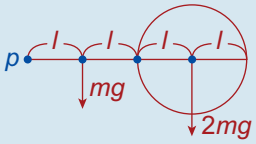
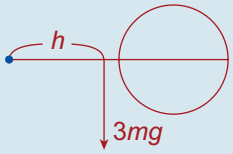
To find *h*:

Forces:



Resultant:



$mg(l) + 2mg(3l) = 3mg(h)$

$$\Rightarrow h = \frac{7}{3}l$$

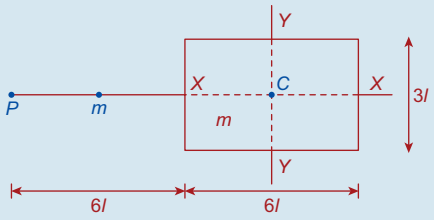
The mass of the system is $3m$.

$$T = 2\pi\sqrt{\frac{I}{mgh}}$$

$$= 2\pi\sqrt{\frac{\frac{61ml^2}{3}}{(3m)g\left(\frac{7l}{3}\right)}}$$

$$= 2\pi\sqrt{\frac{61l}{21g}}$$

Q. 6. (i)



Rod:

$$I_P = \frac{4}{3}m(3l)^2$$

$$\Rightarrow I_P = 12ml^2$$

Lamina:

$$I_{XX} = \frac{m}{3}\left(\frac{3l}{2}\right)^2$$

$$= \frac{3ml^2}{4}$$

$$I_{YY} = \frac{m}{3}(3l)^2$$

$$= 3ml^2$$

⊥ Axes:

$$I_C = I_{XX} + I_{YY}$$

$$= \frac{15ml^2}{4}$$

|| Axes:

$$I_P = I_C + mr^2$$

$$\Rightarrow I_P = \frac{15ml^2}{4} + m(9l)^2$$

$$= \frac{339ml^2}{4}$$

$$\therefore I_{\text{Total}} = I_{\text{Rod}} + I_{\text{Lamina}}$$

$$= 12ml^2 + \frac{339ml^2}{4}$$

$$= \frac{387ml^2}{4}$$

Find Position of Centre of Gravity G:

Moments about *p*:

$$m(3l) + m(9l) = 2mh$$

$$\Rightarrow h = 6l$$

So $T = 2\pi\sqrt{\frac{I}{mgh}}$

$$= 2\pi\sqrt{\frac{387ml^2}{4(2m)g(6l)}}$$

$$= 2\pi\sqrt{\frac{129l}{16g}}$$

(ii) **Simple Pendulum Equivalent:**

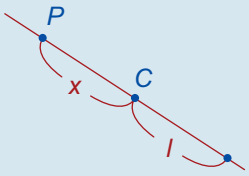
$$2\pi\sqrt{\frac{k}{g}} = 2\pi\sqrt{\frac{129l}{16g}}$$

$$\Rightarrow k = \frac{129l}{16}$$

Q. 7. $I_P = I_C + md^2$

$$= \frac{1}{3}ml^2 + mx^2$$

$h = x \quad m = m$



$$T = 2\pi\sqrt{\frac{I}{mgh}}$$

$$= 2\pi\sqrt{\frac{\frac{1}{3}ml^2 + mx^2}{mgx}}$$

$$= 2\pi\sqrt{\frac{7l}{6g}}$$

$$\Rightarrow \frac{\frac{1}{3}l^2 + x^2}{x} = \frac{7l}{6}$$

$$\Rightarrow 2l^2 + 6x^2 = 7lx$$

$$\Rightarrow 6x^2 - 7lx + 2l^2 = 0$$

$$\Rightarrow (3x - 2l)(2x - l) = 0$$

$$\Rightarrow x = \frac{2}{3}l \quad \textbf{OR} \quad x = \frac{1}{2}l$$