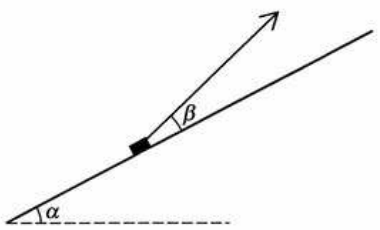
1



A small block of weight 5.1 N rests on a smooth plane inclined at an angle α to the horizontal, where $\sin\alpha = \frac{8}{17}$. The block is held in equilibrium by means of a light inextensible string. The string makes an angle β above the line of greatest slope on which the block rests, where $\sin\beta = \frac{7}{25}$ (see diagram). Find the tension in the string. [3]

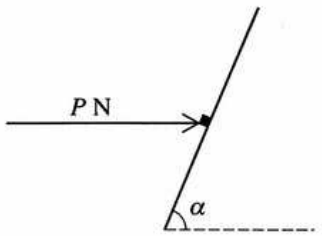
2 A box of mass 25 kg is pulled in a straight line along a horizontal floor. The box starts from rest at a point A and has a speed of $3\,\text{m s}^{-1}$ when it reaches a point B. The distance AB is 15 m. The pulling force has magnitude 220 N and acts at an angle of $\alpha°$ above the horizontal. The work done against the resistance to motion acting on the box, as the box moves from A to B, is 3000 J. Find the value of α. [5]

3 The resistance to motion acting on a runner of mass 70 kg is kv N, where $v\,\text{m s}^{-1}$ is the runner's speed and k is a constant. The greatest power the runner can exert is 100 W. The runner's greatest steady speed on horizontal ground is $4\,\text{m s}^{-1}$.

(i) Show that $k = 6.25$. [2]

(ii) Find the greatest steady speed of the runner while running uphill on a straight path inclined at an angle α to the horizontal, where $\sin\alpha = 0.05$. [4]

4



A rough plane is inclined at an angle α to the horizontal, where $\tan\alpha = 2.4$. A small block of mass 0.6 kg is held at rest on the plane by a horizontal force of magnitude P N. This force acts in a vertical plane through a line of greatest slope (see diagram). The coefficient of friction between the block and the plane is 0.4. The block is on the point of slipping down the plane. By resolving forces parallel to and perpendicular to the inclined plane, or otherwise, find the value of P. [8]

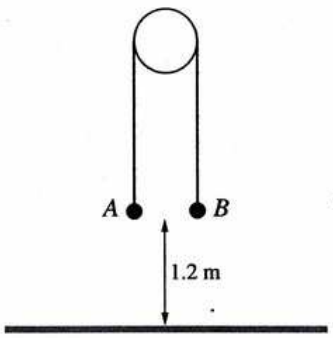
5 A particle P moves in a straight line. P starts from rest at O and travels to A where it comes to rest, taking 50 seconds. The speed of P at time t seconds after leaving O is v m s^{-1}, where v is defined as follows.

$$\begin{aligned} \text{For } 0 \leqslant t \leqslant 5, \quad & v = t - 0.1t^2, \\ \text{for } 5 \leqslant t \leqslant 45, \quad & v \text{ is constant}, \\ \text{for } 45 \leqslant t \leqslant 50, \quad & v = 9t - 0.1t^2 - 200. \end{aligned}$$

(i) Find the distance travelled by P in the first 5 seconds. [3]

(ii) Find the total distance from O to A, and deduce the average speed of P for the whole journey from O to A. [6]

6



Particles A of mass 0.4 kg and B of mass 1.6 kg are attached to the ends of a light inextensible string which passes over a fixed smooth pulley. A is held at rest and B hangs freely, with both straight parts of the string vertical and both particles at a height of 1.2 m above the floor (see diagram). A is released and both particles start to move.

(i) Find the work done on B by the tension in the string, as B moves to the floor. [5]

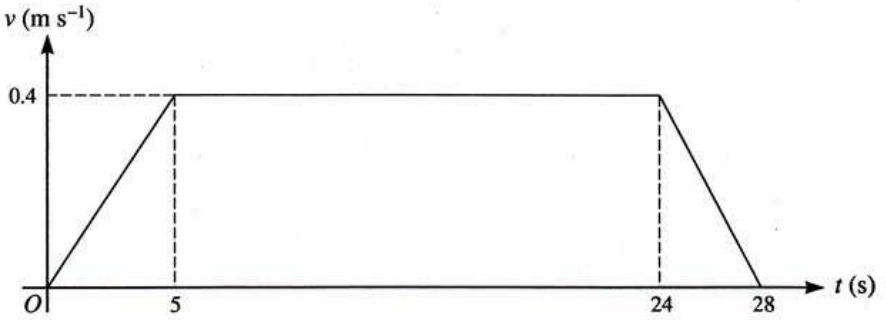
When particle B reaches the floor it remains at rest. Particle A continues to move upwards.

(ii) Find the greatest height above the floor reached by particle A. [4]

[Question 7 is printed on the next page.]

[Turn over

7



An elevator is pulled vertically upwards by a cable. The velocity-time graph for the motion is shown above. Find

(i) the distance travelled by the elevator, [2]

(ii) the acceleration during the first stage and the deceleration during the third stage. [2]

The mass of the elevator is 800 kg and there is a box of mass 100 kg on the floor of the elevator.

(iii) Find the tension in the cable in each of the three stages of the motion. [3]

(iv) Find the greatest and least values of the magnitude of the force exerted on the box by the floor of the elevator. [3]