Mixed practice 21

1. A car moves on a straight horizontal road, under the action of a constant driving force of magnitude 1360 N. It accelerates from rest to the speed of 12.6 m s^{-1} in 8 seconds.

   a Assuming that any resistance forces can be ignored, find the mass of the car.

   b How would your answer change if a resistance force were included?

2. A box of mass 13 kg slides across a rough horizontal floor with an initial speed of 2.6 m s^{-1} and moves in a straight line. It comes to rest after it has travelled 3.7 m. Find the magnitude of the frictional force between the box and the floor.

3. A van of mass 1600 kg travels on a straight horizontal road under the action of a constant driving force of magnitude 2170 N. The total resistance force on the van is 865 N.

   a Find the acceleration of the van.

   b Given that the van starts from rest, find the time taken for it to travel 260 m.

4. **a** A box has weight 268 N. Find its mass.

   b The box is being pulled vertically upwards using a light inextensible rope and accelerates uniformly with $a = 0.9$ m s^{-2}. Find the tension in the rope.

   c The box is now lowered at a constant speed. Find the tension in the rope.

   d Explain how you have used the modelling assumption that the rope is:

   i light **ii** inextensible.

5. A particle of mass 2.5 kg is in equilibrium under the action of three forces, $\mathbf{F}_1 = (6.3\mathbf{i} + 1.7\mathbf{j})$ N, $\mathbf{F}_2 = (-3.7\mathbf{i} + 2.1\mathbf{j})$ N and $\mathbf{F}_3 = (p\mathbf{i} + q\mathbf{j})$ N.

   a Find the values of p and q.

   The force $\mathbf{F}_3$ is now removed.

   b Find, in vector form, the acceleration of the particle.

6. In the sport of curling, a heavy stone is projected in a straight line across a horizontal ice surface. A player projects a stone of mass 21 kg, and it comes to rest 14 s after the instant of projection, having travelled 32 m.

   a Calculate the deceleration of the stone.

   b Find the magnitude of the frictional force acting on the stone.

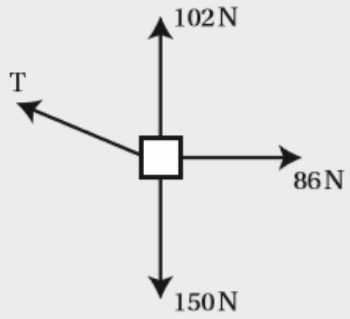
7 A car of mass 750 kg accelerates uniformly from 30 km h^{-1} to 40 km h^{-1} while travelling 200 m in a straight line. The resistance to the motion of the car has magnitude 380 N.

a Find the magnitude of driving force.

The car now starts to brake with a braking force of 620 N. The resistance force remains unchanged.

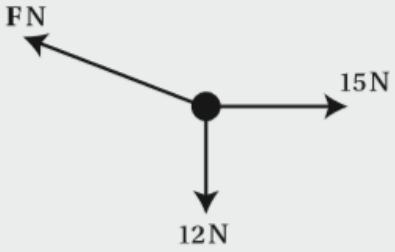
b How long does it take for the car to stop?

8 A box rests in equilibrium on a smooth horizontal floor. Four children pull the box using light inextensible ropes, all in the horizontal plane. The tensions in the ropes are shown in the diagram.



Find the magnitude of the force marked **T** and the angle it makes with the 102 N force.

9 A particle is in equilibrium under the action of the three forces shown in the diagram.



Find the magnitude of **F** and the angle it makes with the direction of the 15 N force.

10 Two horizontal forces **X** and **Y** act at a point *O* and are at right angles to each other. **X** has magnitude 12 N and acts along a bearing of 090°. **Y** has magnitude 15 N and acts along a bearing of 000°.

i Calculate the magnitude and bearing of the resultant of **X** and **Y**.

ii A third force **E** is now applied at *O*. The three forces **X**, **Y** and **E** are in equilibrium. State the magnitude of **E**, and give the bearing along which it acts.

Mixed practice 21

1 **a** 863 kg **b** Lower mass

2 11.9 N

3 **a** $0.816\ \text{m s}^{-2}$ **b** 25.2 s

4 **a** 27.3 kg **b** 293 N

c 268 N

d **i** Does not contribute to system mass

ii Constant tension throughout, perfectly transmits tension forces

5 **a** $p = -2.6,\ q = -3.8$ **b** $\begin{pmatrix} 1.04 \\ 1.52 \end{pmatrix} \text{m s}^{-2}$

6 **a** $0.327\ \text{m s}^{-2}$ **b** 6.86 N

7 **a** 481 N **b** 8.33 s

8 98.5 N, 60.8°

9 19.2 N, 141°

10 **a** 19.2 N, 038.7° **b** 19.2 N, 219°

11 16.8 N, thrust

12 **a** $(7.5\mathbf{i} - 0.75\mathbf{j})\ \text{m s}^{-2}$ **b** 30.1 N, 174°

13 165 N, 13.8° above horizontal