Mark Scheme 4730
January 2007

1		M1		For using the principle of conservation of energy
	½ 0.6x5^2 – ½ 0.6v^2 = 0.6g(2x0.4) [v^2 = 9.32]	A1		
	[T + 0.6g = 0.6a]	M1		For using Newton's second law
	[a = 9.32/0.4]	M1		For using a = v^2/r
	T + 0.6g = 0.6x9.32/0.4	A1ft		ft incorrect energy equation
	Tension is 8.1N	A1	6	

2	$28\cos30^o - 10\cos30^o$ [= $\lvert\Delta v_H\rvert$ = (I/m)cosθ]	B1		
	$10\sin30^o + 28\sin30^o$ [= $\lvert\Delta v_V\rvert$ = (I/m)sinθ]	B1		
	[X = - Icosθ = -0.8885, Y = Isinθ = 1.083]	M1		For using mv change for component or resultant
		M1		For using I^2 = X^2 + Y^2
	I = 1.40	A1		
	[tanθ = 1.083/0.8885 or 19/15.588..]	M1		For using θ =tan^{-1}(Y/-X) or tan^{-1}($\lvert\Delta v_V\rvert$ / $\lvert\Delta v_H\rvert$)
	θ = 50.6	A1	7	

	ALTERNATIVELY			
2		M1		For using cosine rule in correct triangle
	(I/m)^2 = 28^2 + 10^2 –2x28x10cos60^o [=604]	A1		
	[I = 0.057 $\sqrt{604}$]	M1		For using I = mv change
	I = 1.40	A1		
		M1		For using sine rule in correct triangle
	(I/m)/sin60^o = 10/sin(θ -30^o) or 28/sin(150^o-θ)	A1		
	θ = 50.6	A1	7	

3	(i) 160a = 2aY	M1		For taking moments for AB about B
	Component at B is 80N	A1		
	Component at C is 240N	B1ft	3	ft 160 + Y
	(ii)	M1		For taking moments for BC about B or C (and using X = F) or for whole about A
	$160a\cos60^o + 2aF\sin60^o = 240x2a\cos60^o$ or $80x2a\cos60^o + 160a\cos60^o = 2aX\sin60^o$ or $240(2 + 2\cos60^o)a = 160a + 160(2 + \cos60^o)a + 2aF\sin60^o$	A1ft		
	Frictional force is 92.4N	A1		
	Direction is to the left	B1	4	
	(iii) [92.4/240]	M1		For using F = μR
	Coefficient is 0.385	A1ft	2	

4	(i)	M1		For using T = mg and T = λe/L
	3.5e/0/7 = 0.2g [e = 0.392]	A1		
	Position is 1.092m below O.	A1	3	AG
	(ii)	M1		For using Newton's second law
	$0.2g – 3.5(0.392 + x)/0.7 = 0.2a$	A1ft		ft incorrect e
	$a = -25x$	A1ft		ft incorrect e
	$[25A^2 = 1.6^2$ or $½ (0.2)1.6^2 + 3.5x0.392^2/(2x0.7) + 0.2gA = 3.5x(0.392 + A)^2/(2x0.7)$	M1		For using $A^2n^2 = v_{max}^2$ or Energy at lowest point = energy at equilibrium point (4 terms needed including 2 EE terms)
	Amplitude is 0.32m	A1ft	5	
	(iii) $[x = 0.32\sin2^c]$	M1		For using x = Asin nt or Acos(π/2 - nt)
	x = 0.291	A1		
	$[v = 0.32x5\cos2^c$ or $v^2 = 25(0.32^2 – 0.291^2)$ or $0.256 + 0.38416 + 0.2g(0.291) = ½ 0.2v^2 + 2.5(0.683)^2$	M1		For using v = Ancos nt or $v^2 = n^2(A^2 – x^2)$ or Energy at equilibrium point = energy at x = 0.291
	$v^2 = 0.443$	A1		May be implied
	v = -0.666 (or 0.666 upwards)	A1	5	

5	(i) [$mg - mkv^2 = ma$]	M1		For using Newton's second law
	$(v\,dv/dx)/(g - kv^2) = 1$	A1	2	AG
	(ii) [$-\frac{1}{2}[\ln(g - kv^2)]/k = x \quad (+C)$]	M1		For separating variables and attempting to integrate
	[$-(\ln g)/2k = C$]	M1		For using v(0) = 0 to find C
	$x = [-\frac{1}{2}[\ln\{(g - kv^2)/g\}]/k$	A1		Any equivalent expression for x
	$[\ln\{(g - kv^2)/g\} = \ln(e^{-2kx})]$	M1		For expressing in the form $\ln f(v^2) = \ln g(x)$ or equivalent
	$v^2 = (1 - e^{-2kx})g/k$	A1		
		M1		For using $e^{-Ax} \rightarrow 0$ for +ve A
	Limiting value is $\sqrt{g/k}$	A1ft	7	AG
	(iii) [$1 - e^{-600k} = 0.81$]	M1		For using $v^2(300) = 0.9^2 g/k$
	[$-600k = \ln(0.19)$]	M1		For using logarithms to solve for k
	$k = 0.00277$	A1	3	

6	(i) [$u\sin30^o = 3$]	M1		For momentum equation for B, normal to line of centres
	$u = 6$	A1	2	
	(ii) [$4\sin88.1^o = v\sin45^o$]	M1		For momentum equation for A, normal to line of centres
	$v = 5.65$	A1		
		M1		For momentum equation along line of centres
	$0.4(4\cos88.1^o) - mu\cos30^o = -0.4v\cos45^o$	A1		
	$m = 0.318$	A1	5	
	(iii)	M1		For using NEL
	$0.75(4\cos\theta + u\cos30^o) = v\cos45^o$	A1		
	$4\sin\theta = v\sin45^o$	B1		
	[$3\cos\theta + 4.5\cos30^o = 4\sin\theta$]	M1		For eliminating v
	$8\sin\theta - 6\cos\theta = 9\cos30^o$	A1	5	AG
7	(i)(a) Extension = $1.2\alpha - 0.6$	B1		
	[$T = mg\sin\alpha$]	M1		For resolving forces tangentially
	$0.5x9.8\sin\alpha = 6.86(1.2\alpha - 0.6)/0./6$	A1ft		
	$\sin\alpha = 2.8\alpha - 1.4$	A1	4	AG
	(i)(b) [0.8, 0.756.., 0.745.., 0.742.., 0.741.., 0.741..,]	M1		For attempting to find α_2 and α_3
	$\alpha = 0.74$	A1	2	
	(ii) $\Delta h = 1.2(\cos0.5 - \cos0.8)$ [0.217…]	B1		
	[$0.5x9.8x0.217.. = 1.06355..$]	M1		For using $\Delta(PE) = mg\Delta h$
	[$6.86(1.2x0.8 - 0.6)^2/(2x0.6) = 0.74088$]	M1		For using EE = $\lambda x^2/2L$
		M1		For using the principle of conservation of energy
	$\frac{1}{2}\,0.5v^2 = 1.06355.. - 0.74088$	A1		Any correct equation for v^2
	Speed is $1.14ms^{-1}$	A1		
	Speed is decreasing	B1ft	7	