Topic X4 Mechanics (Pre-TT B) [32] MARKSCHEME

1.

Applies Newton's 2nd Law to form a 3 term equation Award mark even if signs not correct	AO1.1a	M1	$F - 80 \times 10 = -80 \times 1.5$
Obtains a correct 3 term equation.	AO1.1b	A1	$F - 800 = -120$
Obtains correct reaction force. Must be given to 1 sf FT from incorrect 3 term equation provided M1 mark was awarded (condone omission of units)	AO1.1b	A1F	$F = 680 = 700$ (N) to 1 sf
Total		**3**	

2.

(a)(i)	Sums the forces given correctly	AO1.1b	B1	$F = F_1 + F_2 + F_3$ $= 33i - 11j$
	Uses Pythagoras to find the magnitude of the vector and obtains correct magnitude (given to 3 sig figs)	AO1.1b	B1	$\lvert F\rvert = \sqrt{33^2 + (-11)^2}$ $= 34.8$ N (3 sf)
a)(ii)	Uses trig expression with appropriate values	AO1.1a	M1	$\tan\theta = \frac{11}{33}$
	Obtains correct angle (given to nearest 0.1°)	AO1.1b	A1	$\theta = \tan^{-1}\left(\frac{1}{3}\right)$ $= 18.4°$ (3 sf) OR $\sin\theta = \frac{11}{\sqrt{1210}}$ $\theta = \sin^{-1}\left(\frac{11}{\sqrt{1210}}\right)$ $= 18.4°$ (3 sf) OR $\cos\theta = \frac{33}{\sqrt{1210}}$ $\theta = \cos^{-1}\left(\frac{33}{\sqrt{1210}}\right)$ $= 18.4°$ (3 sf)
(b)	States negative of 'their' part (a)(i)	AO2.2a	B1F	$F_4 = -33i + 11j$
	Total		**5**	

3.

(i)	10500 + 3000 + 1500 Driving force below 15000 gives retardation	M1 A1 2	For summing 3 resistances Accept generalised case or specific instance
(ii)	35000 – 15000 = 80000a Acceleration is 0.25 ms^{-2}	M1 A1 2	Newton's second law for whole train AG Accept verification
(iii)	 35000 – 10500 – 8500 = 0.25*m* Mass is 64000 kg	M1 A1 A1 3	For applying Newton's second law to *E* only, at least 2 forces out of the relevant 3.
(iv)	 -15000 – 15000 = 80000*a* OR -3000-10500-15000=(80000 - *m*)*a* -1500 = *ma* Mass is 4000 kg	M1 A1 M1 A1 A1 5	For applying Newton's second law with all appropriate forces *a* = -0.375 For applying Newton's second law to *B* only, only 1 force Or cv(*a*)
(v)	-15000 – 10500 ± *T* = 64000(-0.375) *T* = ± 1500 ➔ forward force on *E* of 1500 N OR (working with A and B) -1500 – 3000 ± *T* = (80000 - 64000)(-0.375) *T* = ± 1500 ➔ forward force on *E* of 1500	B1ft B1 2 B1ft B1	Follow through cv (m_E, *a*), or accept use of m_E, *a* Follow through cv (m_E, *a*), or accept use of m_E, *a*

4.

i	**Also if in ii**	T – 0.45g = 0.45x0.98 T = 4.85(1) N	M1 A1 [2]	N2L on 0.45 kg, weight - tension and +/-0.98m Not 4.9, 4.8 (4.851 is exact, but 4.85 acceptable) {g=9.81→ T=4.85 or 4.86 or better}
ii	**Also If in i**	mg – 4.85(1) = 0.98m m = 4.85(1)/(9.8-0.98) or m(g – 0.98) = 4.85(1) m = 0.55 *OR* 0.98 = g (m-0.45)/(m+0.45) m = (g+0.98)/(g-0.98) x 0.45 m = 0.55	M1 A1ft A1 [3] M1 A1 A1	N2L on Q, weight – tension, tension=T(i), and 0.98m Simplified to a single term in m, ft cv(T(i)) art 0.550 {g=9.81→ m=0.55(0) or better} a = g x Δ(masses)/Σ(masses)
iii		$v^2 = (0 +) 2x0.98x0.36$ v = 0.84 ms^{-1}	M1 A1 [2]	Uses $v^2 = u^2 + 2as$, a not 9.8, 2as>0, u = 0 or omitted
iv		$0 = 0.84^2 – 2x9.8s$ (s = 0.036) S = 0.036 + 2x0.36 = 0.756 m	M1 A1 A1 [3]	$0 =(cv(iii))^2 – 2gs$, or $t=cv(iii)/g$ and $s = ut+/-gt^2/2$ May be implied by final answer (eg 0.396) Must be 3 sf (exact) {g=9.81→ s=0.756 or better}