

Question Number	Scheme	Marks
1. (a)	$T = \frac{10000}{20}$ or equivalent $T - R - 400 g \sin \theta = 0$ $R = 220$	M1 A1 M1 A1 A1 (5 marks)
2. (a)	$\mathbf{a} = 2\mathbf{i} - 6\mathbf{j}$ $t = 4: \mathbf{a} = 8\mathbf{i} - 6\mathbf{j}$ $ \mathbf{F} = 0.75 \sqrt{(8^2 + 6^2)} = 7.5\text{N}$	M1 dep. M1 M1 M1 A1 (5)
(b)	$\mathbf{I} = 9\mathbf{i} - 9\mathbf{j}$ $9\mathbf{i} - 9\mathbf{j} = \frac{3}{4}(\mathbf{v} - (27\mathbf{i} - 30\mathbf{j}))$ $\mathbf{v} = 39\mathbf{i} - 42\mathbf{j} \text{ m s}^{-1}$	B1 M1 A1 f.t. A1 (4) (9 marks)
3. (a)	$\frac{1}{2} \times 2 \times 10^2 - \frac{1}{2} \times 2 \times v^2 = 2g \times 3 \sin 30^\circ$ $v = 8.4 \text{ m s}^{-1} (8.40 \text{ m s}^{-1})$	M1 A1 A1 A1 (4)
Or	$(a = -g \sin 30^\circ)$ $v^2 = 10^2 - 2g \sin 30^\circ \times 3$ $v = 8.4 \text{ m s}^{-1} (8.40 \text{ m s}^{-1})$	M1 A1 A1 A1 (4)
(b)	$R = 2g \cos 30^\circ$ $3F; \frac{1}{2} \times 2 \times 10^2 - \frac{1}{2} \times 2 \times 7^2; 2g \times 3 \sin 30^\circ$ $3\mu R = \frac{1}{2} \times 2 \times 10^2 - \frac{1}{2} \times 2 \times 7^2 - 2g \times 3 \sin 30^\circ$ $\mu = 0.42(4)$	B1 B2 (-1 e.e.o.o) M1 A1 (5)
OR	$R = 2g \cos 30^\circ$ $a = \frac{(7^2 - 10^2)}{2 \times 3} = \frac{17}{2}; -F; -2g \sin 30^\circ$ $-\mu R - 2g \sin 30^\circ = -\frac{17}{2} \times 2$ $\mu = 0.42(4)$	B1 B2 (-1 e.e.o.o) M1 A1 (5) (9 marks)

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4.	<p>(a) $M(B), N 2a \cos \theta = W a \cos \theta + \frac{1}{4} W \frac{3a}{2} \sin \theta$</p> <p>$N = \frac{7W}{8}$</p> <p>(b) $R = \frac{1}{4} W; \quad F + N = W$</p> <p>$F \leq \mu R$ or $F = \mu R$</p> <p>$\frac{1}{2} \leq \mu^*$ (exact)</p> <p>(c) It does not bend</p> <p>Or has negligible thickness</p>	<p>M1 A2 (-1 e.e.)</p> <p>dep. M1 A1 (5)</p> <p>B1; B1</p> <p>M1</p> <p>A1 c.s.o. (5)</p> <p>B1 (1)</p> <p>(10 marks)</p>
5.	<p>(a) $2ut = 735$</p> <p>$0 = 3ut - \frac{1}{2} gt^2$</p> <p>eliminating t</p> <p>$u = 24.5^*$</p> <p>(b) $t = \frac{735}{49} = 15$</p> <p>(c) Initially: $v^2 = (2u)^2 + (3u)^2$</p> <p>(7803.25)</p> <p>$\frac{1}{2} mv^2 - \frac{1}{2} m 65^2 = mgh$</p> <p>$h = 180 \text{ m (183 m)}$</p> <p>OR $v_y^2 = 65^2 - (2u)^2$ (1824)</p> <p>$v_y^2 = (3u)^2 - 2gh$</p> <p>$h = 180 \text{ m (183 m)}$</p>	<p>M1 A1</p> <p>M1 A1</p> <p>dep. M1</p> <p>A1 (6)</p> <p>M1 A1 (2)</p> <p>M1</p> <p>M1 A1</p> <p>A1 (4)</p> <p>M1</p> <p>M1 A1</p> <p>A1 (4)</p> <p>(12 marks)</p>

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

Question Number	Scheme	Marks
6. (a)	$u \rightarrow \rightarrow 0$ CLM: $mu = mv_1 + 3mv_2$ $m \quad 3m$ NIL: $eu = -v_1 + v_2$ $v_1 \rightarrow \quad v_2 \rightarrow$ solving, $v_2 = \frac{u}{4}(1+e)^*$	B1 M1 A1 dep. M1 A1 (5)
(b)	Solving for v_1 : $\left \frac{u}{4}(1-3e) \right $	M1 A1 (2)
(c)	$\frac{1}{2} m \frac{u^2}{16} (1-3e)^2 + \frac{1}{2} 3m \frac{u^2}{16} (1+e)^2 = \frac{1}{6} mu^2$ $e^2 = \frac{1}{9}$ $e = \frac{1}{3}$	M1 A1 f.t. A1 dep. M1 A1 A1 (6)
(d)	$v_1 = \frac{u}{4} (1 - 3 \times \frac{1}{3}) = 0 \Rightarrow$ at rest.	A1 c.s.o. (1) (14 marks)

Question Number	Scheme	Marks
7. (a)	$AD: 10m\bar{x} = 3m \frac{5a}{2} + 3m \times 5a$	M1 A1
	$\bar{x} = 2.25a$ *	A1 (3)
(b)	$AB: 10m\bar{y} = 2m \times 2a + 3m \times a$	M1
	$\bar{y} = 0.7a$	A1 (2)
(c)	$\tan \theta = \frac{2.5a - \bar{x}}{\bar{y}}$	M1 A1 f.t.
	$\theta = 20^\circ$	A1 (3)
	$M(0), 10mg \times \frac{a}{4} = P \times 2a$	M1 A1 A1
	(OR: $4mg \times \frac{5a}{2} - 3mg \times \frac{5a}{2} = P \times 2a$)	
	$P = \frac{5mg}{4}$ * (exact)	A1 (4)
(e)	$S = \frac{5mg}{4}; R = 10mg$	B1; B1
	$F = \sqrt{S^2 + R^2} = \frac{5mg\sqrt{65}}{4}$ (10.1 mg)	M1 A1 (4)
		(16 marks)