

Mark Scheme 4730 January 2006

1	$\pm (5.4\cos 45^\circ - 8.7)$	M1	For attempting to find Δv in i dir'n
		M1	For using $I = m(\Delta v)$ in i direction
	$I\cos\theta = \pm 0.4(5.4\cos 45^\circ - 8.7)$	A1	(= ∓ 1.953)
	$I\sin\theta = 0.4 \times 5.4\sin 45^\circ$	B1	(= 1.527)
	$I = \sqrt{(1.527^2 + 1.953^2)}$ or	M1	For using Pythagoras or trig.
	$\theta = \tan^{-1}[1.527/(-1.953)]$		
	Magnitude is 2.48 kgms^{-1}	A1	
	Direction is 142° to original dir'n.	A1	[7] Accept $\theta = 38.0^\circ$ with θ shown appropriately
	OR	M1	For using Impulse = mass x Δv
	$I = 0.4(5.4^2 + 8.7^2 -$	M1	For appropriate use of cosine rule
$2 \times 5.4 \times 8.7 \cos 45^\circ)^{1/2}$	A1		
Magnitude is 2.48 kgms^{-1}	A1		
$\sin\theta / 5.4 = \sin 45^\circ / 6.1976$	M1	For appropriate use of sine rule	
$\theta = 38.0^\circ$	A1		
2	(i)	M1	For correct use of Newton's 2 nd law
	$0.5\text{dv}/\text{dt} = 1 + kt^2$	A1	
	$v = 2t + 2kt^3/3$	A1	[3]
			SR(max 1/3) for omission of mass but otherwise correct
			$v = t + kt^3/3$
			B1
	(ii) $x = t^2 + kt^4/6$	M1	For integration w.r.t. t
	$2 = 1 + k/6$	M1	For substitution and attempting to solve for k
	$k = 6$	A1	
		M1	For attempting to solve quadratic in t^2 for t
$t = 2$	A1	[5] With no extra solutions	
3	(i)	M1	For use of EE formula
	$EE = \lambda x(5-3)^2 / (2 \times 3)$	A1	
	$2\lambda/3 = 1.6 \times 9.8 \times 5$	M1	For equating EE and PE
	$\lambda = 117.6 \text{ N}$	A1	[4] AG
	(ii)	M1	For use of conservation of energy
	$0.5 \times 1.6v^2 = 1.6 \times 9.8 \times 4.5$	A2,1,0	-1 each error
	$117.6 \times 1.5^2 / (2 \times 3)$		
	$v = 5.75 \text{ ms}^{-1}$	A1	[4]

4	Perp. vel. of A after impact = 4	B1		
	[5x0] - 2x4 = 5a + 2b	M1	For using cons'n of m'm'tum // l.o.c	
		A1		
	0.75 x 4 = b-a	M1	Using N.E.L. // l.o.c.	
		A1		
		M1	For solving sim. equ.	
	Speed of B is 1ms ⁻¹ ; direction //l.o.c. and to the right	A1		
	$v_A = \sqrt{4^2 + (-2)^2}$	M1	For method of finding the speed of A	
tan(angle) = 4/2	M1	For method of finding the direction of A		
Speed of A is 4.47 ms ⁻¹ ; direction is 63.4° to l.o.c. and to the left	A1	[10]		
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5	(i)	M1	For any moment equ. that includes F and all other relevant forces	
	1.8F = 0.9x40 + 1.4x9	A2,1,0	-1 each error	
	Magnitude is 27 N	A1	[4] AG	
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	(ii) Vertical comp. is 22 N downwards	B1		
		M1	For any moment equ. that includes X and all other relevant forces	
	1.2X = (40+9-27)x(3.8-1.8) + 64	A2,1,0 ft	-1 each error.	
	x1 (1.2X = 44 + 64)		ft wrong vert. comp.	
	Horizontal comp. is 90 N to the left	A1	[5]	
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(iii) $\mu = 27/[90]$	M1	For use of $\mu = F/R$		
Coefficient of friction is 0.3	A1	[2] ft wrong answer in (ii)		
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6	(i)	M1	For use of conservation of energy	
	$0.5 \times 0.3v^2 - 0.5 \times 0.3 \times 2^2 =$ $0.3 \times 9.8 \times 0.5 \cos 60 -$			
		A2,1,0	-1 each error	
	$0.3 \times 9.8 \times 0.5 \cos \theta$			
	$v^2 = 8.9 - 9.8 \cos \theta$	A1	[4] AG	
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	(ii)	M1	For using Newton's 2 nd law radially	
	$T + 0.3 \times 9.8 \cos \theta = 0.3v^2/0.5$	A1		
	$T + 2.94 \cos \theta =$ $0.6(8.9 - 9.8 \cos \theta)$	M1	For correct substitution for v ²	
	Tension is (5.34 - 8.82cos θ)N	A1	[4] Accept any correct form	
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	(iii)	M1	For using T = 0	
Basic value $\theta = 52.7^\circ$	A1 ft	ft any T of the form a - bcos θ		
Angle = (360-52.7) - 60	M1			
Angle turned through is 247°	A1	[4]		

7	(i)	M1	For using $T = \lambda e/L$ once
	For $180e/1$ or $360(0.8-e)/1.2$ or $T_A = 180 \times 0.5/1$ or $T_B = 360 \times$ $0.3/1.2$	A1	
	$480e = 240$ or $T_A = 90, T_B = 90$	M1	For using $T_A(e) = T_B(e)$ or attempting to show $T_A = T_B$ when $BQ = 1.5$
	$BQ = 1 + 0.5 = 1.5$ m or $T_A = T_B$	A1	[4] AG
	(ii) $T_B = 360(0.3 - x)/1.2$	B1	
	$T_A = 180(0.5 + x)$	B1	
	$1.2d^2x/dt^2 =$ $300(0.3-x) - 180(0.5+x)$	M1	For using Newton's 2 nd law
	$d^2x/dt^2 = -400x$	A1	
	Period is $2\pi/\sqrt{[400]} = 0.314$ s	A1	[5] AG
	(iii)	M1	For using $T_B = 0$
	Max amplitude = $1.5 - 1.2 = 0.3$ m	A1	
	amplitude = $u/\sqrt{400}$ or	M1	For using Amp. = u/ω or 'energy at equil. pos'n = energy at max. displ.'
	$180 \times 0.5^2/(2 \times 1) +$ $360 \times 0.3^2/(2 \times 1.2)$ $+ \frac{1}{2} \times 1.2 u_{\max}^2 =$ $180 \times 0.8^2/(2 \times 1)$		
	Maximum value of u is 6	A1	[4] AG
	(iv) $-0.2 = 0.3 \sin 20t$	M1	For relevant trig. equation
	$20t = 0.7297 + 3.142$	M1	For method of obtaining relevant solution
	Time taken is 0.194s	A1	[3]