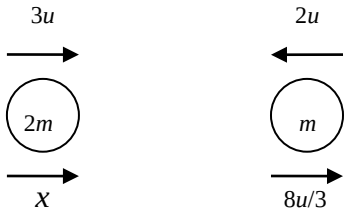
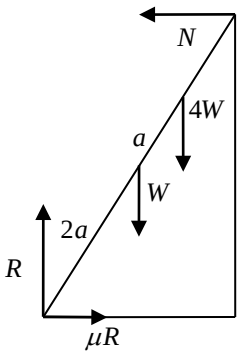
Question Number	Scheme	Marks
1.	(a) Kinetic Energy = $\frac{1}{2}\times 3\times 8^2 = 96$, J	B1 B1 (2)
	(b) $F = \mu 3g$	B1
	Work-Energy $\mu 3g \text{x} 12 = 96$	M1 A1ft
	$\mu = 0.27$ or 0.272	A1 (4)
	Alternative for (b) $a = \frac{8^2 - 0^2}{2\times 12} = \frac{8}{3}$	B1
	N2L $\mu 3g = 3 \text{ x } \frac{8}{3}$	M1 A1
	$\mu = 0.27$ or 0.272	A1 (4) **6**
2.	(a) $\dot{\mathbf{r}} = (2t+4)\mathbf{i} + (3-3t^2)\mathbf{j}$	M1 A1
	$\dot{\mathbf{r}}_3 = 10\mathbf{i} - 24\mathbf{j}$ substituting t =3	M1
	$\lvert\dot{\mathbf{r}}_3\rvert = \sqrt{(10^2 + 24^2)} = 26 \ (\text{m s}^{-1})$	M1 A1 (5)
	(b) $0.4(\mathbf{v} - (10\mathbf{i} - 24\mathbf{j})) = 8\mathbf{i} - 12\mathbf{j}$ ft their $\dot{\mathbf{r}}_3$	M1 A1ft
	$\mathbf{v} = 30\mathbf{i} - 54\mathbf{j} \ (\text{m s}^{-1})$	A1 (3) **8**
3.	(a) $T_r = \frac{12000}{15} \ (= 800)$	M1
	N2L $800 - R = 1000\times 0.2$ ft their 800	M1 A1ft
	$R = 600$ ✱ cso	A1 (4)
	(b) $1000g \times \frac{1}{40} + T_r = R$	M1 A1
	$T_r = \frac{7000}{U}$	M1
	$U \approx 20$ accept 19.7	M1 A1 (5) **9**

Question Number	Scheme	Marks
4.	(a) 	
	LM $6mu - 2mu = 2mx + \frac{8}{3}mu$ $\left(x = \frac{2}{3}u\right)$	M1 A1
	NEL $\frac{8}{3}u - x = 5ue$	M1 A1
	Solving to $e = \frac{2}{5}$	M1 A1 (6)
	(b) Initial K.E.$= \frac{1}{2}\times 2m(3u)^2 + \frac{1}{2}\times m(2u)^2 = 11mu^2$	
	Final K.E. $= \frac{1}{2}\times 2m\left(\frac{2}{3}u\right)^2 + \frac{1}{2}\times m\left(\frac{8}{3}u\right)^2 = 4mu^2$ both	M1
	Change in K.E. $= 7mu^2$ ✱ M1 Subtracting and simplifying to kmu^2 A1cso	M1 A1 (3)
	(c) $m\left(\frac{8}{3}u + v\right) = \frac{14}{3}mu$ $(v = 2u)$	M1 A1
	$e = \frac{2}{8/3} = \frac{3}{4}$	M1 A1 (4)
		13

Question Number	Scheme	Marks
5.	(a)	
	$12m\bar{x} = 6m \times 9$	M1
	$\bar{x} = 4\frac{1}{2}$	A1
	$12m\bar{y} = 16m - 8m$	M1
	$\bar{y} = \frac{2}{3}$	A1 (4)
	(b) $(12+k)m \times 4 = 12m \times 4\frac{1}{2} + km \times 3$ ft their $\bar{x}$	M1 A1ft
	$k = 6$	A1 (3)
	(c) $18m \times \lambda = 12m \times \frac{2}{3}, \Rightarrow \lambda = \frac{4}{9}$	M1 A1 (2)
	(d) $\tan\theta = \frac{4}{4/9}, \Rightarrow \theta \approx 83.7°$ ft their λ, cao	M1 A1ft A1 (3) **12**
6.	(a) 	
	μR	B1
	$\uparrow R = 5W$	B1
	M(B): $4Wa\cos\theta + W.2a\cos\theta + \mu R4a\sin\theta = R.4a\cos\theta$	M1 A1
	Having enough equations & solving them for μ	M1
	$\mu = 0.35$	A1 (6)
	(b) $\uparrow S = (5+k)W$	B1
	Use of $F = 0.35S$ or $F \le 0.35S$	M1
	M(B): $kW4a\cos\theta + W.2a\cos\theta + F4a\sin\theta = S.4a\cos\theta$	M1 A1
	Having enough equations & solving them for k	M1
	$k = \frac{10}{7}$ awrt 1.42	A1
	$k \square \frac{10}{7}$ ft their k, accept > and decimals	A1ft (7) **13**

Question Number	Scheme	Marks
7.	(a) $u_x = 11\cos 30°$	B1
	$\rightarrow \quad 11\cos 30° \times t = 10 \quad \Rightarrow \quad t = 1.05$ (s) cao	M1 A1 (3)
	(b) $s = \underline{11\sin 30°} \times t - 4.9t^2 \approx 0.37$	B1 M1 A1
	$(2-1) - 0.37 = 0.63$ (m)	A1 (4)
	(c) $V\cos 30° \times t = 10 \qquad \left(t = \dfrac{10}{V\cos 30°}\right)$	M1 A1
	$s = V\sin 30° \times \dfrac{10}{V\cos 30°} - \dfrac{4.9\times 100}{V^2\cos^2\theta} = 1$	M1 A1
	$V^2 = 136.86$	M1
	$V \approx 12$ accept 11.7	A1 (6)
	(d) B and/or T are not particles	
	(They have extension giving a range of answers)	B1 (1)
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