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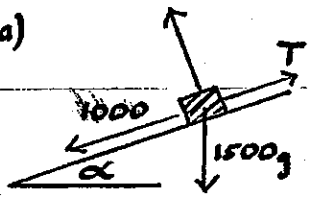
Stewart House 32 Russell Square London WC1B 5DN

January 2002

Advanced Supplementary/Advanced Level

General Certificate of Education

Subject **MECHANICS 6678** Paper No. **M2**

Question number	Scheme	Marks
1.	Work done = Loss in K.E. $R \times 200 = \frac{1}{2} \times 4 \times 25^2$ $R = 6.25$	M1 A1=A1 A1 4 (4)
2.	(a)  $T = \frac{P}{v} = \frac{60\,000}{30} (=2000)$	B1
	N2L: $2000 - 1000 - 1500 \times 9.8 \times \frac{1}{12} = 1500a$	M1 A1
	$a = (-)\ 0.15\ (ms^{-2})$ cao	A1 4
	(b) ↗ $T' = 1000 + 1500 \times 9.8 \times \frac{1}{12} (=2225)$	M1 A1
	$P = Tv$ $80\,000 = 2225v$	M1
	$v \approx 36\ (ms^{-1})$ accept 36.0	A1 4
	(c) The resistance is likely to increase with speed	B1 1 (9)
3.	(a) $\underset{\sim}{a} = 6t\underset{\sim}{i} + 6\underset{\sim}{j}$	M1
	$t=2$ $\underset{\sim}{a} = 12\underset{\sim}{i} + 6\underset{\sim}{j}$	A1
	N2L $\underset{\sim}{F} = m\underset{\sim}{a} = 3.6\underset{\sim}{i} + 1.8\underset{\sim}{j}$	M1
	$\lvert\underset{\sim}{F}\rvert = \sqrt{(3.6^2 + 1.8^2)} \approx 4.02$ (accept 4.03) cao	M1 A1 5
	(b) $\underset{\sim}{r} = (t^3 + c_1)\underset{\sim}{i} + (3t^2 - 4t + c_2)\underset{\sim}{j}$ ignore constants	M1 A1+A1
	Using $t=0$, $\underset{\sim}{r} = (t^3 + 3)\underset{\sim}{i} + (3t^2 - 4t - 4)\underset{\sim}{j}$	M1
	$t=4$, $\underset{\sim}{r} = 67\underset{\sim}{i} + 28\underset{\sim}{j}$ (m)	A1 5 (10)

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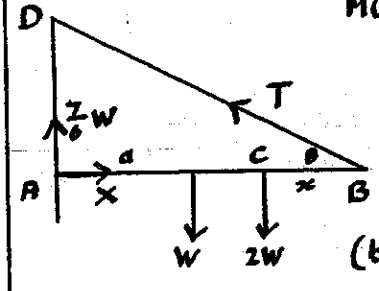
4	(a)	
	ABC WXYZ Template	
	mass ratio $48a^2$ $4a^2$; $44a^2$	B1; B1✓
	c.m. $\frac{8a}{3}$ $2a$ $\bar{x}$	B1 B1
	M(AB) $44a^2\bar{x} + 8a^2 = 48a^2 \times \frac{8a}{3}$	M1 A1
	solving to $\bar{x} = \frac{30}{11}a$ * cso	A1 7
	(b)	
	M(AB) or M(ZY)	
	$K M \times 8a + M \times \frac{30}{11}a = M(1+K)3a$ $KM \times 5a = M(3a - \frac{30}{11}a)$	M1 A2(1,0)
	solving to $K = \frac{3}{55}$ $K = \frac{3}{55}$ or awrt 0.055	A1 4
5.	(a)	
		
	M(A) $T \times 2a\sin\theta = Wa + 2W(2a-x)$	M1 A2(1,0)
	$T \times \frac{6}{5}a = 5Wa - 2Wx$	
	$T = \frac{5(5a-2x)}{6a}W$ * cso	M1 A1 5
	(b) M(B) $\frac{7}{6}W \times 2a = Wa + 2Wx$	M1 A1
	$x = \frac{2}{3}a$ O.E.	A1 3
	(c) R(→) $X = T\cos\theta = \frac{5}{6}(5 - \frac{4}{3})W \times \frac{4}{5}$ ✓	M1 A1✓
	$= \frac{22}{9}W$	M1 A1 4
	Alternative to (b)	
	R(↑) $\frac{7}{6}W + T\sin\theta = 3W$	
	$\frac{7}{6}W + \frac{5(5a-2x)W}{6a} \times \frac{3}{5} = 3W$	M1 A1
	$x = \frac{2}{3}a$	A1 3

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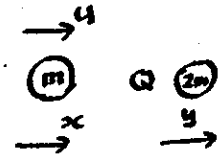
6.	 (a) LM $mu = mx + 2my$	B1
	NEL $x - y = -eu$	M1 A1
	Solving to $y = \frac{1}{3}(1+e)u$ * cso.	M1 A1 5
	(b) Obtaining $x = \frac{1}{3}(1-2e)u$ allow angular	M1 A1
	Direction unchanged implies $x > 0$	M1
	$e < \frac{1}{2}$ ignore $e \geq 0$	A1 4
	(c) $y = \frac{5}{12}u$, $x = \frac{1}{6}u$	
	Final K.E $= \frac{1}{2}m(\frac{1}{6}u)^2 + \frac{1}{2}2m(\frac{5}{12}u)^2 \left(= \frac{27}{144}mu^2\right)$	M1 A1
	Loss in K.E $= \frac{1}{2}mu^2 - \frac{27}{144}mu^2 = \frac{5}{16}mu^2$	M1 A1 4
	(d) Heat, sound, (work done by) internal forces	B1 1 (14)
7.	(a) (↑) $u_y = 80\sin 60°$, $v_y = 0$	B1, B1
	$0^2 = (80\sin 60)^2 - 2\times 9.8 \times s$	M1
	$s \approx 244.9$	
	Height is 260 m. Accept 265	A1 4
	(b) $0 = 80\sin 60° - 9.8t$	M1
	$t = 7.1$ (s) Accept 7.07	A1 2
	(c) (→) $u_x = 80\cos 60°$ $(=40)$	B1
	LM $100\times 40 = 40\times v + 60\times 80$	M1
	$v = (-)20$ * cso	A1 3
	(d) Let N be point on ground vertically below B	
	$ON = 80\cos 60° \times$ their (b) $(=282.79)$	M1
	↓ $264.9 = \frac{1}{2}\times 9.8 \times t^2 \Rightarrow t \approx 7.35$ awrt	M1 A1
	$CN = 20\times 7.35 \approx 147$ awrt	M1 A1
	$OC = 140$ (m) accept 136	A1 6 (15)