Connected Particles and Newton's Third Law MS (From OCR 4761)

Q1, (Jan 2005, Q2)

(i) (A) (B)	the pulleys are smooth and the string is light the string is inextensible	 E1 E1	Accept only 'the pulley is smooth'.	 2
(ii)	Diagrams	B1	All forces present with labels and arrows. Acc not reqd.	1
	For X, N2L upwards $T - 2g = 2a$ For Y, N2L downwards $4g - T = 4a$ Solve for a and T $a = \frac{g}{3}$ (3.27 (3 s. f.)) $T = \frac{8}{3}g$ (26.1 (3 s. f.))	 M1 A1 A1 A1 F1	 N2L. Allow $F = mga$. All forces present Award for equation for X or Y or combined Any form Any form FT second answer	5
	total	8		

Q2, (Jan 2006, Q4)

(i)	N2L in direction of motion $D - (100 + 300) = (900 + 700) \times 1.5$ D = 2800 so 2800 N	 M1 A1 A1	 Apply N2L. Allow 1 resistance omitted and sign error but total mass must be used. Condone use of $F = mga$. No extra forces. All correct cao	3
(ii)	N2L on trailer $T - 300 = 700 \times 1.5$ T =1350 so 1350 N	 M1 A1	 Use either car or trailer. All forces present. No extras. Correct mass and a Allow sign error. Must use $F = ma$. cao	2
				5

Q3, (Jan 2007, Q5)

(i)	sphere $19.6 - T = 2a$ block $T - 14.8 = 4a$	M1 A1 A1	N2L. All forces attempted in one equation. Allow sign errors. No extra forces. Don't condone $F = mga$. Accept $2g$ for 19.6	3
(ii)	Solving $T = 18$ $a = 0.8$	M1 A1 F1	Attempt to solve. Award only if two equations present both containing a and T. Either variable eliminated. Either found cao Other value. Allow wrong equation(s) and wrong working for 1st value [If combined equation used award: M1 as in (i) for the equation with mass of 6 kg; A1 for $a = 0.8$; M1 as in (i) for equation in T and a for either sphere or block; A1 equation correct; F1 for T, FT **their** a; B1 Second equation in T and a.]	3
				6

Q4, (Jun 2007, Q3)

(i)	String light and pulley smooth	E1	Accept pulley smooth alone	1
(ii)	$5g$ (49) N thrust	M1 B1 A1	Three forces in equilibrium. Allow sign errors. for $15g$ (147) N used as a tension $5g$ (49) N thrust. Accept $\pm 5g$ (49). Ignore diagram. [Award SC2 for $\pm 5g$ (49) N without 'thrust' and SC3 if it is]	3
				4

Q5, (Jun 2007, Q4)

(i)		M1	N2L. Allow $F = mga$. Allow wrong or zero resistance. No extra forces. Allow sign errors. If done as 1 equn need $m = 20\,000$. If A and B analysed separately, must have 2 equns with 'T'.	
	$P - 800 = 20000 \times 0.2$	A1	N2L correct.	
	$P = 4800$	A1		3
(ii)	New accn $4800 - 2800 = 20000a$	M1	$F = ma$. Finding new accn. No extra forces. Allow 500 N but not 300 N omitted. Allow sign errors.	
	$a = 0.1$	A1	FT **their** P	2
(iii)	$T - 2500 = 10000 \times 0.1$	M1	N2L with new a. Mass 10000. All forces present for A or B except allow 500 N omitted on A. No extra forces	
	$T = 3500$ so 3500 N	A1	cao	2
				7

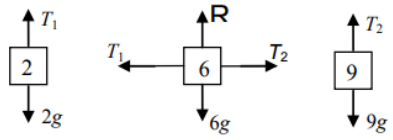
Q6, (Jun 2010, Q4)

(i)	Diagram for P or Q Other diagram	B1 B1 2	Must be properly labelled with arrows Must be properly labelled with arrows consistent with 1st diagram Accept single diagram if clear.
(ii)	Let tension in rope be T N and accn ↑ a m s^{-2}	M1	N2L applied correctly to either part. Allow $F = mga$ and sign errors. Do not condone missing or extra forces.
	For box P: N2L ↑ $1030 - 75g - T = 75a$	A1	
	For box Q: N2L ↑ $T - 25g = 25a$	A1 3	Direction of a consistent with equation for P. [Condone taking + ve downwards in either equation. +ve direction must be consistent in both equations to receive both A1s]
(iii)		M1	Solving for T **their** simultaneous equations with 2 variables.
	tension is 257.5 N	A1 2	cao CWO
		7	

Q7, (Jun 2013, Q5)

(i)		If the acceleration is to the right		
		Overall $30 - F = (4+6)\times 2$	M1	Newton's 2nd Law in one direction. No extra forces allowed and signs must be correct.
		$F = 10$	A1	
		If the acceleration is to the left	M1	For considering second direction. No extra forces allowed and signs must be correct.
		$F = 50$	A1	
			[4]	
(ii)		6 kg block $30 - T = 6\times 2$	M1	Newton's 2nd law with correct elements on either block
		$\Rightarrow T = 18$	A1	CAO No follow through from part (i)
		In the other case $T = 42$	A1	CAO No follow through from part (i)
			[3]	

Q8, (Jun 2015, Q2)

(i)			**B1**	Diagrams for both 2 and 9 kg blocks. The tensions must be different from each other. No extra forces.
			B1	Tensions on 6 kg block. The tensions must be different from each other. No extra forces.
			B1	$6g$ and R on 6 kg block. No extra forces.
				Special Case When the tensions are given as T_1, T_2, T_3, T_4 (or equivalent) award up to SC1 SC0 for the first two marks.
			[3]	
(ii)		$9g - T_2 = 9a$	**M1**	First equation correct
		$T_2 - T_1 = 6a$ $T_1 - 2g = 2a$	**M1**	Both the remaining two equations correct. Do not give this mark if both tensions are shown as the same.
		$a = \frac{7}{17}g = 4.04\ (\text{m s}^{-2})$	**A1**	The final three marks are dependent on both M marks a, T_1 and T_2 may be found in any order and FT should be allowed from the first of these found
		$T_1 = 27.7\ (\text{N})$	**A1**	
		$T_2 = 51.9\ (\text{N})$	**A1**	
			[5]	