Forces of magnitudes 10 N and 8 N act in directions as shown in the diagram.

(i) Write down in terms of $\theta$ the component of the resultant of the two forces

(a) parallel to the force of magnitude 10 N, [1]

(b) perpendicular to the force of magnitude 10 N. [1]

(ii) The resultant of the two forces has magnitude 8 N. Show that $\cos \theta = \frac{5}{8}$. [3]

2 A block of mass 20 kg is at rest on a plane inclined at $10^\circ$ to the horizontal. A force acts on the block parallel to a line of greatest slope of the plane. The coefficient of friction between the block and the plane is 0.32. Find the least magnitude of the force necessary to move the block,

(i) given that the force acts up the plane,

(ii) given instead that the force acts down the plane. [6]

3 A car of mass 1200 kg is travelling on a horizontal straight road and passes through a point $A$ with speed 25 m s$^{-1}$. The power of the car’s engine is 18 kW and the resistance to the car’s motion is 900 N.

(i) Find the deceleration of the car at $A$. [4]

(ii) Show that the speed of the car does not fall below 20 m s$^{-1}$ while the car continues to move with the engine exerting a constant power of 18 kW. [2]

4 A load of mass 160 kg is lifted vertically by a crane, with constant acceleration. The load starts from rest at the point $O$. After 7 s, it passes through the point $A$ with speed 0.5 m s$^{-1}$. By considering energy, find the work done by the crane in moving the load from $O$ to $A$. [6]
Particles $A$ and $B$, of masses 0.5 kg and $m$ kg respectively, are attached to the ends of a light inextensible string which passes over a smooth fixed pulley. Particle $B$ is held at rest on the horizontal floor and particle $A$ hangs in equilibrium (see diagram). $B$ is released and each particle starts to move vertically. $A$ hits the floor 2 s after $B$ is released. The speed of each particle when $A$ hits the floor is 5 m s$^{-1}$.

(i) For the motion while $A$ is moving downwards, find

(a) the acceleration of $A$, [2]

(b) the tension in the string. [3]

(ii) Find the value of $m$. [3]

6 A train travels from $A$ to $B$, a distance of 20 000 m, taking 1000 s. The journey has three stages. In the first stage the train starts from rest at $A$ and accelerates uniformly until its speed is $V$ m s$^{-1}$. In the second stage the train travels at constant speed $V$ m s$^{-1}$ for 600 s. During the third stage of the journey the train decelerates uniformly, coming to rest at $B$.

(i) Sketch the velocity-time graph for the train’s journey. [2]

(ii) Find the value of $V$. [3]

(iii) Given that the acceleration of the train during the first stage of the journey is 0.15 m s$^{-2}$, find the distance travelled by the train during the third stage of the journey. [4]

7 A particle $P$ is held at rest at a fixed point $O$ and then released. $P$ falls freely under gravity until it reaches the point $A$ which is 1.25 m below $O$.

(i) Find the speed of $P$ at $A$ and the time taken for $P$ to reach $A$. [3]

The particle continues to fall, but now its downward acceleration $t$ seconds after passing through $A$ is $(10 - 0.3t)$ m s$^{-2}$.

(ii) Find the total distance $P$ has fallen, 3 s after being released from $O$. [7]