1

$T\cos\theta = mg$

$T\sin\theta = m\omega^2 r$

$'\frac{5}{3}mg'\sin\theta = m\omega^2 a\sin\theta$

$\omega = \sqrt{\dfrac{5g}{3a}}$

4

Areas	$2a^2$	$\frac{1}{2}a(2a)$	$2a^2 + \frac{1}{2}a(2a)$
Distances from D	$-\frac{1}{2}a$	$\frac{2}{3}a$	$\overline{x}$

$-2a^2\left(\frac{1}{2}a\right) + \frac{1}{2}\left(2a^2\right)\left(\frac{2}{3}a\right) = \left(3a^2\right)\overline{x}$

$m\left(\frac{1}{9}a\right) = km(2a)$

$k = \frac{1}{18}$

Alternative method for question 4

Ratio of masses	$2a^2$	$\frac{1}{2}a(2a)$	$k\left(2a^2 + \frac{1}{2}a(2a)\right)$

$2\left(\frac{1}{2}a\right) = 1\left(\frac{2}{3}a\right) + 3k(2a)$

$k = \frac{1}{18}$

1	Let v_A and v_B be the speeds of A and B respectively after the collision. $4mv_A + mv_B = 4mu$
	$-v_A + v_B = eu$
	$v_A = \frac{3}{4}u, \quad v_B = u$
	$e = \frac{1}{4}$
	Alternative method for question 1
	Let v_A and v_B be the speeds of A and B respectively after the collision. $4mv_A + mv_B = 4mu$
	$-v_A + v_B = eu$
	$v_A = \frac{1}{5}u\left(4-e\right), \; v_B = \frac{4}{5}u\left(1+e\right)$
	$\frac{4m\left(\frac{1}{5}u\left(4-e\right)\right)}{m\left(\frac{4}{5}u\left(1+e\right)\right)} = 3, \qquad e = \frac{1}{4}$

2	$\uparrow N_1 \cos\theta_1 = mg$ $\rightarrow N_1 \sin\theta_1 = m\left(r\sin\theta_1\right)\omega_1^2$
	$\uparrow N_2 \cos\theta_2 = mg$ $\rightarrow N_2 \sin\theta_2 = m\left(r\sin\theta_2\right)\omega_2^2$
	$\dfrac{\frac{5}{4}g}{\frac{5}{3}g} = \dfrac{r\omega_1^2}{r\omega_2^2}$
	$\dfrac{\omega_1}{\omega_2} = \frac{1}{2}\sqrt{3}$

1	$T_A \cos 45° + T_B \sin 45° = m\omega^2 l \sin 45°$
	$T_A \sin 45° - T_B \cos 45° = mg$
	$2T_A = m\omega^2 l + \sqrt{2}\,mg$
	$T_A = \frac{1}{2}m\left(\omega^2 l + \sqrt{2}\,g\right)$