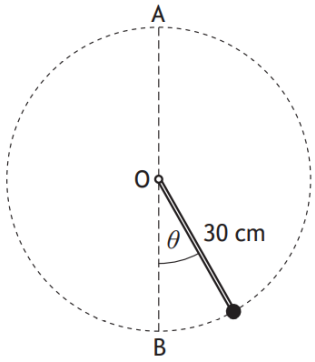
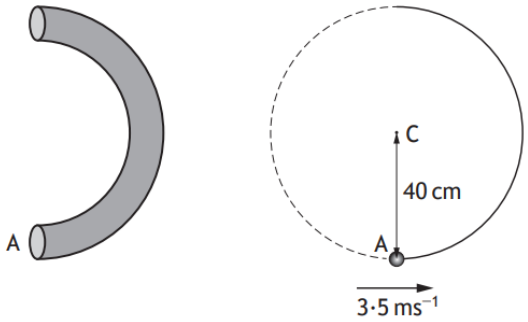
Y	Q	Work, Energy and Power
22	10	A particle of mass 0.1 kg is suspended from a fixed point O by a light inextensible rod of length 30 cm. The rod is rotating in a vertical circle with diameter AB and makes an angle θ with OB. The particle has a speed of 1.2 m s^{-1} at A.  (a) Use conservation of energy to find the speed of the particle at B. **2** (b) Find the tension in the rod when the particle is at A and interpret your answer. **3** (c) Find the size of the angle θ when the tension in the rod is zero. **5**
22	14	A particle of mass 5 kg is initially at rest. It is projected horizontally from an origin, O, along the positive direction of the x-axis. The particle moves with variable acceleration given by $a = (15 + x - 2x^2)\,\text{m s}^{-2}$, $x \geq 0$ where x is measured in metres. (a) Calculate the displacement from O at which the particle reaches its maximum speed. **2** (b) (i) Calculate the work done in reaching this maximum speed. **3** (ii) Hence, or otherwise, calculate the maximum speed. **2**
22	16	A particle of mass 0.1 kg is launched at an acute angle to the horizontal, from the origin, with a kinetic energy of 20 joules. It moves in a vertical x-y plane under the influence of gravity and there is no resistance to motion. (a) Find the speed of the particle when it is at a height of 10 metres. **2** (b) Find the height of the particle when it has a velocity of $\begin{pmatrix} 4 \\ 5 \end{pmatrix}\text{m s}^{-1}$. **2** (c) Determine the kinetic energy of the particle at its maximum height. **1**
19	13	A body of mass m kilograms is projected with speed $V\,\text{m s}^{-1}$ up a rough plane inclined at an angle θ to the horizontal. The body comes to rest after travelling a distance of s metres up the slope. The coefficient of friction between the body and the slope is μ. (a) Show that $s = \dfrac{V^2}{2g(\mu\cos\theta + \sin\theta)}$. **4** (b) Given that the work done against friction is equal to $\frac{1}{8}mV^2$ joules, find an expression for μ in terms of θ. **3**

19	14	A vertical semicircle of radius 40 cm is formed from a length of smooth pipe as shown in the diagram. A ball is projected with a speed of $3{\cdot}5\,\text{m s}^{-1}$ from A, the bottom of the semicircle.  The centre of the circular path is the point C and the ball comes to instantaneous rest at a point P. (a) Find the size of angle PCA. **4** The ball is projected from A again with an initial speed of u metres per second. (b) Determine the restriction on u required for the ball to exit at the top of the pipe. **3** (c) Given that the ball acts as a particle, state another assumption that has been made about the ball in your solution. **1**
17	9	A body of mass 20 kg is moving along a rough horizontal surface with speed $12\,\text{m s}^{-1}$. As it passes through a point P, a horizontal force $F = \left(249 - 50\sqrt{x}\right)$ newtons is applied, where x metres is the displacement of the body from P. Given that the coefficient of friction between the body and the surface is 0·25: (a) find the work done on the body in the first 10 metres of its motion from P **4** (b) find the speed of the body after travelling 10 metres from P. **2**
16	3	A constant force $\mathbf{F} = (2\mathbf{i} + 3\mathbf{j})$ N acts on a particle as it moves in a straight line from point A to point B with position vectors $(-3\mathbf{i} + \mathbf{j})$ metres and $(6\mathbf{i} + 4\mathbf{j})$ metres respectively. Calculate the work done by the force. **3**