

Resultant forces

When several forces act on an object at the same time, their effects combine and act as though there is a single force, called a resultant force. The resultant force can be found by drawing the forces as arrows on a diagram.

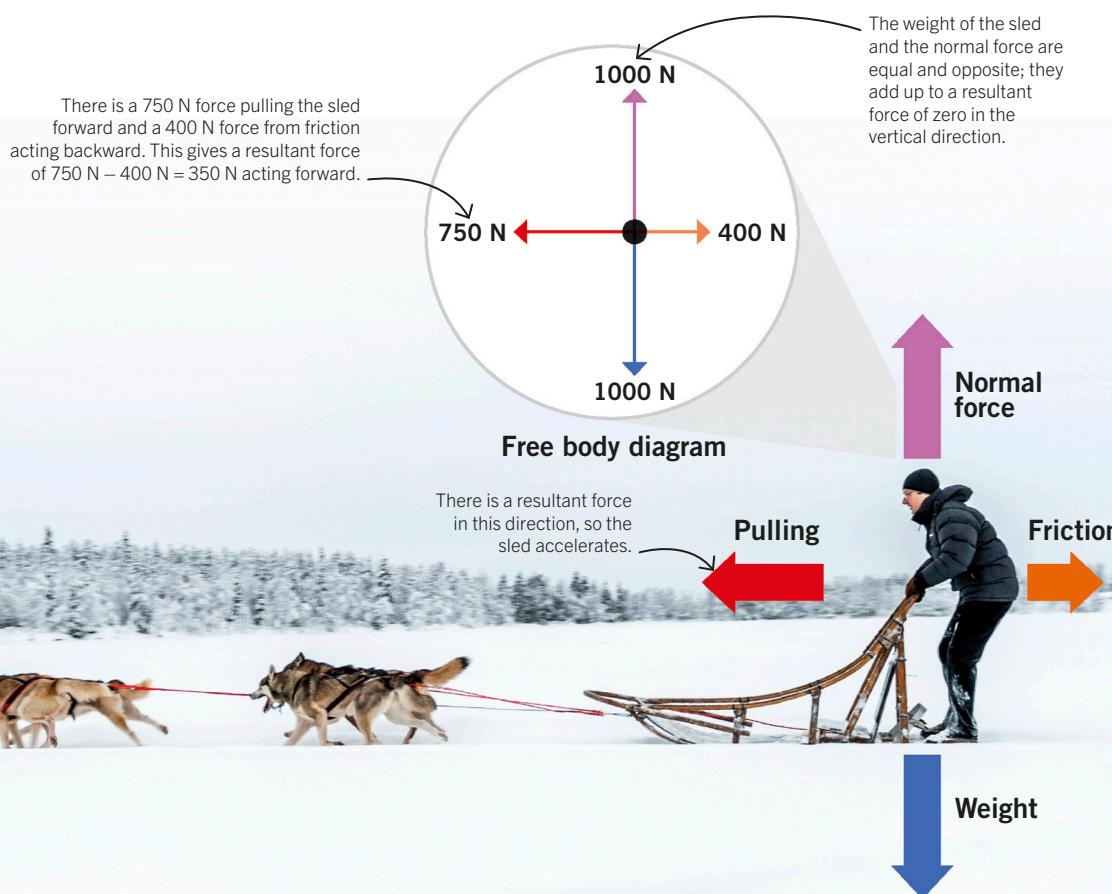
Finding resultant forces

The sled below has several different forces acting on it. The sled's weight pushing down on the ground is balanced by a reaction force (called a normal force) acting upward from the ground. The dogs are creating a pulling force (called tension) through the ropes, but friction with the ground creates a force in the opposite direction. If the pulling force is greater than friction, there is a resultant force that causes a change in motion: the sled accelerates.



Key facts

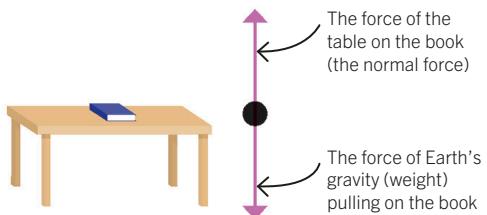
- ✓ When several forces act on an object, their effects combine and act as if there is a single force (a resultant force).
- ✓ Forces acting on an object can be shown on a free body diagram.
- ✓ If two forces are acting in the same direction, you can work out the resultant by adding them.
- ✓ If two forces are acting in opposite directions, work out the resultant by subtracting one from the other.





Free body diagrams

A free body diagram shows the forces acting on an object. The object can be represented by a dot or a square, and the forces are represented by labeled arrows pointing away from it. Here, a book is resting on a table. The diagram only shows forces acting on the book. (Forces acting on the table are omitted.)



Calculating resultant forces

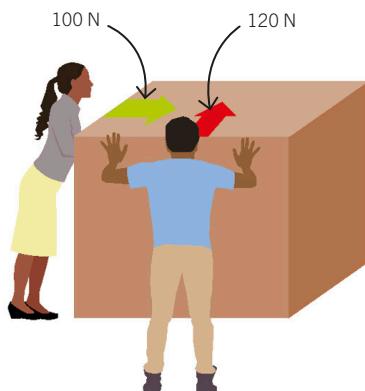
Question 1

One person pushes a piano with a force of 100 N, but another person pushes back the opposite way with a force of 150 N. What's the resultant force?



Question 2

Two people try to push a heavy box. One person pushes with a force of 100 N. The other person pushes at right angles with a force of 120 N. What's the resultant force?



Answer 1

1. Draw a free body diagram showing the forces acting on the piano.



2. Find the answer by subtraction:

$$\begin{aligned}\text{Resultant force} &= 150 \text{ N} - 100 \text{ N} \\ &= 50 \text{ N to the left}\end{aligned}$$

Answer 2

When forces (or any vector quantities) don't act in a straight line, you can add them by drawing a scale diagram.

1. Draw one force from the end of the other to form a triangle. In this diagram, $1 \text{ cm} = 10 \text{ N}$.

2. Measure the sloping side of the triangle with a ruler to find the magnitude of the force.

3. Measure the angle with a protractor to find the direction of the force.

4. Write both in your answer:
 $\text{Force} = 156 \text{ N at } 50^\circ$.

