TASK A

1 A box of mass 5 kg lies on a horizontal table. A horizontal force of magnitude 20 N is applied to the box. Find the magnitude of the resistive force if the acceleration is $1\,\text{m s}^{-2}$.

2 A crate of mass 60 kg lies on a horizontal floor. A horizontal force of magnitude 300 N is applied to the box. Find the acceleration of the crate if the resistive force has magnitude 210 N.

3 A car of mass 1000 kg is travelling along a horizontal road. The total resistance to motion is 400 N and the driving force is 1600 N. Calculate the acceleration of the car.

4 A rope is attached to a block of mass 250 kg, which lies on horizontal ground. The rope is pulled horizontally with tension T. The magnitude of the resistive force is 650 N. Find T if the block accelerates at $0.25\,\text{m s}^{-2}$.

5 Calculate the acceleration acting on an object if

a The resultant force is $(9\mathbf{i} + 18\mathbf{j})$ N and the mass is 5 kg,

b The resultant force is $\begin{pmatrix} 3 \\ 5 \end{pmatrix}$ N and the mass is 2 kg,

c The resultant force is 7 N and the mass is 25 kg,

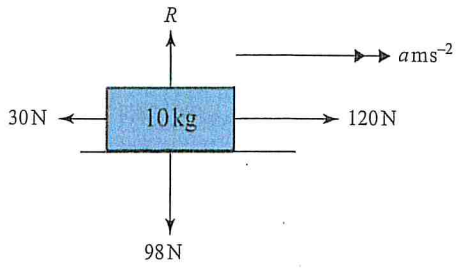
d The forces acting on the object are $(5\mathbf{i} - \mathbf{j})$ N and $(3\mathbf{i} - 4\mathbf{j})$N and the mass is 4 kg,

e The forces acting on the object are $(3\mathbf{i} + 8\mathbf{j})$ N, $(9\mathbf{i} + 11\mathbf{j})$ N, $(-\mathbf{i} - 7\mathbf{j})$ N and $(4\mathbf{i} + 9\mathbf{j})$ N and the mass is 0.25 kg.

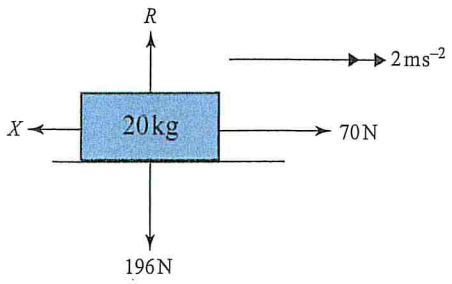
6 A car of mass 1200 kg is at rest on a horizontal road. Work out the force needed to give the car an acceleration of $3\,\text{m s}^{-2}$ if the total resistance to motion is 300 N.

7 Work out the missing values in the following diagrams.

a



b



8 A truck of mass 2000 kg is travelling on a horizontal road. The total resistance to motion is 500 N. A horizontal braking force of magnitude 900 N is applied to the truck. Work out the deceleration of the truck.

9 A box of mass m kg rests on a horizontal floor. A horizontal force 40 N is applied to the box which gives it an acceleration of $2\,\text{m s}^{-2}$. Calculate the value of m if the total resistance to motion is 12 N.

10 A car of mass 800 kg is moving along a straight level road with a velocity of $30\,\text{m s}^{-1}$, when the driver spots an obstacle ahead. The driver immediately applies the brakes, providing a net braking force of 3000 N. Calculate

a The deceleration,

b The time taken for the car to come to rest,

c The distance travelled by the car in coming to rest.

TASK B

1 Work out the mass of a car if a resultant force of magnitude 700 N causes a constant acceleration that brings the car from rest to $10\,\text{m s}^{-1}$ in 200 m.

2 Work out the magnitude of the resultant force on a bike of mass 100 kg that goes from $15\,\text{m s}^{-1}$ to $12\,\text{m s}^{-1}$ in 20 m.

3 Work out how far an initially stationary object of mass 0.5 kg will travel in 1 second if a resultant force of 30 N is applied to it for that one second.

4 A train of mass 50 tonnes accelerates from rest to a speed of $10\,\text{m s}^{-1}$ over a distance of 50 m. If the total resistance to motion is 3000 N then work out the driving force acting on the train.

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5 A cyclist and her bike have a combined mass of 80 kg. She travels on a horizontal road at $12\,\text{m s}^{-1}$ and the total resistance to motion is 25 N.

a What is the magnitude of the force that she is applying?

The cyclist sees a problem ahead so immediately stops pedalling and applies the brake. Her braking distance is 10 m.

b Assuming that the resistance to motion stays at 25 N, find the braking force that she applies.

c State, with a reason, what will actually happen to the resistance to motion and what effect this will have on your answer to part **b**.

6 A box of mass m kg has the following forces acting on it: $(2\mathbf{i} + 7\mathbf{j})$ N, $(3\mathbf{i} - 2\mathbf{j})$ N, $(11\mathbf{i} - 2\mathbf{j})$ N, $(11\mathbf{i} + 3\mathbf{j})$ N and $(5\mathbf{i} + p\mathbf{j})$ N. The resultant acceleration is $(7\mathbf{i} + p\mathbf{j})$. Find the values of m and p

7 A parachutist of mass 80 kg and weight 800 N is falling to the ground. Her speed changes from $50\,\text{m s}^{-1}$ to $10\,\text{m s}^{-1}$ in 2 seconds.

a Assuming constant acceleration over these two seconds, find the resistive force of the parachute.

b Comment on the assumption that the acceleration will be constant over these two seconds.

8 A lorry of mass m kg accelerates from rest to a speed of $20\,\text{m s}^{-2}$ over 16 seconds. The total resistance to motion of the lorry is 1200 N and the driving force of the lorry is 3700 N. Find m

9 A string is attached to the top of a box of mass 5 kg and weight 49 N. The box is at rest on the ground. The string is held vertically above the box and the tension in the string is slowly increased until the box is just about to lift off the ground.

a Find the tension in the string at this point.

The tension in the string is then increased to 60 N.

b Find how long the box takes to reach a height of 1 m.

When the box is at a height of 1 m above the ground the tension is reduced to 40 N.

c Find the speed at which the box hits the ground.

10 A force $\begin{pmatrix} 3 \\ 4 \end{pmatrix}$ N is applied to a box of mass 4 kg. Another force $\begin{pmatrix} a \\ b \end{pmatrix}$ N of magnitude 10 N is to be applied in order to give the box the greatest possible acceleration. Find a and b and find the magnitude of the acceleration of the box.

Challenge

11 Calculate the two possible values of x if the forces $\begin{pmatrix} x \\ 1 \end{pmatrix}$ N and $\begin{pmatrix} 8 \\ x \end{pmatrix}$ N applied to a box of mass 5 kg cause an acceleration of magnitude $2.6\,\text{m s}^{-2}$. Assume there is no resistance to motion. Assume both forces act only in directions parallel to the ground.

12 Work out R and m in this diagram.