

# **Mark Scheme 4730**

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1	$\pm (5.4\cos 45^\circ - 8.7)$	M1	For attempting to find $\Delta v$ in <b>i</b> dir'n	
		M1	For using $I = m(\Delta v)$ in <b>i</b> direction	
	$I\cos\theta = \pm 0.4(5.4\cos 45^\circ - 8.7)$	A1	(= $\mp 1.953$ )	
	$I\sin\theta = 0.4 \times 5.4\sin 45^\circ$	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 $2.48 \text{ kgms}^{-1}$	A1		
	Direction is $142^\circ$ to original dir'n.	A1	[7] Accept $\theta = 38.0^\circ$ with $\theta$ shown appropriately	
	<b>OR</b>	M1	For using Impulse = mass x $\Delta v$	
	$I = 0.4(5.4^2 + 8.7^2 -$	M1	For appropriate use of cosine rule	
$2 \times 5.4 \times 8.7 \cos 45^\circ)^{1/2}$	A1			
Magnitude is $2.48 \text{ kgms}^{-1}$	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 <sup>nd</sup> law	
	$0.5dv/dt = 1 + kt^2$	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)	M1	For integration w.r.t. t	
	$x = t^2 + kt^4/6$	M1	For substitution and attempting to solve for k	
	$2 = 1 + k/6$	A1		
	$k = 6$	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
		$EE = \lambda \times (5-3)^2 / (2 \times 3)$	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]	

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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 <sup>-1</sup> ; 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 <sup>-1</sup> ; direction is 63.4° to l.o.c. and to the left	A1	[10]

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
	(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]
	(iii) $\mu = 27/[90]$	M1	For use of $\mu = F/R$
	Coefficient of friction is 0.3	A1	[2] ft wrong answer in (ii)

6	(i)	M1	For use of conservation of energy
	$0.5x0.3v^2 - 0.5x0.3x2^2 = 0.3x9.8x0.5\cos60 - 0.3x9.8x0.5\cos\theta$	A2,1,0	-1 each error
	$v^2 = 8.9 - 9.8\cos\theta$	A1	[4] AG
	(ii)	M1	For using Newton's 2 <sup>nd</sup> law radially
	$T + 0.3x9.8\cos\theta = 0.3v^2/0.5$	A1	
	$T + 2.94\cos\theta = 0.6(8.9 - 9.8\cos\theta)$	M1	For correct substitution for v <sup>2</sup>
	Tension is(5.34 - 8.82cosθ)N	A1	[4] Accept any correct form
	(iii)	M1	For using T = 0
	Basic value $\theta = 52.7^\circ$	A1 ft	ft any T of the form a - bcosθ

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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		
	$T_B = 360 \times$	A1	
	$0.3/1.2$		
	$480e = 240$ 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	
	$1.2d^2x/dt^2 =$	M1	For using Newton's 2 <sup>nd</sup> law
$300(0.3-x) - 180(0.5+x)$			
$d^2x/dt^2 = -400x$	A1		
Period is $2\pi / \sqrt{[400]} = 0.314$ s	A1	[5] AG	
(iii)	M1	For using $T_B = 0$	
Max amplitude = $1.5 - 1.2 = 0.3$	A1		
m			
amplitude = $u / \sqrt{400}$ or	M1	For using Amp. = $u/\omega$ or 'energy at equil. pos'n = energy at max. displ.'	
$180 \times 0.5^2 / (2 \times 1) +$			
$360 \times 0.3^2 / (2 \times 1.2)$			
$+ \frac{1}{2} 1.2 u_{\max}^2 =$			
$180 \times 0.8^2 / (2 \times 1)$			
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]	