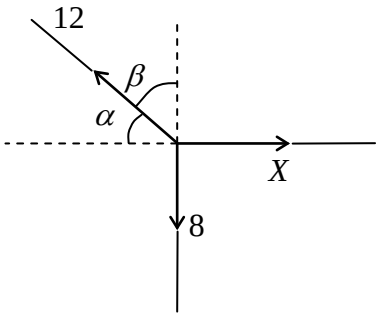
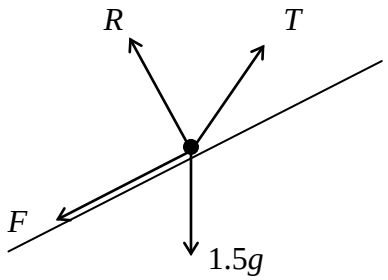
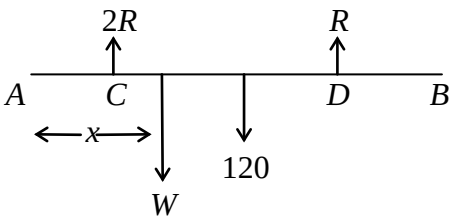
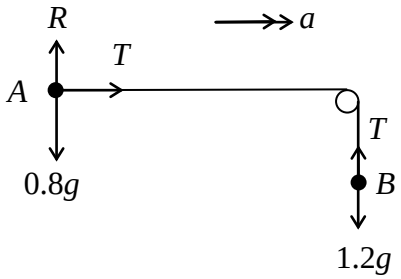
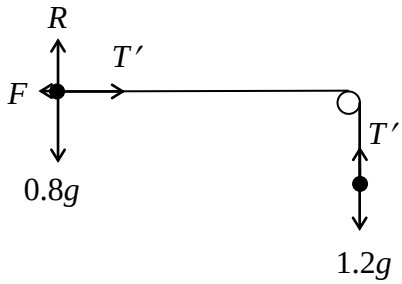
Question Number	Scheme	Marks
1. (*a*)	CLM: $2000 \times 10 = 2000v + 3000 \times 5$	M1, A1
	$v = 2.5$ m s^{-1}	B1 **(3)**
(*b*)	$I = 3000 \times 5$ (or $2000(10 - 2.5)$)	M1
	$= 15\,000$ Ns	A1 **(2)**
		(5 marks)
2. (*a*)	 R(↑) $8 = 12\cos\beta$ or $12\sin\alpha$ $\Rightarrow \beta = 41.8°$ or $\alpha = 48.2°$ $\Rightarrow \theta = 138.2°$	M1 A1 A1 **(3)**
(*b*)	R(→) $X = 12\cos 41.8°$ (or $12\sin 48.2°$)	M1 A1ft
	$= 8.94$	A1 **(3)**
		(6 marks)
3. (*a*)	$\mathbf{a} = [-14\mathbf{i} + 21\mathbf{j} - (6\mathbf{i} - 27\mathbf{j})] \div 4$	M1 A1
	$= (-5\mathbf{i} + 12\mathbf{j})$ m s^{-2}	A1 **(3)**
(*b*)	$\lvert\mathbf{a}\rvert = \sqrt{(5^2 + 12^2)} = 13$	M1
	$\lvert\mathbf{F}\rvert = m\lvert\mathbf{a}\rvert = 0.4 \times 13 = 5.2$ N	M1 A1 **(3)**
		(6 marks)
Alt (*b*)	$\mathbf{F} = 0.4(5\mathbf{i} + 12\mathbf{j}) = 2\mathbf{i} + 4.8\mathbf{j}$	M1
	$\lvert\mathbf{F}\rvert = \sqrt{(2^2 + 4.8^2)} = 5.2$ N	M1 A1 **(3)**

Question Number	Scheme	Marks
4. (*a*)	$\mathbf{p} = 10t\mathbf{j}$	B1
	$\mathbf{q} = (6\mathbf{i} + 12\mathbf{j}) + (-8\mathbf{i} + 6\mathbf{j})t$	M1 A1 **(3)**
(*b*)	$t = 3$: $\mathbf{p} = 30\mathbf{j}$, $\mathbf{q} = -18\mathbf{i} + 30\mathbf{j}$	M1 A1
	$\Rightarrow$ dist. apart = 18 km	A1 **(3)**
Alt. (*b*)	$\mathbf{PQ} = \mathbf{q} - \mathbf{p} = (6 - 8t)\mathbf{i} + (12 - 4t)\mathbf{j}$	M1
	$t = 3$: $\mathbf{PQ} = -18\mathbf{i} + 0\mathbf{j}$ or $\lvert\mathbf{PQ}\rvert^2 = (6 - 8t)^2 + (12 - 4t)^2$	A1
	Dist. = 18 km $t = 3 \rightarrow \lvert\mathbf{PQ}\rvert = 18$	A1
(*c*)	Q north of $P \Rightarrow 6 - 8t = 0$	M1
	$t = \frac{3}{4}$	A1 **(2)**
		(8 marks)
5.	 R(↗): $T\cos 20° = F + 1.5g\sin 30°$	M1 A2,1,0
	R(↖): $T\sin 20° + R = 1.5g\cos 30°$	M1 A2,1,0
	Using $F = \frac{1}{3}R$	M1
	Eliminating R, solve T	M1, M1
	$T = 11$ or 11.0 N	A1
		(10 marks)
6.		
(*a*)	M(A): $Wx + 120 \times 1.5 = R \times 2 + 2R \times 1$	M1 A2, 1, 0
	R(↑) $3R = W + 120$	M1 A1
	Hence $Wx + 180 = 3R = W = 120$	M1
	$W(1 - x) = 60$	A1
	$W = \dfrac{60}{1 - x}$	M1 A1cso **(8)**
(*b*)	$W > 0 \Rightarrow x < 1$	M1 A1 **(2)**
		(10 marks)

Question Number	Scheme	Marks
7. (*a*)	$v^2 = u^2 + 2as$: $0 = u^2 - 2 \times 9.8 \times 25.6$	M1 A1
	$u^2 = 501.76 \Rightarrow u = 22.4$ **(✶)**	A1cso **(3)**
(*b*)	$-1.5 = 22.4T - 4.9T^2$	M1 A1
	$4.9T^2 - 22.4T - 1.5 = 0$	
	$T = \dfrac{22.4 \pm \sqrt{22.4^2 + 4 \times 1. \times 4.9)}}{9.8}$	M1
	$= 4.64$ s	A1 **(4)**
(*c*)	Speed at ground $v = 22.4 - 9.8 \times 4.64$	M1
	$v = -23.07$	A1
	(or $v^2 = 22.4^2 + 2 \times 9.8 \times 1.5$, $v = 23.05$)	
	$v^2 = u^2 + 2as$: $0 = 23.07^2 + 2 \times a \times 0.025$	M1 A1ft
	($\rightarrow a = -10644.5$)	
	$F - 0.6g = 0.6a$	M1
	$F = 6390$ N (3 sf)	A1 **(6)**
(*d*)	Air resistance; variable F;	B1 **(1)**
		(14 marks)

Question Number	Scheme	Marks
8. (*a*)		
	A: $T = 0.8a$	B1
	B: $1.2g - T = 1.2a$	M1 A1
	Solve: $T = 0.48g = 4.7$ N	M1 A1 **(5)**
(*b*)	$a = 0.6g = 5.88$	M1
	Hence $0.6 = \frac{1}{2} \times 0.6g \times t^2$	M1
	$t = 0.45$ or 0.452 s	A1 **(3)**
		
	$F = \mu R = \frac{1}{5} \times 0.8g$	B1
	A: $T' - F = 0.8a'$	M1 A1
	B: $1.2g - T' = 1.2a'$	B1
	Solve: $a' = 0.52g$	M1 A1
	$0.6 = \frac{1}{2} \times 0.52g \times t^2$	M1
	$t = 0.49$ or 0.485 s	A1 **(8)**
		(16 marks)