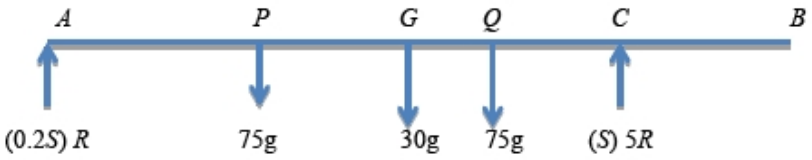
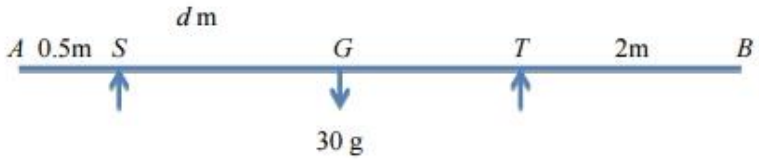
Mark Scheme

Q1.

Question Number	Scheme	Marks
(a)	 $(\uparrow)\ R+5R=75g+30g+75g$ $M(A)\quad 75gx+75g2x+30g\ \times\ 3=5R\ \times\ 4$ $x=\frac{34}{15}=2.3$ or better (N.B. Or another Moments Equation)	M1 A2 M1 A2 A1 (M1 A2) (7)
(b)	uniform – mass is or acts at midpoint of plank; centre of mass is at middle of plank; weight acts at the middle of the plank, centre of gravity is at midpoint rod - plank does not bend, remains straight, is inflexible, is rigid	B1 B1 (2) **9**
	Notes	
(a)	First M1 for either a vertical resolution (with correct of terms) or a moments equation (all terms dim correct and correct no. of terms) First A1 and Second A1 for a correct equation in R (or S where $S = 5R$) only or R and x only or S and x only. (–1 each error , A1A0 or A0A0) Second M1 for a moments equation (all terms dim correct and correct no. of terms) Third A1 and Fourth A1 for a correct equation in R (or S where $S = 5R$) only or R and x only or S and x only. (–1 each error, A1A0 or A0A0) Fifth A1 for $x = {}^{34}/_{15}$ oe or 2.3 (or better) **(i)** In a moments equation, if R and $5R$ (or S and $0.2S$) are interchanged, treat as 1 error. **(ii)** Ignore diagram if it helps the candidate. **(iii)** If an equation is correct but contains both R and S, *or $S = 5R$ is never used*, treat as 1 error. **(iv)** Full marks possible if all g's omitted. **(v)** For inconsistent omission of g, penalise each omission. $M(B),\ R\times 6+5R\times 2=75g(6-x)+75g(6-2x)+30g\times 3$ $M(C),\ 75g(4-x)+75g(4-2x)+30g\times 1=R\times 4$ $M(G),\ 75g(3-x)+5R\times 1=R\times 3+75g(2x-3)$ $M(P),\ Rx+30g(3-x)+75gx=5R(4-x)$ $M(Q),\ 75gx+30g(2x-3)+5R(4-2x)=R\times 2x$	
(b)	First B1 for first correct answer seen. Second B1 for the other answer, but only award this second mark if no extras given.	

Q2.

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

Q3.

Question Number	Scheme	Marks
a	Resolving vertically: $T + 2T\left(=3T\right) = W$ Moments about A: $2W = 2T \times d$ Substitute and solve: $2W = 2\frac{W}{3}d$ $d = 3$	M1A1 M1A1 **DM1** A1 (6)
b	Resolving vertically: $T + 4T = W + kW \quad \left(5T = W\left(1+k\right)\right)$ Moments about A: $2W + 4kW = 3 \times 4T$ Substitute and solve: $2W + 4kW = \frac{12}{5}W\left(1+k\right)$ $2 + 4k = \frac{12}{5} + \frac{12}{5}k$ $\frac{8}{5}k = \frac{2}{5}, \qquad k = \frac{1}{4}$	M1A1 **ft** M1A1 **ft** **DM1** A1 (6)
		[12]

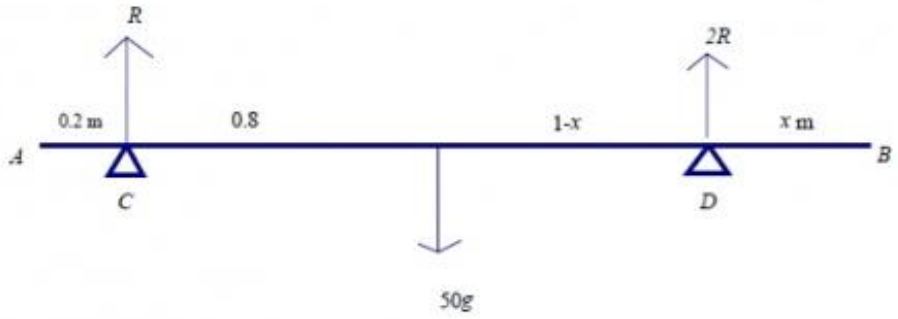
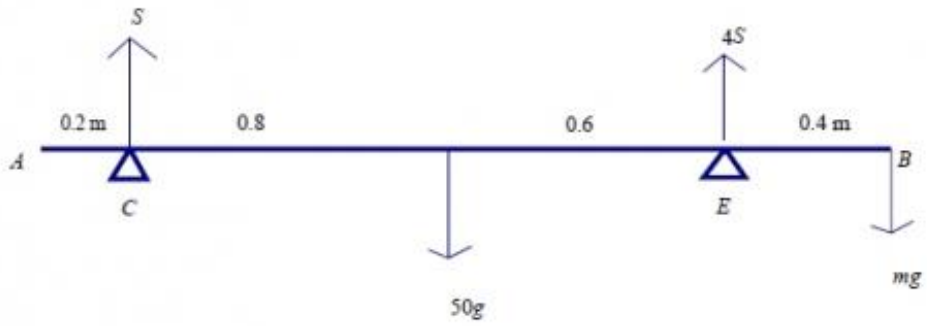
Q4.

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]

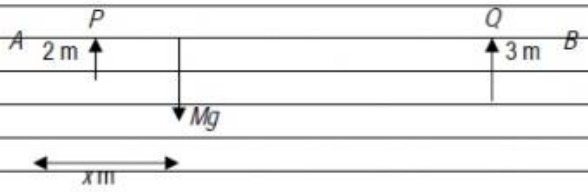
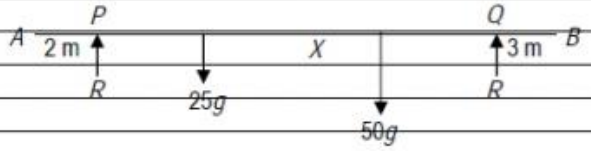
Q5.

Question Number	Scheme	Marks
(a)	$T_A+T_C=85g$	M1 A1
	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 $M(B)$, $T_A\times 5+T_C\times 0.5=25g\times 2.5$	M1 A1
	OR $M(G)$, $T_A\times 2.5+60g\times 2.5=2\times T_C$	
	$T_A=\frac{40g}{9}=44$N or 43.6N; $T_C=\frac{725g}{9}=790$N or 789 N	A1; A1 (6)
(b)	M(C), $25g\times 2=Mg\times 0.5$	M1 A1
(i)	$M=100$	A1
(ii)	$T_c=25g+100g$	M1 A1
	$T_c=125g$ (1200 or 1230)N	B1 (6) **12**

Q6.

Question Number	Scheme	Marks
(a)		
	Vertical equilibrium: $R+2R=50g$,	M1A1
	Moments about C: $50g\times0.8=(1.8-x)\times2\times R$	M1A1
	$3\times0.8=3.6-2x$, $x=0.6$	**DM1**A1
		(6)
(b)		
	S, $4S$	B1
	Vertical equilibrium: $S+4S=(50+m)g=5S$	M1A1
	Moments about B: $50g\times1=4S\times0.4+S\times1.8=3.4S$	M1A1
	$50\times\frac{5}{3.4}=(50+m)$	**DM1**
	$m=400/17$, 24, 23.5 or better	A1
		(7)
		[13]

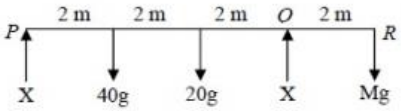
Q7.

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]

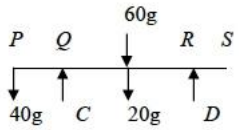
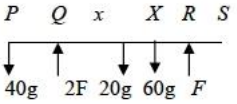
Q8.

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**

Q9.

Question Number	Scheme	Marks
(a)		
(i)	**EITHER** M(*R*), $8X + 2X = 40g \times 6 + 20g \times 4$	M1 A2
	solving for *X*, $X = 32g = 314$ or 310 N	M1 A1
(ii)	($\uparrow$) $X + X = 40g + 20g + Mg$ (or another moments equation)	M1 A2
	solving for *M*, $M = 4$	M1 A1
(i)	**OR** M(*P*), $6X = 40g \times 2 + 20g \times 4 + Mg \times 8$	M1 A2
	solving for *X*, $X = 32g = 314$ or 310 N	M1 A1
(ii)	($\uparrow$) $X + X = 40g + 20g + Mg$ (or another moments equation)	M1 A2
	solving for *M*, $M = 4$	M1 A1 (10)
(b)	Masses concentrated at a point or weights act at a point	B1 (1) **11**

Q10.

Question Number	Scheme	Marks
(a)		
	$C + D = 120g$	
	$M(Q)$, $80g.0.8 - 40g.0.4 = D.1.6$	M1 A1
	solving	M1 A1
	$C = 90g; D = 30g$	M1 A1 A1 (7)
(b)		
	$2F + F = 40g + 20g + 60g$	M1 A1
	$M(Q)$, $60gx + 20g.0.8 = 40g.0.4 + F.1.6$	
	solving	M1 A1
	$QX = x = \frac{16}{15}$ m = 1.07m	M1 A1 (6) **[13]**