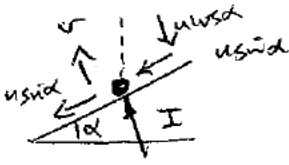
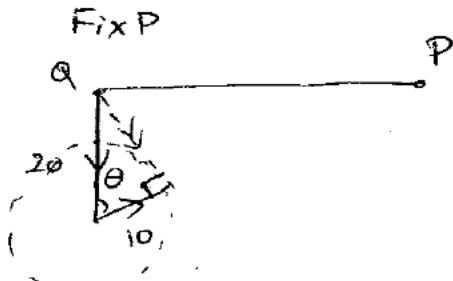
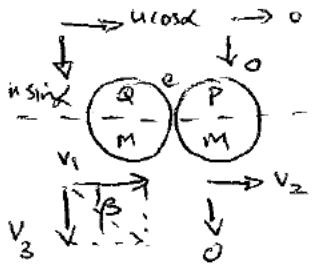
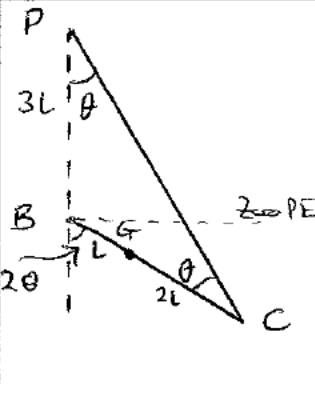
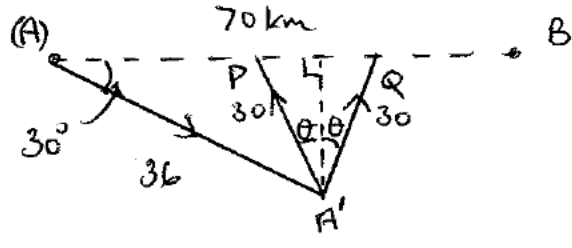


Question Number	Scheme	Marks
1. (a)	 <p> <math>\text{Cpt along plane} = 10 \sin \alpha</math>  <math>\text{after impact} = 10 \times \frac{3}{5}</math>  <math>= 6</math> </p> <p> <math>V = e \times 10 \cos \alpha</math>  <math>(= \frac{1}{2} \times 10 \times \frac{4}{5} = 4)</math> </p> <p> <math>\text{Speed} = \sqrt{4^2 + 6^2} = \underline{7.21 \text{ ms}^{-1} \text{ (3SF)}}</math> </p>	<p>B1</p> <p>M1 A1</p> <p>M1 A1 (5)</p>
1. (b)	<p> <math>I = \frac{1}{2} (4 - -8) = \underline{6 \text{ N s}}</math> </p>	<p>M1 A1 (2)</p> <p>(7)</p>
2.	 <p> <math>\text{Vector } \Delta</math>  <math>\cos \theta = \frac{10}{20}</math>  <math>\Rightarrow \theta = \underline{060^\circ}</math> </p>	<p>M1 A1</p> <p>M1 A1</p> <p>A1 (5)</p>
3.	 <p> <math>v_3 = u \sin \alpha</math> </p> <p> <math>\text{CM: } v_1 + v_2 = u \cos \alpha</math>  <math>\text{NIL: } -v_1 + v_2 = e u \cos \alpha</math>  <math>\frac{v_2}{v_1} = \tan \beta</math> </p> <p> <math>e \text{ lin } v_2</math>  <math>e \text{ lin } v_3</math>  <math>e \text{ lin } v_1</math> </p> <p> <math>\Rightarrow \underline{\tan \beta (1 - e) = 2 \tan \alpha} *</math> </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	
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)



L. (a) 

Minimum speed for interception =  $36 \sin 30^\circ = 18$

$\cos \theta = \frac{18}{30} (= \frac{3}{5})$

$\Rightarrow \theta = 56.3^\circ$

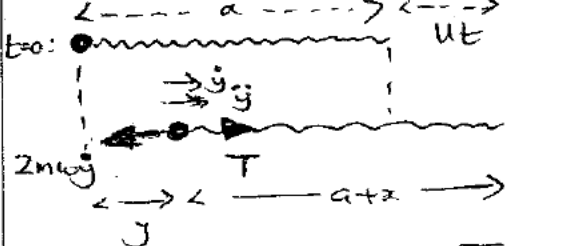
Explanation

(b)

$AQ = 36 \cos 30^\circ + 30 \sin \theta$   
 $(18\sqrt{3} + 24)$

Time =  $\frac{70}{(18\sqrt{3} + 24)} = 1.27 \text{ hrs.}$

M1 A1  
M1 A1  
A1  
M1 A1 (7)  
A1 (5)

7. (a) 

$d + ut = y + (a + x)$   
 $ut = y + x$  \*

(b) For particle,  $R(\rightarrow)$ ,  $T - 2mg \sin \theta = ma$

$T = \frac{5ma \cos^2 \theta}{a}$

$u = \dot{y} + \dot{x}$ ;  $0 = \ddot{y} + \ddot{x}$

$5m \cos^2 \theta \ddot{x} - 2mg \sin \theta (\ddot{x} - \ddot{y}) = m \ddot{x} (-\ddot{x})$

$\Rightarrow \ddot{x} + 2\omega \ddot{x} + 5\omega^2 \ddot{x} = 2\omega u$  \*

(c) AE:  $u^2 + 2\omega u + 5\omega^2 = 0 \Rightarrow (u + \omega)^2 = -4\omega^2$   
 $u = -\omega + 2i\omega$

CF:  $x = e^{-\omega t} (A \cos 2\omega t + B \sin 2\omega t)$

PI:  $x = \frac{2\omega u}{5\omega^2} = \frac{2u}{5\omega}$

ES:  $x = e^{-\omega t} (A \cos 2\omega t + B \sin 2\omega t) + \frac{2u}{5\omega}$

$x=0, t=0: 0 = A + \frac{2u}{5\omega} \Rightarrow A = -\frac{2u}{5\omega}$

$\ddot{x} = -\omega e^{-\omega t} (A \cos 2\omega t + B \sin 2\omega t) + e^{-\omega t} (-2\omega A \sin 2\omega t + 2\omega B \cos 2\omega t)$

$t=0, \ddot{y}=0 \Rightarrow \ddot{x} = u$   
 $u = -\omega A + 2\omega B \Rightarrow B = \frac{3u}{10\omega}$

$x = e^{-\omega t} \left( \frac{3u}{10\omega} \sin 2\omega t - \frac{2u}{5\omega} \cos 2\omega t \right) + \frac{2u}{5\omega}$

M1 A1 (2)  
M1 A1  
B1; B1  
M1 A1 (7)  
A1  
B1  
M1 A1  
M1  
A1 (8)  
(17)

MJF. K. 705