

# Useful Equations

## Average speed

$$\text{Average speed} = \frac{\text{total distance}}{\text{total time}}$$

**Example:** A bicycle messenger traveled a distance of 136 km in 8 hours. What was the messenger's average speed?

$$\frac{136 \text{ km}}{8 \text{ h}} = 17 \text{ km/h}$$

The messenger's average speed was **17 km/h**.

## Average acceleration

$$\text{Average acceleration} = \frac{\text{final velocity} - \text{starting velocity}}{\text{time it takes to change velocity}}$$

**Example:** Calculate the average acceleration of an Olympic 100 m dash sprinter who reaches a velocity of 15 m/s south at the finish line. The race was in a straight line and lasted 10 s.

$$\frac{15 \text{ m/s} - 0 \text{ m/s}}{10 \text{ s}} = 1.5 \text{ m/s/s}$$

The sprinter's average acceleration is **1.5 m/s/s south**.

## Net force

### Forces in the Same Direction

When forces are in the same direction, add the forces together to determine the net force.

**Example:** Calculate the net force on a stalled car that is being pushed by two people. One person is pushing with a force of 13 N northwest and the other person is pushing with a force of 8 N in the same direction.

$$13 \text{ N} + 8 \text{ N} = 21 \text{ N}$$

The net force is **21 N northwest**.

### Forces in Opposite Directions

When forces are in opposite directions, subtract the smaller force from the larger force to determine the net force.

## Net force (cont'd)

**Example:** Calculate the net force on a rope that is being pulled on each end. One person is pulling on one end of the rope with a force of 12 N south. Another person is pulling on the opposite end of the rope with a force of 7 N north.

$$12 \text{ N} - 7 \text{ N} = 5 \text{ N}$$

The net force is **5 N south**.

## Density

$$\text{Density} = \frac{\text{mass}}{\text{volume}}$$

**Example:** Calculate the density of a sponge with a mass of 10 g and a volume of 40 mL.

$$\frac{10 \text{ g}}{40 \text{ mL}} = 0.25 \text{ g/mL}$$

The density of the sponge is **0.25 g/mL**.

## Pressure

**Pressure** is the force exerted over a given area. The SI unit for pressure is the pascal, which is abbreviated Pa.

$$\text{Pressure} = \frac{\text{force}}{\text{area}}$$

**Example:** Calculate the pressure of the air in a soccer ball if the air exerts a force of 10 N over an area of 0.5 m<sup>2</sup>.

$$\text{Pressure} = \frac{10 \text{ N}}{0.5 \text{ m}^2} = 20 \text{ N/m}^2 = 20 \text{ Pa}$$

The pressure of the air inside of the soccer ball is **20 Pa**.

## Concentration

$$\text{Concentration} = \frac{\text{mass of solute}}{\text{volume of solvent}}$$

**Example:** Calculate the concentration of a solution in which 10 g of sugar is dissolved in 125 mL of water.

$$\frac{10 \text{ g of sugar}}{125 \text{ mL of water}} = 0.08 \text{ g/mL}$$

The concentration of this solution is **0.08 g/mL**.