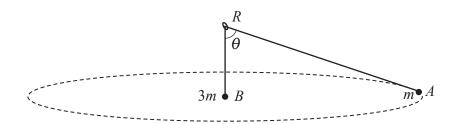
	varticle is projected with speed $u$ at an angle $\alpha$ above the horizontal from a point $O$ on a horizontal ne. The particle moves freely under gravity.
(a)	Write down the horizontal and vertical components of the velocity of the particle at time <i>T</i> after projection.
	time $T$ after projection, the direction of motion of the particle is perpendicular to the direction of jection.
(b)	Express $T$ in terms of $u$ , $g$ and $\alpha$ . [2]
(c)	Deduce that $T > \frac{u}{a}$ .
(c)	Deduce that $T > \frac{u}{g}$ . [1]

pring. The spring and particle $P$ are at rest on the surface.  Another particle $Q$ of mass $km$ is moving with speed $\sqrt{4ga}$ along the horizontal surface towards $P$ in			
the direction $BA$ . The particles greatest amount by which the specific productions are the specific productions of the specific production $BA$ .	s P and Q collide directly and co	oalesce. In the subsequent motion th	
Find the value of $k$ .		[6	

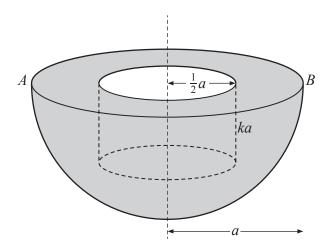
3



Particles A and B, of masses m and 3m respectively, are connected by a light inextensible string of length a that passes through a fixed smooth ring R. Particle B hangs in equilibrium vertically below the ring. Particle A moves in horizontal circles with speed V. Particles A and B are at the same horizontal level. The angle between AR and BR is  $\theta$  (see diagram).

Show that $\cos \theta = \frac{1}{3}$ .	
Find an expression for $y$ in terms of $a$ and $a$	
Find an expression for $v$ in terms of $a$ and $g$ .	
Find an expression for $v$ in terms of $a$ and $g$ .	
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Find an expression for <i>v</i> in terms of <i>a</i> and <i>g</i> .	

4

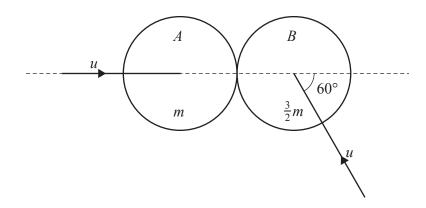


An object is formed by removing a solid cylinder, of height ka and radius  $\frac{1}{2}a$ , from a uniform solid hemisphere of radius a. The axes of symmetry of the hemisphere and the cylinder coincide and one circular face of the cylinder coincides with the plane face of the hemisphere. AB is a diameter of the circular face of the hemisphere (see diagram).

(a)	Show that the distance of the centre of mass of the object from AB is $\frac{3a}{20}$	$\frac{n(2-k^2)}{(8-3k)}.$	[4]
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When the object is freely suspended from the point A, the line AB makes an angle  $\theta$  with the downward vertical, where  $\tan \theta = \frac{7}{18}$ .

Find the possible values of $k$ .	
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Two uniform smooth spheres A and B of equal radii have masses m and  $\frac{3}{2}m$  respectively. The two spheres are each moving with speed u on a horizontal surface when they collide. Immediately before the collision A's direction of motion is along the line of centres, and B's direction of motion makes an angle of  $60^{\circ}$  with the line of centres (see diagram). The coefficient of restitution between the spheres is  $\frac{2}{3}$ .

Find the angle through which the direction of motion of <i>B</i> is deflected by the collision.

A particle P of mass 2 kg moves along a horizontal straight line. The point O is a fixed point on this line. At time ts the velocity of P is v ms<sup>-1</sup> and the displacement of P from O is x m.

A force of magnitude  $\left(8x - \frac{128}{x^3}\right)$  N acts on P in the direction OP. When t = 0, x = 8 and v = -15.

Show that $v = -\frac{2}{x}(x^2 - 4)$	).	
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Find an expression for $x$ in terms of $t$ .	

strii taut P b	the end of a light inextensible string of length $a$ is attached to a fixed point $O$ . The other end of the ing is attached to a particle $P$ of mass $m$ . The particle $P$ is held vertically below $O$ with the string at and then projected horizontally. When the string makes an angle of $60^{\circ}$ with the upward vertical becomes detached from the string. In its subsequent motion, $P$ passes through the point $A$ which is stance $A$ vertically above $A$ .				
(a)	The speed of $P$ when it becomes detached from the string is $V$ . Use the equation of the trajector of a projectile to find $V$ in terms of $a$ and $g$ .				

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