

Newton's three laws of motion

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

Name: _____ Date: _____ Class: _____

These problems train you to use Newton's three laws: explain motion with inertia, find net forces from diagrams, calculate with $F = m \times a$ and identify action-reaction pairs. They begin with recall and finish with multi-step problems with friction and two objects.

They suit Grade 8, Year 9 and Class 8 students, in line with middle school physical science (NGSS MS-PS2-1 and MS-PS2-2) and KS3 courses.

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

Problem 1 Which law is it? (easy)

Match each statement with Newton's first, second or third law.

1. 'An object keeps its motion unless an unbalanced force acts.'
2. 'Net force = mass $\times$ acceleration.'
3. 'Every force has an equal and opposite reaction.'

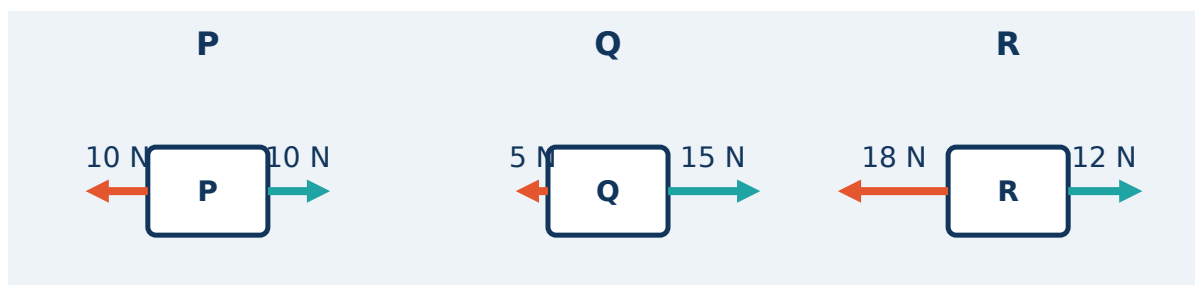
Problem 2 Inertia on the bus (easy)

Wanjiru in Nairobi stands on a matatu that brakes suddenly. She lurches forward.

1. State which of Newton's laws explains this.
2. Explain why she lurches forward.
3. State which has more inertia: a 2 kg ball or a 5 kg ball.

Problem 3 Balanced or unbalanced? (easy)

Look at the forces on the boxes P, Q and R.



Horizontal forces on three boxes.

1. Calculate the net force on each box.
2. State which box moves at a constant velocity.
3. State the direction of acceleration of box R.

Problem 4 Force from acceleration (easy)

A trolley of mass 4 kg accelerates at 3 m/s^2 .

1. Write the formula for force.
2. Calculate the net force.

Problem 5 Mass and weight (easy)

Bilal in Lahore has a school bag of mass 6.0 kg. Use $g = 9.8 \text{ N/kg}$.

1. State the unit of mass and the unit of weight.
2. Calculate the weight of the bag.

Problem 6 Name the reaction (easy)

Name the reaction force in each case.

1. A foot pushes backward on the ground when running.
2. A bat hits a cricket ball to the right.
3. A swimmer pushes the water backward.

Problem 7 Shopping trolley (medium)

Emma in Leeds pushes a trolley of mass 30 kg with a net force of 120 N.

1. Write the formula for acceleration.
2. Calculate the acceleration.

Problem 8 Find the mass (medium)

A net force of 90 N gives a runner's cart an acceleration of 1.5 m/s^2 .

1. Rearrange $F = m \times a$ to make m the subject.
2. Calculate the mass of the cart.

Problem 9 Pushing a sled (medium)

Diego in Texas pushes a sled of mass 25 kg with a force of 80 N. Friction is 30 N.

1. Calculate the net force.
2. Calculate the acceleration.

Problem 10 Kicking a football (medium)

Kofi in Accra kicks a football of mass 0.43 kg with an average force of 215 N.

1. Calculate the acceleration of the ball during the kick.
2. Explain why a heavier ball would accelerate less for the same kick.

Problem 11 Mass against acceleration (medium)

Mei pulls trolleys of different masses with the same net force, and records their accelerations: 0.5 kg: 8.0 m/s²; 1.0 kg: 4.0 m/s²; 2.0 kg: 2.0 m/s²; 4.0 kg: 1.0 m/s².

1. Calculate the force used each time.
2. Describe the pattern.
3. Predict the acceleration for a mass of 8.0 kg.

Problem 12 Braking motorbike (medium)

A rider and motorbike have a total mass of 250 kg. The brakes give a net backward force of 750 N.

1. Calculate the size of the deceleration.
2. Calculate how much the speed falls in 2.0 seconds, since acceleration is the change in speed each second.

Problem 13 Rocket launch (medium)

Explain each point with Newton's third law.

1. How does a rocket accelerate in space with nothing to push against?
2. Why does a balloon fly around the room when you let go?

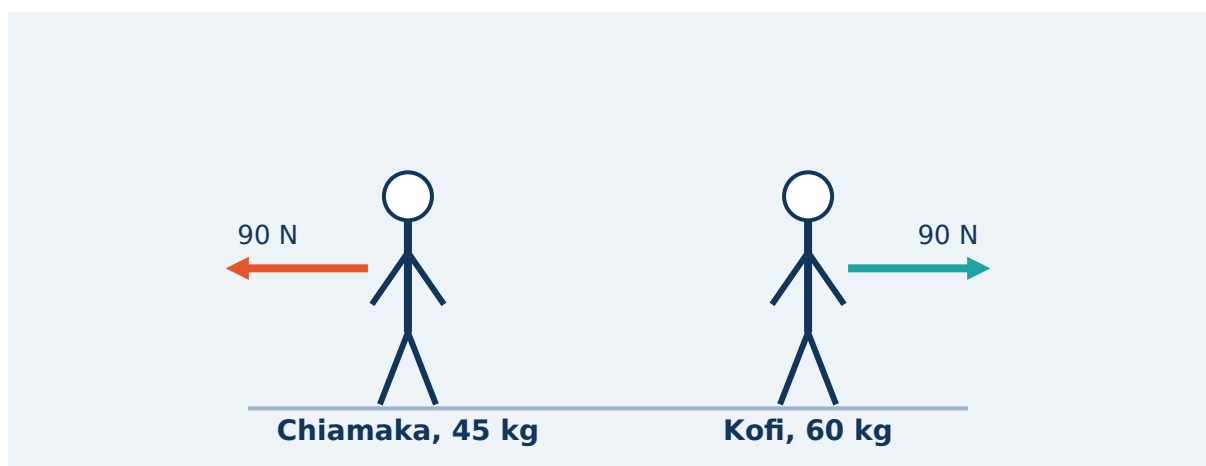
Problem 14 Seat belts (medium)

Explain, using Newton's first law, why passengers in a car need seat belts.

1. Describe what happens to a passenger without one when the car stops suddenly in a crash.
2. Explain why a belt reduces injury.

Problem 15 Skaters push apart (medium)

Chiamaka (45 kg) and Kofi (60 kg) stand on skateboards and push apart with a force of 90 N each.

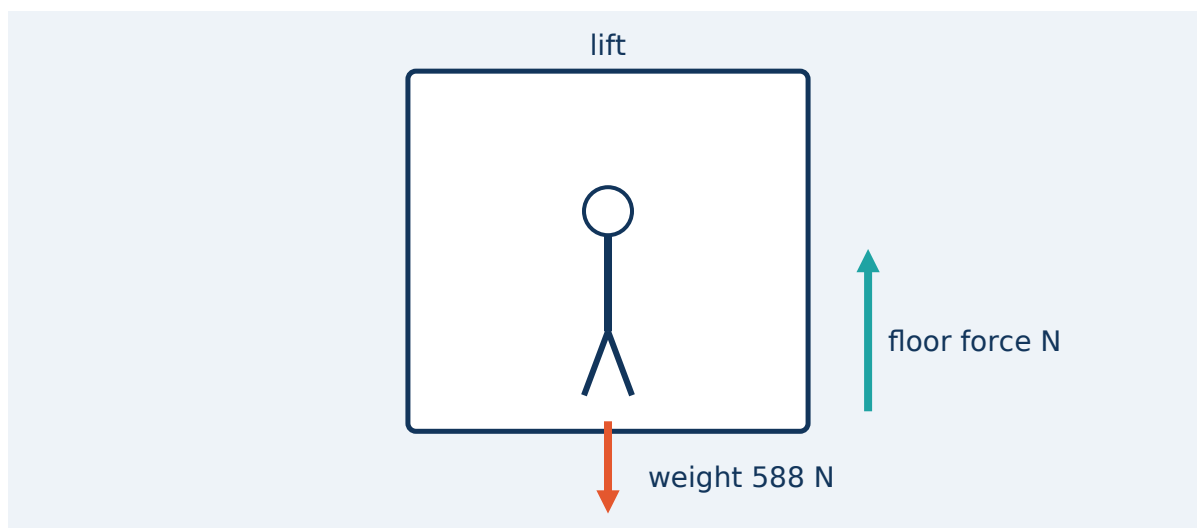


Two skaters push apart with equal forces.

1. State the force on Kofi from Chiamaka and the force on Chiamaka from Kofi.
2. Calculate Chiamaka's acceleration.
3. Calculate Kofi's acceleration.

Problem 16 Person in a lift (hard)

Aarav in Pune has a mass of 60 kg and stands in a lift that accelerates upward at 1.0 m/s^2 . Use $g = 9.8 \text{ N/kg}$.



Forces on a person in a lift.

1. Calculate Aarav's weight.
2. Calculate the net force needed for the acceleration.
3. Calculate the force N from the floor.

Problem 17 Truck and trailer (hard)

A truck of mass 1500 kg pulls a trailer of mass 500 kg. The engine force is 6000 N. Resistance forces are 600 N on the truck and 400 N on the trailer.

1. Calculate the net force on the whole system.
2. Calculate the acceleration.
3. Calculate the tension in the coupling between them.

Problem 18 Spot the errors (hard)

A student writes three statements.

- (A) A heavier object has less inertia.
- (B) The ground's force on your foot cancels your force on the ground, so nothing moves.
- (C) A net force of 10 N on a 5 kg mass gives an acceleration of 50 m/s^2 .

1. Correct (A).
2. Correct (B).
3. Correct (C) and give the right acceleration.

Problem 19 Two cars (hard)

Car A has a mass of 1200 kg, a driving force of 4200 N and resistance of 1200 N. Car B has a mass of 900 kg, a driving force of 3000 N and resistance of 600 N. Both start from rest.

1. Calculate the net force on each car.
2. Calculate each acceleration.
3. State which car gains more speed in 4.0 s and by how much.

Problem 20 Trolley and hanging mass (hard)

A trolley of mass 0.80 kg is pulled along a smooth table by a string over a pulley, with a hanger of mass 0.20 kg on the other end. Use $g = 9.8 \text{ N/kg}$ and ignore friction.

1. Calculate the weight of the hanger, which is the force pulling the whole system.
2. Calculate the acceleration of the system.
3. Explain why the acceleration is much less than 9.8 m/s^2 .
4. Calculate the tension in the string.