Mark Scheme 4730
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1	$\pm(5.4\cos45^o - 8.7)$	M1		For attempting to find Δv in **i** dir'n
		M1		For using I = m(Δ v) in **i** direction
	$I\cos\theta = \pm 0.4(5.4\cos45^o - 8.7)$	A1		(= $\mp$ 1.953)
	$I\sin\theta = 0.4x5.4\sin45$	B1		(= 1.527)
	$I = \sqrt{(1.527^2 + 1.953^2)}$ or $\theta = \tan^{-1}[1.527/(-1.953)]$	M1		For using Pythagoras or trig.
	Magnitude is 2.48 $kgms^{-1}$	A1		
	Direction is 142^o to original dir'n.	A1	[7]	Accept $\theta = 38.0^o$ with θ shown appropriately
OR		M1		For using Impulse = mass x Δv
		M1		For appropriate use of cosine rule
	$I = 0.4\ (5.4^2 + 8.7^2 -$			
	$2x5.4x8.7\cos45^o)^{½}$	A1		
	Magnitude is 2.48 $kgms^{-1}$	A1		
		M1		For appropriate use of sine rule
	$\sin\theta/5.4 = \sin45^o/6.1976$	A1		
	$\theta = 38.0^o$	A1		

2	(i)	M1		For correct use of Newton's 2nd 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) $x = t^2 + kt^4/6$	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
	$EE = \lambda x\ (5-3)^2/(2 x 3)$	A1		
	$2\lambda/3 = 1.6 x 9.8 x 5$	M1		For equating EE and PE
	$\lambda = 117.6$ N	A1	[4]	AG
	(ii)	M1		For use of conservation of energy
	$0.5x1.6v^2 = 1.6x9.8x4.5 - 117.6x1.5^2/(2x3)$	A2,1,0		-1 each error
	$v = 5.75\ ms^{-1}$	A1	[4]	

4	Perp. vel. of A after impact = 4	B1		
		M1		For using cons'n of m'm'tum // l.o.c
	[5x0] - 2x4 = 5a + 2b	A1		
		M1		Using N.E.L. // l.o.c.
	0.75 x 4 = b-a	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^o 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 x1 (1.2X = 44 + 64)	A2,1,0 ft		-1 each error. ft wrong vert. comp.
	Horizontal comp. is 90 N to the left	A1	[5]	
	(iii) μ = 27/[90]	M1		For use of μ =F/R
	Coefficient of friction is 0.3	A1 ft	[2]	ft wrong answer in (ii)

6	(i)	M1		For use of conservation of energy
	$0.5x0.3v^2 - 0.5x0.3x2^2 = 0.3x9.8x0.5\cos 60 - 0.3x9.8x0.5\cos\theta$	A2,1,0		-1 each error
	$v^2 = 8.9 - 9.8\cos\theta$	A1	[4]	AG
	(ii)	M1		For using Newton's 2nd 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^2
	Tension is$(5.34 - 8.82\cos\theta)$N	A1	[4]	Accept any correct form
	(iii)	M1		For using T = 0
	Basic value $\theta = 52.7^o$	A1 ft		ft any T of the form a - bcosθ
	Angle = (360-52.7) - 60	M1		
	Angle turned through is 247^o	A1	[4]	

7	(i)	M1		For using T = λ e/L once
	For 180e/1 or 360(0.8-e)/1.2 **or** T_A = 180 x 0.5/1 or T_B = 360 x 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 2nd 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 $180x0.5^2/(2x1) + 360x0.3^2/(2x1.2) + ½\ 1.2u_{max}^2 = 180x0.8^2/(2x1)$	M1		For using Amp. = u/ω or 'energy at equil. pos'n = energy at max. displ.'
	Maximum value of u is 6	A1	[4]	AG
	(iv) -0.2 = 0.3sin20t	M1		For relevant trig. equation
	20t = 0.7297 + 3.142	M1		For method of obtaining relevant solution
	Time taken is 0.194s	A1	[3]	