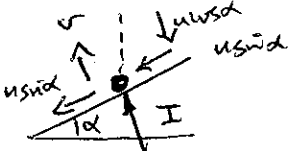
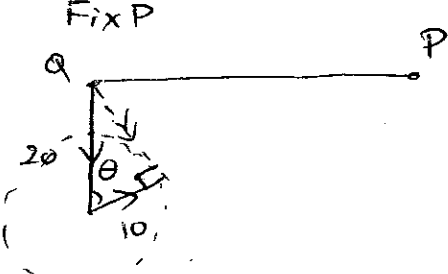
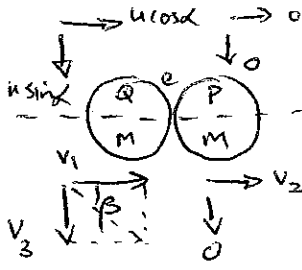
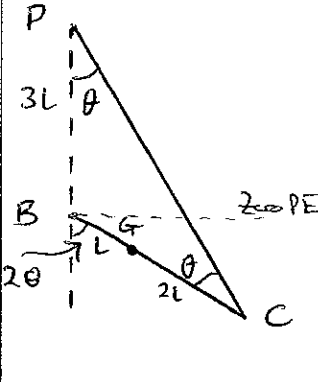


Question Number	Scheme	Marks
1. (a)	 <p> $\text{Cpt along plane} = 10 \sin \alpha$ $\text{after impact} = 10 \times \frac{3}{5}$ $= 6$ </p> <p> $V = e \times 10 \cos \alpha$ $(= \frac{1}{2} \times 10 \times \frac{4}{5} = 4)$ </p> <p> $\text{Speed} = \sqrt{4^2 + 6^2} = \underline{7.21 \text{ ms}^{-1} \text{ (3SF)}}$ </p>	<p>B1</p> <p>M1 A1</p> <p>M1 A1 (5)</p>
1. (b)	<p> $I = \frac{1}{2} (4 - -8) = \underline{6 \text{ Ns}}$ </p>	<p>M1 A1 (2)</p> <p>(7)</p>
2.	 <p> $\text{Vector } \Delta$ $\cos \theta = \frac{10}{20}$ $\Rightarrow \theta = \underline{0.60^\circ}$ </p>	<p>M1 A1</p> <p>M1 A1</p> <p>A1 (5)</p>
3.	 <p> $v_3 = u \sin \alpha$ </p> <p> $\text{CM: } v_1 + v_2 = u \cos \alpha$ $\text{NIL: } -v_1 + v_2 = e u \cos \alpha$ $\frac{v_3}{v_1} = \tan \beta$ </p> <p> $\text{elim } v_2$ $\text{elim } v_3$ $\text{elim } u$ </p> <p> $\Rightarrow \underline{\tan \beta (1-e) = 2 \tan \alpha} *$ </p>	<p>B1</p> <p>M1 A1</p> <p>M1 A1</p> <p>M1 A1</p> <p>M1</p> <p>M1</p> <p>M1</p> <p>A1 (11)</p>

Question Number	Scheme	Marks
4.(a)	For constant speed, $F - kv^2 = 0$ $\Rightarrow v = \sqrt{\frac{F}{k}}$ *	M1 A1 (2)
(b)	$F - kv^2 = Ma$ $\Rightarrow F - kv^2 = Mv \frac{dv}{dx}$ $\int dx = M \int \frac{v}{F - kv^2} dv$ $x = \frac{-M}{2k} \ln(F - kv^2) + C$ $x=0, v=0 \Rightarrow C = \frac{M}{2k} \ln F$ $x = \frac{M}{2k} \left\{ \ln F - \ln(F - kv^2) \right\}$ $X = \frac{M}{2k} \ln \left(\frac{F}{F - k \cdot \frac{F}{4k}} \right)$ $= \frac{M}{2k} \ln \frac{4}{3}$ *	M1 A1 M1 M1 A1 M1 A1 M1 A1 (9) (11)
5.(a)	 $GPE = -mgL \cos 2\theta$ $EPE = \frac{mg}{6} \frac{(6L \cos \theta - L)^2}{2L}$ $= \frac{mg}{12L} (36L^2 \cos^2 \theta - 12L^2 \cos \theta + L^2)$ $= mgL (3 \cos^2 \theta - \cos \theta) + C$ $V = -mgL (2 \cos^2 \theta - 1) + mgL (3 \cos^2 \theta - \cos \theta) + C$ $= mgL (\cos^2 \theta - \cos \theta) + C$ *	B1 M1 M1 M1 M1 M1 A1 (6)
(b)	$\frac{dV}{d\theta} = mgL (-2 \cos \theta \sin \theta + \sin \theta) = 0$ $\sin \theta (-2 \cos \theta + 1) = 0$ $\sin \theta = 0$ or $\cos \theta = \frac{1}{2}$ $\theta = 0$ or $\theta = \pm \frac{\pi}{3}$	M1 A1; M1 M1 A1 A1 (6) (12)

<p>6. (a)</p>		<p>Minimum speed for interception = $36 \sin 30^\circ = 18$</p> <p>$\cos \theta = \frac{18}{30} (= \frac{3}{5})$</p> <p>$\Rightarrow \theta = 4/3$</p> <p>Explanation</p>	<p>M1 A1</p> <p>M1 A1</p> <p>A1</p> <p>M1 A1 (7)</p>
<p>(b)</p>	<p>$AQ = 36 \cos 30^\circ + 30 \sin \theta$ $(18\sqrt{3} + 24)$</p> <p>Time = $\frac{70}{(18\sqrt{3} + 24)} = 1.27 \text{ hrs.}$</p>	<p>M1 A2</p> <p>M1 A1 (5)</p> <p>(12)</p>	
<p>7. (a)</p>		<p>$y + ut = y + (a - x)$</p> <p>$ut = y + x$ *</p>	<p>M1 A1 (2)</p>
<p>(b)</p>	<p>For particle, $R(\rightarrow)$, $T - 2m\omega y = m\ddot{y}$</p> <p>$T = \frac{5ma\omega^2 x}{a}$</p> <p>$u = \dot{y} + \dot{x}$; $0 = \ddot{y} + \ddot{x}$</p> <p>$5m\omega^2 x - 2m\omega(u - \dot{x}) = m(-\ddot{x})$</p> <p>$\Rightarrow \ddot{x} + 2\omega\dot{x} + 5\omega^2 x = 2\omega u$ *</p>	<p>M1 A1</p> <p>M1</p> <p>B1; B1</p> <p>M1 A1 (7)</p>	
<p>(c)</p>	<p>AE: $u^2 + 2\omega u + 5\omega^2 = 0 \Rightarrow (u + \omega)^2 = -4\omega^2$</p> <p>$u = -\omega + 2i\omega$</p> <p>CF: $x = e^{-\omega t} (A \cos 2\omega t + B \sin 2\omega t)$</p> <p>PI: $x = \frac{2\omega u}{5\omega^2} = \frac{2u}{5\omega}$</p> <p>ES: $x = e^{-\omega t} (A \cos 2\omega t + B \sin 2\omega t) + \frac{2u}{5\omega}$</p> <p>$x=0, t=0: 0 = A + \frac{2u}{5\omega} \Rightarrow A = -\frac{2u}{5\omega}$</p> <p>$\ddot{x} = -\omega e^{-\omega t} (A \cos 2\omega t + B \sin 2\omega t) + e^{-\omega t} (-2\omega A \sin 2\omega t + 2\omega B \cos 2\omega t)$</p> <p>$t=0, \dot{y}=0 \Rightarrow \dot{x} = u$</p> <p>$u = -\omega A + 2\omega B \Rightarrow B = \frac{3u}{10\omega}$</p> <p>$x = e^{-\omega t} \left(\frac{3u}{10\omega} \sin 2\omega t - \frac{2u}{5\omega} \cos 2\omega t \right) + \frac{2u}{5\omega}$</p>	<p>B1</p> <p>M1</p> <p>B1</p> <p>B1</p> <p>M1 A1 ✓</p> <p>M1</p> <p>A1 (8)</p> <p>(17)</p>	

MJJ. 4.705