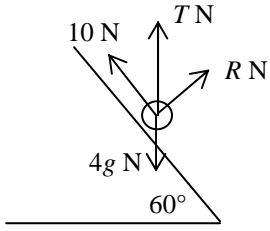| Q 1		mark	comment	sub
(i)	N2L $\uparrow$ $1000-100\times9.8=100a$ a = 0.2 so 0.2 m s^{-2} upwards	M1 B1 A1	N2L. Accept $F = mga$ and no weight Weight correct (including sign). Allow if seen. Accept ±0.2. Ignore units and direction	3
(ii)	$T_{BA}-980=100\times0.8$ so tension is 1060 N	M1 A1	N2L. $F = ma$. Weight present, no extras. Accept sign errors.	2
(iii)	$T_{BA}\cos30=1060$ $T_{BA}=1223.98...$ so 1220 N (3 s. f.)	M1 A1 A1	Attempt to resolve their (ii). Do not award for **their** 1060 resolved unless all forces present and all resolutions needed are attempted. If start again allow no weight. Allow $\sin\leftrightarrow\cos$. No extra forces. Condone sign errors FT **their** 1060 only cao	3
		8		

2		mark	comment	sub
	either Overall, N2L $\rightarrow$ $135 - 9 = (5 + 4)a$	M1	Use of N2L. Allow $F = mga$ but no extra forces. Allow 9 omitted.	
	$a = 14$ so 14 m s^{-2}	A1		
	For A, N2L $\rightarrow$ $T - 9 = 4 \times 14$	M1	N2L on A or B with correct mass. $F = ma$. All relevant forces and no extras.	
	so 65 N	A1	cao	
	or $135 - T = 5a$	M1	* 1 equa ion in T and a. Allow sign errors. Allow $F = mga$	
	$T - 9 = 4a$	A1	Both equations correct and consistent	
	Solving	M1	Dependent on M* solving for T.	
	$T = 65$ so 65 N	A1	cao.	
				4
		4		

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

Q4				
(i)	$P - 800 = 20000 \times 0.2$ $P = 4800$	M1 A1 A1	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'. N2L correct.	3
(ii)	New accn $4800 - 2800 = 20000a$ $a = 0.1$	M1 A1	$F = ma$. Finding new accn. No extra forces. Allow 500 N but not 300 N omitted. Allow sign errors. FT **their** P	2
(iii)	$T - 2500 = 10000 \times 0.1$ $T = 3500$ so 3500 N	M1 A1	N2L with new a. Mass 10000. All forces present for A or B except allow 500 N omitted on A. No extra forces cao	2
				7

5		**mark**		**Sub**

(i) $F = 14000 \times 0.25$ M1   Use of N2L . Allow $F = mga$ and wrong mass. No extra forces.

so 3500 N   A1

           2

(ii) $4000 - R = 3500$ so 500 N   B1   FT *F* from (i). Condone negative answer.

           1

(iii) $1150 - R_{\mathrm{T}} = 4000 \times 0.25$ M1   N2L applied to truck (or engine) using all forces required. No extras. Correct mass. Do not allow use of $F = mga$. Allow sign errors.

so 150 N   A1   cao

           2

(iv)   **either**

Component of weight down slope is   M1   Attempt to find cpt of *weight* (allow wrong mass). Accept $\sin \leftrightarrow \cos$. Accept use of $m\sin\theta$.

Extra driving force is cpt of *mg* down slope   M1   May be implied. Correct mass. No extra forces. Must have resolved weight component. Allow $\sin \leftrightarrow \cos$

$14000 g \sin 3°$
$= 14000 \times 9.8 \times 0.0523359... = 7180.49...$
so 7180 N (3 s. f.)   A1

or

    M1   Attempt to find cpt of *weight* (allow wrong mass). Accept $\sin \leftrightarrow \cos$. Accept use of $m\sin\theta$.

$D - 500 - 14000 g \sin 3 = 14000 \times 0.25$ M1   N2L with all terms present with correct signs and mass.
No extras. FT 500 N. Accept **their** 500 + 150 for resistance. Must have resolved weight component. Allow $\sin \leftrightarrow \cos$.

$D = 11180.49...$ so extra is 7180 N (3 s. f.)   A1   Must be the extra force.

           3
           8

(i)	$T^{AB} \sin \alpha = 147$	M1	Attempt at resolving. Accept $\sin \leftrightarrow \cos$. Must have T resolved and equated to 147.	
	so $T_{AB} = \dfrac{147}{0.6}$	B1	Use of 0.6. Accept correct subst for angle in wrong expression.	
	$= 245$ so 245 N	A1	Only accept answers agreeing to 3 s. f. [Lami: M1 pair of ratios attempted; B1 correct sub;A1]	3
(ii)	$T_{BC} = 245 \cos \alpha$	M1	Attempt to resolve 245 and equate to T, or equiv Accept $\sin \leftrightarrow \cos$	
	$= 245 \times 0.8 = 196$	E1	Substitution of 0.8 clearly shown [SC1 $245 \times 0.8 = 196$] [Lami: M1 pair of ratios attempted; E1]	2
(iii)	Geometry of A, B and C and weight of B the	E1	Mention of two of: same weight: same direction AB: same direction BC	
	same and these determine the tension	E1	Specific mention of same geometry & weight or recognition of same force diagram	2

(iv)

196 N T 90 N

			No extra forces.
		B1	Correct orientation and arrows
		B1	'T' 196 and 90 labelled. Accept 'tension' written out.

either

Realise that 196 N and 90 N are horiz and vert forces where resultant has magnitude and line of action of the tension		M1	Allow for only β or T attempted
$\tan \beta = 90/196$		B1	Use of arctan (196/90) or arctan (90/196) or equiv
$\beta = 24.6638...$ so 24.7 (3 s. f.)		A1	
$T = \sqrt{196^2 + 90^2}$		M1	Use of Pythagoras
$T = 215.675\ldots$ so 216 N (3 s. f.)		E1	

or

$\uparrow \quad T \sin \beta - 90 = 0$		B1	Allow if $T = 216$ assumed
$\rightarrow \quad T \cos \beta - 196 = 0$		B1	Allow if $T = 216$ assumed
Solving $\tan \beta = \dfrac{90}{196} = 0.45918...$		M1	Eliminating T, or…
$\beta = 24.6638...$ so 24.7 (3 s. f.)		A1	[If $T = 216$ assumed, B1 for β ; B1 for check in 2nd
$T = 215.675\ldots$ so 216 N (3 s. f.)		E1	equation; E0]

7

(v)	Tension on block is 215.675.. N (pulley is smooth and string is light)	B1	May be implied. Reasons not required.	
	$M \times 9.8 \times \sin 40 = 215.675... + 20$	M1	*Equating* their tension on the block unresolved ± 20 to weight component. If equation in any other direction, normal reaction must be present.	
		A1	Correct	
	$M = 37.4128\ldots$ so 37.4 (3 s. f.)	A1	Accept answers rounding to 37 and 38	

4

18

7		mark		Sub
(i)		B1	All forces present. No extras. Accept *mg*, *w* etc. All labelled with arrows. Accept resolved parts only if clearly additional. Accept no angles	1
(ii)	Resolve parallel to the plane $10 + T \cos 30 = 4g \cos 30$ $T = 27.65299\ldots$ so 27.7 N (3 s. f.)	M1 A1 A1	All terms present. Must be resolution in at least 1 term. Accept $\sin \leftrightarrow \cos$. If resolution in another direction there must be an equation only in *T* with no forces omitted. No extra forces. All correct Any reasonable accuracy	3
(iii)	Resolve perpendicular to the plane $R + 0.5\,T = 2g$ $R = 5.7735\ldots$ so 5.77 N (3 s. f.)	M1 A1 A1	At least one resolution correct. Accept resolution horiz or vert if at least 1 resolution correct. All forces present. No extra forces. Correct. FT *T* if evaluated. Any reasonable accuracy. cao.	3
	total	7		