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Mark Scheme (Results)
Summer 2010

GCE

GCE Mechanics M2 (6678/01)

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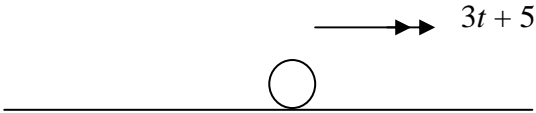Ask The Expert can be accessed online at the following link:

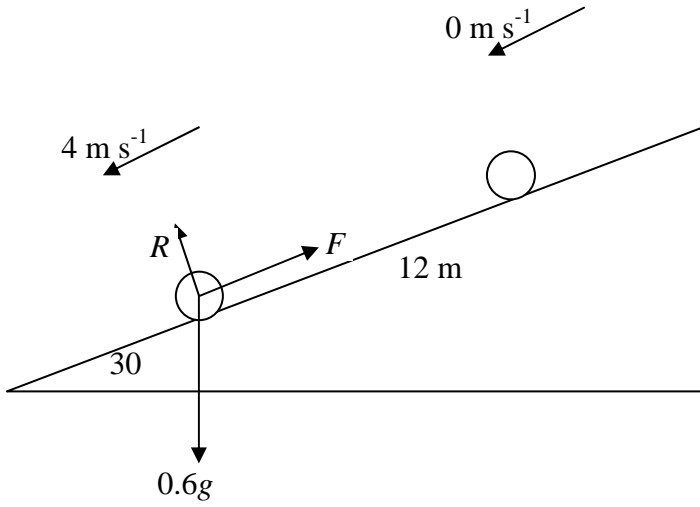http://www.edexcel.com/Aboutus/contact-us/
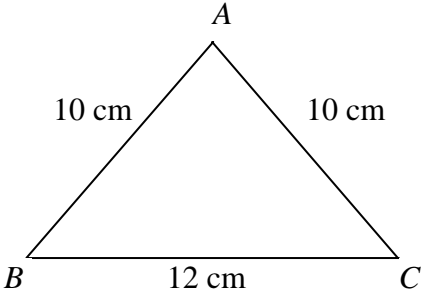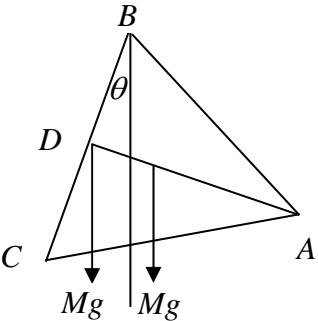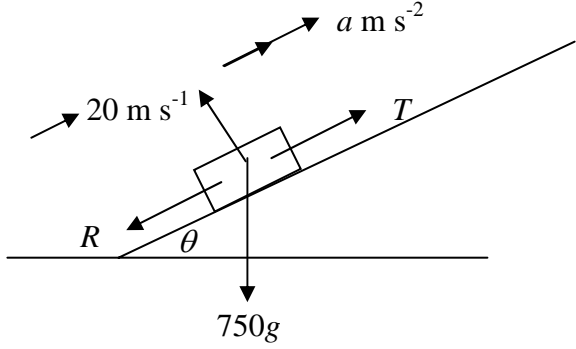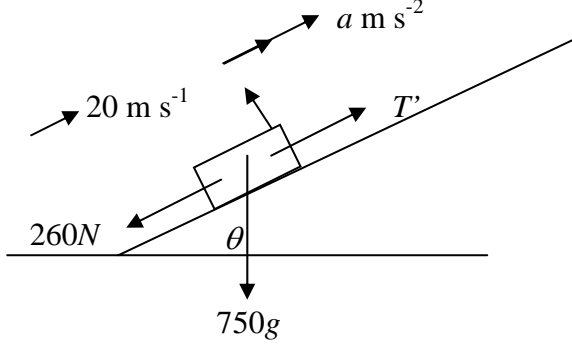
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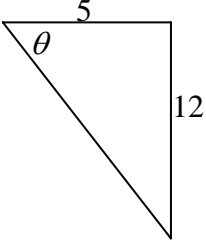
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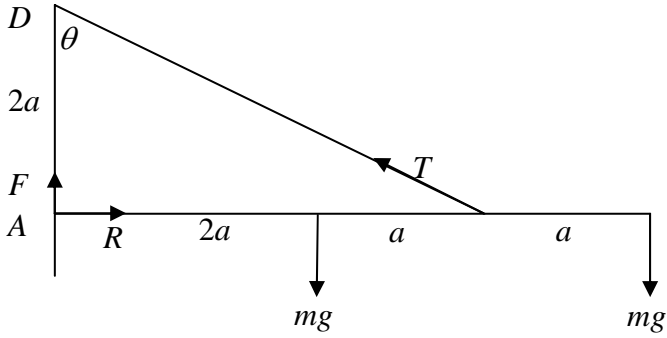
Question Number	Scheme	Marks
Q1	$3t + 5$	
	$\dfrac{\mathrm{d}v}{\mathrm{d}t} = 3t + 5$	
	$v = \int (3t + 5)\,\mathrm{d}t$	M1*
	$v = \frac{3}{2}t^2 + 5t \ (+c)$	A1
	$t = 0 \ \ v = 2 \ \Rightarrow \ c = 2$	B1
	$v = \frac{3}{2}t^2 + 5t + 2$	
	$t = T \qquad 6 = \frac{3}{2}T^2 + 5T + 2$	DM1*
	$\qquad 12 = 3T^2 + 10T + 4$	
	$\qquad 3T^2 + 10T - 8 = 0$	
	$\qquad (3T - 2)(T + 4) = 0$	M1
	$\qquad T = \frac{2}{3} \ \ (T = -4)$	
	$\qquad \therefore T = \frac{2}{3} \ \ (\text{or } 0.67)$	A1
		[6]

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Question Number	Scheme	Marks
Q2		
(a)	K.E gained $= \frac{1}{2} \times 0.6 \times 4^2$ P.E. lost $= 0.6 \times g \times (12 \sin 30)$ Change in energy = P.E. lost - K.E. gained $$= 0.6 \times g \times 12 \sin 30 - \frac{1}{2} \times 0.6 \times 4^2$$ $= 30.48$ Work done against friction $= 30$ or 30.5 J	M1 A1 A1 A1 (4)
(b)	$R(\uparrow) \quad R = 0.6g \cos 30$ $F = \dfrac{30.48}{12}$ $F = \mu R$ $\mu = \dfrac{30.48}{12 \times 0.6g \cos 30}$ $\mu = 0.4987$ $\mu = 0.499$ or 0.50	B1 B1ft M1 A1 (4) [8]

Question Number	Scheme					Marks
Q3						

	(a)		AB	AC	BC	frame		

	mass ratio	10	10	12	32		B1
	dist. from BC	4	4	0	$\overline{x}$		B1

Moments about BC:

$$10 \times 4 + 10 \times 4 + 0 = 32\overline{x}$$

M1 A1

$$\overline{x} = \frac{80}{32}$$

$$\overline{x} = 2\tfrac{1}{2} \quad (2.5)$$

A1 (5)

(b)

Moments about B:

$$Mg \times 6\sin\theta = Mg \times \left(\overline{x}\cos\theta - 6\sin\theta\right)$$

M1 A1 A1

$$12\sin\theta = \overline{x}\cos\theta$$

$$\tan\theta = \frac{\overline{x}}{12}$$

$$\theta = 11.768..... = 11.8°$$

A1 (4)

Alternative method :

C of M of loaded frame at distance $\tfrac{1}{2}\overline{x}$ from D along DA

B1

$$\tan\theta = \frac{\tfrac{1}{2}\overline{x}}{6}$$

M1 A1

$$\theta = 11.768..... = 11.8°$$

A1

[9]

Question Number	Scheme	Marks
Q4		
(a)	$T = \dfrac{15000}{20} = 750$	M1
	R(parallel to road) $T = R + 750g\sin\theta$	M1 A1
	$R = 750 - 750 \times 9.8 \times \frac{1}{15}$	
	$R = 260 \,*$	A1 (4)
(b)		
	$T' = \dfrac{18000}{20} = 900$	M1
	$T' - 260 - 750g \times \sin\theta = 750a$	M1 A1
	$a = \dfrac{900 - 260 - 750 \times 9.8 \times \frac{1}{15}}{750}$	
	$a = 0.2$	A1 (4)
		[8]

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Question Number	Scheme	Marks
Q5 (a)	$\mathbf{I} = m\mathbf{v} - m\mathbf{u}$ $= 0.5 \times 20\mathbf{i} - 0.5(10\mathbf{i} + 24\mathbf{j})$ $= 5\mathbf{i} - 12\mathbf{j}$ $\lvert 5\mathbf{i} - 12\mathbf{j} \rvert = 13$ Ns	M1 A1 M1 A1 (4)
(b)	 $\tan \theta = \dfrac{12}{5}$ $\theta = 67.38$ $\theta = 67.4°$	M1 A1 (2)
(c)	K.E. lost $= \frac{1}{2} \times 0.5(10^2 + 24^2) - \frac{1}{2} \times 0.5 \times 20^2$ $= 69$ J	M1 A1 A1 (3) [9]

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Question Number	Scheme	Marks
Q6		
(a)	$M(A)$ $\quad 3a \times T \cos\theta = 2amg + 4amg$	M1 A1 A1
	$\cos\theta = \left(\dfrac{2}{\sqrt{9+4}} = \right)\dfrac{2}{\sqrt{13}}$	B1
	$\dfrac{6}{\sqrt{13}}T = 6mg$	
	$T = mg\sqrt{13}$ $\quad *$	A1 (5)
(b)	$3a \times T \times \cos\theta = 2amg + 4aMg$	M1
	$T = \dfrac{(2mg + 4Mg)}{6}\sqrt{13} \leq 2mg\sqrt{13}$	A1
	$mg + 2Mg < 6mg$	
	$M \leq \dfrac{5}{2}m$ $\quad *$ $\qquad\qquad\qquad$ cso	A1 (3)
		[8]

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Question Number	Scheme	Marks
Q7 (a)	Vertical motion: $v^2 = u^2 + 2as$ $(40 \sin \theta)^2 = 2 \times g \times 12$ $(\sin \theta)^2 = \dfrac{2 \times g \times 12}{40^2}$ $\theta = 22.54 = 22.5°$ (accept 23)	M1 A1 A1 (3)
(b)	Vert motion $P \rightarrow R$: $\quad s = ut + \frac{1}{2}at^2$ $-36 = 40 \sin \theta t - \dfrac{g}{2}t^2$ $\dfrac{g}{2}t^2 - 40 \sin \theta t - 36 = 0$ $t = \dfrac{40 \sin 22.54 \pm \sqrt{(40 \sin 22.54)^2 + 4 \times 4.9 \times 36}}{9.8}$ $t = 4.694...$ Horizontal P to R: $\quad s = 40 \cos \theta t$ $= 173$ m $\qquad$ (or 170 m)	M1 A1 A1 A1 M1 A1 (6)
(c)	Using Energy: $\dfrac{1}{2}mv^2 - \dfrac{1}{2}m \times 40^2 = m \times g \times 36$ $v^2 = 2\left(9.8 \times 36 + \frac{1}{2} \times 40^2\right)$ $v = 48.0.....$ $v = 48$ m s^{-1} (accept 48.0)	M1 A1 A1 (3) [12]

Question Number	Scheme	Marks
Q8		

(a)
(i)

Con. of Mom: $3mu - mu = 3mv + mw$

$$2u = 3v + w \qquad (1)$$

N.L.R: $\qquad \frac{1}{2}(u+u) = w - v$

$$u = w - v \qquad (2)$$

(1) – (2) $\qquad u = 4v$

$$v = \tfrac{1}{4}u$$

M1# A1
M1# A1

DM1#
A1

(ii) In (2) $\qquad u = w - \tfrac{1}{4}u$

$$w = \tfrac{5}{4}u$$

A1 (7)

(b) *B* to wall: N.L.R: $\frac{5}{4}u \times \frac{2}{5} = V$

$$V = \tfrac{1}{2}u$$

M1
A1ft (2)

(c)

B to wall: $\qquad \text{time} = 4a \div \dfrac{5}{4}u = \dfrac{16a}{5u}$

B1ft

Dist. Travelled by $A = \dfrac{1}{4}u \times \dfrac{16a}{5u} = \dfrac{4}{5}a$

B1ft

In *t* secs, *A* travels $\dfrac{1}{4}ut$, *B* travels $\dfrac{1}{2}ut$

Collide when speed of approach $= \mathbf{\dfrac{1}{2}ut + \dfrac{1}{4}ut}$, distance to cover $=$

$4a - \dfrac{4}{5}a$

M1$

$$\therefore t = \frac{4a - \frac{4}{5}a}{\frac{3}{4}u} = \frac{16a}{5} \times \frac{4}{3u} = \frac{64a}{15u}$$

DM1$ A1

Total time $= \dfrac{16a}{5u} + \dfrac{64a}{15u} = \dfrac{112a}{15u} \qquad *$

A1 (6)

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