

Inertia, resultant force and reaction pairs

Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · Worksheet

Name: _____ Date: _____ Class: _____

These 20 problems train you to apply Newton's laws: finding resultant forces, using $F = m \times a$, converting units, naming third-law pairs and explaining terminal velocity. They go from recall to multi-step reasoning with graphs and data. They suit GCSE, IGCSE, O Level and Class 9-10 students and match NGSS HS-PS2-1.

Level: Physics grades 9-10 (GCSE · IGCSE · O Level · Class 9-10) · **Curriculum:** HS-PS2-1, GCSE P5

Problem 1 Which law is it? (easy)

Link each statement to Newton's first, second or third law.

1. A rocket pushes hot gas downwards and the gas pushes the rocket upwards.
2. A loaded trolley accelerates less than an empty one for the same push.
3. A ball rolls on and on across a very smooth floor until something stops it.
4. State the base units that make up one newton.

Problem 2 Motorbike push (easy)

A motorbike and rider have a combined mass of 180 kg. They accelerate at 2.5 m/s^2 .

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

Problem 3 Cricket ball and bat (easy)

A cricket ball of mass 0.16 kg is struck so that it accelerates at 2000 m/s^2 while in contact with the bat.

1. Calculate the resultant force on the ball.
2. State the size and direction of the force of the ball on the bat.

Problem 4 Balanced or not? (easy)

The figure shows horizontal forces on two sleds.



Horizontal forces on sled A and sled B.

1. Find the resultant force on sled A and describe its motion if it is already moving.
2. Find the resultant force on sled B and give its direction.

Problem 5 Coin on a card (easy)

Emma in Leeds balances a coin on a card over a glass. She flicks the card sideways quickly and the coin drops into the glass.

1. Name the law that explains the result.
2. Explain why the coin does not move sideways with the card.

Problem 6 Mass and weight (easy)

Kofi in Accra has a mass of 50 kg. Use $g = 9.8 \text{ N/kg}$ on Earth and 1.6 N/kg on the Moon.

1. Calculate his weight on Earth.
2. Calculate his weight on the Moon.
3. State his mass on the Moon.

Problem 7 Name the partner force (medium)

For each force, name the other force in its third-law pair.

1. The ground pushes forwards on a runner's foot.
2. A tow rope pulls a broken-down van forward.
3. The Earth pulls a falling apple downwards (gravitational force).

Problem 8 Pushing a crate (medium)

Diego in Texas pushes a crate of mass 25 kg with a force of 140 N. Friction on the crate is 60 N.

1. Calculate the resultant force.
2. Calculate the acceleration.

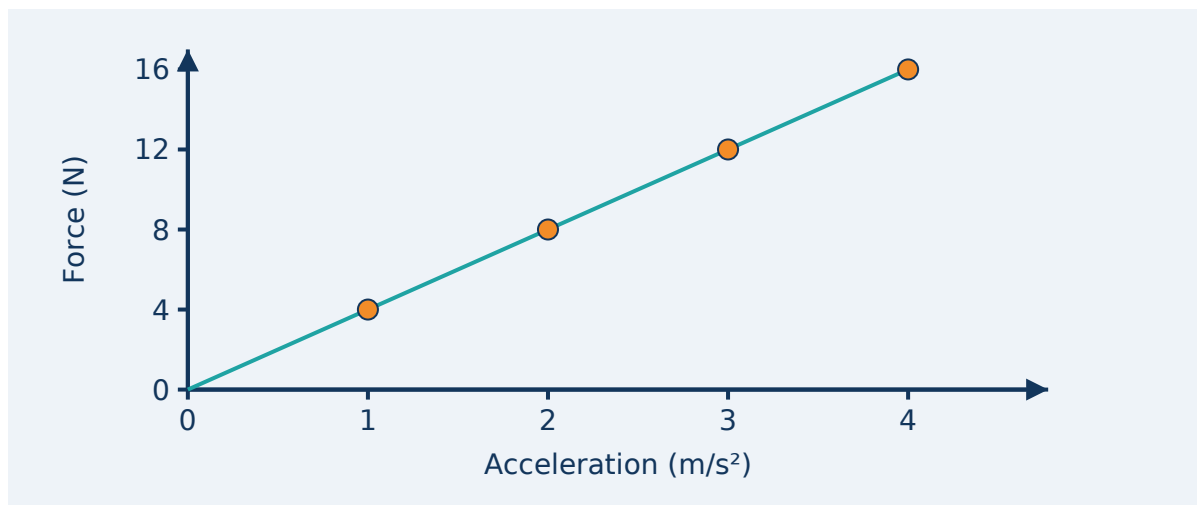
Problem 9 Driving force of a car (medium)

A car of mass 900 kg accelerates at 1.8 m/s^2 . The resistive forces total 500 N.

1. Calculate the resultant force.
2. Calculate the driving force of the engine.

Problem 10 Reading a force graph (medium)

The graph shows the force needed to accelerate a trolley.



Force against acceleration for a trolley.

1. Read the force needed for an acceleration of 2.5 m/s^2 .
2. Calculate the gradient of the line and state what it represents.
3. Find the acceleration produced by 20 N .

Problem 11 Same force, different masses (medium)

A steady force of 60 N acts on a 5.0 kg trolley and then on a 15 kg trolley.

1. Calculate the acceleration of each trolley.
2. State how many times smaller the second acceleration is and why.

Problem 12 Kilonewtons and tonnes (medium)

Convert units before you calculate.

1. A car of mass 1.2 tonnes ($1 \text{ tonne} = 1000 \text{ kg}$) has a resultant force of 2.4 kN . Calculate its acceleration.
2. A 350 g ball accelerates at 20 m/s^2 . Calculate the resultant force.

Problem 13 Crate under a helicopter (medium)

A crate of mass 200 kg hangs from a helicopter cable. The cable pulls up with 2260 N . Use $g = 9.8 \text{ N/kg}$.

1. Calculate the weight of the crate.
2. Calculate the resultant force.
3. Calculate the acceleration and give its direction.

Problem 14 Rowing a boat (medium)

Bilal rows a boat across a lake near Lahore.

1. Use Newton's third law to explain how the oars make the boat move forward.

- Explain why the boat does not keep accelerating forever.

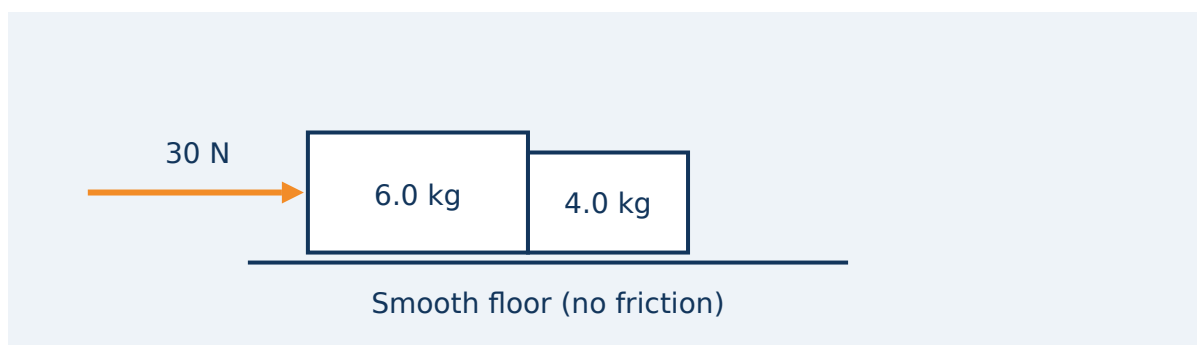
Problem 15 Braking car (medium)

A car of mass 1100 kg slows from 20 m/s to rest in 5.0 s with constant braking.

- Calculate the acceleration (use $a = \text{change in velocity} \div \text{time}$).
- Calculate the resultant braking force.

Problem 16 Two crates in contact (hard)

A force of 30 N pushes a 6.0 kg crate that touches a 4.0 kg crate on a smooth floor.

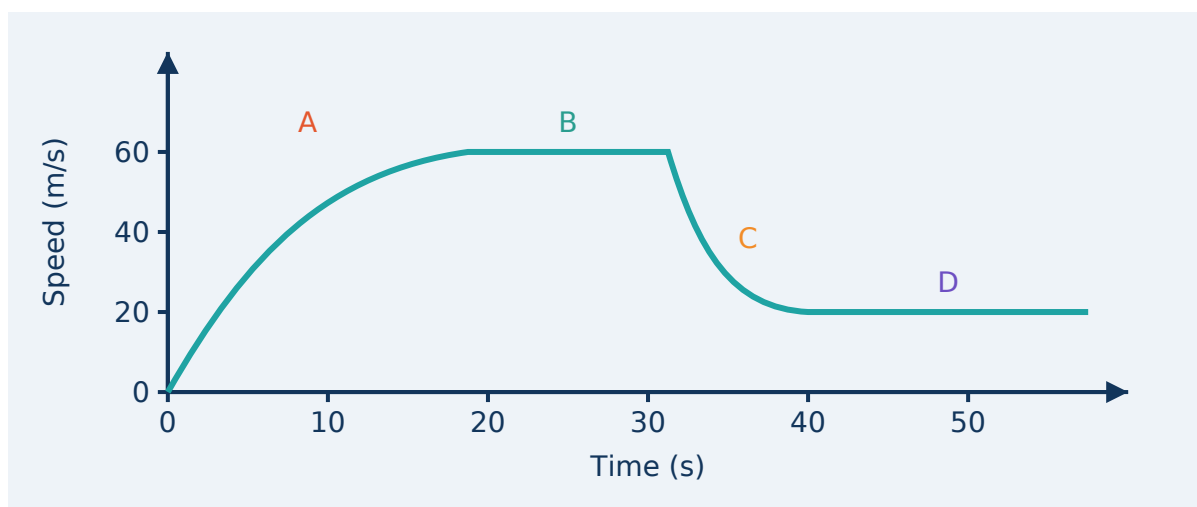


Two crates in contact, pushed along a smooth floor.

- Calculate the acceleration of both crates together.
- Calculate the force that the 6.0 kg crate exerts on the 4.0 kg crate.
- State the force that the 4.0 kg crate exerts on the 6.0 kg crate and name the law.
- Check that the resultant force on the 6.0 kg crate gives the same acceleration.

Problem 17 Skydiver speed graph (hard)

An 80 kg skydiver falls as in the graph. Use $g = 9.8 \text{ N/kg}$.



Speed-time graph of an 80 kg skydiver: A, B, C and D mark four phases of the fall.

- Calculate the weight of the skydiver.
- At one moment in A the air resistance is 300 N. Calculate the acceleration.
- State the air resistance in B and explain why.

4. At the start of D the air resistance is 2500 N. Calculate the size and direction of the acceleration.

Problem 18 Lift cable tension (hard)

A lift with passengers has a mass of 800 kg. Use $g = 9.8 \text{ N/kg}$.

1. Calculate the tension in the cable when the lift moves down at a constant 2.0 m/s.
2. Calculate the tension while the lift speeds up downwards at 1.5 m/s².
3. Calculate the tension while the lift, moving downwards, slows down at 2.0 m/s².

Problem 19 Spot the errors (hard)

A student makes three statements. Identify the mistake in each one and correct it.

1. "The reaction to your weight is the push of the floor on your feet, so these two forces cancel."
2. "A car moving at a steady 25 m/s needs a resultant forward force."
3. "A 5 kg stone falls faster than a 1 kg stone in a vacuum because its weight is larger."

Problem 20 Trolley data (hard)

Mei in Singapore pulls trolleys of different masses with the same resultant force of 3.0 N and measures the accelerations.

Mass (kg)	Acceleration (m/s ²)
0.50	6.1
1.0	2.9
1.5	2.0
2.0	1.5

1. Calculate $m \times a$ for each row.
2. State what the results show and give the mean value.
3. Predict the acceleration of a 3.0 kg trolley.
4. Describe the shape of the graph of acceleration against mass.