

June 2004

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 50

SYLLABUS/COMPONENT: 9709/04

**MATHEMATICS
Paper 4 (Mechanics 1)**



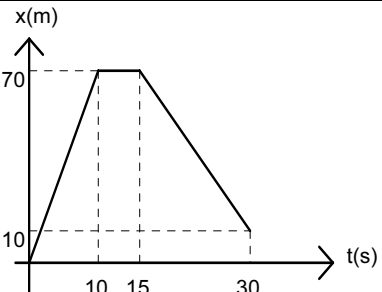
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1	(i)	$F = 13 \cos \alpha$ Frictional component is 12 N	M1 A1 2	For resolving forces horizontally
	(ii)	$R = 1.1 \times 10 + 13 \sin \alpha$ Normal component is 16 N	M1 A1 2	For resolving forces vertically (3 terms needed)
	(iii)	Coefficient of friction is 0.75	B1 ft 1	

2		$X = 100 + 250 \cos 70^\circ$ $Y = 300 - 250 \sin 70^\circ$ $R^2 = 185.5^2 + 65.1^2$ $R = 197$ $\tan \alpha = 65.1/185.5$ $\alpha = 19.3$	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) $X = 100 + 250 \sin 70^\circ$ and $Y = 300 - 250 \cos 70^\circ$ (334.9 and 214.5) B1 Method marks as scheme M1 M1 $R = 398 \text{ N}$ and $\alpha = 32.6$ A1
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OR

		316(.227766..) or 107(.4528..) or 299(.3343.. 71.565 ...° or 37.2743 ..° or -51.7039 ..° $R^2 = 316.2^2 + 250^2 - 2 \times 316.2 \times 250 \cos 38.4^\circ$ $R^2 = 107.5^2 + 100^2 - 2 \times 107.5 \times 100 \cos 142.7^\circ$ $R^2 = 299.3^2 + 300^2 - 2 \times 299.3 \times 300 \cos 38.3^\circ$ $R = 197$ $\sin(71.6 - \alpha) = 250 \sin 38.4 \div 197$ $\sin(37.3 - \alpha) = 100 \sin 142.7 \div 197$ $\sin(51.7 + \alpha) = 300 \sin 38.3 \div 197$ $\alpha = 19.3^\circ$	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
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3	(i)	Distance AC is 70 m $7 \times 10 - 4 \times 15$ 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 1 st line segment appears steeper than the 3 rd and the 3 rd 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 1 out of 3 marks) For first 2 segments correct B1

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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)	$R = 0.2 \times 10 \times \cos 16.3^\circ$ $F = 0.288 \text{ N}$ WD = 0.72 J or $a = 1.36$ or resultant downward force = 0.272 N $KE = 1.4 - 0.72$ or $KE = \frac{1}{2} 0.2(2 \times 1.36 \times 2.5)$ or 0.272×2.5 Kinetic energy is 0.68 J	B1 B1 ft B1 ft M1 A1 ft 5	1.92 From 0.15R (may be implied by subsequent exact value 0.72, 1.36 or 0.68) From 2.5F 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 $KE = \frac{1}{2} mv^2$ and $v^2 = 2as$ or $KE = \text{resultant downward force} \times 2.5$

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 $20000 = 1000v$ Speed is 20 ms^{-1}	M1 A1 M1 A1 4	For using Newton's 2 nd law (3 terms needed) For using $P = Fv$
	(ii)	$20000/v - 400 = 0$ $v_{\max} = 50 \text{ ms}^{-1}$	M1 A1 2	For using $P = Fv$ and Newton's 2 nd 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 $v^2 = 30^2 - 500$; $t_{\text{up}} = (20 - 0)/10$ $t = 1, 5$ or $t_{\text{up}} = 2$ Time = $5 - 1 = 4$ s or Time = $2 \times 2 = 4$ s or $1 < t < 5$	M1 A1 A1 3	For using $25 = ut - \frac{1}{2}gt^2$ and attempting to solve for t or for using $v^2 = u^2 - 2g(25)$ and $t_{\text{up}} = (v - 0)/g$
	(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 $s = ut - \frac{1}{2}gt^2$ 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)	$t_{\text{up}} = 3$ $3 - 1.25$ Time is 1.75 s or $1.25 < t < 3$	B1 M1 A1 3	For using t_{up} and above = $t_{\text{up}} - t_{\text{equal}}$

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
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