Topic X3 Mechanics AS (Pre-TT B) [53] MARKSCHEME

1.

(i)		$\frac{P}{15}$ or $\frac{P}{20}$ seen	B1	1.1a	Use of tractive force $T=\frac{P}{v}$	
		$\frac{P}{15}-225k=1250(0.54)$ or $\frac{P}{20}-400k=1250(0.3)$	M1	3.3	Attempt to use N2L once	Can be with T for **M1** N2L is Newton's second law
		$\frac{P}{15}-225k=1250(0.54)$	A1	1.1		
		$\frac{P}{20}-400k=1250(0.3)$	A1	1.1		
			M1	3.4	Attempt to solve for P or k BC	
		$k=0.568$	A1	1.1		0.567567…
		$P=12040\,\text{W}$	A1	1.1		12040.540…
			[7]			
(ii)		$kv^2=\frac{15000}{v}$	*M1	2.2a		
		$v^3=\frac{15000}{0.567...}$	dep*M1	3.4	Substituting their k and solving for v	
		$v=29.8\,\text{m s}^{-1}$	A1	1.1	29.78684…	
			[3]			

2.

(i)	½.700.20^2 or ½.700.15^2	B1		either K.E.	
	700x9.8x400sin5°	B1		correct P.E.	
	½.700.15^2+700.9.8.400sin5°= ½.700.20^2 + W.D.	M1		for 4 terms with W.D.	
	W.D. = 178,000 J	A1	4	or 178 kJ	
(ii)	D=200 + 700.9.8sin5°	M1			
	D = 798 N	A1		may be implied	
	P = Dx15 = 12,000 = 12kW	A1	3	AG **(11,968W)**	
(iii)	D' = 11,968÷20 = 598	M1			
	D'-700.9.8sin5°-200 = 700a	M1			
	a = 0.285 ms^{-2} (±)	A1	3	allow 0.283 (from 12kW)	**10**
	Alternative for false assumption			**of constant acceleration**	
(i)	D-700 x 9.8sin5° = 700a and $15^2 = 20^2 + 2a.400$	M1		(D = 445, a = -0.21875)	
	W.D. = 400xD = 178,000	A1		2 marks (out of 4) maximum	

3.

4 ia b	If reversed 2.9 + 2 = e(3 + 1.5) e > 1 impossible 2.9 - 2 = e(3 + 1.5) e = 0.2	M1 A1 [2] M1 A1 [2]	 Award B1 if no explicit numerical justification May be seen in ia
ii	 3m – 0.2x1.5 = 2m + 0.2x2.9 m = 0.88	M1 A1 A1 [3]	Conservation of momentum Accept with g included consistently Do not award if g used
iii	0.68 = 0.2v + 0.2x2.9 v = 0.5 e = 0.5/2.9 e = 0.172	M1 A1 M1 A1 [4]	Impulse = change in momentum Separation speed not 2.9 Allow 5/29

4.

(i)	$T\cos45° + R\sin45° = mg$	*M1 A1	3 terms
	$T\sin45° - R\cos45° = ml\sin45°\omega^2$	*M1 A1	3 terms; $a = r\omega^2$
	$2T = \sqrt{2}mg + ml\omega^2$ $T = m/2(\sqrt{2}g + l\omega^2)$	Dep*M1 A1 **6**	Method to eliminate R **AG** www
(ii)	$R = 0$ $2R = \sqrt{2}mg - ml\omega^2$ or $T\cos45° = mg$ or $T = ml\omega^2$ Solve to find ω	B1 B1 M1	may be implied
	$\omega = 4.16$ rad s^{-1}	A1 **4**	**10**

5.

6	(i) $[\frac{1}{2}m7^2 = \frac{1}{2}mv^2 + 2mg]$	M1		For using the principle of conservation of energy
	Speed is 3.13ms^{-1}	A1		
	$[T = mv^2/r]$	M1		For using Newton's second law horizontally and $a = v^2/r$
	Tension is 1.96N	A1ft	4	
	(ii) $[T - mg\cos\theta = mv^2/r]$	M1		For using Newton's second law radially
		M1		For using T = 0 (may be implied)
	$v^2 = -2g\cos\theta$	A1		
		M1		For using the principle of conservation of energy
	$\frac{1}{2}m7^2 = \frac{1}{2}mv^2 + mg(2 - 2\cos\theta)$	A1		
	$[-2g\cos\theta = 49 - 4g + 4g\cos\theta]$	M1		For eliminating v^2
	$6g\cos\theta = -9.8$	A1		May be implied by answer
	$\theta = 99.6$	A1	8	
Alternative for candidates who eliminate v^2 before using T = 0.				
	(ii) $[T - mg\cos\theta = mv^2/r]$	M1		For using Newton's second law radially
		M1		For using the principle of conservation of energy
	$\frac{1}{2}m7^2 = \frac{1}{2}mv^2 + mg(2 - 2\cos\theta)$	A1		
	$[T - mg\cos\theta = m(49 - 4g + 4g\cos\theta)2]$	M1		For eliminating v^2
		M1		For using T = 0 (may be implied)
	$-2g\cos\theta = 49 - 4g + 4g\cos\theta$	A1ft		ft error in energy equation
	$6g\cos\theta = -9.8$	A1		May be implied by answer
	$\theta = 99.6$	A1	8	