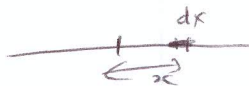
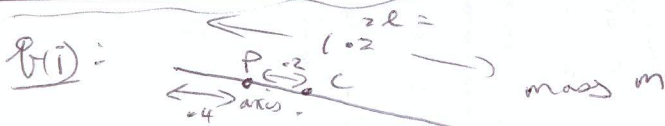


1993 8(a):

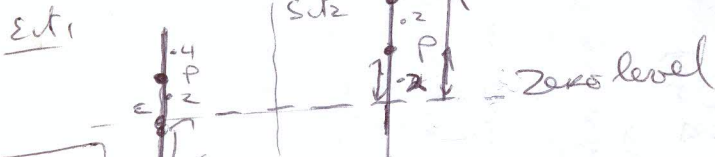


$\rho = \text{density}$   
 $\rho = \frac{dm}{dx} \Rightarrow dm = \rho dx$   
 and  $\rho = \frac{m}{2l} \Rightarrow m = \rho 2l$

$dI = dm x^2$   
 $dI = \rho dx x^2$   
 $I = \int \rho x^2 dx$   
 $= \rho \left[ \frac{x^3}{3} \right]_{-l}^l$   
 $= \rho \left[ \frac{l^3}{3} - \left( -\frac{l^3}{3} \right) \right]$   
 $= \rho \frac{2l^3}{3}$   
 $= \frac{\rho 2l^3}{3}$   
 $= \frac{m l^2}{3} \rho 2l$



$I_P = I_C + m(PC)^2$   
 $= \frac{m(0.6)^2}{3} + m(0.2)^2$   
 $= 0.16m$



least value of  $v$  to reach top  
 $\epsilon_2 = mg(0.4) + 0$   
 $= mg(0.4)$

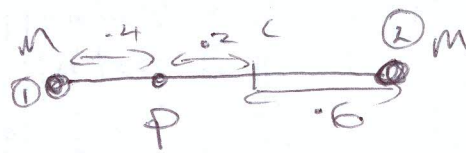
$\epsilon_1 = 0 + \frac{1}{2} I \omega^2$   
 $= \frac{1}{2} (0.16m) \omega^2$   
 $= 0.08m \omega^2$

PCE  $\Rightarrow \epsilon_1 = \epsilon_2$

$\Rightarrow 0.08m \omega^2 = mg \cdot 0.4$   
 $\omega^2 = \frac{0.4}{0.08} g$   
 $\omega^2 = 49$   
 $\omega = 7$   
 least  $\omega = 7 \Rightarrow \omega \geq 7$

$v = 8 \text{ m/s} \Rightarrow \frac{v}{0.8} \geq 7$   
 $v \geq 5.6 \text{ m/s}^{-1}$

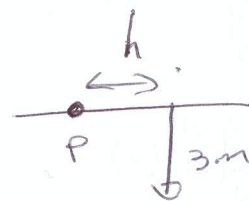
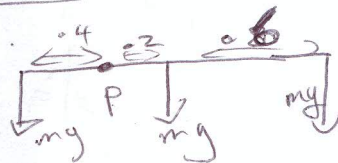
(ii)  $T = 2\pi \sqrt{\frac{I}{mgh}}$



$I_{\text{system}} = I_P + I_P^{(1)} + I_P^{(2)}$   
 $= 0.16m + m(0.4)^2 + m(0.6)^2$   
 $= 0.16m + 0.16m + 0.36m$   
 $= 0.68m$

Total mass =  $m + m + m = 3m$

Find h:



$\sum \tau_{\text{center}} = -0.4mg + 0.2mg + 0.8mg$   
 $= 0.6mg$   
 non  $\epsilon = 3mgh$

Principle moments  $\Rightarrow$   
 $0.6mg = 3mgh$   
 $0.2 = h$

$\therefore T = 2\pi \sqrt{\frac{0.68m}{3m g(0.2)}}$   
 $= 2\pi \sqrt{\frac{0.96}{0.6(9.8)}}$   
 $= 2\pi \sqrt{\frac{0.96}{5.88}}$   
 $= 2\pi \sqrt{0.1632653}$   
 $= 2(3.14)(0.404061)$   
 $= 2.5375 \text{ seconds}$   
 $= 2.54 \text{ seconds}$   
 to 2 dec places