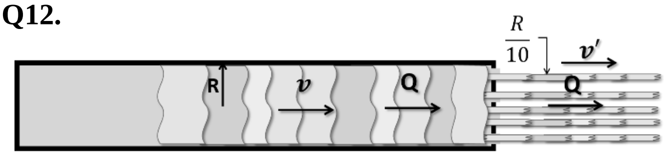
$\tau_P = 0 \quad \Rightarrow \quad l_i = l_f$

$\Rightarrow \quad mv_0R - I_0\,\omega_0 = mvR + I_0\,\omega$

$\Rightarrow \quad mv_0\,R - mR^2\,\dfrac{v_0}{2R} = mvR + mR^2\,\dfrac{v}{R}$

$\Rightarrow \quad mv_0\,\dfrac{R}{2} = 2mv\,R \quad \Rightarrow \quad v = \dfrac{v_0}{4}$

Q12.



Flow through tube⇨ $Q = \pi R^2 v$ ....(1)

Total flow through holes⇨ $Q = 5 \times \left[\pi\left(\dfrac{R}{10}\right)^2 v'\right]$

⇨ $Q = 5\pi\dfrac{R^2}{100}v'$ ⇨ $Q = \dfrac{\pi R^2}{20}v'$ ......(2)

Equating (1) and (2): $\pi R^2 v = \dfrac{\pi R^2}{20}v'$

⇨ $\boldsymbol{v' = 20v}$

Q13.

$E_1 = E_2$

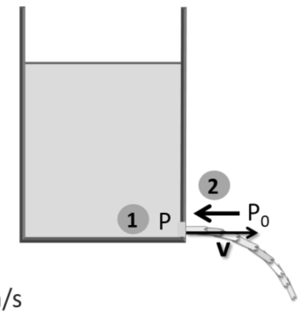
$P = P_0 + \dfrac{1}{2}\rho v^2$

⇨ 5.5×10^5

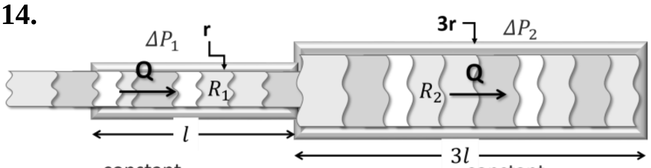
$= 1 \times 10^5 + \dfrac{1}{2} \times 1000 \times v^2$

⇨ $4.5 \times 10^5 = \dfrac{1}{2} \times 1000 \times v^2$

⇨ $v^2 = 9 \times 10^2$ ⇨ $v = 30\text{m/s}$



Q14.



constant

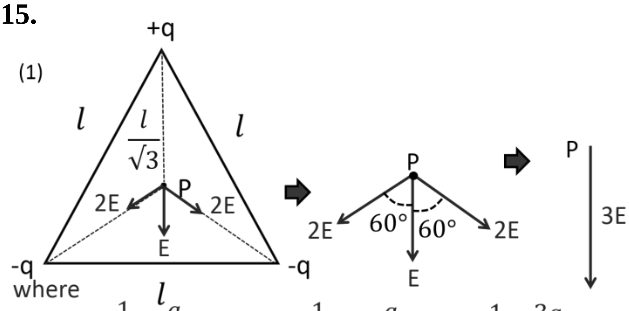
$Q = \dfrac{\Delta P}{R}$ ⇨ $\Delta P \propto R$ ⇨ $\Delta P \propto \dfrac{8\eta l}{\pi r^4}$ ⇨ $\Delta P \propto \dfrac{l}{r^4}$

constant

⇨ $\dfrac{\Delta P_1}{\Delta P_2} = \dfrac{l_1}{l_2} \times \left(\dfrac{r_2}{r_1}\right)^4$ ⇨ $\dfrac{\Delta P_1}{\Delta P_2} = \dfrac{l}{3l} \times \left(\dfrac{3r}{r}\right)^4$ ⇨ $\dfrac{\Delta P_1}{\Delta P_2} = \dfrac{1}{3} \times 3^4$

⇨ $\dfrac{\Delta P_1}{\Delta P_2} = 27$

Q15.

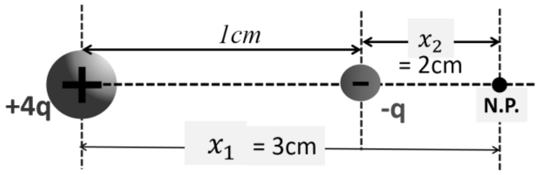


where

$E = \dfrac{1}{4\pi\in_0}\dfrac{q}{r^2}$ ⇨ $E = \dfrac{1}{4\pi\in_0}\dfrac{q}{\left(\dfrac{l}{\sqrt{3}}\right)^2} = \dfrac{1}{4\pi\in_0}\dfrac{3q}{l^2}$

Field intensity $= 3E = 3\left(\dfrac{1}{4\pi\in_0}\dfrac{3q}{l^2}\right) = \dfrac{1}{4\pi\in_0}\dfrac{9q}{l^2}$

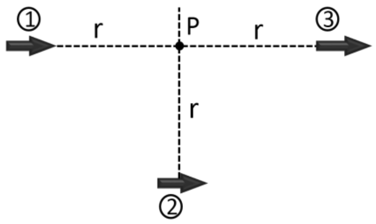
Q16.



$$x_1 = \frac{l\sqrt{q_1}}{\sqrt{q_1} \sim \sqrt{q_2}} \Rightarrow x_1 = \frac{1\sqrt{9q}}{\sqrt{9q} \sim \sqrt{4q}}$$

$$\Rightarrow x_1 = \frac{1 \times 3}{3 \sim 2} \Rightarrow x_1 = 3cm \Rightarrow x_2 = 3 - 1 = 2cm$$

Q17. (1)



$$V_P = V_1 + V_2 + V_3$$

$$\Rightarrow V_P = \left(+\frac{1}{4\pi \in_0}\frac{p}{r^2}\right) + (0) + \left(-\frac{1}{4\pi \in_0}\frac{p}{r^2}\right)$$

$$\Rightarrow V_P = 0$$

Q18.

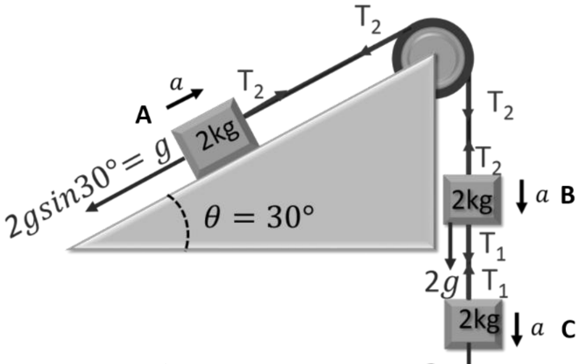
$$\vec{E} = -\left(\frac{\partial}{\partial x}i + \frac{\partial}{\partial y}j + \frac{\partial}{\partial z}k\right)(4x^2)$$

$$= -[\frac{\partial}{\partial x}(4x^2)i + \frac{\partial}{\partial y}(4x^2)j + \frac{\partial}{\partial z}(4x^2)k]$$

$$= -[8xi + 0j + 0k]$$

$$= -8xi$$

Q19.



$$2a = 2g - \cancel{T_1} \quad ....(1)$$

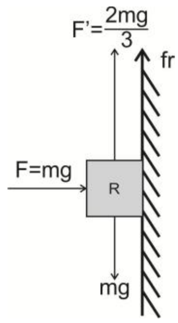
$$2a = \cancel{T_1} + 2g - \cancel{T_2} \quad ....(2)$$

$$2a = \cancel{T_2} - g \quad ....(3)$$

$$6a = 3g \Rightarrow a = \frac{g}{2}$$

$$\Rightarrow a = \frac{10}{2} \Rightarrow a = 5m/s^2$$

Q20. Since mg>F' in vertical direction hence there is a tendency to move the body down hence friction force will act upward to oppose the downward motion.



R = mg ……..(1)

$\mu_s R = \frac{1}{2} \times mg$ ……..(2)

Action force

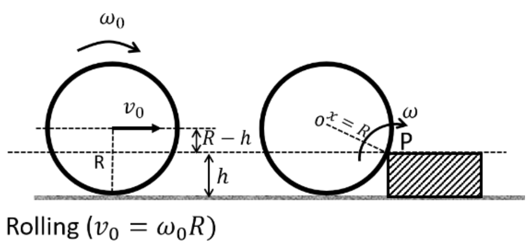
$$mg - F' = mg - \frac{2mg}{3} = \frac{mg}{3} < \mu_s R\left(= \frac{mg}{2}\right)$$

$\Rightarrow$ static condition

$\Rightarrow$ fr = action force

$$= \frac{mg}{3}$$

Q21.



<u>$l_i = l_f$ **about point p**</u>

$$mv_o \times (R-h) + I_o\omega_o = I_p\omega$$

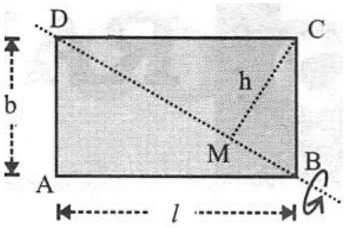
$$\Rightarrow \quad mv_o(R-h) + \frac{2}{5}mR^2 \times \frac{v_o}{R} = \left[\frac{2}{5}mR^2 + mR^2\right]\omega$$

$$\Rightarrow \quad mv_o\left[R - h + \frac{2}{5}R\right] = \frac{7}{5}mR^2\omega$$

$$\Rightarrow \quad v_o\left[\frac{7}{5}R - h\right] = \frac{7}{5}R^2\omega$$

$$\Rightarrow \quad \omega = \frac{v_o\left[\frac{7}{5}R - h\right]}{\frac{7}{5}R^2} \quad \Rightarrow \quad \omega = \left(1 - \frac{5h}{7R}\right)\frac{v_o}{R}$$

Q22. The laming can be considered as two joint identical triangular lamina each of height h about base DB.



Moment of inertia of the lamina $= 2\left[\dfrac{\left(\dfrac{m}{2}\right)h^2}{6}\right]$

$= \dfrac{mh^2}{6}$ .... (1)

<u>To find h</u>

Areaof triangle $= \dfrac{1}{2} \times$ Area of rectangle

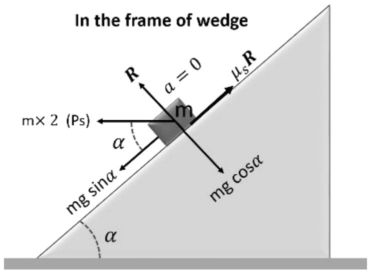
$\Rightarrow \dfrac{1}{2} \times h \times DB = \dfrac{1}{2} \times b \times l$

$\Rightarrow \; h \times \sqrt{b^2 + l^2} = b \times l \;\; \Rightarrow \;\; h = \dfrac{bl}{\sqrt{b^2 + l^2}}$ ....(2)

From (1) & (2) $I = \dfrac{m}{6} \times \left(\dfrac{bl}{\sqrt{b^2 + l^2}}\right)^2$

$= \dfrac{mb^2l^2}{6\,(b^2 + l^2)} = \dfrac{12b^2l^2}{6\,(b^2 + l^2)} = \dfrac{2b^2l^2}{(b^2 + l^2)}$

Q23. Since minimum value of friction force is acting hence the condition of friction becomes limiting.



Along the plan of wedge $\Rightarrow$

$mg\sin\alpha + 2m\cos\alpha = \mu_s R$ ....(1)

Perpendicular to the plan of wedge $\Rightarrow$

$mg\cos\alpha = R + 2m\sin\alpha$

$\Rightarrow R = mg\cos\alpha - 2m\sin\alpha$ ....(2)

<u>From (1) & (2)</u>

$mg\sin\alpha + 2m\cos\alpha = \mu_s(mg\cos\alpha - 2m\sin\alpha)$

Dividing equation by $\cos\alpha \;\Rightarrow$

$mg\tan\alpha + 2m = \mu_s\,(mg - 2m\tan\alpha)$

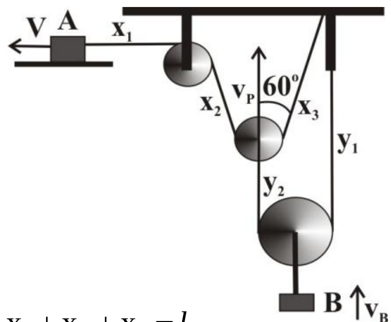
$\Rightarrow \; g\tan\alpha + 2 = \mu_s\,(g - 2\tan\alpha)$

$\Rightarrow 10 \times \dfrac{1}{5} + 2 = \mu_s\left(10 - 2 \times \dfrac{1}{5}\right)$

$\Rightarrow \; 2 + 2 = \mu_s\left(\dfrac{50 - 2}{5}\right)$

$\Rightarrow \;\; 4 = \mu_s \times \dfrac{48}{5} \;\; \Rightarrow \;\; \mu_s = \dfrac{5}{12}$

Q24.



$x_1 + x_2 + x_3 = l$

$v - v_P\cos 60^o - v_P\cos 60^o = 0$

$\Rightarrow \;\; v - \dfrac{v_P}{2} - \dfrac{v_P}{2} = 0$

$\Rightarrow \;\; v = v_P$.....(1)

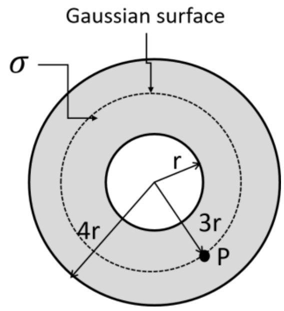
$y_1 + y_2 = l' \Rightarrow \;\; -v_B + (v_P - v_B) = 0$

$\Rightarrow \;\; v_P = 2v_B$.......(2)

from (1) & (2) : $v = 2v_B \Rightarrow \;\; v_B = v/2$

$\Rightarrow \;\; v_B = \dfrac{10}{2} = 5\,m/s$

Q25.



$E4\pi(3r)^2 = \dfrac{\left[\dfrac{4}{3}\pi(3r)^3 - \dfrac{4}{3}\pi r^3\right]}{\epsilon_0}\rho$

$\Rightarrow E4\pi \cdot 9r^2 = \dfrac{\dfrac{4}{3}\pi r^3[27 - 1]}{\epsilon_0}\rho$

$\Rightarrow E \cdot 9 = \dfrac{26r}{3\epsilon_0}\rho \Rightarrow E = \dfrac{26\rho}{27\epsilon_0}r$

$30 - \beta = 27 \;\Rightarrow\; \beta = 3$