Topic X3 Mechanics AS (Post-TT A) [67] MARKSCHEME

1.

(a)	Uses fact that at max speed driving force equals resistance	AO3.4	M1	$F = 30 \times 40$ $= 120$
	States or uses $P = Fv$	AO1.2	B1	$P = (30 \times 40) \times 40$ $= 48000$ W
	Obtains correct value for power	AO1.1b	A1	
(b)	Uses resistance model in a three term equation of motion.	AO3.4	M1	$F - 30 \times 25 = 1200a$ $F = 1200a + 750$ $48000 = 25(1200a + 750)$ $a = \frac{1920 - 750}{1200}$ $= 0.975\,\text{m s}^{-2}$ $= 0.98\,\text{m s}^{-2}$ to 2 sf
	Obtains a correct equation of motion.	AO1.1b	A1	
	Solves 'their' equation of motion for a.	AO1.1a	M1	
	Obtains correct acceleration. FT 'their' equation provided both M1 marks awarded	AO1.1b	A1F	
	Total		**7**	

2.

Question	Scheme	Marks	AOs
6(a)	Using the model and $v^2 = u^2 + 2as$ to find v	M1	3.4
	$v^2 = 2as = 2g \times 2.4 = 4.8g \Rightarrow v = \sqrt{(4.8g)}$	A1	1.1b
	Using the model and $v^2 = u^2 + 2as$ to find u	M1	3.4
	$0^2 = u^2 - 2g \times 0.6 \Rightarrow u = \sqrt{(1.2g)}$	A1	1.1b
	Using the correct strategy to solve the problem by finding the sep. speed and app. speed and applying NLR	M1	3.1b
	$e = \sqrt{(1.2g)} / \sqrt{(4.8g)} = 0.5$ *	A1*	1.1b
		(6)	
(b)	Using the model and e = sep. speed / app. speed, $v = 0.5\sqrt{(1.2g)}$	M1	3.4
	Using the model and $v^2 = u^2 + 2as$	M1	3.4
	$0^2 = 0.25\,(1.2g) - 2gh \Rightarrow h = 0.15$ (m)	A1	1.1b
		(3)	
(c)	Ball continues to bounce with the height of each bounce being a quarter of the previous one	B1	2.2b
		(1)	
			(10 marks)

3.

(i)	$P/10 - 800x9.8\sin12° - 100k = 800x0.25$	M1		$P/10 = D_1$ ok
		A1		D_1 ok
	$P/20 - 400k = 800x0.75$	M1		$P/20 = D_2$ ok
		A1		$D_1 = 2D_2$ needed for this A1
	solving above	M1		
	$k = 0.900$	A1		**AG** 0.9000395
	$P = 19\ 200$	A1	7	or 19.2 kW (maybe in part (ii))
(ii)	$0.9\ v^2 = 28\ 800/v$	M1		ok if $19200/v$
	solving above	M1	*	($v^3 = 32\ 000$)
	$v = 31.7\ m\ s^{-1}$	A1	3	**10**

4.

$[G] = \frac{[F][r]^2}{[m_1][m_2]}$ or $[G] = \frac{[F][r]^2}{[m]^2}$	**M1**	**1.1**	**Use of rearranged formula to find [G]**
$[r] = L$ and $[m] = M$	**B1**	**1.1**	**soi**
$[F] = M[a] = MLT^{-2}$	**B1**	**1.1**	**soi**
So $[G] = M^{-1}L^3T^{-2}$	**A1**	**1.1**	**Correct answer $M^{-1}L^3T^{-2}$**
	[4]		

5.

(i)	$T\sin30°$	B1			
	$T\sin30° = 0.3x0.4x2^2$	M1		resolving horizontally	
		A1			
	$T = 0.96$	A1	4		
(ii)	$R + T\cos30° = 0.3x9.8$	M1		resolving vertically	
		A1			
	$R = 2.11$	A1√	3	√ their T (2.94−$T\cos30°$)	
(iii)	$T_1\sin30° = 0.3 \times v^2/0.4$	M1		or $0.3x0.4x\omega^2$	
		A1		($T_1 = 1.5v^2$)	
	$T_1\cos30° = 0.3 \times 9.8$	B1		($T_1 = 1.96\sqrt{3} = 3.3948$)	
	$R = 0$	B1		may be implied or stated	
	$\tan30° = v^2/(0.4 \times 9.8)$ for elim of T_1	M1		and $v=0.4\omega$ ($\omega = 3.76$)	
	$v = 1.50$	A1	6		**13**

6.

(i)	$2mu - 3kmu = -mu + kmv$	M1		
	$v = \ldots\ldots$	M1		attempting to make v the subject
	$v = 3u(1 - k)/k$	A1		
				$3u/k - 3u$
	$(0 <) k < 1$	A1	**4**	not ≤ 1
ii)	$I = mu - -2mu$	M1		or $km(3u/k - 3u + 3u)$
	$3mu$	A1	**2**	+ only
iii)	$v = \pm 3u$	B1		
	$e = (u/2 + 3u)/4u$	M1		
	$e = 7/8$ or 0.875	A1	**3**	**9**

7.

(i)	$\frac{1}{2}\,0.3v^2 + \frac{1}{2}\,0.4v^2$	B1		
	$\pm\,0.3g(0.6\sin\theta)$	B1		
	$\pm\,0.4g(0.6\theta)$	B1		
	$[0.35v^2 = 2.352\theta - 1.764\sin\theta]$	M1		For using the principle of conservation of energy.
	$v^2 = 6.72\theta - 5.04\sin\theta$	A1	5	AG
(ii)		M1		For applying Newton's 2nd Law radially to P and using $a = v^2/r$
	$0.3(v^2/0.6) = 0.3g\sin\theta - R$	A1		
	$[\frac{1}{2}(6.72\theta - 5.04\sin\theta) =$ $0.3g\sin\theta - R]$	M1		For substituting for v^2.
	Magnitude is $(5.46\sin\theta - 3.36\theta)$N	A1		AG
	$[5.46\cos\theta - 3.36 = 0]$	M1		For using $dR/d\theta = 0$
	Value of θ is 0.908	A1	6	
(iii)	$[T - 0.3g\cos\theta = 0.3a]$	M1		For applying Newton's 2nd Law tangentially to P
	$[0.4g - T = 0.4a]$	M1		For applying Newton's 2nd Law to Q [If $0.4g - 0.3g\cos\theta = 0.3a$ is seen, assume this derives from $T - 0.3g\cos\theta = 0.3a$ ..... M1 and $T = 0.4g$ ..... M0]
	Component is $5.6 - 4.2\cos\theta$	A1	3	
OR				
(iii)	$0.4g - 0.3g\cos\theta = (0.3 + 0.4)a$	B2		
	Component is $5.6 - 4.2\cos\theta$	B1	3	
OR				
(iii)	$[2v(dv/d\theta) = 6.72 - 5.04\cos\theta]$	M1		For differentiating v^2 (from (i)) w.r.t. θ
	$2\,(0.6a) = 6.72 - 5.04\cos\theta$	M1		For using $v(dv/d\theta) = ar$
	Component is $5.6 - 4.2\cos\theta$	A1	3	