

June 2003

GCE A AND AS LEVEL

MARK SCHEME

MAXIMUM MARK: 50

SYLLABUS/COMPONENT: 9709/04

MATHEMATICS
Paper 4 (Mechanics 1)



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Mechanics 1

1	(i)	Tension is 8000 N or 800g Accept 7840 N (from 9.8) or 7850 (from 9.81)	B1	1
	(ii)	For using $P = \frac{\Delta W}{\Delta t}$ or $P = Tv$	M1	
		$\Delta W = 8000 \times 20$ or $v = \frac{20}{50}$	A1 ft	
		Power applied is 3200 W Accept 3140 W (from 9.8 or 9.81)	A1	3
		SR (for candidates who omit g) (Max 2 out of 3) $P = 800 \times 20 \div 50$ B1 Power applied is 320 W B1		
2	(i) (a)	For resolving in the direction PQ	M1	
		Component is $2 \times 10\cos 30^\circ - 6\cos 60^\circ$ or 14.3 N or $10\sqrt{3} - 3$ N	A1	2
	(b)	Component is $\pm 6\cos 30^\circ - 6\cos 60^\circ$ or ± 5.20 N or $\pm 3\sqrt{3}$ N	B1	1
		SR (for candidates who resolve parallel to and perpendicular to the force of magnitude 6 N) (Max 2 out of 3) For resolving in both directions M1 For $X = 6 - 10\cos 30^\circ$ or -2.66 N and $Y = 10 + 10\sin 30^\circ$ or 15 N A1 SR (for candidates who give a combined answer for (a) and (b)) (Max 2 out of 3) For resolving in both directions M1 For $(6\cos 30^\circ)\mathbf{i} + (2 \times 10\cos 30^\circ - 6\cos 60^\circ)\mathbf{j}$ or any vector equivalent A1		
		(i) For using Magnitude = $\sqrt{ans(i)^2 + ans(ii)^2}$	M1	
		Magnitude is 15.2 N ft only following sin/cos mix and for answer 5.66 N	A1 ft	2
3	(i)	Region under $v = 2t$ from $t = 0$ to $t = T$ indicated	B1	1
	(ii)	For attempting to set up and solve an equation using area $\Delta = 16$ or for using $s = \frac{1}{2} 2t^2$	M1	
		For $16 = \frac{1}{2} 2T^2$	A1	
		$T = 4$	A1	3
		SR (for candidates who find the height of the Δ but do not score M1) (Max 1 out of 3) For $h/T = 2$ or $h = 2T$ or $v = 8$ B1		

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	(iii)	For using distance = $10 \times$ ans (ii) or for using the idea that the distance is represented by the area of the relevant parallelogram or by the area of the trapezium (with parallel sides 9 and 4 and height 10) minus the area of the triangle (with base 5 and height 10)	M1	
		Distance is 40m	A1 ft	2
4	(i)	For differentiating x	M1	
		$\dot{x} = t + \frac{1}{10}t^2$	A1	
		Speed is 20 ms^{-1}	A1	3
	(ii)	$\ddot{x} = 1 + \frac{1}{5}t$	B1 ft	
		For attempting to solve $\ddot{x}(t) = 2\ddot{x}(0) \quad (1 + \frac{1}{5}t = 2)$	M1	
		$t = 5$	A1	3
5	(i)	For resolving forces on any two of A, or B, or A and B combined ($T_1 = W_A + T_2, T_2 = W_B, T_1 = W_A + W_B$)	M1	
		Tension in S_1 is 4 N or Tension in S_2 is 2 N Accept $0.4g$ or 3.92 (from 9.8 or 9.81) for T_1 Tension in S_2 is 2 N or Tension in S_1 is 4 N Accept $0.2g$ or 1.96 (from 9.8 or 9.81) for T_2	B1 A1	3
		SR (for candidates who omit g) (Max 1 out of 3) $T_1 = 0.4$ and $T_2 = 0.2$ B1		
	(ii)	For applying Newton's second law to A, or to B, or to A and B combined	M1	
		For any one of the equations $T + 2 - 0.4 = 0.2a$, $2 - T - 0.2 = 0.2a$, $4 - 0.4 - 0.2 = 0.4a$	A1	
		For a second of the above equations	A1	
		For solving the simultaneous equations for a and T	M1	
		Acceleration is 8.5 ms^{-2} , tension is 0.1 N Accept 8.3 from 9.8 or 8.31 from 9.81 SR (for candidates who obtain only the 'combined' equation) (Max 3 out of 5) For applying Newton's second law to A and B combined M1 For $4 - 0.4 - 0.2 = 0.4a$ A1 Acceleration is 8.5 ms^{-2} A1	A1	5

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6	(i)	For using $F = \mu R$ and $R = mg$ ($F = 0.025 \times 0.15 \times 10$)	M1	
		Frictional force is 0.0375 N or 3/80 N Accept 0.0368 from 9.8 or 9.81	A1	2
	(ii)	For using $F = ma$ ($-0.0375 = 0.15a$) or $d = \mu g$	M1	
		Deceleration is 0.25 ms^{-2} (or $a = -0.25$) A.G.	A1	2
	(iii)	For using $s = ut + \frac{1}{2}at^2$ ($s = 5.5 \times 4 + \frac{1}{2}(-0.25)16$)	M1	
		Distance AB is 20m	A1	2
	(iv)	For using $v^2 = u^2 + 2as$ ($v^2 = 3.5^2 - 2 \times 0.25 \times 20$)	M1	
		Speed is 1.5 ms^{-1} (ft $\sqrt{(24.5 - (iii))/2}$)	A1 ft	2
	(v)	Return dist. = $\frac{3.5^2}{2 \times 0.25}$ or distance beyond A = $\frac{(iv)^2}{2 \times 0.25}$	M1	
		Total distance is 44.5 m (ft $24.5 + (iii)$ or $2((iv)^2 + (iii))$)	A1 ft	2
7	(i)	PE gain = $mg(2.5\sin 60^\circ)$	B1	
		For using KE = $\frac{1}{2}mv^2$	M1	
		For using the principle of conservation of energy ($\frac{1}{2}m8^2 - \frac{1}{2}mv^2 = mg(2.5\sin 60^\circ)$)	M1	
		Alternative for the above 3 marks: For using Newton's Second Law or stating $a = -g \sin 60^\circ$ $a = -8.66$ (may be implied) For using $v^2 = u^2 + 2as$ ($v^2 = 64 - 2 \times 8.66 \times 2.5$)	M1* A1 M1dep*	
		Speed is 4.55 ms^{-1} Accept 4.64 from 9.8 or 9.81	A1	4
	(ii)	For using $\frac{1}{2}mu^2 (>) mg h_{\max}$ ($\frac{1}{2}8^2 > 10 h_{\max}$)	M1	
		For obtaining 3.2m A.G.	A1	2
	(iii)	Energy is conserved or absence of friction or curve BC is smooth (or equivalent) and B and C are at the same height or the PE is the same at A and B (or equivalent)	B1	1

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	(iv)	WD against friction is 1.4×5.2	B1	
		For WD = KE loss (or equivalent) used	M1	
		$1.4 \times 5.2 = \frac{1}{2} 0.4(8^2 - v^2)$ or $1.4 \times 5.2 = \frac{1}{2} 0.4((i)^2 - v^2) + 0.4 \times 10(2.5 \sin 60^\circ)$ (12.8 or $4.14 + 8.66$)	A1	
		Alternative for the above 3 marks: For using Newton's Second Law $0.4g(2.5 \sin 60^\circ \div 5.2) - 1.4 = 0.4a$ ($a = 0.6636$) For using $v^2 = u^2 + 2as$ with $u \neq 0$ ($v^2 = 4.55^2 + 2 \times 0.6636 \times 5.2$)	M1* A1 M1dep*	
		Speed is 5.25 ms^{-1}	A1	4