June 2004

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 50

SYLLABUS/COMPONENT: 9709/04

MATHEMATICS
Paper 4 (Mechanics 1)

UNIVERSITY of CAMBRIDGE
International Examinations

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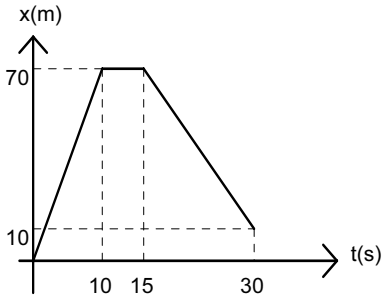
1	**(i)**	$F = 13\cos\alpha$ Frictional component is 12 N	M1 A1	2	For resolving forces horizontally
	(ii)	$R = 1.1\times10 + 13\sin\alpha$ Normal component is 16 N	M1 A1	2	For resolving forces vertically (3 terms needed)
	(iii)	Coefficient of friction is 0.75	B1 ft	1	

2		$X = 100 + 250\cos70^\circ$ $Y = 300 - 250\sin70^\circ$ $R^2 = 185.5^2 + 65.1^2$ $R = 197$ $\tan\alpha = 65.1/185.5$ $\alpha = 19.3$	B1 B1 M1 A1 ft M1 A1 ft	6	For using $R^2 = X^2 + Y^2$ ft only if one B1 is scored or if the expressions for the candidate's X and Y are those of the equilibrant For using $\tan\alpha = Y/X$ ft only if one B1 is scored SR for sin/cos mix (max 4/6) $X = 100 + 250\sin70^\circ$ and $Y = 300 - 250\cos70^\circ$ (334.9 and 214.5) B1 Method marks as scheme M1 M1 R = 398 N and α = 32.6 A1
		OR			
		316(.227766..) or 107(.4528..) or 299(.3343..) 71.565 …° or 37.2743 .. ° or –51.7039 .. ° $R^2 = 316.2^2 + 250^2 - 2\times316.2\times250\cos38.4^\circ$ $R^2 = 107.5^2 + 100^2 - 2\times107.5\times100\cos142.7^\circ$ $R^2 = 299.3^2 + 300^2 - 2\times299.3\times300\cos38.3^\circ$ R = 197 $\sin(71.6 - \alpha) = 250\sin38.4 \div 197$ $\sin(37.3 - \alpha) = 100\sin142.7 \div 197$ $\sin(51.7 + \alpha) = 300\sin38.3 \div 197$ $\alpha = 19.3^\circ$	B1 B1 M1 A1 ft M1 A1 ft		Magnitude of the resultant of two of the forces Direction of the resultant of two of the forces For using the cosine rule to find R ft only if one B1 is scored For using the sine rule to find α ft only if one B1 is scored

3	**(i)**	Distance AC is 70 m $7\times10 - 4\times15$ Distance AB is 10 m	B1 M1 A1	3	For using |AB| = |AC| - |BC|
	(ii)		M1 A1 A1 ft	3	Graph consists of 3 connected straight line segments with, in order, positive, zero and negative slopes. $x(t)$ is single valued and the graph contains the origin 1st line segment appears steeper than the 3rd and the 3rd line segment does not terminate on the t-axis Values of t (10, 15 and 30) and x (70, 70, 10) shown, or can be read without ambiguity from the scales SR (max 1out of 3 marks) For first 2 segments correct B1

4	**(i)**	KE = 0.2g(0.7) Kinetic energy is 1.4 J	M1 A1	2	For using KE = PE lost and PE lost = *mgh*
	(ii)	$R = 0.2\times 10\times \cos 16.3^{o}$ $F = 0.288$ N WD = 0.72 J or $a = 1.36$ or resultant downward force = 0.272 N KE = 1.4 – 0.72 or KE = ½ 0.2(2×1.36×2.5) or 0.272× 2.5 Kinetic energy is 0.68 J	B1 B1 ft B1 ft M1 A1 ft	 5	1.92 From 0.15*R* (may be implied by subsequent exact value 0.72, 1.36 or 0.68) From 2.5*F* or from $0.2a = 0.2\times 10\times (7/25) - F$ (may be implied by subsequent exact value 0.68) For using KE = PE lost – WD or KE = ½ mv^2 and $v^2 = 2as$ or KE = resultant downward force × 2.5

5	**(i)**	$10t^2 - 0.25t^4$ (+*C*) Expression is $10t^2 - 0.25t^4 - 36$	M1 DM1 A1	 3	For integrating *v* For including constant of integration and attempting to evaluate it
	(ii)	Displacement is 60 m	A1 ft	1	Dependent on both M marks in (i); ft if there is not more than one error in *s*(*t*)
	(iii)	$(t^2 - 36)(1 - 0.25t^2) = 0$ Roots of quadratic are 4, 36 *t* = 2, 6	M1 A1 A1 ft	 3	For attempting to solve *s* = 0 (depends on both method marks in (i)) or $\int_0^t v\,dt$ =36 (but not –36) for t^2 by factors or formula method ft only from 3 term quadratic in t^2

6	**(i)**	 DF – 400 = 1200×0.5 20000 = 1000*v* Speed is 20 ms^{-1}	M1 A1 M1 A1	 4	For using Newton's 2nd law (3 terms needed) For using *P* = *Fv*
	(ii)	20000/*v* - 400 = 0 v_{max} = 50 ms^{-1}	M1 A1	 2	For using *P* = *Fv* and Newton's 2nd law with *a* = 0 and *F* = 400 AG
	(iii)	20000 = $\frac{1500000}{\Delta T}$ or distance = 1500 000/400 = 3750 and time = 3750/50 Time taken is 75 s	M1 A1	 2	For using $P = \frac{\Delta W}{\Delta T}$ or for using 'distance = work done/400' and 'time =distance/50'

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7	(i)	$25 = 30t - 5t^2 \rightarrow t^2 - 6t + 5 = 0 \rightarrow (t-1)(t-5) = 0$ or $v^2 = 30^2 - 500$; $t_{up} = (20-0)/10$ $t = 1$, 5 or $t_{up} = 2$ Time = 5 – 1 = 4 s or Time = $2 \times 2 = 4$s or $1 < t < 5$	M1 A1 A1	3	For using $25 = ut - ½ gt^2$ and attempting to solve for t or for using $v^2 = u^2 - 2g(25)$ and $t_{up} = (v-0)/g$
	(ii)	$s_1 = 30t - 5t^2$ and $s_2 = 10t - 5t^2$ $30t - 10t = 25$ $t = 1.25$ $v_1 = 30 - 10 \times 1.25$ or $v_2 = 10 - 10 \times 1.25$ or $v_1^2 = 30^2 - 2 \times 10(29.6875)$ or $v_2^2 = 10^2 - 2 \times 10(4.6875)$ Velocities 17.5ms^{-1} and – 2.5ms^{-1}	M1 M1 A1 M1 A1	5	For using $s = ut - ½ gt^2$ for P_1 and P_2 For using $s_1 = s_2 + 25$ and attempting to solve for t For using $v = u - gt$ (either case) or for calculating s_1 and substituting into $v_1^2 = 30^2 - 2 \times 10s_1$ or calculating s_2 and substituting into $v_2^2 = 10^2 - 2 \times 10s_2$
		OR			
	(ii)	$v_1 = 30 - 10t$, $v_2 = 10 - 10t$ $\rightarrow v_1 - v_2 = 20$ $(30^2 - v_1^2) \div 20 =$ $(10^2 - v_2^2) \div 20 + 25$ $v_1 - v_2 = 20$, $v_1^2 - v_2^2 = 300$ Velocities are 17.5 ms^{-1} and – 2.5 ms^{-1}	M1 M1 A1 M1 A1	5	For using $v = u - gt$ for P_1 and P_2 and eliminating t For using $v^2 = u^2 - 2gs$ for P_1 and P_2 and then $s_1 = s_2 + 25$ For solving simultaneous equations in v_1 and v_2
	(iii)	$t_{up} = 3$ 3 – 1.25 Time is 1.75 s or $1.25 < t < 3$	B1 M1 A1	3	For using $t_{up \text{ and above}} = t_{up} - t_{equal}$
		OR			
	(iii)	0 = 17.5 - 10t Time is 1.75 s or $1.25 < t < 3$	M2 A1		For using $0 = u - gt$ with u equal to the answer found for v_1 in **(ii)** SR (max 1 out of 3 marks) $0 = 17.5 + 10t$ B1 ft