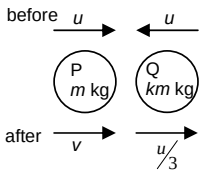
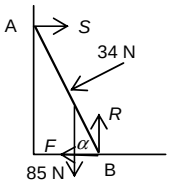
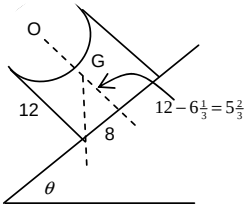
4762 Mechanics 2

Q 1		mark	comment	sub
(a)				
(i)		B1		1
(ii)				
	$mu - kmu = mv + km\frac{u}{3}$	M1	PCLM applied	
		A1	Either side correct (or equiv)	
	$v = \left(1 - \frac{4k}{3}\right)u$	E1	Must at least show terms grouped	
				3
(iii)				
	Need $v < 0$	E1	Accept $\frac{4k}{3} > 1$ without reason	
	so $k > \frac{3}{4}$	B1		
			[SC1: $v = 0$ used and inequality stated without reason]	
				2
(iv)				
	$\frac{\frac{u}{3} - v}{-u - u} = -\frac{1}{2}$	M1	Use of NEL	
		A1		
	so $v = -\frac{2u}{3}$	E1		
	$-\frac{2u}{3} = u\left(1 - \frac{4k}{3}\right)$	M1		
	so $k = 1.25$	A1	cao	
				5
(b)				
(i)	$9\begin{pmatrix}1\\-2\end{pmatrix} + 5\begin{pmatrix}3\\2\end{pmatrix} = 8\mathbf{V}$	M1	Use of PCLM	
		B1	Use of mass 8 in coalescence	
		M1	Use of **I** = **F***t*	
	$\mathbf{V} = \begin{pmatrix}3\\-1\end{pmatrix}$	E1		
				4
(ii)				
	i cpt $3 \to -3 \times \frac{1}{2}$	M1	Allow wrong sign	

	j cpt unchanged	B1	May be implied	
	new velocity $\begin{pmatrix} -1.5 \\ -1 \end{pmatrix}$ m s^{-1}	A1	cao [Award 2/3 if barrier taken as $\begin{pmatrix} 1 \\ 0 \end{pmatrix}$]	3
		18		

Q 2		mark	comment	sub
(a)				
(i) (A)	Yes. Only WD is against conservative forces.	E1	Accept only WD is against gravity or no work done against friction.	
(B)	Block has no displacement in that direction	E1		2
(ii)				
	$0.5\times50\times1.5^2 = 20gx - 5gx$	M1	Use of WE with KE. Allow m = 25.	
		B1	Use of 50	
		M1	At least 1 GPE term	
		A1	GPE terms correct signs	
	x = 0.38265… so 0.383 m (3 s. f.)	A1	cao	5
(iii)				
	$0.5\times50\times V^2 - 0.5\times50\times1.5^2$	M1	WE equation with WD term. Allow GPE terms missing	
		B1	Both KE terms. Accept use of 25.	
	$= 2\times20g - 2\times5g - 180$	B1	Either GPE term	
		B1	180 with correct sign	
	V = 2.6095… so 2.61 m s^{-1}	A1	cao	5
(b)				
	Force down the slope is			
	$2000 + 450g\sin 20$	M1	Both terms. Allow mass not weight	
		B1	Weight term correct	
	Using $P = Fv$	M1		
	$P = (2000 + 450g\sin 20)\times2.5$	F1	FT **their** weight term	
	P = 8770.77… so 8770 W (3 s. f.)	A1	cao	5
		17		

Q 3		mark	comment	sub
(i)				
	c.w. moments about A	M1	Moments equation.	
	$5R_B - 3\times 85 = 0$ so $R_B = 51$ giving 51 N ↑	A1	Accept no direction given	
	Either a.c. moments about B or resolve ↑	M1		
	$R_A = 34$ so 34 N ↑	F1	Accept no direction given	
				4
(ii)				
	c.w. moments about A	M1	Moments with attempt to resolve at least one force. Allow $s \leftrightarrow c$.	
	$85\times 3\cos\alpha - 27.2\times 5\sin\alpha = 0$	B1	Weight term	
		B1	horiz force term	
	so $\tan\alpha = \frac{3\times 85}{27.2\times 5} = \frac{15}{8}$	E1	Must see some arrangement of terms or equiv	
				4
(iii)				
		B1	All forces present and labelled	
	a.c. moments about B	M1	Moments with attempt to resolve forces and all relevant forces present	
	$85\times 2\times\cos\alpha + 34\times 2.5 - 5S\times\sin\alpha = 0$	B1	34×2.5	
		A1	All other terms correct. Allow sign errors.	
	S = 37.4	A1	All correct	
	Resolving horizontally and vertically	M1	Either attempted	
	→ $S - F - 34\sin\alpha = 0$ so F = 7.4	E1		
	↑ $R - 85 - 34\cos\alpha = 0$	A1	R = 101 need not be evaluated here [Allow A1 for the two expressions if correct other than $s \leftrightarrow c$]	
	Using $F = \mu R$	M1		
	$\mu = \frac{7.4}{101}$ = 0.07326… so 0.0733 (3 s. f.)	A1	cao	
				10
		18		

Q 4		mark	comment	sub
(i)				
	Taking a *y*-axis vert downwards from O		Allow areas used as masses	
	$2\pi\sigma\times8^2\times4+2\pi\sigma\times8\times k\times\frac{k}{2}$	M1	Method for c.m.	
		B1	'4' used	
		B1	$16\pi k$	
		B1	*k*/2 used	
	$=\left(2\pi\sigma\times8^2+2\pi\sigma\times8k\right)\bar{y}$	B1	Masses correct	
	so $\bar{y}=\frac{64+k^2}{16+2k}$	E1	Must see some evidence of simplification Need no reference to axis of symmetry	
				6
(ii)				
	k = 12 gives OG as 5.2 and mass as $320\pi\sigma$	B1	Allow for either. Allow $\sigma=1$	
	$320\pi\sigma\times5.2+\pi\sigma\times8^2\times12$	M1	Method for c.m. combining with (i) or starting again	
		B1	One term correct	
		B1	Second term correct	
	$=\left(320\pi\sigma+64\pi\sigma\right)\bar{y}$			
	$\bar{y}=6\frac{1}{3}$	E1	Some simplification shown	
				5
(iii)				
		B1 B1 B1	G above edge of base $12-6\frac{1}{3}=5\frac{2}{3}$ seen here or below 8 seen here or below	
	$\tan\theta=\frac{8}{5\frac{2}{3}}$	M1	Accept $\frac{5\frac{2}{3}}{8}$ or attempts based on $6\frac{1}{3}$ and 8.	
	θ = 54.6887… so 54.7° (3 s. f.)	A1	cao	
				5
(iv)				
	Slips when $\mu=\tan\theta$	M1	Or ….	
	$\frac{8}{5\frac{2}{3}}=1.4117...$	B1		
	< 1.5 so does not slip	A1	There must be a reason	
				3
		19		