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Mark Scheme (Results)
January 2008

GCE

GCE Mathematics (6678/01)

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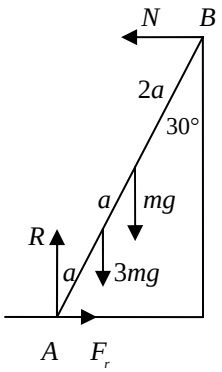
January 2008
6678 Mechanics M2
Mark Scheme

Question Number	Scheme	Marks
1.	(a) KE lost is $\frac{1}{2}\times 2.5\times 8^2 = 80 \ (\text{J})$	M1 A1 **(2)**
	(b) Work energy $80 = R\times 20$ ft their (a) $R = 4$	M1 A1 ft A1 **(3)** **[5]**
	Alternative to (b) $0^2 = 8^2 - 2\times a\times 20 \Rightarrow a = (-)1.6$ N2L $R = 2.5\times 1.6$ ft their a $= 4$	M1 A1ft A1 **(3)**
2.	(a) $\dot{\mathbf{p}} = (6t-6)\mathbf{i} + (9t^2-4)\mathbf{j} \quad (\text{m s}^{-1})$	M1 A1 **(2)**
	(b) $9t^2 - 4 = 0$ $t = \frac{2}{3}$	M1 DM1 A1 **(3)**
	(c) $t = 1 \Rightarrow \dot{\mathbf{p}} = 5\mathbf{j}$ ft their $\dot{p}$ (+/-) $2\mathbf{i} - 6\mathbf{j} = 0.5(\mathbf{v} - 5\mathbf{j})$ $\mathbf{v} = 4\mathbf{i} - 7\mathbf{j} \quad (\text{m s}^{-1})$	B1ft M1 M1 A1 **(4)** **[9]**

Question Number	Scheme	Marks
3.	(a) $20\,000 = 16F \quad (F = 1250)$	M1 A1
	↗ $F = 550 + 1000 \times 9.8 \sin\theta$ ft their F	M1 A1ft
	Leading to $\sin\theta = \frac{1}{14}$ ✱ cso	A1 **(5)**
	(b) N2L ↗ $550 + 1000 \times 9.8 \times \sin\theta = 1000a$	
	$(550 + 1000 \times 9.8 \times \frac{1}{14} = 1000a \quad)$	M1 A1
	or 1250 = 1000a	
	$(a = (-)1.25)$	
	$v^2 = u^2 + 2as \Rightarrow 16^2 = 2 \times 1.25 \times y$	M1
	$y \approx 102$ accept 102.4, 100	A1 **(4)**
		[9]
	Alternative to (b)	
	Work-Energy $\frac{1}{2} \times 1000 \times 16^2 - 1000 \times 9.8 \times \frac{1}{14} y = 550y$	M1 M1 A1
	$y \approx 102$ accept 102.4, 100	A1 **(4)**
4.	(a) Triangle Circle S	
	Mass ratio 126 9π (28.3) $126 - 9\pi$ (97.7)	B1 B1ft
	$\bar{x}$ 7 5 $\bar{x}$	
	$\bar{y}$ 4 5 $\bar{y}$ 4, 7 seen	B1
	$126 \times 7 = 9\pi \times 5 + (126 - 9\pi) \times \bar{x}$ ft their table values	M1 A1ft
	$\bar{x} \approx 7.58 \ (\frac{882 - 45\pi}{126 - 9\pi})$ awrt 7.6	A1
	$126 \times 4 = 9\pi \times 5 + (126 - 9\pi) \times \bar{y}$ ft their table values	M1 A1ft
	$\bar{y} \approx 3.71 \ (\frac{504 - 45\pi}{126 - 9\pi})$ awrt 3.7	A1 **(9)**
	(b) $\tan\theta = \frac{\bar{y}}{21 - \bar{x}}$ ft their $\bar{x}, \bar{y}$	M1 A1ft
	$\theta \approx 15°$	A1 **(3)**
		[12]

Question Number	Scheme	Marks
5.	(a) 	
	M(A) $N \times 4a\cos 30° = 3mg \times a\sin 30° + mg \times 2a\sin 30°$	M1 A2(1,0)
	$N = \frac{5}{4}mg\tan 30°$ ($= \frac{5}{4\sqrt{3}}mg$ = 7.07…m)	DM1 A1
	$\rightarrow \quad F_r = N \quad , \quad \uparrow \quad R = 4mg$	B1, B1
	Using $F_r = \mu R$	B1
	$\frac{5}{4\sqrt{3}}mg = \mu R$ for their R	M1
	$\mu = \frac{5}{16\sqrt{3}}$ awrt 0.18	A1 **(10)**
		[10]
	Alternative method:	
	M(B): $mg \times 2a\sin 30 + 3mg \times 3a\sin 30 + F \times 4a\cos 30 = R \times 4a\sin 30$	
	$11mga\sin 30 + F \times 4a\cos 30 = R \times 4a\sin 30$	M1A3(2,1,0)
	$\frac{11mg}{2} + F\frac{4\sqrt{3}}{2} = 2R$	DM1A1
	$\uparrow \quad R = 4mg$,	B1
	Using $F_r = \mu R$	B1
	$8\mu\sqrt{3} = \frac{5}{2}, \quad \mu = \frac{5}{16\sqrt{3}}$	M1 A1

6.	(a) $\rightarrow \quad 30 = 2ut$	B1
	$\uparrow \quad -47.5 = 5ut - 4.9t^2$	M1 A1
	$-47.5 = 75 - 4.9t^2$ eliminating u or t	DM1
	$t^2 = \dfrac{75 + 47.5}{4.9} \left(= 25\right)$	DM1
	$t = 5$ ✱ cso	A1 **(6)**
	(b) $30 = 2ut \Rightarrow 30 = 10u \Rightarrow u = 3$	M1 A1 **(2)**
	(c) $\uparrow \quad \dot{y} = 5u - 9.8t = -34$ M1 requires both	M1 A1
	$\rightarrow \quad \dot{x} = 2u = 6$ $\dot{x}$ and $\dot{y}$	A1
	$v^2 = 6^2 + \left(-34\right)^2$	DM1
	$v \approx 34.5 \ \left(\text{m s}^{-1}\right)$ accept 35	A1 **(5)**
		[13]
	Alternative to (c)	
	$\frac{1}{2}mv_B^2 - \frac{1}{2}mv_A^2 = m \times g \times 47.5$ with $v_A^2 = 6^2 + 15^2 = 261$	M1 A(2,1,0)
	$v_B^2 = 261 + 2 \times 9.8 \times 47.5 \ \left(= 1192\right)$	DM1
	$v_B \approx 34.5 \ \left(\text{m s}^{-1}\right)$ accept 35	A1 **(5)**
	BEWARE : Watch out for incorrect use of $v^2 = u^2 + 2as$	

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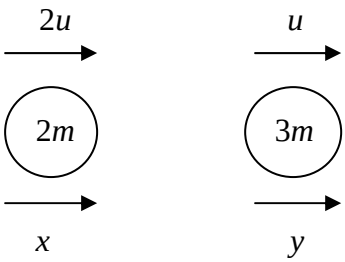
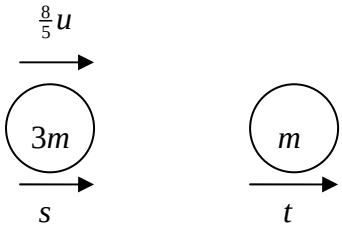
7.	(a) 	
	LM $4mu + 3mu = 2mx + 3my$	M1 A1
	NEL $y - x = \frac{1}{2}u$	B1
	Solving to $y = \frac{8}{5}u$ ∗ cso	M1 A1 **(5)**
	(b) $x = \frac{11}{10}u$ or equivalent	B1
	Energy loss $\frac{1}{2}\times 2m\left((2u)^2 - \left(\frac{11}{10}u\right)^2\right) + \frac{1}{2}\times 3m\left(u^2 - \left(\frac{8}{5}u\right)^2\right)$	M1 A(2,1,0)
	$= \frac{9}{20}mu^2$	A1 **(5)**
	(c) 	
	LM $\frac{24}{5}mu = 3ms + mt$	M1 A1
	NEL $t - s = \frac{8}{5}eu$	B1
	Solving to $s = \frac{2}{5}u(3-e)$	M1 A1
	For a further collision $\frac{11}{10}u > \frac{2}{5}u(3-e)$	M1
	$e > \frac{1}{4}$ ignore $e \leq 1$	A1 **(7)**
		[17]