

Newton's three laws of motion

Grade 8 science (Year 9 · Class 8) · Worksheet answers

Each answer shows the net force, the formula and the substitution before the result with its unit. Use the same steps in your own working: draw the forces, find the net force, then divide by the mass.

Level: Grade 8 science (Year 9 · Class 8) · **Curriculum:** MS-PS2-1, MS-PS2-2

Problem 1 Which law is it?

1. **First law.**
2. **Second law.**
3. **Third law.**

Problem 2 Inertia on the bus

1. Newton's **first law** (inertia).
2. Her body tends to keep moving forward at the old speed while the bus slows down, because no force acts on her to slow her down.
3. The **5 kg ball** has more inertia.

Problem 3 Balanced or unbalanced?

1. P: $10 - 10 = 0 \text{ N}$. Q: $15 - 5 = 10 \text{ N to the right}$. R: $18 - 12 = 6 \text{ N to the left}$.
2. Box **P** (balanced forces).
3. **To the left**, the direction of the net force.

Problem 4 Force from acceleration

1. $F = m \times a$.
2. $F = 4 \text{ kg} \times 3 \text{ m/s}^2 = 12 \text{ N}$.

Problem 5 Mass and weight

1. Mass: **kilogram (kg)**. Weight: **newton (N)**.
2. $W = m \times g = 6.0 \times 9.8 = 58.8 \text{ N}$, so about **59 N**.

Problem 6 Name the reaction

1. The ground pushes the foot **forward**.
2. The ball pushes the bat **to the left**.
3. The water pushes the swimmer **forward**.

Problem 7 Shopping trolley

1. $a = F \div m$.
2. $a = 120 \div 30 = \mathbf{4.0 \text{ m/s}^2}$.

Problem 8 Find the mass

1. $m = F \div a$.
2. $m = 90 \div 1.5 = \mathbf{60 \text{ kg}}$.

Problem 9 Pushing a sled

1. Net force = $80 - 30 = \mathbf{50 \text{ N}}$.
2. $a = 50 \div 25 = \mathbf{2.0 \text{ m/s}^2}$.

Problem 10 Kicking a football

1. $a = 215 \div 0.43 = \mathbf{500 \text{ m/s}^2}$.
2. $a = F \div m$, so for the same force a bigger mass gives a smaller acceleration.

Problem 11 Mass against acceleration

1. $0.5 \times 8.0 = 1 \times 4.0 = 2.0 \times 2.0 = 4.0 \times 1.0 = \mathbf{4.0 \text{ N}}$ each time.
2. Doubling the mass **halves the acceleration**.
3. $a = 4.0 \div 8.0 = \mathbf{0.50 \text{ m/s}^2}$.

Problem 12 Braking motorbike

1. $a = 750 \div 250 = \mathbf{3.0 \text{ m/s}^2}$ (backward).
2. Speed falls 3.0 m/s each second, so in 2.0 s it falls by $\mathbf{6.0 \text{ m/s}}$.

Problem 13 Rocket launch

1. The rocket pushes hot gas backward, so the gas pushes the rocket forward with an equal and opposite force. **The gas is what it pushes against.**
2. The balloon pushes air out backward, and the escaping air pushes the balloon forward.

Problem 14 Seat belts

1. The passenger keeps moving forward at the old speed after the car stops, because no force acts on them to slow them.
2. They continue forward until they hit the dashboard or windscreen.
3. The belt applies a force that slows the passenger together with the car, **so the stopping force is spread across the body**.

Problem 15 Skaters push apart

1. Both are **90 N**, in opposite directions (third law).
2. $a = 90 \div 45 = \mathbf{2.0 \text{ m/s}^2}$.
3. $a = 90 \div 60 = \mathbf{1.5 \text{ m/s}^2}$.

Problem 16 Person in a lift

1. $W = 60 \times 9.8 = \mathbf{588 \text{ N}}$.
2. $F = m \times a = 60 \times 1.0 = \mathbf{60 \text{ N}}$ upward.
3. $N - 588 = 60$, so $N = \mathbf{648 \text{ N}}$.

Problem 17 Truck and trailer

1. $6000 - 600 - 400 = \mathbf{5000 \text{ N}}$.
2. $a = 5000 \div (1500 + 500) = \mathbf{2.5 \text{ m/s}^2}$.
3. For the trailer: $T - 400 = 500 \times 2.5 = 1250$, so $T = \mathbf{1650 \text{ N}}$.

Problem 18 Spot the errors

1. A heavier object has **more** inertia.
2. The two forces act on different objects, so they do not cancel. The ground's force on your foot is what accelerates you.
3. $a = F \div m = 10 \div 5 = \mathbf{2 \text{ m/s}^2}$. The student multiplied instead of dividing.

Problem 19 Two cars

1. A: $4200 - 1200 = \mathbf{3000 \text{ N}}$. B: $3000 - 600 = \mathbf{2400 \text{ N}}$.
2. A: $3000 \div 1200 = \mathbf{2.5 \text{ m/s}^2}$. B: $2400 \div 900 = \mathbf{2.67 \text{ m/s}^2}$.
3. A gains $2.5 \times 4.0 = 10 \text{ m/s}$. B gains $2.67 \times 4.0 = 10.7 \text{ m/s}$. **Car B gains 0.7 m/s more.**

Problem 20 Trolley and hanging mass

1. $W = 0.20 \times 9.8 = \mathbf{1.96 \text{ N}}$.
2. Total mass = 1.00 kg, so $a = 1.96 \div 1.00 = \mathbf{1.96 \text{ m/s}^2}$ (about 2.0 m/s^2).
3. The force has to accelerate the trolley as well as the hanger, so the larger total mass cuts the acceleration.
4. Trolley: $T = 0.80 \times 1.96 = \mathbf{1.57 \text{ N}}$ (about 1.6 N).