1.	(a)	$(\downarrow) 0.4g - T = 0.4a$	M1 A1	
		$(\uparrow) T - 0.3g = 0.3a$	M1 A1	
		solving for T	DM1	
		T = 3.36 or 3.4 or 12g/35 (N)	A1	6
	(b)	$0.4g - 0.3g = 0.7a$	DM1	
		$a = 1.4$ m s^{-2}, $g/7$	A1	2
	(c)	$(\uparrow) v = u + at$		
		$v = 0.5 \text{ x } 1.4$	M1	
		$= 0.7$	A1 ft on a	
		$(\uparrow) s = ut + \frac{1}{2}at^2$		
		$s = 0.5 \text{ x } 1.4 \text{ x } 0.5^2$	M1	
		$= 0.175$	A1 ft on a	
		$(\downarrow) s = ut + \frac{1}{2}at^2$		
		$1.175 = -0.7t + 4.9t^2$	DM1 A1 ft	
		$4.9t^2 - 0.7t - 1.175 = 0$		
		$t = \dfrac{0.7 \pm \sqrt{0.7^2 + 19.6 \text{ x } 1.175}}{9.8}$	DM1 A1 cao	
		$= 0.5663..\text{or } -...$		
		Ans 0.57 or 0.566 s	A1 cao	9

[17]

2.	(a)	N2L A: $5mg - T = 5m \times \dfrac{1}{4}g$		M1 A1	
		$T = \dfrac{15}{4}mg$ *	cso	A1	3
	(b)	N2L B: $T - kmg = km \times \dfrac{1}{4}g$		M1 A1	
		$k = 3$		A1	3
	(c)	The tensions in the two parts of the string are the same		B1	1

(d)	Distance of A above ground $s_1 = \frac{1}{2} \times \frac{1}{4} g \times 1.2^2 = 0.18g (\approx 1.764)$	M1 A1		
	Speed on reaching ground $v = \frac{1}{4} g \times 1.2 = 0.3g (\approx 2.94)$	M1 A1		
	For B under gravity $(0.3g)^2 = 2gs_2 \Rightarrow s_2 = \frac{(0.3)^2}{2} g = (\approx 0.441)$	M1 A1		
	$S = 2s_1 + s_2 = 3.969 \approx 4.0$ (m)	A1	7	
				[14]

3.	(a)	For whole system: 1200 – 400 – 200 = 1000a	M1 A1		
		$a = 0.6 \text{ m s}^{-2}$	A1	3	
	(b)	For trailer: T – 200 = 200 × 0.6	M1 A1 **ft**		
		T = 320 N	A1		
			OR:		
		OR: For car: 1200 – 400 – T = 800 × 0.6	M1 A1 **ft**		
		T = 320 N	A1	3	
	(c)	For trailer: 200 + 100 = 200f or –200f	M1 A1		
		$f = 1.5 \text{ m s}^{-2}$ (–1.5)	A1		
		For car: 400 + F – 100 = 800f or –800f	M1 A2		
		F = 900	A1	7	
		(N.B. For both: 400 + 200 + F = 1000f)			
					[13]

6. (a)	$s = ut + \frac{1}{2}at^2 \Rightarrow 3.15 = \frac{1}{2}a \times \frac{9}{4}$		M1A1	
	$a = 2.8$ (m s^{-2}) *	cso	A1	3
(b)	N2L for P: $0.5g - T = 0.5 \times 2.8$		M1A1	
	$T = 3.5$ (N)		A1	3
(c)	N2L for Q: $T - mg = 2.8m$		M1A1	
	$m = \frac{3.5}{12.6} = \frac{5}{18}$ *	cso	DM1A1	4

(d)	The acceleration of P is equal to the acceleration of Q.	B1	1	
(e)	$v = u + at \Rightarrow v = 2.8 \times 1.5$ (or $v^2 = u^2 + 2as \Rightarrow v^2 = 2 \times 2.8 \times 3.15$) ($v^2 = 17.64$, $v = 4.2$)	M1A1		
	$v = u + at \Rightarrow 4.2 = -4.2 + 9.8t$	DM1A1		
	$t = \frac{6}{7}$, 0.86, 0.857 (s)	DM1A1	6	
				[17]

8.	(a)	Car + trailer: $2100a = 2380 - 280 - 630$	M1 A1	
		$= 1470 \Rightarrow a = 0.7 \text{ m s}^{-2}$	A1	3
		M1 for a complete (potential) valid method to get a		

(b) e.g. trailer $700 \times 0.7 = T - 280$ M1 A1ft

$\Rightarrow T = 770$ N A1 3

If consider car: then get 1400a = 2380 – 630 – T.
Allow M1 A1 for equn of motion for car or trailer wherever seen (e.g. in (a)).

So if consider two separately in (a), can get M1 A1 from (b) for one equation; then M1 A1 from (a) for second equation, and then A1 [(a)] for a and A1 [(b)] for T.

In equations of motion, M1 requires no missing or extra terms and dimensionally correct (e.g. extra force, or missing mass, is M0).
If unclear which body is being considered, assume that the body is determined by the mass used. Hence if '1400a' used, assume it is the car and mark forces etc accordingly.
But allow e.g. 630/280 confused as an A error.

(c) Car: $1400a' = 2380 - 630$ M1 A1

$\Rightarrow a' = 1.25 \text{ ms}^{-2}$ A1

distance $= 12 \times 4 + \frac{1}{2} \times 1.25 \times 4^2$ M1 A1ft

= 58 m A1 6

Must be finding a new acceleration here. (If they get 1.25 erroneously in (a), and then simply assume it is the same acceln here, it is M0).

(d) Same acceleration for car and trailer B1 1

Allow o.e. but you must be convinced they are saying that it is same acceleration for both bodies.
E.g. 'acceleration constant' on its own is B0
Ignore extras, but 'acceleration and tension same at A and B' is B0

[13]

12.	(a)	3 kg: $3g - T = 3 \times \frac{3g}{7}$	M1 A1	
		$\Rightarrow T = \underline{\frac{12g}{7} \text{ or } 16.8 \text{ N or } 17 \text{ N}}$	A1	3
	(b)	m kg: $T - mg = m.\frac{3g}{7}$	M1 A1	
			↓	
		$\frac{12g}{7} = mg + \frac{3mg}{7}$ (Sub for T and solve)	M1	
		$\Rightarrow m = \underline{1.2}$	A1	4

[7]

16. (a) Car + truck: $2000a = 2400 - 600 - 400$ M1 A1

$a = 0.7 \text{ m s}^{-2}$ A1 3

(b)	Car only: T – 400 = 800 × 0.7 [*or* truck only: 2400 – T – 600 = 1200 × 0.7]	M1 A1 ft	
	T = 960 N	A1	3
(c)	New acceleration of truck a' given by		
	1200 a' = 2400 – 600	M1	
	a' = 2400 – 600 = 1.5 m s^{-1}	A1	
	Time to reach 28 m s^{-1} = $\frac{28-20}{1.5}$ = 5.33 s	M1 A1	
	Time to reach 28 m s^{-1} if rope had not broken = $\frac{28-20}{0.7}$ = 11.43 s	M1 A1	
	Difference = 6.1 s ≈ 6 s (*)	A1	7

[13]

[16]