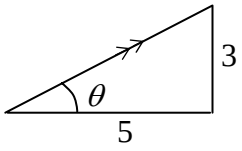
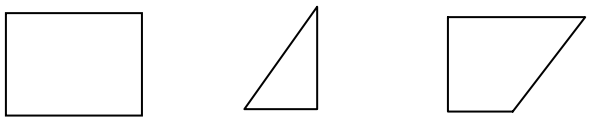
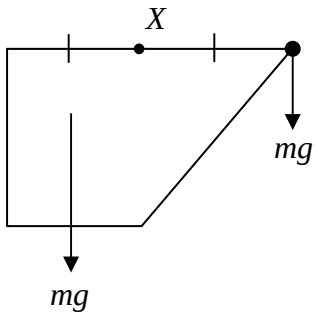
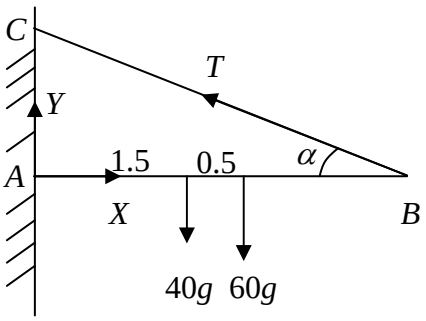
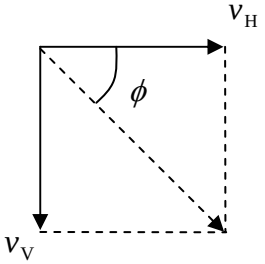
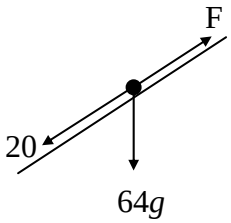
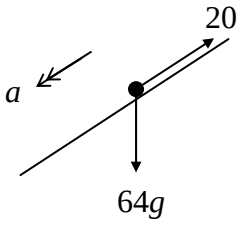
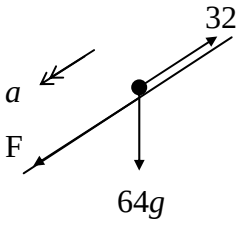
Question Number	Scheme	Marks
1. (*a*)	$x = \int 6t - 2t^2 \ \mathrm{d}x$	M1
	$= 3t^2 - \frac{2}{3}t^3$	A1
	$v = 0 \Rightarrow 6t - 2t^2 = 0 \Rightarrow t = 3$ (or 0)	M1
	$t = 3$: $x = (3 \times 9) - (\frac{2}{3} \times 27) = 9$ m	M1 A1
		(5 marks)
2. (*a*)	$\mathbf{I} = 0.2[(15\mathbf{i} + 15\mathbf{j}) - (-10\mathbf{i})]$	M1
	$= 5\mathbf{i} + 3\mathbf{j}$	M1
	$\lvert\mathbf{I}\rvert = \sqrt{(5^2 + 3^2)} = \sqrt{34} = 5.8$ Ns	M1 A1 (4)
(*b*)	 $\tan\theta = \frac{3}{5} \Rightarrow \theta = 31°$ (nearest degree)	M1 A1 (2)
(*c*)	K E Gain $= \frac{1}{2} \times 0.2[(15^2 + 15^2) - 10^2)] = 35$ J	M1 A1 (2)
		(8 marks)
3. (*a*)		
	Area: $6a^2$ a^2 $5a^2$ (ratio)	B1
	CM from *AD*: $\frac{3a}{2}$ $\left(2a + \frac{2a}{3}\right) = \frac{8a}{3}$ $\bar{x}$	B1 B1
	$6 \times \frac{3a}{2} - 1 \times \frac{8a}{3} = 5\bar{x}$	M1
	$\bar{x} = \frac{19a}{15}$	A1 (5)
(*b*)	M(*X*),  $Mg\left(\frac{3a}{2} - \frac{19a}{15}\right) = mg \times \frac{3a}{2}$	M1 A1 ft A1
	$\Rightarrow m = \frac{7M}{45}$	A1 (4)
		(9 marks)

(ft = follow through mark)

Question Number		Scheme	Marks
4.	(*a*)	 M(*A*), $40g \times \frac{3}{2} + 60g \times 2 = T \sin \alpha \times 3$ use of $\sin \alpha = \frac{3}{5}$ $60g + 120g = \frac{9T}{5}$ $\Rightarrow T = 100g = 980$ N (*)	M1 A2, 1, 0 B1 A1 (5)
	(*b*)	$(\rightarrow)$: $X = T \cos \alpha$ $(\uparrow)$ $Y + T \sin \alpha = 100g$ $R = \sqrt{(X^2 + Y^2)} = \sqrt{(784^2 + 392^2)}$ $= 877$ N (3 sf)	B1 M1 A1 M1 A1 A1 (6)
	(*c*)	Cable light $\Rightarrow$ tension same throughout $\Rightarrow$ force on rod at *D* is $60g$	B1 (1)
			(12 marks)
5.	(*a*)	$(\rightarrow)$: $u \cos \alpha \times T = 8$ $u \times \frac{4}{5} \times T = 8$ $uT = 10$ (*)	 M1 A1 (2)
	(*b*)	$(\uparrow)$: $-4 = u \sin \alpha T - \frac{1}{2} gT^2$ $-4 = u \times \frac{3}{5}\left(\frac{10}{u}\right) - \frac{1}{2} \times 9.8\left(\frac{10}{u}\right)^2$ $u = 7$	M1 A1 M1 M1 A1 (7)
		 $v_H = u \cos \alpha = \frac{28}{5}$ $v_V^2 = (-u \sin \alpha) + 2g \times 4$ $\Rightarrow v_V = 9.8$ $(= \frac{49}{5})$ $\tan \phi = \frac{49/5}{28/5} = \frac{7}{4}$	B1 ft M1 A1 ft M1 A1 cao (5)
			(12 marks)

(ft = follow through mark; cao = correct answer only; (*) indicates final line is given on the paper)

Question Number		Scheme	Marks
6.	(*a*)		
		(↗): F = 20 + 64*g* sin α	M1
		= 64.8 N	A1
		$P = Fv = 64.8 \times 5 = 324$ W	M1 A1 (4)
	(*b*)		
		(↙): 64*g* sin α – 20 = 64*a*	M1 A1
		$a = 0.3875$ m s^{-2}	A1
		$v^2 = 5^2 + 2 \times 0.3875 \times 80$	M1
		$v = \sqrt{87} = 9.3$ m s^{-1} (2 sf)	A1 (5)
	(*c*)	$\frac{8}{5} \times 20 = 32$ N	B1 (1)
	(*d*)		
		F = $\frac{200}{8}$	B1
		$\frac{200}{8}$ + 64*g* sin α – 32 = 64*a*	M1 A1
		$a = 0.59$ m s^{-2} (2 sf)	A1 (4)
			(14 marks)

Question Number	Scheme	Marks
7. (*a*)	$u \rightarrow$ $\rightarrow 0$ A (*m*) e (2*m*) B $\rightarrow$ $\rightarrow$ v_1 v_2	$mu = mv_1 + 2mv_2$ $eu = -v_1 + v_2$ $v_1 = \frac{u}{3}(1-2e)$; $v_2 = \frac{u}{3}(1+e)$	M1 A1 M1 A1 M1 A1 A1 (7)
(*b*)	$v_1 > 0 \Rightarrow \frac{u}{3}(1-2e) > 0 \Rightarrow e < \frac{1}{2}$	M1 A1 (2)
(*c*)	$v_2 \rightarrow$ $\rightarrow 0$ A (2*m*) (4*m*) B $\rightarrow$ $\rightarrow$ v_3 v_4	$2mv_2 = 2mv_3 + 4mv_4$ $ev_2 = -v_3 + v_4$ $v_3 = \frac{v_2}{3}(1-2e) = \frac{u}{9}(1-2e)(1+e)$	M1 M1 A1
	Further collision if $v_1 > v_3$	
	i.e. if $\frac{u}{3}(1-2e) > \frac{u}{9}(1-2e)(1+e)$	M1
	i.e. if $3 > 1 + e$ (as $(1-2e) > 0$)	
	i.e. if $2 > e$	M1
	which is always true, so further collision occurs	A1 cso (6)
		(15 marks)

(cso = correct solution only)