Topic X4 Mechanics (Post-TT) [55] MARKSCHEME

1.

70 x 9.8 or 70g 70 x 0.3 686 + 21 707 N	B1 B1 M1 A1 [4]	=686 =21 + cvs [70(9.8+0.3) gets B1B1M1]

2.

4 i	$v^2 = 7^2 - 2\times9.8\times2.1$ $v = 2.8$ ms^{-1}	M1 A1 A1 [3]	Uses $v^2 = u^2 - 2gs$. Accept $7^2 = u^2 + 2gs$
ii	$v = 0$ $0^2 = 7^2 - 2\times9.8s$ $s = 2.5$ m	B1 M1 A1 [3]	Velocity = 0 at greatest height Uses $0 = u^2 - 2gs$. Accept $7^2 = 2\times9.8s$.
iii	$v = -5.7$ (or $t = 0.71$ oef to reach greatest height) $-5.7 = 7 - 9.8t$ or $5.7 = (0+) 9.8T$ $t = 1.3(0)$ s (1.2959..)	B1 M1 A1 [3]	Allows for change of direction Uses $v = u +$ or $-$ gt. Not 1.29 unless obtained from g=9.81 consistently

3.

(i)	½ 25v_m = 8 or ½Tv_m+½(25 – T)v_m = 8	B*1		Do not accept solution based on isosceles or right angled triangle
	Greatest speed is 0.64 ms^{-1}	D*B 1	2	
(ii)		M1		For using v = u + at or the idea that gradient represents acceleration
	V = 0.02 x 40	A1		
	V = 0.8	A1	3	
(iii)		M1		For using the idea that the area represents displacement. nb trapezium area is 16+8+8
		M1		For A = ½ (L_1 + L_2)h or other appropriate breakdown
	½ (70 + T) x 0.8 = 40 - 8	A1ft		½ (30 + T) x 0.8 = 40 - 8- ½ x 40 x 0.8 ft cv(0.8)
	Duration is 10s	A1	4	
(iv)		M1		For using v = u + at or the idea that gradient represents acceleration
	0=0.8+a(30–10)	A1ft		ft cv(10) and cv(0.8)
	Deceleration is 0.04ms^{-2}	A1	3	Accept -0.04 from correct work
	Or	M1		Using the idea that the area represents displacement.
	40-8-½ x 40 x 0.8-10x0.8	A1ft		Ft cv(0.8 and 10)
	=0.8(30-10)-a(30–10)^2/2	A1		Accept -0.04 from correct work. d=-0.04 A0
	Deceleration is 0.04ms^{-2}			

4.

(a)	Differentiates, with at least one term correct	AO1.1a	M1	$\frac{dv}{dt} = 12t - 36t^2$
	Selects and applies $F = ma$ to 'their' derivative Condone use of 400 for mass	AO1.1a	M1	$F = ma = 0.4\ (12t - 36t^2)$
	Obtains correct expression for force FT from 'their' $F = ma$ equation, provided the first M1 has been awarded (may be in factorised form)	AO1.1b	A1F	$= 4.8t - 14.4t^2$
(b)	Integrates v to find r, with at least one term correct	AO3.1b	M1	$r = \int \left(6t^2 - 12t^3\right) dt$
	Obtains correct integral (condone absence of c)	AO1.1b	A1	$r = 2t^3 - 3t^4 + c$
	Deduces the value of c using initial conditions FT use of 'their' integral provided M1 awarded	AO2.2a	A1F	When $t = 0$, $r = 0$ so $0 = 2\times 0^2 - 3\times 0^4 + c$ so $c = 0$
	Forms and solves an equation for t (condone numerical slip)	AO1.1a	M1	$0 = 2t^3 - 3t^4$ $= t^3(2 - 3t)$ $t = 0$ or $t = \frac{2}{3}$
	Interprets solution, realising that the non-zero time is required (Must include units) FT use of 'their' equation for t provided both M1 marks have been awarded	AO3.2a	A1F	Next at O at $\frac{2}{3}$ seconds
	Total		**8**	

5.

(i)	T = 400 N D = 400 + 900 = 1300 N	B1 M1 A1 [3]	Order immaterial Or T + 900; sign correct
(ii)	 500x0.6 = T - 400 T = 700 N 1250x0.6 = D - 900 -700 D = 2350 N *OR* (500 + 1250)x0.6 = D - 400 - 900 D = 2350 N	 M1 A1 A1 M1 A1ft A1 M1 A1 A1 [6]	(Award M marks even if g included in ma terms. M marks require correct number forces) Uses N2L one object only Uses N2L other object ft cv(T from (ii)); allow T instead of its value Uses N2L for both objects

6.

(i)		$T - 0.4g = 0.4 \times 2.45$ $T = 4.9$ N	M1 A1 A1 [3]	N2L on P , two vertical forces, accept with 0.4x2.45g Correct terms and signs Exact, g=9.81 (4.904, accept 4.9) g=10 (4.98, not 5.0)
(ii)		$mg - T = \pm 2.45m$ $m = 2/3$ kg $v = 2.45 \times 0.3$ (= 0.735) Momentum = (2/3) × (2.45 × 0.3) Momentum loss = 0.49 kgms^{-1}	M1 A1 FT B1 M1 A1 [5]	Correct terms (possible incorrect signs), and use of cv(T(i)) FT cv(T(i))/7.35, g=9.81 (FT cv(T(i))/7.351 = 0.667)g=10 (FT cv(T(i))/7.55 = 0.6596 = 0.66) This may be seen in (i). The M1A1 pair of marks may be awarded only in part (ii) when the candidate uses the value of m which was found in (i). Must be positive Accept ±. cv(m) x cv(v) Exact,. but accept any value which rounds to ±0.490. g=9.81 (0.49) g=10 (0.4848=0.485, not 0.48)
(iii)		$S = 2.45 \times 0.3^2/2$ $S = \pm 0.11(025)$ OR $S = (0 + 0.735) \times 0.3 / 2$ $S = \pm 0.11(025)$ $0 = (2.45 \times 0.3)^2 \pm 2 \times 9.8s$ $s = \pm 0.027(56..)$ OR (using $t_A = 0.735/9.8 = 0.075$) $s = 0.735 \times 0.075 - 9.8 \times 0.075^2 / 2$ $s = \pm 0.027(56..)$ Distance = 0.248 m	M1 A1 M1 A1 M1 A1 A1 FT [5]	Distance while Q descends. Watch for $s = vt - at^2/2$. If v=0, M0A0 M1 Using landing speed from (ii) A1 Distance P ascends while Q at rest, must use g May be implied, g=9.81 (0.02753) g=10 (0.0270) Calculating ascend time after string goes slack M1 Using candidate's values of speed and t_A to find $\pm s$ A1 May be implied 2 × |cv(S)| + |cv(s)|. Accept 0.25. g=9.81 (0.248) g=10 (0.247511..)