Homework 13

1) A particle of mass 2 kg is accelerated horizontally from rest at a point O by a force $8t\mathbf{i}$, whose magnitude is measured in newtons and where $\mathbf{i}$ is the unit vector in the direction of motion and t seconds is the time from the start of the motion.

(a) Find the velocity, $\mathbf{v}$, of the particle as a function of time t. 2

(b) Calculate the work done on the particle in the first second of the motion. 3

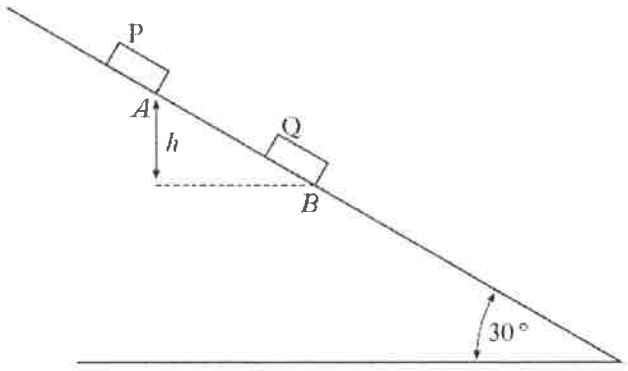
2) A body of mass 20 kg is moving along a rough horizontal surface with speed $12\,\text{m s}^{-1}$. As it passes through a point P, a horizontal force $F = \left(249 - 50\sqrt{x}\right)$ newtons is applied, where x metres is the displacement of the body from P.

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

3) The diagram shows a ramp, inclined at 30° to the horizontal, which has a smooth section above B and a rough section below B. Identical blocks, P and Q, each has weight W newtons. Block Q is stationary at B, held by friction, and block P is held at rest at A. Block P is a vertical height of h metres above block Q (where the dimensions of the blocks should be ignored).



When block P is released, it slides down the ramp colliding and coupling with block Q. The combined blocks then move down the rough section of the ramp, coming to rest at a vertical height $\frac{1}{2}h$ metres below B.

(i) Find, in terms of g and h, the speed of the combined block immediately after the collision. 3

(ii) Using the work/energy principle, show that the constant frictional force acting on the combined block whilst it is moving has magnitude $\frac{3}{2}W$ newtons. 4

4) A particle of mass 3 kilograms moves under the action of its own weight and a constant force $\mathbf{F} = (3\boldsymbol{i} + 5{\cdot}4\boldsymbol{j})$ where $\boldsymbol{i}$ and $\boldsymbol{j}$ are unit vectors in the horizontal and vertical directions respectively.

Initially the particle has velocity $(2\boldsymbol{i} - \boldsymbol{j})$ m s^{-1} as it passes through a point A. The particle passes through B after 4 seconds. Find the work done to move the particle from A to B. 5

5) An object of mass 9 kg starts from rest at an origin and moves in a straight line so that its acceleration in m s^{-2} is given as $a = 4 - \sqrt{t}$, where t is the time in seconds.

Calculate its maximum speed and hence the increase in kinetic energy. 4