Statics and Dynamics in 2d Without Friction (From OCR 4728)

Q1, (Jun 2005, Q4)

(i) α		M1		For using $s = ut + ½ at^2$ for the first stage
	$2 = 0.8u + ½ a(0.8)^2$	A1		
		M1		For obtaining another equation in u and a with relevant values of velocity, displacement and time
	$8 = 2u + ½ a2^2$ or $6 = 1.2(u + 0.8a) + ½ a(1.2)^2$ or $6 = 1.2(2 \times 2 \div 0.8 - u) + ½ a(1.2)^2$	A1		
		M1		For eliminating a or u
	$u = 1.5$	A1		
	Acceleration is 2.5 ms^{-2}	A1	7	
(i) β		M1		For using $s = vt - ½ at^2$ for the first stage
	$2 = 0.8v - ½ a(0.8)^2$	A1		
		M1		For using $s = ut + ½ at^2$ for the second stage
	$6 = 1.2v + ½ a(1.2)^2$	A1		
		M1		For obtaining values of a and v and using $v = u + at$ for first stage to find u
	Acceleration is 2.5 ms^{-2} (v = 3.5) $u = 1.5$	A1 A1	7	
(i) γ	$2 \div 0.8$ ms^{-1} and $6 \div 1.2$ ms^{-1}	M1		For finding average speeds in both intervals
	= 2.5 ms^{-1} and 5ms^{-1}	A1		
	$t_1 = 0.4$ and $t_2 = (0.8 +) 0.6$	B1		For finding mid-interval times
	$5 = 2.5 + a(1.4 - 0.4)$	M1		For using $v = u + at$ between the mid-interval times
	Acceleration is 2.5 ms^{-2}	A1		
	$2.5 = u + 2.5 \times 0.4$ or $5 = u + 2.5 \times 1.4$	M1		For using $v = u + at$ between t = 0 and one of the mid-interval times
	$u = 1.5$	A1	7	
(ii)	$2.5 = 9.8\sin\alpha$ $\alpha = 14.8^\circ$	M1 A1ft	2	For using $(m)a = (m)g\sin\alpha$ ft value of acceleration

Q2, (Jun 2007, Q3)

(i)		M1	An equation with R, T and 50 in linear combination.
	$R + T\sin 72^\circ = 50g$	A1	$R + 0.951T = 50g$
		[2]	
(ii)	$T = 50g/\sin 72^\circ$	M1	Using R = 0 (may be implied) and $T\sin 72^\circ = 50(g)$
	$T = 515$ (AG)	A1	Or better
	$T = mg$	B1	
	$m = 52.6$	B1	Accept 52.5
		[4]	
(iii)	$X = T\cos 72^\circ$	B1	Implied by correct answer
	$X = 159$	B1	Or better
		[2]	

Q3, (Jun 2010, Q6)

	$T - 0.85g \sin 30 = 0.85a$	B1	Either equation correct
i	$0.55g - T = 0.55a$	B1	Both eqns correct and consistent 'a' direction
a	$a = 1.225/1.4$	M1	Solves 2 sim eqn
	$a = 0.875$	A1	
	$T = 4.91$	A1	4.908 or better – has to be positive
		[5]	
b	$F = 2T\cos 30$	M1	Or Pythagoras or cosine rule
	$F = 8.5(02..)$	A1ft	cv(4.91)x√3
		[2]	
ii		M1	Uses $v^2 = u^2 + 2a(1.5)$, u non-zero, a from (i)
	$v^2 = 1.3^2 + 2x0.875x1.5$ (=4.315)	A1ft	$v = 2.077....(v^2 = 1.69+3xcv(0.875))$
	$a = +/-g\sin 30$	B1	$a = +/-4.9$
	$0 = 4.315 - 2x4.9s$	M1	Uses $0^2 = u^2 +/- 2as$, with a not g or (i), u not1.3
	$(s = 0.44\ldots)$	A1	May be implied – need not be 3sf
	$S = 1.94$	A1	
		[6]	

Q4, (Jan 2006, Q6)

(i)	$T_A\cos\alpha - T_B\cos\beta = W$	M1	For resolving 3 forces vertically, condone *Wg*, sin
	$T_A = T_B\ (= T)$	B1	May be implied or shown in diagram
	$\cos\alpha > \cos\beta \rightarrow \alpha < \beta$	A1 [3]	AG
(ii)(a)	$T\sin\alpha + T\sin\beta = 14$	M1	Resolve 3 forces horiz accept cos
	$\sin\alpha = 0.6$ and $\sin\beta = 0.8$	DM1	
	Tension is 10 N	A1 [3]	
(ii)(b)	$10\cos\alpha - 10\cos\beta = W$	M1	Must use cv T, and *W* (not *Wg*)
	$\alpha = 36.9^\circ,\ \beta = 53.1^\circ$	DM1	Or $\cos\alpha = 0.8$ and $\cos\beta = 0.6$
			SR -1 for assuming $\alpha + \beta = 90^\circ$
	$W = 2$	A1 ft [3]	ft for *T*/5 (accept 1.99)
	See appendix for solution based on resolving along *RA* and *RB*.		
(iii)	*R* is below *B*	B1	Accept *R* more than 0.5 m below *A*
	Tension is 1 N	B1 ft [2]	ft for *W*/2 accept *W*/2

Q5, (Jun 2011, Q6)

i		"...smooth ring...", "..no friction at ring.."	B1 [1]	If a variety of reasons is offered, "smooth ring" must be the last
ii		$T\cos\theta + 5 = T\cos(90-\theta)$ $T\cos\theta + 5 = T\sin\theta$ .....(a) $T\sin\theta + T\sin(90-\theta) = 7$ $T\sin\theta + T\cos\theta = 7$ ..... (b)	M1 A1 M1 A1 [4]	"Resolves horiz" equation, needs TCorSθ, 3 terms, 2 of which are T resolved "Resolves vert" equation, needs TCorSθ, 3 terms, 2 of which are T resolved {Allow candidates solving for (iii) to begin in (ii)}
iii		uses (b)+(a) and (b)-(a) for example $T\sin\theta = 6$ or $2T\sin\theta = 12$, $T\cos\theta = 1$ or $2T\cos\theta = 2$ $T^2 = 6^2 + 1^{(2)}$ $T = 6.08$ N $\tan\theta = 6(/1)$ $\theta = 80.5°$ *OR* (b) gives $T=7/(\sin\theta+\cos\theta)$, subs in (a) for example $12\cos\theta = 2\sin\theta$ then mark as 6(iii) below for D*M1 A1 D*M1 A1	M1* A1 D*M1 A1 D*M1 A1 [6] M1* A1	Attempts to solve 2 equations in 2 unknowns Both terms have values correct Accept √37, 6.1 Uses a correct trig identity Accept 81°, 1.4 rad, 1.41 rad Attempts to solve 2 equations in 2 unknowns Correct two term equation in one variable

Q6, (Jan 2013, Q3)

(i)		$T\text{CorS}20 = 0.25g\text{CorS}30$	M1	Equates cmpt T and cmpt wt // plane (doubt, see diagram and/or (ii))
		$T\cos 20 = 0.25g\sin 30$	A1	1.225
		$T = 1.3(0)$	A1	
			[3]	
(ii)		R +/– $T\text{CorS}20$ =+/- $0.25g\text{CorS}30$	M1	Resolves perp plane, accept letter T
		$R + 1.3\sin 20 = 0.25g\cos 30$	A1 ft	ft(cv(T))
		$R = 1.68$ N	A1	
			[3]	
(iii)		$(m)\text{accn} = +/-(m)9.8\sin 30$	M1*	N2L with single force a cmpt wt (accept cos)
		$a = +/-4.9$	A1	
		$u = +/-9.8\sin 30 \times 0.4$	D*M1	
		$u = 1.96$	A1	Must be +ve (accept loss of – sign)
			[4]	

Q7, (Jun 2016, Q1)

I		$14^2 = 2gh$	**M1**	$v^2=u^2$ +/-$2gs$ with u=0
		$h = 10$ m	**A1**	-ve final answer A0
		$14 = gt$	**M1**	$v = u+gt$ with u=0
		$t = 1.43$ s	**A1**	Accept 10/7
		OR	**[4]**	
		$14 = gt$	**M1**	There are many alternatives, but following through of
		$t = 1.43$ s	**A1**	wrong answer is allowed only for method marks as the
		$h = 0\text{x}1.43 + 9.8\text{x}1.43^2/2$	**M1**	h and t values can be found independently.
		$h = 10(.0)$ m	**A1**	
ii		$20^2 = 14^2 + 2a15$	**M1**	$v^2 = 14^2$ +/- $2as$, $a \neq g$
		$a = 6.8$ m s^{-2}	**A1**	
			A1	
			[3]	