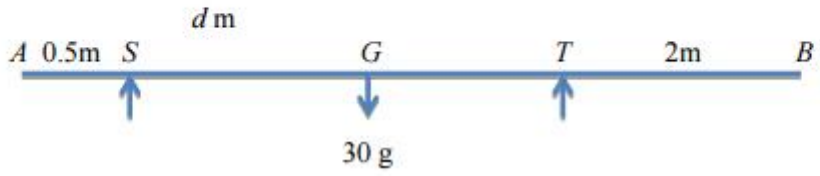
Mark Scheme

Q1.

Question Number	Scheme	Marks
	 $M(S)$: $Mg \leftrightarrow 0.5 = 30g(d-0.5)$ $M(T)$: $Mg \leftrightarrow 2 = 30g(4-d)$ dividing: $4 = \frac{(4-d)}{(d-0.5)}$ => (i) $d = 1.2$ => (ii) $M = 42$	M1 A1 M1 A1 **DM1** A1 A1
	Notes **N.B.** They may use a different variable, other than d, in their moments equations e.g. say they use $x = SG$ consistently, they can score all the marks for their two equations and if they eliminate x correctly, DM1 A1 (for M), and, if they found x correctly, then added 0.5 to obtain d, the other A1 also.	
	First M1 for moments about S (need correct no. of terms, so if they don't realise that the reaction at T is zero it's M0) *to give an equation in d and M only*.	
	First A1 for a correct first equation *in d and M only*. (A1 for both g's or no g's but A0 if one g is missing)	
	N.B. They may use 2 equations and eliminate to obtain their equation *in d and M only* e.g. $M(A)$ $0.5R_S = 30gd$ and (^) $R_S = 30g + Mg$ and then eliminate R_S. The M mark is only earned once they have produced an equation *in d and M only*, with all the usual rules about correct no. of terms etc applying to all the equations they use to obtain it.	
	Second M1 for moments about T (need correct no. of terms, so if they don't realise that the reaction at S is zero it's M0) *to give an equation in d and M only*	
	Second A1 for a correct second equation *in d and M only*. (A1 for both g's or no g's but A0 if one g is missing)	
	N.B. They may use 2 equations and eliminate to obtain their equation *in d and M only* e.g. $M(B)$ $2R_T = 30g(6 - d)$ and (^) $R_T = 30g + Mg$ and then eliminate R_T. The M mark is only earned once they have produced an equation *in d and M only*, with all the usual rules about correct no. of terms etc applying to all the equations they use to obtain it.	

	Third M1, dependent on 1st and 2nd M marks, for eliminating either M or d to produce an equation in either d only or M only.	
	Third A1 for (d =) 1.2 oe (**N.B.** Neither this A mark nor the next one can be awarded if there are any errors in the equations.) **Beware:** If one g is missing consistently from each of their equations, they can obtain $d = 1.2$ but award A0	
	Fourth A1 for (M =) 42	
	Scenario 1: Below are the possible equations, (if they don't use $M(S)$), any two of which can be used, by eliminating R_S, to obtain an equation *in d and M only*, for the first M1. N.B. If R_T appears in any of these and doesn't subsequently become zero then it's M0.	
	$M(A)$ $0.5R_S = 30gd$	
	$M(B)$ $5.5R_S = 30g(6 - d) + 6Mg$	
	$M(T)$ $3.5R_S = 30g(4 - d) + 4Mg$	
	(^) $R_S = 30g + Mg$	
	Scenario 2: Below are the possible equations, (if they don't use $M(T)$), any two of which can be used, by eliminating R_T, to obtain an equation *in d and M only*, for the second M1. N.B. If R_S appears in any of these and doesn't subsequently become zero then it's M0.	
	$M(A)$ $4R_T = 30gd + 6Mg$	
	$M(B)$ $2R_T = 30g(6 - d)$	
	$M(S)$ $3.5R_T = 30g(d - 0.5) + 5.5Mg$	
	(^) $R_T = 30g + Mg$	

Q2.

Question Number	Scheme	Marks
(a)	$T_A + T_C = 85g$ OR $M(A)$, $25g \times 2.5 + 60g \times 5 = 4.5 \times T_C$ OR $M(C)$, $T_A \times 4.5 + 60g \times 0.5 = 25g \times 2$ OR $M(B)$, $T_A \times 5 + T_C \times 0.5 = 25g \times 2.5$ OR $M(G)$, $T_A \times 2.5 + 60g \times 2.5 = 2 \times T_C$ $T_A = \frac{40g}{9} = 44\text{N}$ or 43.6N; $T_C = \frac{725g}{9} = 790\text{N}$ or 789 N	M1 A1 M1 A1 A1; A1 (6)
(b)	$\text{M}(C)$, $25g \times 2 = Mg \times 0.5$	M1 A1
(i)	$M = 100$	A1
(ii)	$T_c = 25g + 100g$ $T_c = 125g$ $(1200$ or $1230)\text{N}$	M1 A1 B1 (6) **12**
	Notes	
(a)	First M1 for a moments or vertical resolution equation, with correct no. of terms and dimensionally correct. First A1 for a correct equation. Second M1 for a moments equation, with correct no. of terms and dimensionally correct. Second A1 for a correct equation. Third A1 for 44 (N) or 43.6 (N) or 40g/9 Fourth A1 for 790 (N) or 789 (N) or 725g/9 Deduct 1 mark for inexact multiples of g **N.B.** If they assume that both tensions are the same, can only score max M1 in (a) for *M(A)* or *M(C)*. If a vertical resolution is used, please give marks for this equation FIRST. If not, enter marks for each moments equation in the order in which they appear.	

(b)	**SCHEME CHANGE** B1 BECOMES THE FOURTH A1 First M1 for a moments equation with $T_A = 0$ First A1 for a correct equation Second A1 for $M = 100$ Second M1 for a(nother) moments or vertical resolution equation with $T_A = 0$ Third A1 for a correct equation Fourth A1 (B1) for $T_C = 125g$ or 1230 (N) or 1200 (N) *N.B. Some candidates may need to solve 2 simult. equations in M and T_C and so will earn the 'equation' marks before they earn Second and Fourth A (B) marks.* If a vertical resolution is used, please give marks for this equation SECOND. If not, enter marks for each moments equation in the order in which they appear. The possible equations are: $T_C = 25g + Mg$ M(C), $25g \times 2 = Mg \times 0.5$ M(A), $25g \times 2.5 + 5Mg = 4.5\ T_C$ M(B), $25g \times 2.5 = T_C \times 0.5$ M(G), $T_C \times 2 = Mg \times 2.5$ Any two of these can each earn M1A1 (M0 if incorrect no. of terms) Then Second A1 for $M = 100$ And Fourth A1 (B1) for $T_C = 125g$ or 1230 or 1200 **N.B.** No marks in (b) if they use any answers from (a) or $M = 60$	

Q3.

Question Number	Scheme	Marks
a	Resolving vertically: $T+2T\left(=3T\right)=W$	M1A1
	Moments about B: $2\times 2T=\left(d-1\right)W$	M1A1
	Substitute and solve for d : $2\times 2T=\left(d-1\right)3T$	DM1
	$d=\frac{7}{3}$(m)	A1 (6)
b	Moments about C: $(T_B\times 2)+(kW\times 1)=W\times\frac{2}{3}$	M1A1
	$T_B=W\frac{\left(2-3k\right)}{6}$ or equivalent	A1 (3)
c	solving $T_B\geq 0$ or $T_B>0$ for k.	M1
	$0<k\leq 2/3$ or $0<k<2/3$ only	A1 (2)
		[11]

Notes for Question
Question (a) **N.B.** If Wg is used, mark as a misread. First M1 for an equation in W and T and possibly d (either resolve vertically or moments about any point other than the centre of mass of the rod), with usual rules. First A1 for a correct equation. Second M1 for an equation in W and T and possibly d (either resolve vertically or moments about any point other than the centre of mass of the rod), with usual rules. Second A1 for a correct equation. **N.B.** The above 4 marks can be scored if their d is measured from a different point Third M1, dependent on first and second M marks, for solving for d Third A1 for $d = 7/3$, 2.3 (m) or better **N.B. Alternative** If a single equation is used (see below) by taking moments about the centre of mass of the rod, $2T(3 - d) = T(d - 1)$, this scores M2A2 (-1 each error) Third M1, dependent on first and second M marks, for solving for d Third A1 for $d = 7/3$ **Question (b)** First M1 for producing an equation in T_B and W *only*, either by taking moments about C, or using two equations and eliminating First A1 for a correct equation Second A1 for $W(2 - 3k)/6$ oe. **N.B.** **M0** if they use any information about the tension(s) from part (a). **Question (c)** M1 for solving $T_B\geq 0$ or $T_B>0$ for k. A1 for $0<k\leq 2/3$ or $0<k<2/3$ only. **N.B.** $T = 0 \Rightarrow k = 2/3$ then answer is M0. If they also solve $T_C\geq 0$ or $T_C>0$, can still score M1 and possibly A1.

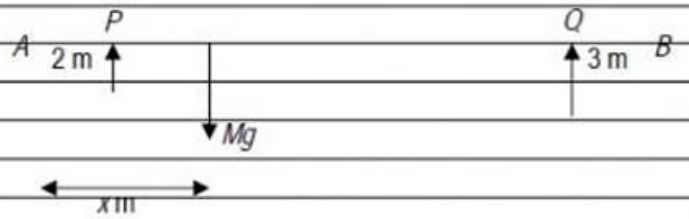
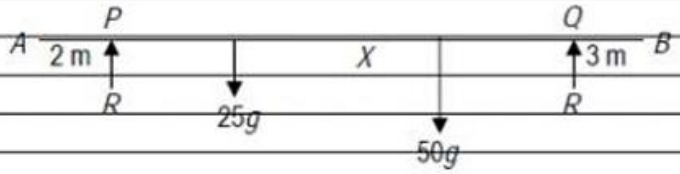
Q4.

Question Number	Scheme	Marks
(a)	$M(D)$, $8R = (80g \text{ x } 6) + (200g \text{ x } 4)$ $R = 160g,\ 1600,\ 1570$	M1 A1 A1 (3)
(b)	$(\uparrow)$, $2S = 80g + 200g$ $S = 140g,\ 1400,\ 1370$	M1 A1 (2)
(c)	$M(B)$, $Sx + (S \text{ x } 10) = (80g \text{ x } 8) + (200g \text{ x } 6)$ $140x + 1400 = 640 + 1200$ $140x = 440$ $x = \frac{22}{7}$	M1 A2 A1 (4) **9**

Q5.

Question Number	Scheme	Marks
(a)	$M(Q)$, $50g(1.4 - x) + 20g \text{ x } 0.7 = T_P \text{ x } 1.4$	M1 A1
	$T_P = 588 - 350x$ Printed answer	A1 (3)
(b)	$M(P)$, $50gx + 20g \text{ x } 0.7 = T_Q \text{ x } 1.4$ or $R(\uparrow)$, $T_P + T_Q = 70g$	M1 A1
	$T_Q = 98 + 350x$	A1 (3)
(c)	Since $0 < x < 1.4$, $98 < T_P < 588$ and $98 < T_Q < 588$	M1 A1 A1 (3)
(d)	$98 + 350x = 3(588 - 350x)$	M1
	$x = 1.19$	DM1 A1 (3) **[12]**

Q6.

Question Number	Scheme	Marks
(a)		
	$M(P)$, $50g \times 2 = Mg \times (x-2)$	M1 A1
	$M(Q)$, $50g \times 3 = Mg \times (12-x)$	M1 A1
(i)	$M = 25$ (kg)	**DM**1 A1
(ii)	$x = 6$ (m)	**DM**1 A1
		(8)
(b)		
	$(\uparrow) R + R = 25g + 50g$	M1 A1 **ft**
	$M(A)$, $2R + 12R = 25g \times 6 + 50g \times AX$	M1 A1 **ft**
	$AX = 7.5$ (m)	**DM**1 A1
		(6)
		[14]