Science 3–4

Chapter 6 — Physical sciences

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Contents

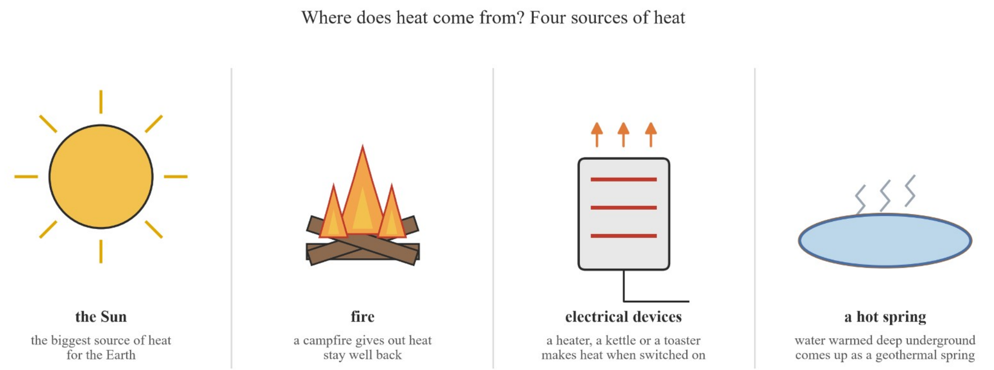
Heat sources and heat transfer

> **What we teach here** — `VC2S4U09` (Victorian Curriculum F–10 Version 2.0, Science, Levels 3 and 4): "heat energy can be generated from different sources; temperature changes may happen when heat is transferred from one object to another". **In our words:** Heat comes from different sources — the Sun, fire, electrical devices and hot water from deep underground. When heat moves from one thing to another, temperatures can change: the thing that gains heat warms up, and the thing that loses heat cools down.

Theory

Where does heat come from?

A **source** of heat is anything that gives out heat. Four sources of heat we meet in everyday life are the Sun, fire, electrical devices, and hot water that comes up from deep underground.



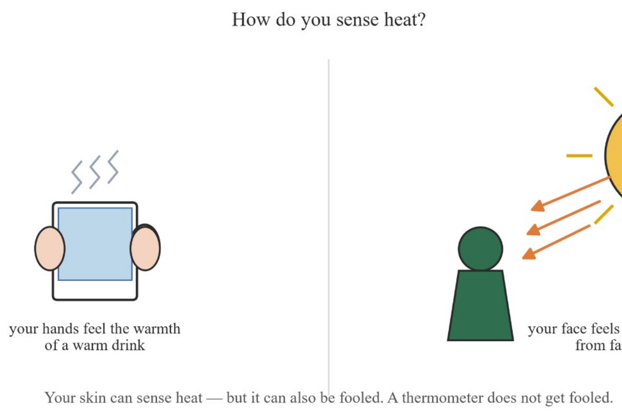
Four panels in a row showing four sources of heat: the Sun with rays, labelled the biggest source of heat for the Earth; a campfire of logs and flames, labelled fire, with the note stay well back; an electrical heater with heat arrows rising from it, labelled electrical devices, a heater, a kettle or a toaster makes heat when switched on; and a steaming pool of water, labelled a hot spring, water warmed deep underground comes up as a geothermal spring.

- **The Sun** is the biggest source of heat for the Earth. You can feel its heat on your face from far away.
- **Fire** gives out heat — a campfire on a cold night, or a wood heater. In this book we only ever meet fire as a source of heat, and we always stay well back from it.
- **Electrical devices** make heat when they are switched on: a heater, a kettle, a toaster.
- **Geothermal springs** are hot water from deep underground. *Geo* means Earth and *thermal* means heat.

Victoria has real geothermal springs. At the Peninsula Hot Springs, near Fingal on the Mornington Peninsula, water is warmed by hot rock 637 m below the ground and comes up to fill pools at 36–42 °C. (Source: Peninsula Hot Springs FAQs, from the Peninsula Hot Springs website — retrieved 20 August 2026.)

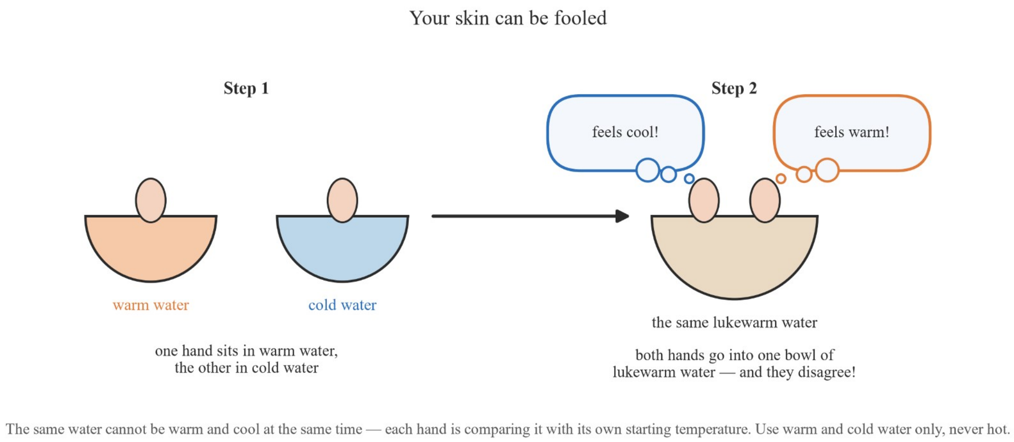
Feeling heat — and being fooled

Your skin can sense heat. Hold your hands around a warm drink and they feel the warmth. Stand facing the Sun and your face feels the Sun's heat from far away.



Two panels. Left: two hands cupped around a steaming mug, captioned your hands feel the warmth of a warm drink. Right: a person facing the Sun with three heat arrows travelling from the Sun to the person, captioned your face feels the Sun's heat from far away. A footer says your skin can sense heat but it can also be fooled, and a thermometer does not get fooled.

But your skin can be fooled. Try the three-bowl trick with warm and cold water — never hot.

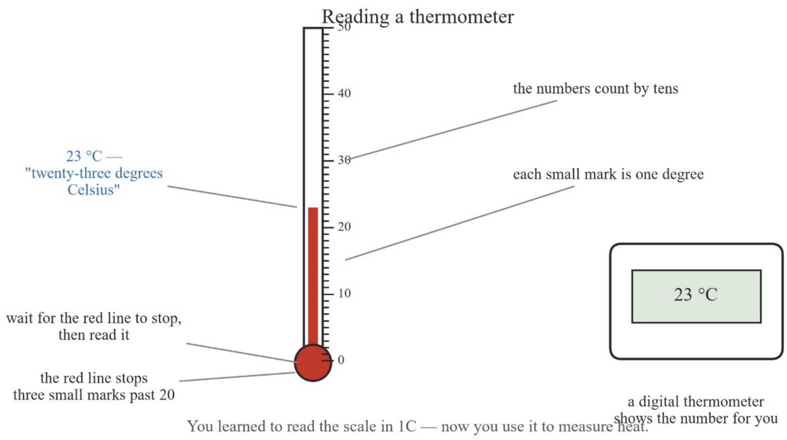


Two steps. Step 1: two bowls, one of warm water and one of cold water, with one hand sitting in each. Step 2: both hands go into one bowl of the same lukewarm water; a blue thought bubble from the hand that sat in warm water says feels cool!, and an orange thought bubble from the hand that sat in cold water says feels warm! A footer says the same water cannot be warm and cool at the same time — each hand is comparing it with its own starting temperature.

The hand that sat in warm water says the lukewarm water feels cool. The hand that sat in cold water says the *same* water feels warm. The same water cannot be warm and cool at the same time — each hand is only comparing the water with its own starting temperature. That is why we do not trust our skin to measure heat. We use a thermometer.

Measuring temperature

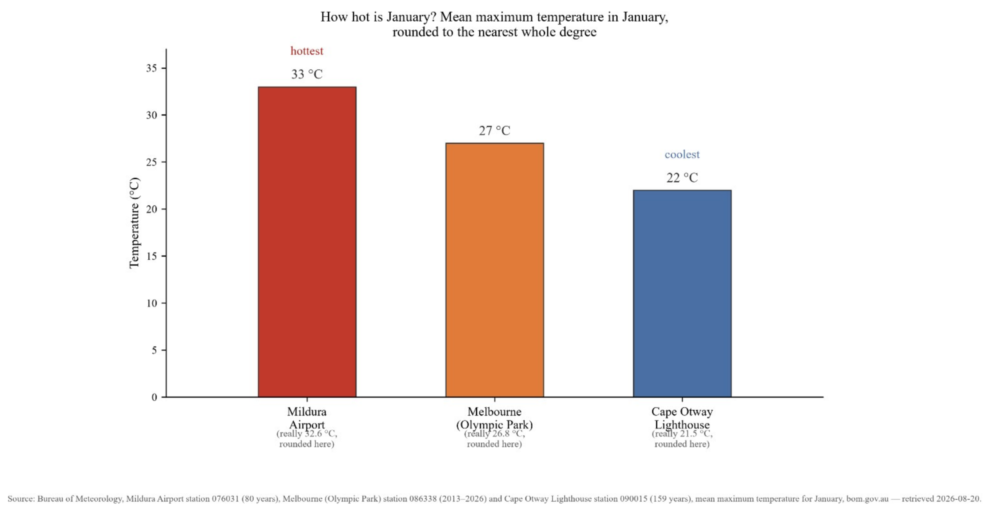
Temperature is how hot or how cold something is. We measure temperature with a **thermometer** and write it with the symbol **°C** — the big thermometer figure shows how to say a °C number out loud. In 1C you learned to read the scale, and the rules are the same here: the numbers count by tens, each small mark is one °C, and you wait for the red line to stop before you read it.



A large thermometer with a scale from 0 to 50 whose red line stops three small marks past 20, with callouts: the numbers count by tens; each small mark is one °C; wait for the red line to stop, then read it; and 23 °C written the way we say it out loud. Beside it, a digital thermometer shows 23 °C on a screen. A footer says you learned to read the scale in 1C — now you use it to measure heat.

How hot is January? Reading a column graph

The Bureau of Meteorology (BOM) measures temperature at weather stations all over Australia. The column graph below uses real BOM numbers for three places in Victoria. Estimate first, then read: which column is tallest, and which is shortest?



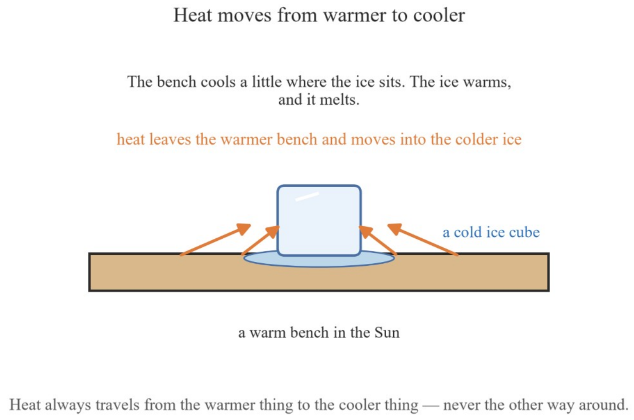
A column graph titled How hot is January? with three columns: Mildura Airport at 33 °C labelled hottest, Melbourne Olympic Park at 27 °C, and Cape Otway Lighthouse at 22 °C labelled coolest. The scale up the side is temperature in °C, from 0 to 35. A source line names the Bureau of Meteorology stations and the date retrieved.

Now read the numbers. Mildura, far inland in the north-west, has the hottest January at 33 °C. Cape Otway, right by the sea, has the coolest at 22 °C. 33 − 22 = 11, so a January day in Mildura sits 11 °C above one at Cape Otway.

(Real data: Bureau of Meteorology, Mildura Airport station 076031, Melbourne (Olympic Park) station 086338 and Cape Otway Lighthouse station 090015 — how hot January days get at each place, bom.gov.au — retrieved 20 August 2026. The graph rounds each number to the nearest whole °C.)

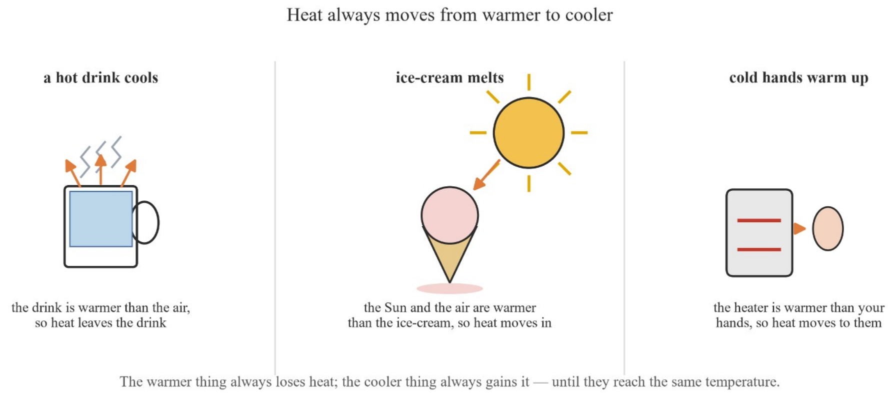
Heat moves from warm to cool

Here is the big rule of this section: when a warm thing touches a cool thing, **heat moves from the warm one to the cool one** — never the other way around.



An ice cube sitting on a warm bench in the Sun, with meltwater around it. Four heat arrows point from the warm bench into the cold ice cube. Text above says heat leaves the warm bench and moves into the cold ice, and the bench cools a little where the ice sits while the ice warms and melts. A footer says heat always travels from the warm thing to the cool thing — never the other way around.

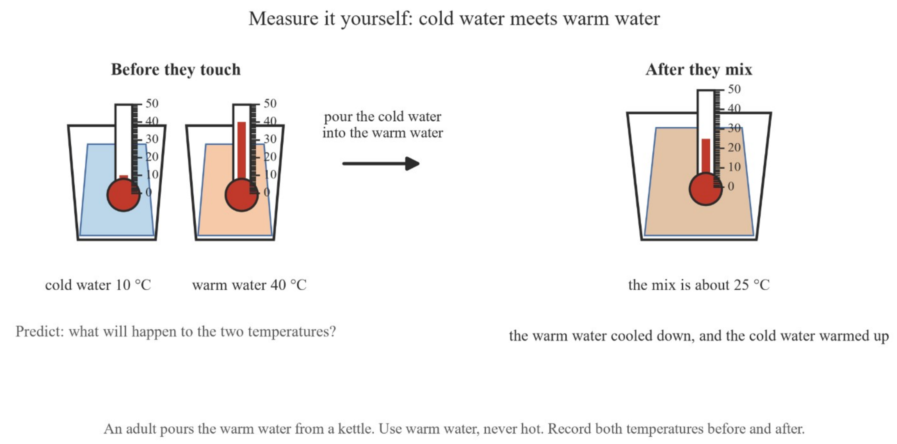
The warm bench loses heat and the cold ice gains it, so the ice warms and melts. The same rule works in three everyday scenes:



Three panels. Left: a steaming mug with heat arrows leaving the drink, captioned the drink is warm and the air is cool, so heat leaves the drink. Middle: an ice-cream in the Sun with a heat arrow moving from the Sun into the ice-cream, captioned the Sun and the air are warm and the ice-cream is cold, so heat moves in. Right: a hand held near a heater with a heat arrow moving from the heater to the hand, captioned the heater is warm and your hands are cold, so heat moves to them. A footer says the warm thing always loses heat and the cool thing always gains it, until they reach the same temperature.

Investigation: cold water meets warm water

You can watch the rule happen with two cups of water and two thermometers. Estimate first, then measure.

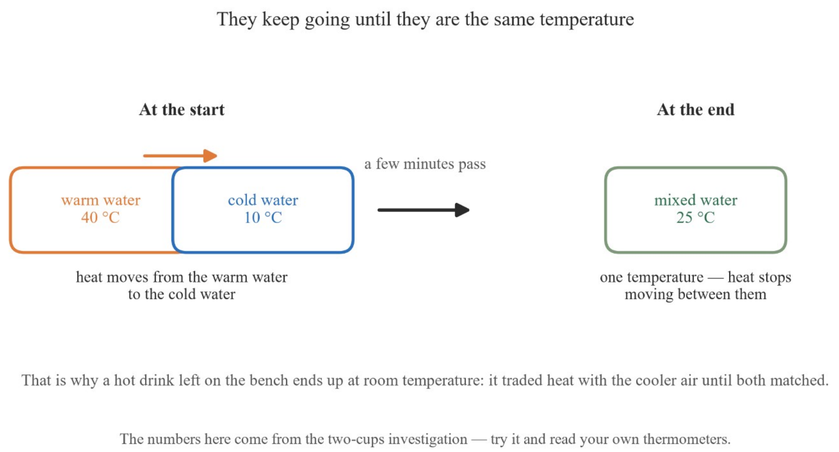


Before and after pictures. Before: a cup of cold water with a thermometer reading 10 °C and a cup of warm water with a thermometer reading 40 °C, and an arrow labelled pour the cold water into the warm water. After: one cup of mixed water with a thermometer reading 25 °C, captioned the warm water cooled down, and the cold water warmed up. A safety line says an adult pours the warm water from a kettle, use warm water never hot, and record both temperatures before and after.

1. **Estimate.** Guess the temperature of each cup before you measure.
2. **Measure.** Read both thermometers and write the numbers down.
3. **Mix.** Pour the cold water into the warm water. (An adult pours the warm water from a kettle. Use warm water, never hot.)
4. **Measure again.** Read the thermometer in the mix and write it down.

What we measure	Our estimate	Our reading
cold water, before	your guess	10 °C
warm water, before	your guess	40 °C
the mix, after	your guess	about 25 °C

The mix lands *between* the two starting temperatures. The warm water cooled down (40 °C to about 25 °C) and the cold water warmed up (10 °C to about 25 °C). Heat moved from the warm water to the cool water until there was only one temperature.

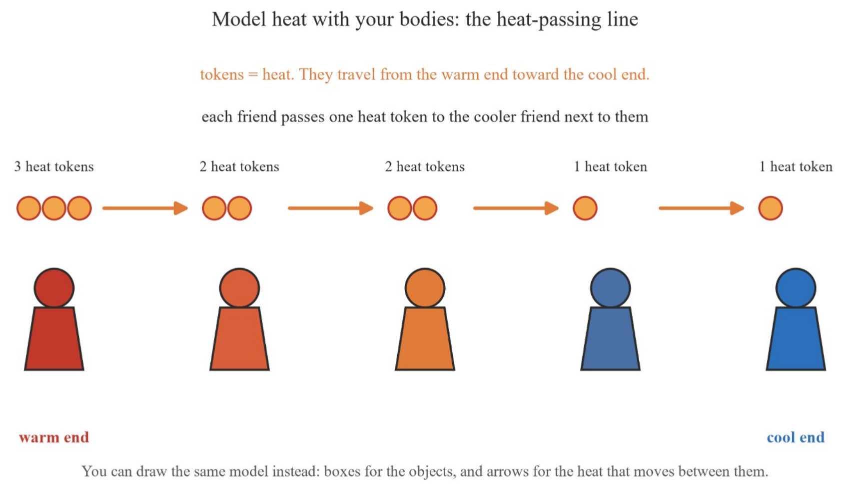


Two panels. At the start: a warm water 40 °C box beside a cold water 10 °C box, with a heat arrow from the warm box to the cold box, captioned heat moves from the warm water to the cold water. At the end, after a few minutes pass: one mixed water 25 °C box, captioned one temperature — heat stops moving between them. Footers say that is why a hot drink left on the bench ends up at room temperature, and the numbers come from the two-cups investigation.

Heat keeps moving while one side is warm and the other is cool. When both sides reach the **same temperature**, heat stops moving between them. That is why a hot drink left on the bench ends up at room temperature: it traded heat with the cool air until both matched.

Model heat with your bodies — and with a drawing

Heat is invisible, so a model helps. Here is a role-play for five people: stand in a line from a warm end to a cool end. The person at the warm end holds 3 heat tokens (beans or counters); the next holds 2, then 2, then 1, and the person at the cool end holds 1. Each person passes one token to the cool person next to them. The tokens stand for heat, and they travel from the warm end toward the cool end.

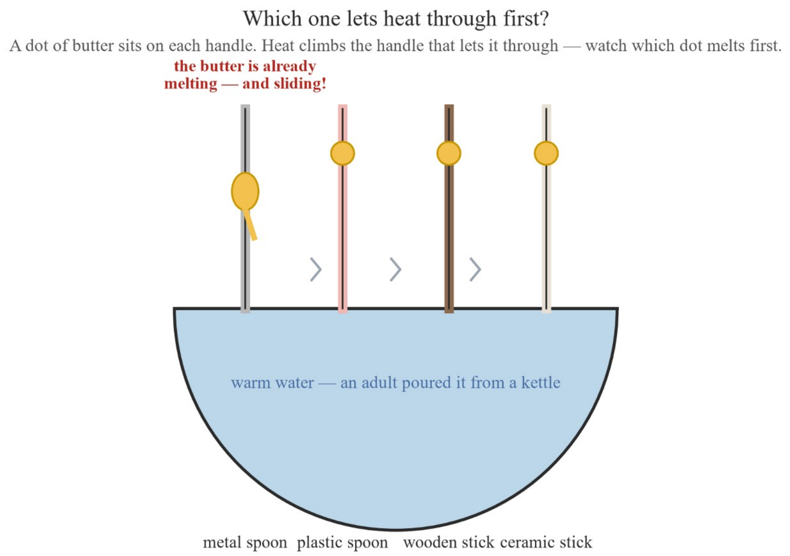


Five people in a line from a red warm end to a blue cool end, with heat tokens above each person: 3, 2, 2, 1 and 1. Arrows pass the tokens from the warm person toward the cool person next to them. Lines above say tokens equal heat, they travel from the warm end toward the cool end, and each friend passes one heat token to the cool friend next to them. A footer says you can draw the same model instead: boxes for the objects, and arrows for the heat that moves between them.

Keep passing and each person ends up holding about the same number of tokens — just as heat keeps moving until both ends are the same temperature. You can draw the same model instead: boxes for the objects, and arrows for the heat that moves between them.

Heat moves through materials at different speeds

Heat moves through some materials fast and through others slowly. Test it with four spoons and a bowl of warm water — an adult pours the water.

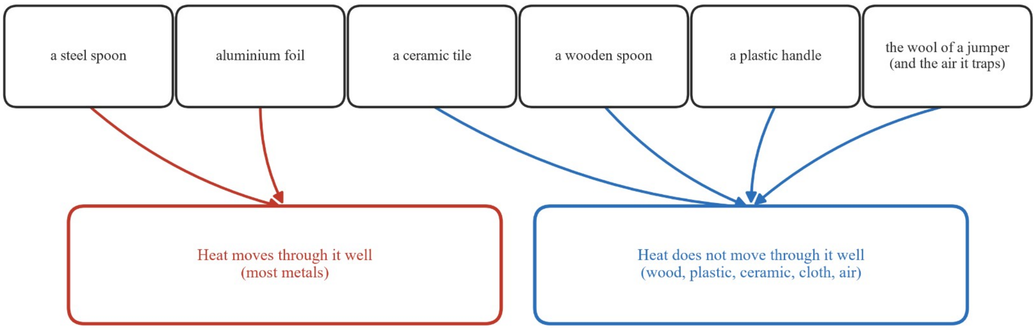


Four spoons standing handle-up in one bowl of warm water: a metal spoon, a plastic spoon, a wooden spoon and a ceramic spoon. A knob of butter on the metal handle has melted so its bead slid down, while the other handles show no melting. Labels name each handle material, and a note says same bowl, same warm water — only the handle material is different.

Put a tiny knob of butter and a light bead near the top of each handle, and stand the spoons in the same bowl of warm water. Same bowl, same warm water, same time — only the handle material is different, so it is a **fair test**. The metal handle carries the heat up fast: its butter melts and the bead slides. The plastic, wooden and ceramic handles carry much less heat, so their butter stays solid.

We say metal **lets heat through well**, and wood, plastic and ceramic **do not let heat through well**. Most metals let heat through well.

Sort the materials: does heat move through it well?



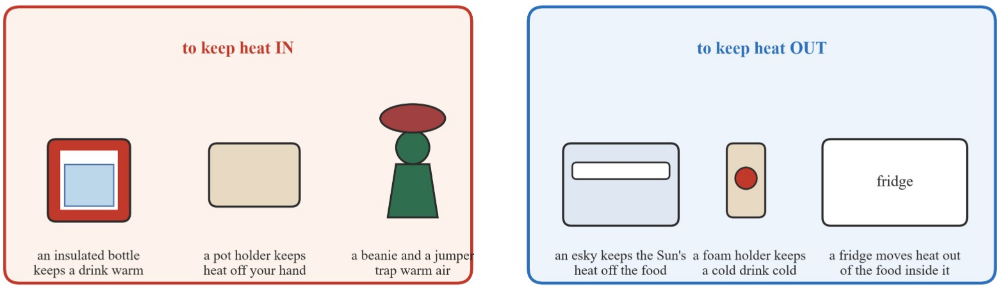
The test from the spoons picture decides the sort: watch which handles carry the heat.

A sorting diagram. Six cards across the top: a steel spoon, aluminium foil, a ceramic tile, a wooden spoon, a plastic handle, and the wool of a jumper (and the air it traps). Arrows sort the steel spoon and the aluminium foil into a red box labelled heat moves through it well (most metals), and the ceramic tile, wooden spoon, plastic handle and wool into a blue box labelled heat does not move through it well (wood, plastic, ceramic, cloth, air). A footer says the test from the spoons picture decides the sort.

Keeping things hot — and keeping things cold

Materials that do not let heat through well are used to keep things hot *and* to keep things cold. An **insulated** thing is made so heat moves slowly in or out. (You were promised this word in 2C — here it is at last.)

Keeping things hot — and keeping things cold



The trick is the same both ways: a material that does not let heat through easily slows the heat down — in or out.

Two panels. To keep heat IN: an insulated bottle with thick walls keeps a drink warm; a pot holder keeps heat off your hand; a person in a beanie and jumper, which trap warm air. To keep heat OUT: an esky keeps the Sun's heat off the food; a foam holder keeps a cold drink cold; a fridge moves heat out of the food inside it. A footer says the trick is the same both ways: a material that does not let heat through well slows the heat down — in or out.

- An **insulated bottle** has thick walls with trapped air, so heat moves slowly out — the drink stays warm.
- An **esky** works the same way in the other direction: heat moves slowly in, so the food stays cool.
- A **beanie** and a jumper trap warm air near your body, because air does not let heat through well.
- A **fridge** moves heat out of the food inside it.

The trick is the same both ways: a material that does not let heat through well slows the heat down — in or out.

Working safely with heat

Hot things can burn. These rules apply to every heat activity in this subtopic.

Working safely with heat

Heat is useful and heat is fun — and hot things can burn. The rules keep you safe while you investigate.

Four safety cards, each with a tick in a circle: an adult pours the warm water; touch to test? ask first, and use the back of your hand; stay well back from fires, heaters and the stove; in the Sun: hat, water and shade at recess. A footer says heat is useful and heat is fun — and hot things can burn, so the rules keep you safe while you investigate.

- An adult pours any warm water from a kettle. Use warm water, never hot.
- If you touch something to test it, ask first, and use the back of your hand for a moment.
- Stay well back from fires, heaters and the stove.
- In the Sun: hat, water and shade at recess.

Words to know in 6A

Word	What it means here
source of heat	anything that gives out heat, like the Sun, a fire, an electrical device or a geothermal spring
heat energy	the energy that moves from a warm thing to a cool thing; you feel it as warmth
temperature	how hot or how cold something is
°C	the symbol for the unit of temperature; the big thermometer figure shows how to say 23 °C out loud
thermometer	the tool that measures temperature; it does not get fooled
lukewarm	between warm and cool; not quite warm and not quite cool
material	what a thing is made of, like metal, wood, plastic or ceramic
lets heat through well	describes a material, like most metals, that heat moves through fast
does not let heat through well	describes a material, like wood, plastic, ceramic, cloth or trapped air, that heat moves through slowly
insulated	made so heat moves slowly in or out
fair test	a test where only one thing is changed, so the result is fair
predict	to say what you think will happen before you test it
geothermal	to do with heat from inside the Earth; a geothermal spring is hot water from deep underground

Worked examples

Example 1 — scaffolded

A class does the two-cups investigation. The cold water reads 10 °C and the warm water reads 40 °C, and the cups hold about the same amount. Estimate the temperature of the mix, then choose the closest reading: 5 °C, 25 °C or 45 °C.

Working	Comment
The mix must be above 10 °C.	The cold water gains heat, so it warms up.
The mix must be below 40 °C.	The warm water loses heat, so it cools down.
So the mix sits between 10 °C and 40 °C — with equal cups, about halfway: 25 °C.	Heat moves from warm to cool until there is one temperature.

So the estimate is "between 10 °C and 40 °C", and the closest choice is 25 °C.

Example 2 — scaffolded

Sort these four into *lets heat through well* and *does not let heat through well*: **a steel spoon, aluminium foil, a wooden spoon, a plastic handle**.

Working	Comment
Steel spoon: steel is a metal, and the spoons test showed metal carries heat fast.	Lets heat through well.
Aluminium foil: aluminium is a metal too.	Lets heat through well.
Wooden spoon: the wooden handle in the spoons test carried little heat.	Does not let heat through well.
Plastic handle: the plastic handle carried little heat.	Does not let heat through well.

So the steel spoon and the aluminium foil let heat through well; the wooden spoon and the plastic handle do not.

Example 3 — unscaffolded

Your friend does the three-bowl trick. One hand sits in warm water, one hand in cold water, and then both hands go into the same lukewarm water. She says, "This water is warm and cool at the same time!" Use what you know to explain what is really happening.

The water is one temperature — lukewarm — and one water cannot be warm and cool at the same time. Each hand is comparing the water with its own starting temperature: the hand that sat in cold water starts off cool, so heat moves into it and it feels warm; the hand that sat in warm water starts off warm, so heat moves out of it and it feels cool. ∴ Her skin is being fooled — the water is lukewarm, and only a thermometer would give the true temperature.

Practice questions

Scaffolded

Q1. Name two sources of heat shown in the first figure in this section.

Q2. Fill in the blank: the tool we use to measure temperature is a ______.

Q3. True or false: when a warm thing and a cool thing touch, heat moves from the cool one to the warm one.

Q4. Read the thermometer figure in this section. What temperature does the red line show?

Q5. In the spoons fair test, which handle carried heat best? How could you tell?

Q6. Fill in the blank: an insulated thing is made so heat moves ______ in or out.

Unscaffolded

Q7. Use the BOM column graph. Mildura's January is how many °C above Melbourne's?

Q8. Use the BOM column graph. Which place has the coolest January, and what is its temperature?

Q9. In the two-cups investigation the warm water started at 40 °C and the mix read about 25 °C. By how many °C did the warm water cool down?

Q10. Explain why the two hands disagree in the lukewarm bowl.

Q11. Name one material that lets heat through well and one that does not.

Q12. A pot of soup is hot on the stove. Should the stirring spoon be metal or wooden? Give a reason with "lets heat through".

Q13. A beanie does not give out heat, yet it keeps your head warm on a cold day. Explain how.

Q14. What does *insulated* mean? Name one insulated thing from this section and say what it keeps hot or cold.

Q15. In the heat-passing line role-play, what do the tokens stand for, and which way do they travel?

Q16. At the Peninsula Hot Springs, where does the heat in the pools come from?

Answers

Q1. Any two of: the Sun, fire, electrical devices, a geothermal spring (hot spring). **Q2.** A thermometer. **Q3.** False — heat moves from the warm one to the cool one. **Q4.** 23 °C. **Q5.** The metal handle; its butter melted and the bead slid down. **Q6.** Slowly. **Q7.** 33 − 27 = 6, so Mildura's January is 6 °C above Melbourne's. **Q8.** Cape Otway (Lighthouse), 22 °C. **Q9.** 40 − 25 = 15, so the warm water cooled down about 15 °C. **Q10.** Each hand is comparing the water with its own starting temperature, so the same lukewarm water feels warm to the cold hand and cool to the warm hand. **Q11.** Any one that lets heat through well (e.g. metal, steel, aluminium) and any one that does not (e.g. wood, plastic, ceramic, wool, trapped air). **Q12.** Wooden — wood does not let heat through well, so the handle stays cool enough to hold; a metal spoon would let the soup's heat reach your hand. **Q13.** The beanie traps warm air near your head, and trapped air does not let heat through well, so heat leaves your head more slowly. **Q14.** Insulated means made so heat moves slowly in or out. Example: an insulated bottle keeps a drink warm (or an esky keeps food cold; a foam holder keeps a cold drink cold). **Q15.** The tokens stand for heat, and they travel from the warm end toward the cool end. **Q16.** From hot rock deep underground — water is warmed 637 m below the ground and comes up as a geothermal spring.

Fully-worked answers

Q1. The first figure shows four sources of heat: **the Sun, fire, electrical devices and a geothermal spring**. Any two of these.

Q2. We measure temperature with a **thermometer** — skin can be fooled, but a thermometer reads the true temperature.

Q3. False. The rule runs one way only: heat moves from the warm thing to the cool thing, never the other way around.

Q4. The red line stops three small marks past 20, so the thermometer shows **23 °C**.

Q5. The **metal** handle carried heat best. We could tell because the butter on the metal handle melted and the bead slid down, while the butter on the plastic, wooden and ceramic handles stayed solid.

Q6. Insulated means made so heat moves **slowly** in or out.

Q7. Mildura reads 33 °C and Melbourne reads 27 °C. 33 − 27 = **6**, so Mildura's January is 6 °C above Melbourne's.

Q8. The shortest column is Cape Otway Lighthouse at **22 °C** — the coolest January of the three places.

Q9. The warm water went from 40 °C to about 25 °C. 40 − 25 = **15**, so it cooled down about 15 °C.

Q10. Heat always moves from warm to cool. The hand that sat in cold water starts off cool, so heat moves from the water into that hand and it feels warm. The hand that sat in warm water starts off warm, so heat moves from that hand into the water and it feels cool. The water is one temperature; the hands disagree because each compares it with its own starting temperature.

Q11. Metals let heat through well — for example a **steel spoon**. Wood, plastic, ceramic, wool and trapped air do not let heat through well — for example a **wooden spoon**.

Q12. Choose the **wooden** spoon. Wood does not let heat through well, so the heat of the soup moves only slowly up the handle and your hand stays comfortable. A metal spoon lets heat through well, so the handle would get too hot to hold.

Q13. A beanie is not a source of heat — your body is. The beanie **traps warm air** near your head, and air does not let heat through well, so heat leaves your head more slowly and your head stays warm.

Q14. Insulated means made so heat moves slowly in or out. An **insulated bottle** has thick walls that slow the heat moving out, so it keeps a drink warm. (An esky or a foam holder works the other way, keeping heat out and things cold.)

Q15. The tokens stand for **heat**, and they travel **from the warm end toward the cool end** — each person passes a token to the cool person next to them, just as heat moves from warm to cool.

Q16. The heat comes from **hot rock deep underground**: water is warmed 637 m below the ground and comes up as a geothermal spring to fill the pools at 36–42 °C. ∴ The Peninsula Hot Springs is a natural source of heat from inside the Earth.

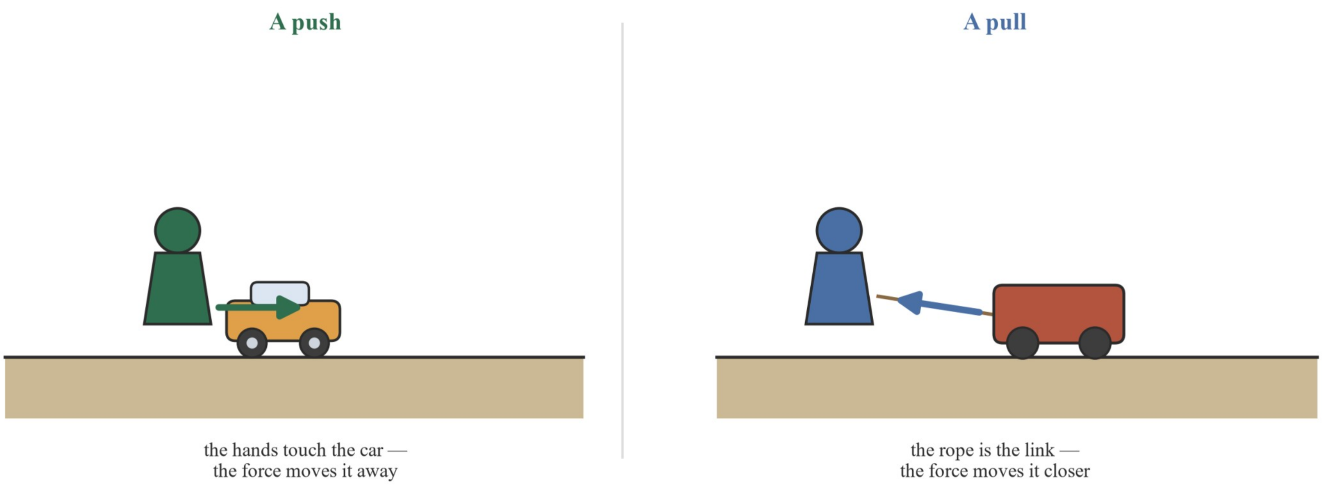
Forces: contact, and at a distance

What we teach here — `VC2S4U10` (Victorian Curriculum F–10 Version 2.0, Science, Levels 3 and 4): “forces, including frictional, gravitational, electrostatic and magnetic, can be exerted by one object on another through direct contact or from a distance and affect the motion (speed and direction) of objects”. **In our words:** a force is a push or a pull. Four forces in this subtopic carry names — frictional, gravitational, magnetic and electrostatic. Some forces need the two things to touch, and some work from a distance. A force can change how fast a thing moves, or the way it is going.

Theory

A force is a push or a pull

You have been using forces all your life. Every time you shove a trolley, kick a ball, tug a door open or haul a bag up, you are using a force. A **force** is a push or a pull that one thing puts on another thing.



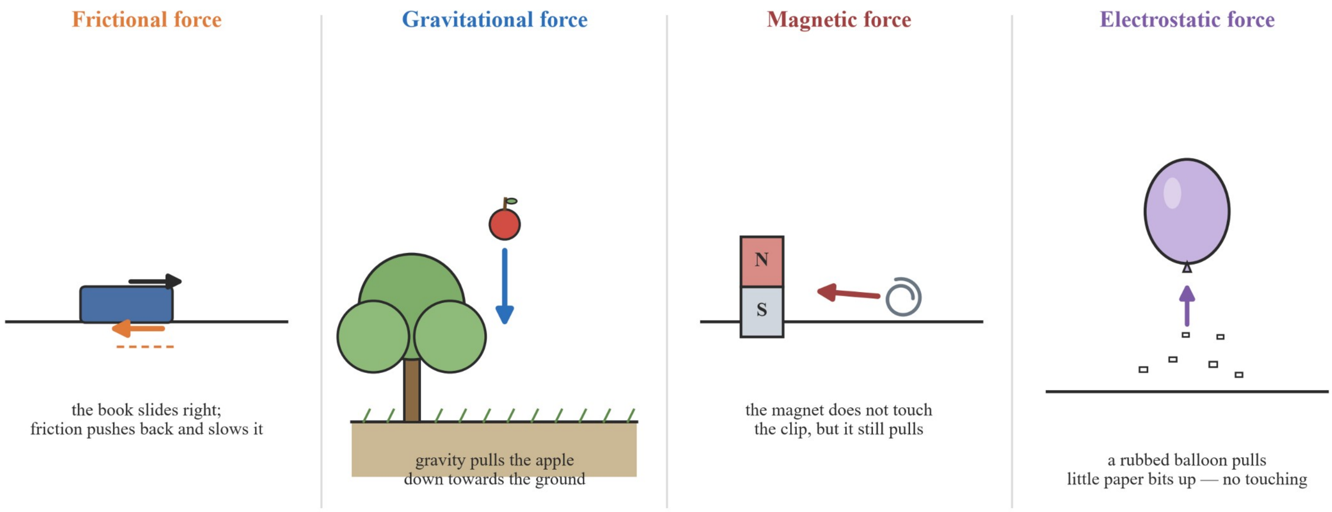
A force is a push or a pull. The arrow shows the way the force works.

Two panels. Left: a person pushes a toy car, and an arrow on the car points away from the person, the way the push works. Right: a person pulls a wagon by a rope, and an arrow points from the wagon towards the person, the way the pull works.

Scientists draw a force as an arrow. The arrow starts on the thing the force acts on, and it points the way the force works: away from you for a push, towards you for a pull.

The four forces with names

Pushes and pulls come in different kinds. This subtopic names four.



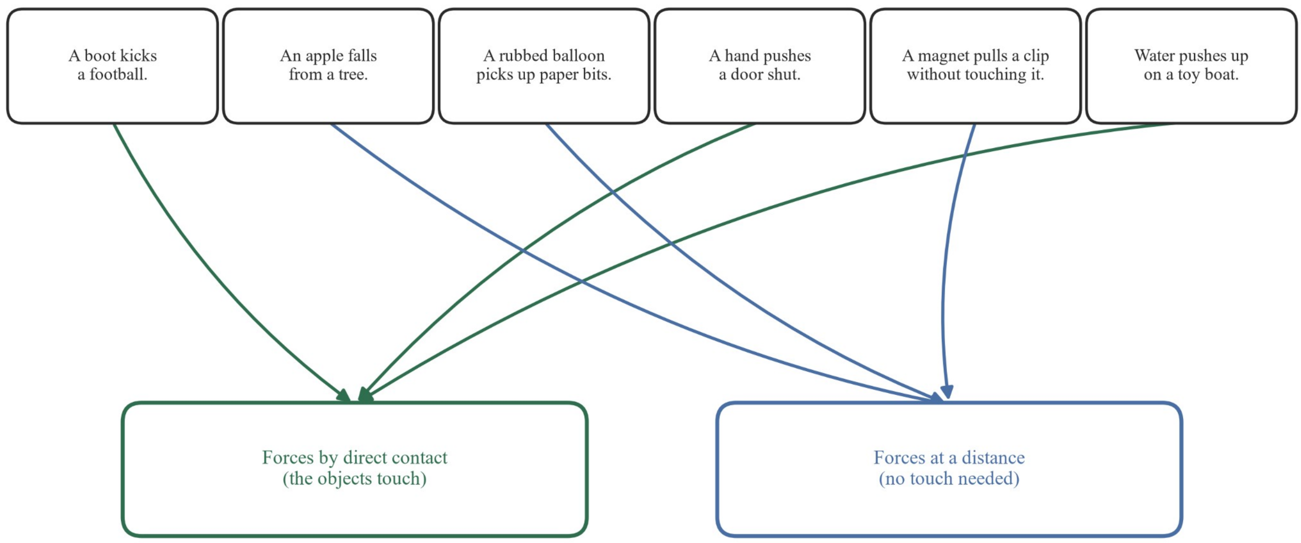
The four forces named in this subtopic: frictional, gravitational, magnetic and electrostatic.

Four panels. A sliding book slows down, with an arrow against its motion, for the frictional force; an apple falls from a tree with a down arrow, for the gravitational force; a bar magnet pulls a paper clip across a gap, for the magnetic force; a rubbed balloon lifts little paper bits without touching them, for the electrostatic force.

- **Frictional force** — shows up when one surface rubs or slides on another. It pushes against the motion and slows the thing down.
- **Gravitational force** — pulls things down, towards the centre of the Earth. It is why dropped things fall.
- **Magnetic force** — a magnet pulls some metal things, even across a gap, without touching them.
- **Electrostatic force** — after rubbing, a thing like a balloon can pull light bits (paper, hair) towards it, without touching them.

Touching, or not touching?

That gives us two big groups. Some forces need the two things to touch — **direct contact**. Some work with a gap between the things — **at a distance**. The test is one question: *are the two things touching when the force works?*



Ask: are the two things touching when the force works? If yes — direct contact. If no — at a distance.

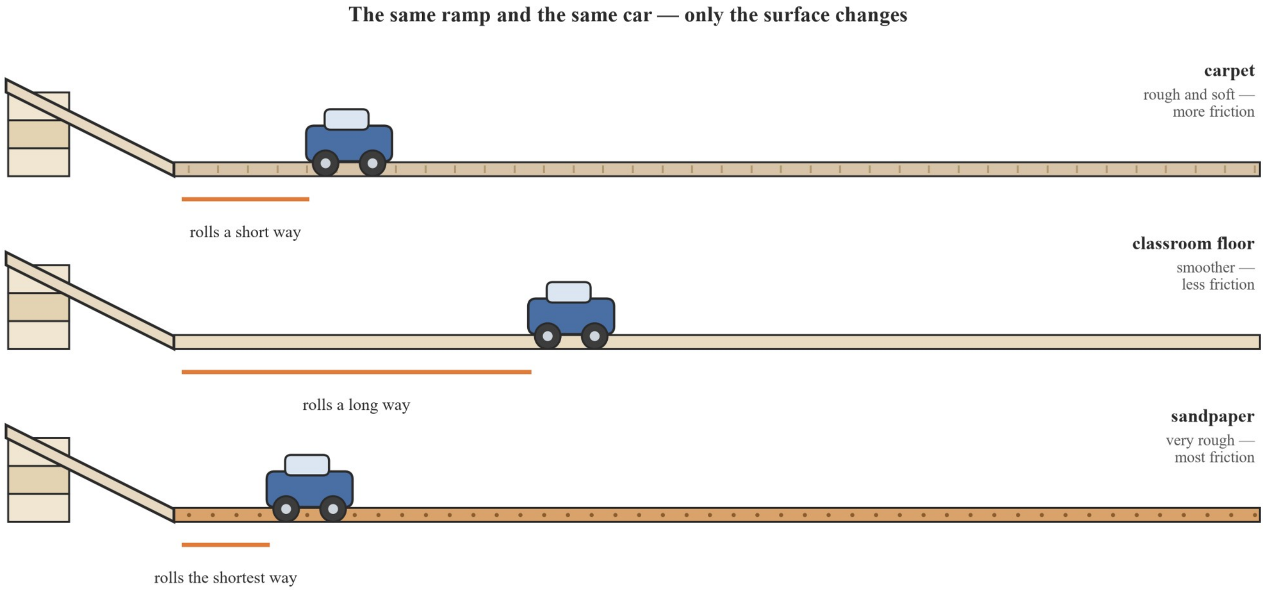
A sorting diagram. Six cards — a boot kicks a football; an apple falls from a tree; a rubbed balloon picks up paper bits; a hand pushes a door shut; a magnet pulls a clip without touching it; water pushes up on a toy boat — are sorted *into two boxes: forces by direct contact (the boot, the hand, the water) and forces at a distance (the falling apple, the balloon, the magnet).*

A boot on a ball, a hand on a door, water on a boat: the things touch, so those are contact forces. A falling apple, a magnet and its clip, a rubbed balloon and its paper bits: no touch needed, so those forces work at a distance.

One careful note: rubbing a balloon on your jumper is a contact force — the balloon and the jumper touch. But once the balloon is rubbed, the pull it puts on paper bits works at a distance. The same balloon can be part of both kinds.

Friction slows things down

Roll a ball across the floor and it does not roll for ever. It slows, and it stops. The force doing that is **friction** — the frictional force between the ball and the floor. Friction pushes against the motion, so it slows things down and can stop them.



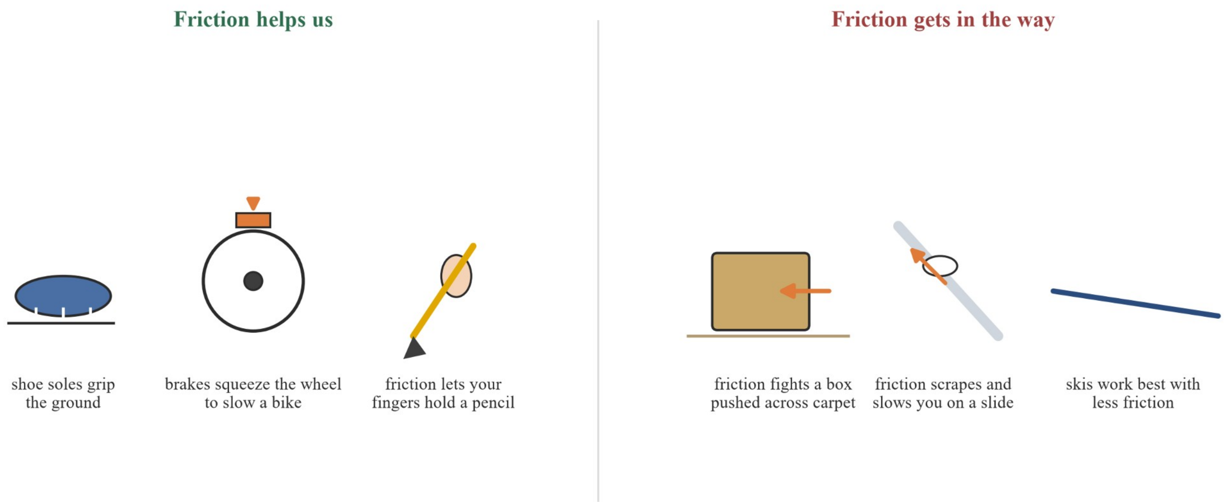
Rougher surfaces give more friction. More friction slows the car sooner.

Three rows with the same ramp and the same toy car; only the surface at the bottom changes. On sandpaper the car rolls the shortest way; on carpet it rolls a short way; on the smooth classroom floor it rolls a long way.

Rougher surfaces give more friction. On sandpaper — very rough — the car slows quickly and rolls the shortest way. On carpet it rolls a little further, and on the smooth floor it rolls the longest way. Same ramp, same car: only the surface changes, so the difference in rolling is the difference in friction.

Friction helps, and friction gets in the way

Friction is not a bad force. Half the time it is the force we want.



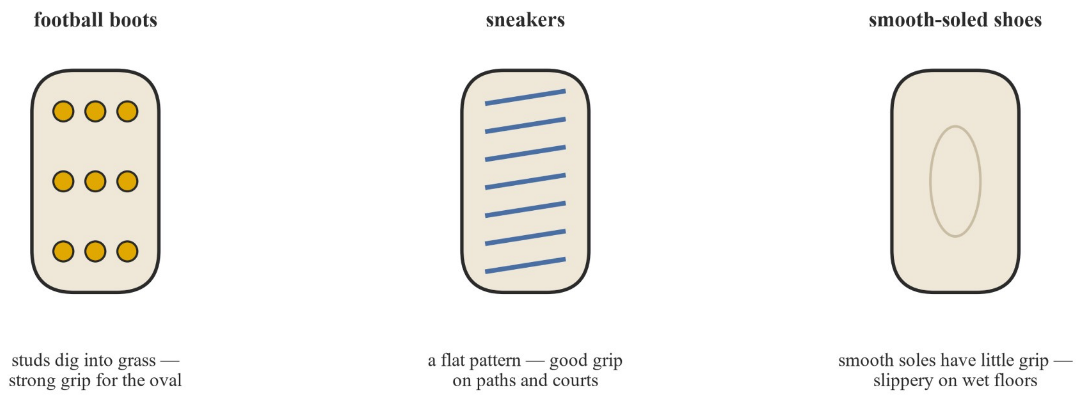
Sometimes we want lots of friction. Sometimes we want very little.

Two panels. Friction helps us: the bottoms of shoes grip the ground, bike brakes squeeze the wheel, and friction lets fingers hold a pencil. Friction gets in the way: friction fights a box pushed across carpet, friction scrapes and slows you on a slide, and skis work best with less friction.

Without friction between your shoes and the ground you could not walk or run — your feet would slip. Brakes on a bike squeeze the wheels so friction slows them. Friction between your fingers and a pencil is why the pencil does not slide out of your hand. But friction also fights you: a box is hard to push across carpet, and a slide would be a better slide with less friction. Sometimes we want lots of friction. Sometimes we want very little.

The bottom of a shoe — friction by design

Look at the bottom of a shoe and you can read what the shoe is for.



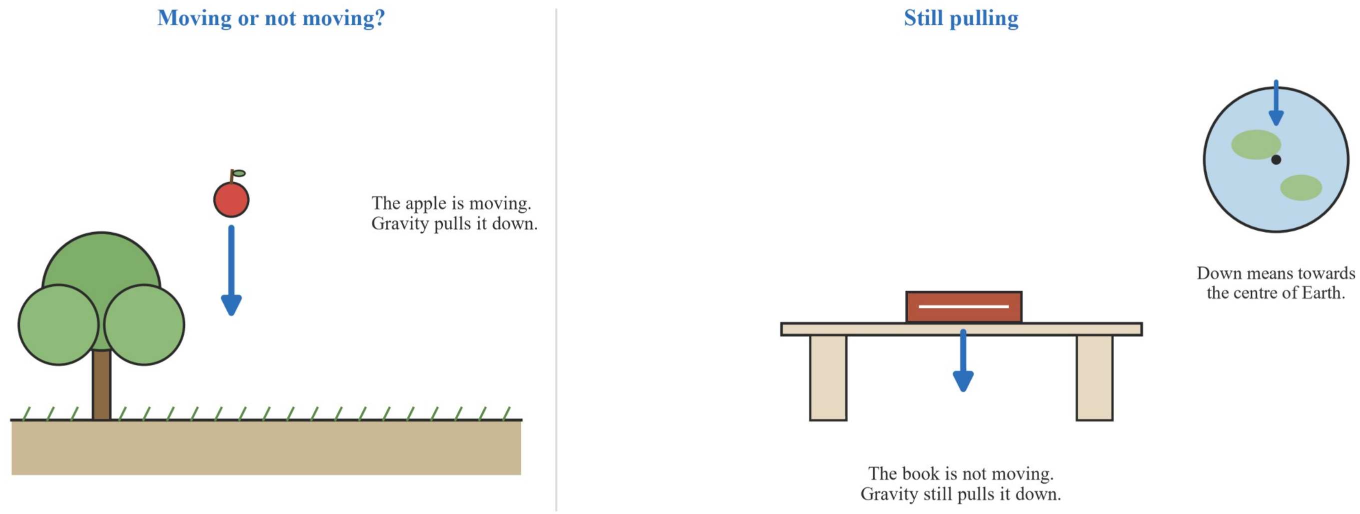
The pattern on the bottom of a shoe changes the friction. The job decides the pattern.

The bottoms of three shoes seen from below. Football boots have studs that dig into grass for strong grip on the oval; sneakers have a flat pattern for good grip on paths and courts; a shoe with a smooth sole has little grip and is slippery on a wet floor.

Football boots carry studs that dig into grass — strong grip for the oval. Sneakers carry a flat pattern — good grip on paths and courts. A smooth sole has little grip. That is why you slip on a wet floor if your sole is smooth. The pattern on the bottom changes the friction, and the job decides the pattern.

Gravity — always pulling down

Let go of anything and it falls. The force pulling it is **gravity** — the gravitational force. Gravity pulls all objects towards the centre of the Earth.



Gravity pulls all objects towards the centre of Earth — whether they are moving or sitting still.

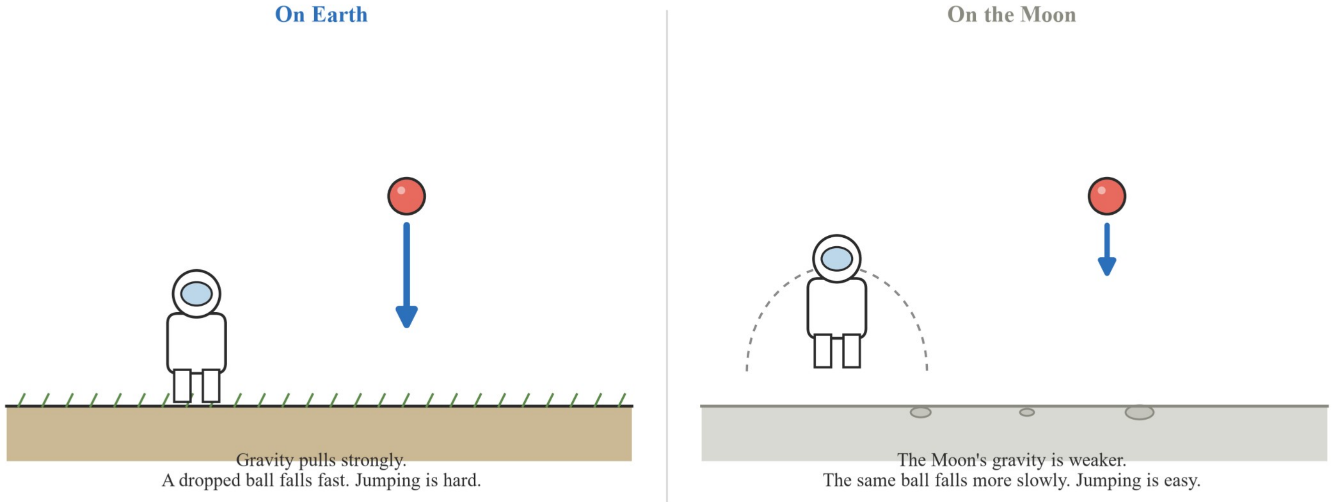
Two panels and an inset. A falling apple has a down arrow: the apple is moving and gravity pulls it down. A book resting on a table also has a down arrow: the book is not moving and gravity still pulls it down. The inset shows a round Earth with an arrow pointing in towards the centre: down means towards the centre of Earth.

Here is the part worth stopping on. A falling apple is moving, and gravity pulls it. A book sitting on a table is not moving — and gravity still pulls it, just as hard. The table holds the book up, but the pull never switches off. **Gravity acts on an object whether it is moving or not moving.**

And "down" is not just the way your feet point. Down means *towards the centre of the Earth*. From every place on Earth, the gravity arrow points in to the centre.

Gravity on the Moon

Astronauts who walked on the Moon dropped things and watched them fall more slowly than on Earth, and they could jump much higher there.



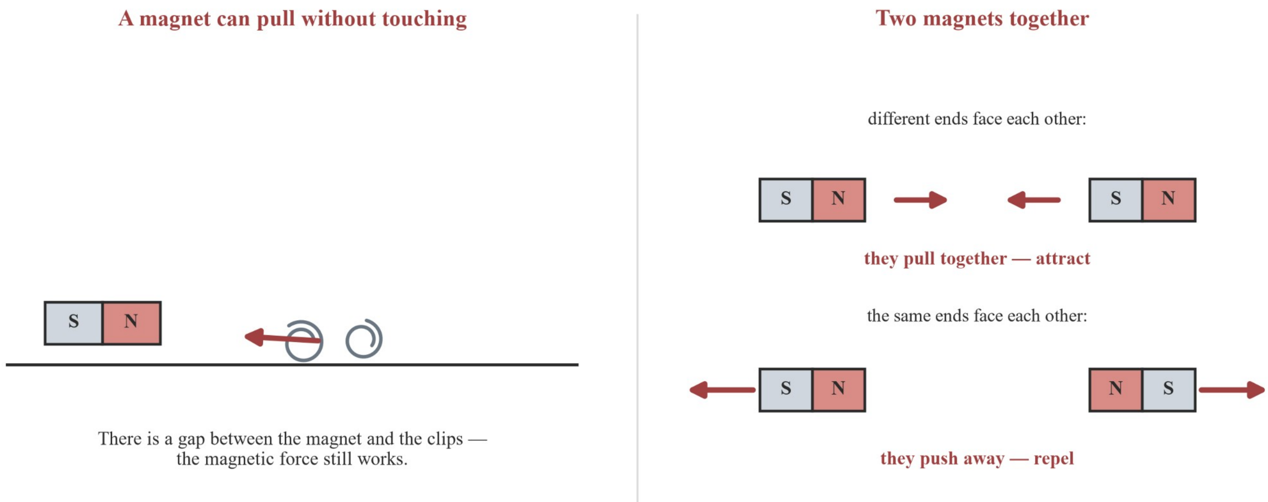
Gravity pulls objects down on the Moon too — but it is weaker there than on Earth.

Two panels. On Earth, a dropped ball has a long down arrow: gravity pulls strongly, the ball falls fast, jumping is hard. On the Moon, the same ball has a shorter down arrow: the Moon's gravity is weaker, the ball falls more slowly, jumping is easy.

The story is one sentence: gravity pulls objects down on the Moon too, but it is weaker there than on Earth. Same force, weaker pull — so things fall more slowly and jumps go higher.

Magnetic force — it works across a gap

Hold a magnet near a paper clip and the clip jumps to the magnet. There is a gap before the clip moves. The magnet does not touch the clip — the magnetic force reaches across the gap. That is a force at a distance.



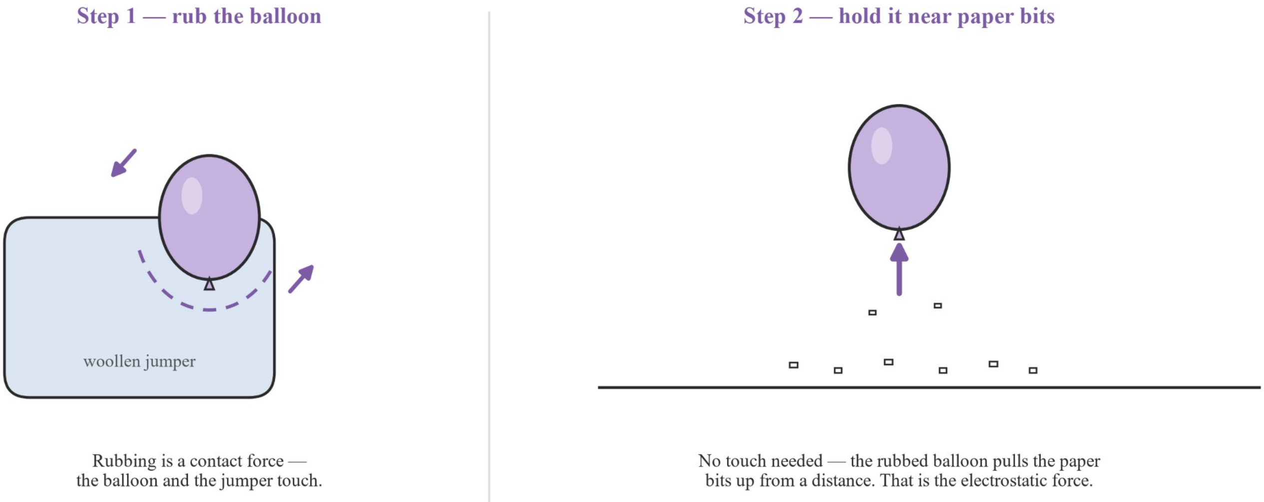
Magnetic forces work at a distance — and two magnets can attract or repel each other.

Two panels. Left: a bar magnet sits with a gap between it and two paper clips, and an arrow shows the clips being pulled towards the magnet. Right: two magnets with different ends facing pull together (attract); two magnets with the same ends facing push away.

Magnets work on each other too, in two ways. The ends of a magnet are labelled **N** and **S**. Turn two magnets so different ends face (N next to S) and they pull together — scientists say they **attract**. Turn them so the same ends face (N next to N, or S next to S) and they push away from each other. Pull together or push away: either way, no touching needed.

Electrostatic force — the rubbed balloon

Blow up a balloon and rub it on a wool jumper for a few seconds. The rubbing is a contact force — balloon and jumper touch. Now hold the balloon over little bits of paper.



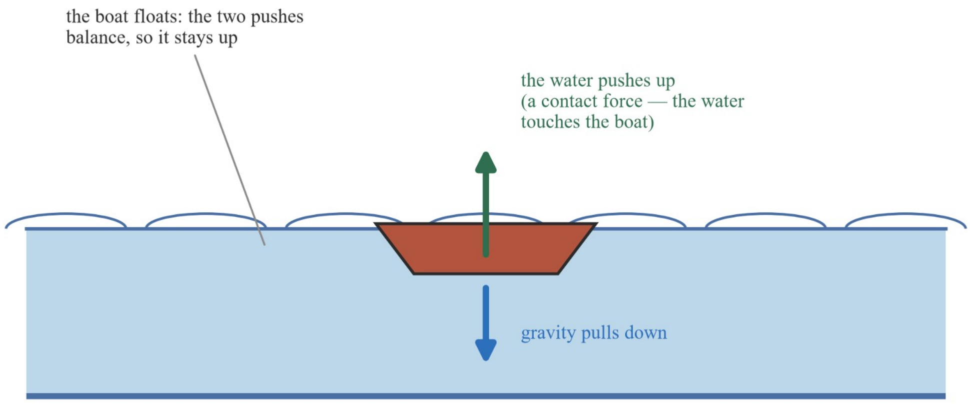
A big spark of electrostatic force is lightning in a storm cloud — the same kind of force, far bigger.

Two panels. Step 1: a balloon is rubbed on a wool jumper, and the rubbing is a contact force because the two touch. Step 2: the rubbed balloon is held near little paper bits and an up arrow shows the bits being pulled towards the balloon — no touch needed, that is the electrostatic force.

The paper bits jump up to the balloon. Nothing touches them until they arrive — the rubbed balloon pulls them from a distance. That pull is the **electrostatic force**. It is the same kind of force that makes your hair lift to a brushed hat in winter, and a very large version of it is the lightning in a storm cloud.

The push of water — why some things float

Not every force in this subtopic pulls down. Put a toy boat on water and the water pushes **up** on it.



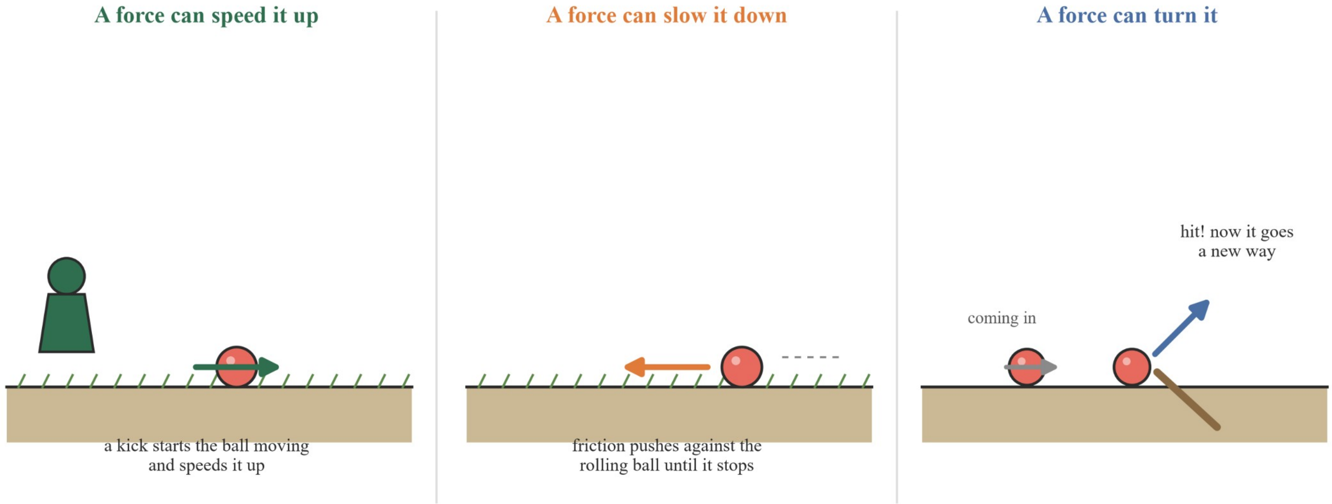
Water pushes up on things in it. That push is why some things float.

A toy boat on water with two arrows: a green arrow up from under the boat, the water pushing up (a contact force, because the water touches the boat), and a blue arrow down, gravity pulling down. The two pushes are the same size, so the boat floats.

Two forces act on the boat: gravity pulls it down, and the water pushes it up. The water touches the boat, so the up-push is a contact force. When the two pushes are the same size, the boat stays up — it floats. That up-push from a liquid is why boats, boards and bath toys sit on top of water instead of sinking straight away.

Forces change motion

What does a force actually *do*? It changes an object's motion — its speed, or its direction, or both.



Forces change motion: they can change how fast something moves, or the way it is going — or both.

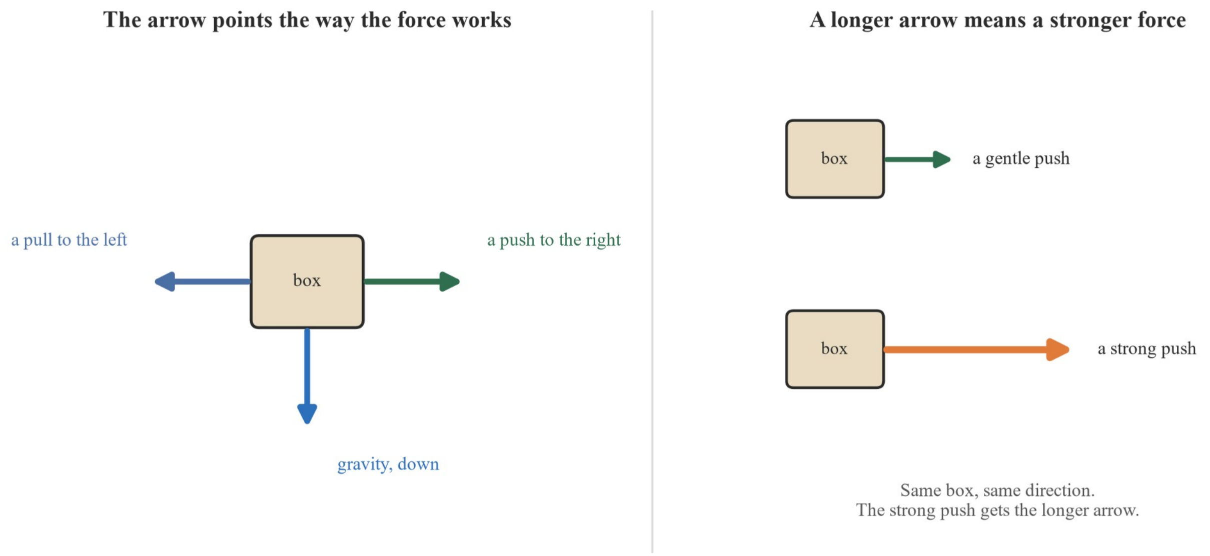
Three panels. A kick starts a ball moving and speeds it up; friction pushes against a rolling ball until it stops; a bat hits a moving ball and sends it a new way.

- A force can **speed up**: a kick starts a still ball moving.
- A force can **slow down or stop**: friction pushes against a rolling ball until it stops.
- A force can **turn**: a bat meets a coming ball and the ball leaves a new way.

Speed and direction are the two knobs a force can turn. Every push and pull in this subtopic is doing one of those three jobs.

Force arrows — direction and magnitude

Remember that scientists draw forces as arrows. The arrow carries two messages.



Scientists call the strength of a force its magnitude. Arrow direction = force direction. Arrow length = magnitude.

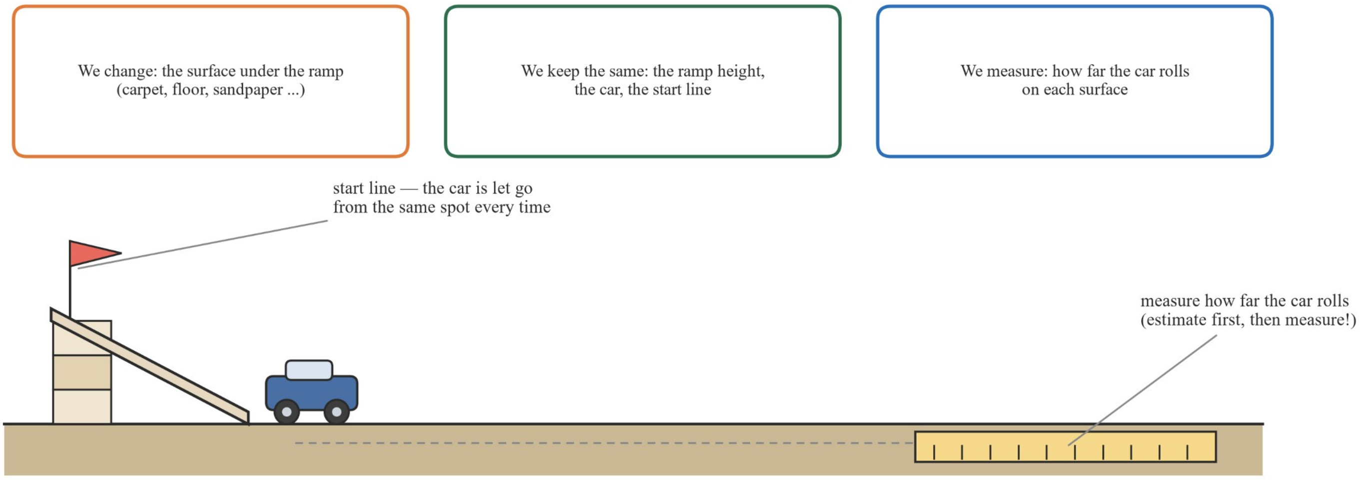
Two panels. Left: one box with three arrows — a push to the right, a pull to the left, and gravity down — showing that the arrow points the way the force works. Right: the same box pushed gently gets a short arrow and pushed strongly gets a longer arrow, showing that a longer arrow means a stronger force.

- **Direction:** the arrow points the way the force works.
- **Magnitude:** that is the scientist's word for how strong the force is. A stronger force gets a longer arrow. A gentle push and a strong push on the same box point the same way, but the strong push is drawn longer.

So a force arrow tells you both of the messages at once: where the force works, and how hard.

Investigation — the ramp and the surfaces

Here is a fair test you can run, using the skills from Chapters 1 and 2. Question: *does the surface change how far a toy car rolls?*



A fair test changes only one thing. Here: the surface. Everything else stays the same.

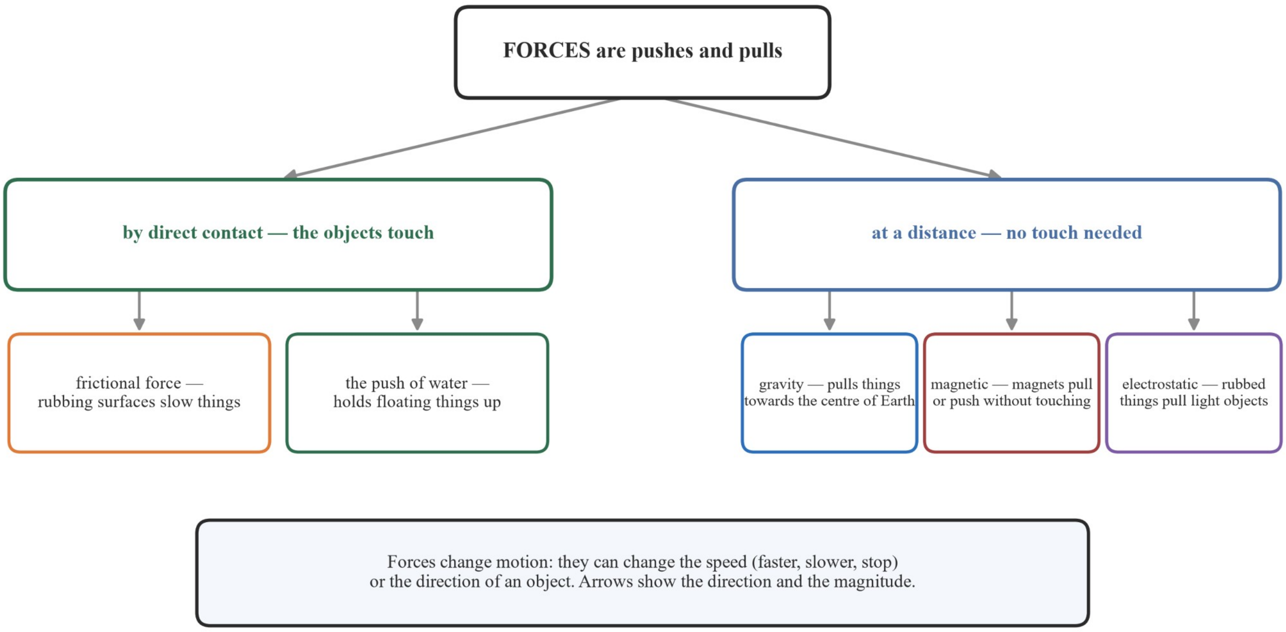
A ramp on a stack of blocks with a toy car at the bottom, a start-line flag on the ramp, a dashed rolling path and a measuring tape. Three planning boxes: we change the surface under the ramp; we keep the same the ramp height, the car and the start line; we measure how far the car rolls on each surface.

- **We change:** the surface the car rolls on — carpet, classroom floor, sandpaper.
- **We keep the same:** the ramp, its height, the car, and the start line the car is let go from.
- **We measure:** how far the car rolls on each surface, with a tape or a metre ruler.

Predict first: which surface will let the car roll the longest way, and why? (Say what your predict is based on — that is the 1A habit.) Estimate the roll before each measure, then measure (the 1C habit). A fair test changes only one thing; here that one thing is the surface.

Safety: the car rolls along the floor, so keep the rolling path clear of bags, feet and people, and check the block stack is steady before you start.

The whole subtopic on one page



A map of the whole subtopic. Top box: forces are pushes and pulls. Left branch, by direct contact — the objects touch: frictional force (rubbing surfaces slow things) and the push of water (holds floating things up). Right branch, at a distance — no touch needed: gravity (pulls things towards the centre of Earth), magnetic (magnets pull or push without touching), and electrostatic (rubbed things pull light objects). Bottom box: forces change motion — they can change the speed (faster, slower, stop) or the direction of an object, and arrows show the direction and the magnitude.

Words to know in 6B

Word	What it means here
force	a push or a pull that one thing puts on another
frictional force	the force between rubbing surfaces; pushes against motion and slows things
gravitational force	the force that pulls objects towards the centre of the Earth
magnetic force	the force from a magnet; pulls some metals without touching them
electrostatic force	the pull from a rubbed thing, like a balloon, on light bits
direct contact	the two things touch when the force works
at a distance	the force works with a gap — no touch needed
attract	when two magnets pull together
surface	the outside top or side of a thing, where it touches or rubs

Word	What it means here
grip	strong friction that stops slipping
magnitude	how strong a force is; the longer the arrow, the stronger the force
motion	a thing moving; forces can change its speed or its direction
force arrow	a drawing of a force: the point shows direction, the length shows magnitude

Worked examples

Example 1 — with steps

Four events are listed below. For each, name the force doing the work and say whether it acts by direct contact or at a distance.

(a) A boot kicks a football on the oval.
(b) The grass slows the rolling ball until it stops.
(c) An apple falls from a tree.
(d) A rubbed balloon lifts paper bits off a table.

Working	Comment
(a) The boot touches the ball when the force works.	Touch = contact. A kick is a push, and the force named for rubbing surfaces is not needed here — this is simply a push by contact.
(b) The ball rolls on the grass; the two surfaces rub.	Rubbing surfaces slowing a thing is the **frictional force**, and the ball touches the grass — contact.
(c) The apple and the Earth never touch; the pull works across the gap.	The pull towards the centre of the Earth is the **gravitational force** — at a distance.
(d) The balloon was rubbed by contact, but the lift on the paper bits needs no touch.	The pull from a rubbed thing is the **electrostatic force** — at a distance.

∴ (a) contact push; (b) frictional, contact; (c) gravitational, at a distance; (d) electrostatic, at a distance. The one-question test does the sorting: *were the two things touching when the force worked?*

Example 2 — with steps

A box sits on the floor. Sam gives it a strong push to the right. Friction pushes back to the left, but the friction force is weaker than Sam's push.

(a) Draw (or describe) the two force arrows.
(b) Which arrow is longer?
(c) What happens to the box's speed, and which way does it move?

Working	Comment
(a) Push arrow: from the box, pointing right. Friction arrow: from the box, pointing left.	A force arrow starts on the object and points the way the force works.
(b) Sam's push is the stronger force, so the push arrow is longer.	Magnitude is drawn as length: stronger force, longer arrow.
(c) The push wins, so the box starts moving right and speeds up.	A force can change speed and direction: here the box goes right (direction) and faster (speed).

∴ right-pointing push arrow longer than the left-pointing friction arrow; the box moves right and speeds up, because the stronger force sets the direction of the change.

Example 3 — on your own

Maya holds a ball still in her hand, then lets it go and it falls.

(a) While the ball is falling, is gravity acting on it? How do you know?
(b) While Maya holds the ball still, is gravity acting on it? Explain.

∴ (a) Yes — the ball falls, and falling is the pull towards the centre of the Earth, so gravity is acting; the changing motion (speeding up as it falls) is the evidence. (b) Yes — gravity acts on an object whether it is moving or not moving. The still ball is pulled down just the same; Maya's hand simply pushes it up with a matching push, the way the table holds up a book.

Example 4 — on your own

(a) A wet grass oval and a wet smooth hall floor both need shoes. Using friction, say why football boots suit the oval and why a smooth sole is a bad pick for the wet hall floor.
(b) On the Moon, an astronaut lets go of a ball and it falls more slowly than the same ball falls on Earth. What does that tell you about gravity on the Moon?

∴ (a) The studs on football boots dig into grass, giving more friction (grip) so players do not slip on the wet oval. A smooth sole gives little friction on a smooth wet floor, so the person slips — the job needs a gripping pattern, not a smooth one. (b) Gravity pulls things down on the Moon too, but it is weaker there than on Earth — same force, weaker pull, slower fall.

Practice questions

With steps

Q1. Say whether each force is a push or a pull: (a) a kick on a football (b) a magnet drawing a paper clip towards it (c) a hand opening a drawer by the handle (d) the water holding a toy boat up

Q2. Name the force doing the work in each: (a) a sliding book slows and stops on the bench (b) an apple falls from a tree (c) a magnet lifts a steel clip off the bench without touching it (d) a balloon, rubbed on a jumper, pulls paper bits up

Q3. Sort these into direct contact and at a distance: (a) a hand pushing a door shut (b) a magnet pulling a clip across a gap (c) water pushing up on a boat (d) gravity pulling on a falling leaf

Q4. Look at the ramp diagram in the Theory. The same car rolls on sandpaper, on carpet and on the classroom floor. (a) On which surface does the car roll the longest way? (b) On which surface is the friction greatest? (c) Explain the pattern in one sentence.

Q5. Put each into "friction helps" or "friction gets in the way": (a) the bottoms of your shoes gripping the ground so you can run (b) a heavy box that is hard to push across carpet (c) bike brakes squeezing the wheel to stop (d) a playground slide you want to slide down fast

Q6. Match each sole to its job and say why, using friction: studs; a flat pattern; a smooth sole. Jobs: a wet grass oval; paths and courts; a job where slipping does not matter.

On your own

Q7. A book rests on a desk. A ball is dropped and is falling past the desk. (a) Is gravity acting on the falling ball? How do you know? (b) Is gravity acting on the book that is not moving? Explain.

Q8. On the Moon, astronauts dropped things and watched them fall slowly, and they jumped high with easy bounces. (a) Name one thing that is the same about gravity on the Moon and on Earth. (b) Name one thing that is different.

Q9. Two bar magnets have their ends labelled N and S. (a) N faces S across a small gap. What will the magnets do? (b) N faces N across the gap. What will the magnets do? (c) Does the magnet need to touch a paper clip to pull it? Say how you know from the Theory.

Q10. Draw a box, then add force arrows for these: (a) a gentle push to the right (b) the same box with a strong push to the right (c) Which arrow is longer, and what word names the strength of a force?

Q11. Name the change of motion in each: speed up, slow down (or stop), or turn. (a) a kick starts a still ball moving (b) friction brings a rolling ball to a stop (c) a bat meets a coming ball and the ball leaves sideways (d) a rolled ball on grass getting slower and slower

Q12. A toy boat floats on water. (a) Name the two forces acting on the boat. (b) Which one is a contact force, and how do you know? (c) The boat is loaded with sand until the water's up-push is not enough. What happens to the boat?

Answers

Q1. (a) push; (b) pull; (c) pull; (d) push. **Q2.** (a) frictional force; (b) gravitational force; (c) magnetic force; (d) electrostatic force. **Q3.** Contact: (a), (c). At a distance: (b), (d). **Q4.** (a) the classroom floor; (b) sandpaper; (c) rougher surfaces give more friction, and more friction slows the car sooner. **Q5.** Helps: (a), (c). Gets in the way: (b), (d). **Q6.** Studs → wet grass oval (they dig in for strong grip); flat pattern → paths and courts (good grip); smooth sole → the job where slipping does not matter (little grip). **Q7.** (a) yes — it is falling, and falling is gravity's pull; (b) yes — gravity acts on an object whether it is moving or not moving; the desk holds the book up. **Q8.** (a) gravity still pulls things down on the Moon; (b) it is weaker there than on Earth. **Q9.** (a) they pull together — attract; (b) they push away; (c) no — the clip jumps across a gap, so the magnetic force works at a distance. **Q10.** (a) a short arrow pointing right; (b) a longer arrow pointing right; (c) the strong push's arrow is longer; the word is magnitude. **Q11.** (a) speed up; (b) stop; (c) turn; (d) slow down. **Q12.** (a) gravity (down) and the water's up-push; (b) the water's push — the water touches the boat; (c) the boat sinks lower and goes under — gravity's pull wins.

Answers with every step

Q1. Run the push-or-pull question on each. (a) A kick moves the ball away from the boot — a **push**. (b) The clip moves towards the magnet — a **pull**. (c) The drawer moves towards the hand on the handle — a **pull**. (d) The water pushes the boat up, away from the water — a **push**. Every force you will ever meet is one of these two.

Q2. Match each story to one of the four named forces. (a) Rubbing surfaces slowing a thing is the **frictional force**. (b) A fall towards the centre of the Earth is the **gravitational force**. (c) A magnet pulling metal across a gap is the **magnetic force**. (d) A rubbed thing pulling light bits is the **electrostatic force**.

Q3. Ask the one question: are the two things touching when the force works? (a) Hand on door — touching — **contact**. (b) Magnet and clip across a gap — not touching — **at a distance**. (c) Water on the boat — touching — **contact**. (d) The Earth and the leaf never touch — **at a distance**.

Q4. Read the three rows. (a) The car rolls the longest way on the **classroom floor**, the smoothest surface. (b) The friction is greatest on **sandpaper**, where the roll is shortest. (c) One sentence: rougher surface, more friction, sooner stop. Same ramp and same car in every row, so the surface is the only difference — that is what makes the comparison fair.

Q5. Sort by whether we want the friction. (a) Grip for running is wanted — **helps**. (b) Friction fighting the box is unwanted — **gets in the way**. (c) Brakes need friction to stop the wheel — **helps**. (d) A slide is for sliding; friction slows you — **gets in the way**. The same force is a helper in one story and a problem in the next.

Q6. Match pattern to job by the friction it gives. **Studs** dig into soft grass for strong grip, so they suit the **wet grass oval**, where slipping is the danger. A **flat pattern** gives good grip on hard ground, so it suits **paths and courts**. A **smooth sole** gives little grip, so it only suits **a job where slipping does not matter**. The pattern changes the friction; the job decides the pattern.

Q7. (a) The ball is falling — moving faster and faster towards the floor. A change of motion needs a force, and the pull towards the centre of the Earth is gravity: **yes, gravity is acting**, and the fall itself is the evidence. (b) The book is still, but gravity does not switch off for still things: **yes, gravity is acting** just the same. The desk pushes up with a matching push and the book stays put — which is exactly why the book presses on the desk.

Q8. (a) The same: gravity pulls objects **down** on the Moon too — dropped things still fall, and jumps still come back to the ground. (b) The different: the Moon's gravity is **weaker** than Earth's, so things fall more slowly and jumps go higher. Same force, weaker pull — and nothing more is needed to explain what the astronauts saw.

Q9. (a) Different ends facing (N next to S) pull together — the magnets **attract**. (b) Same ends facing (N next to N) push away — the magnets push away from each other. (c) **No.** In Theory, the magnet pulls the clip across a visible gap before any touch, so the magnetic force works at a distance; the touch happens only after the pull has done its work.

Q10. (a) A gentle push to the right is a **short arrow** starting at the box and pointing right. (b) The strong push is the **same direction**, so the arrow points right again — but stronger force means longer arrow, so this one is **longer**. (c) The strong push's arrow is longer; the word for the strength of a force is **magnitude**. Direction from the point of the arrow, magnitude from its length — that is the whole code.

Q11. Match each story to one of the three jobs a force does. (a) Still to moving is a **speed up**. (b) Moving to stopped is a **stop** (slowing all the way). (c) Coming in one way and leaving another is a **turn** — a change of direction. (d) Slower and slower on grass is a **slow down**, done by friction. Speed and direction are the two knobs, and every story turns one of them.

Q12. (a) Two forces: **gravity** pulling the boat down, and **the water pushing up** on the boat. (b) The water's push is the **contact force** — the water touches the boat, which is the test for contact; gravity needs no touch, so it is the at-a-distance one. (c) Load the boat with sand and gravity's pull grows while the up-push stays the same size: the pulls no longer match, the down pull wins, and the boat **sinks** — sits lower, then goes under. Floating is the two pushes matching; sinking is them not matching.

Chapter 6 check-up — Physical sciences

This check-up is a piece of class work from your workbook. It is a school instrument, not a VCAA exam — Science Levels 3 and 4 has no outside exam. There is no time to beat. Take as long as you need. If you want, your teacher will read any question out to you.

Chapter 6 check-up · Codes `VC2S4U09` (6A), `VC2S4U10` (6B)

Total: 15 marks · Part A — Questions A1 to A8 · 8 marks · Part B — Questions B1 to B3 · 7 marks

Part A questions are worth 1 mark each. Part B questions are worth 2 or 3 marks, and the marks for each part are written with the question.

Every question in this check-up points to a part of the Levels 3 and 4 achievement standard that Chapter 6 teaches. The extracts, word for word:

They identify different sources of heat energy and measure temperature changes that may occur when heat is transferred from one object to another. — `VC2S4U09` (6A)

They identify forces acting on objects and describe the effects of these. — `VC2S4U10` (6B)

The words in this check-up are the words you learned in Chapter 6. If you need them, the word lists are at the end of 6A and 6B.

In this check-up you will:

- name two sources of heat energy (A1)
- identify the tool that measures temperature (A2)
- say whether a thing is a source of heat or not (A3)
- say which way heat moves on a hot January day (A4)
- name the four forces (A5)
- sort forces into direct contact and at a distance (A6)
- match events to the force doing the work (A7)
- identify the change of motion that friction makes (A8)
- measure how much warm water cools down, and explain it (B1)
- compare footy boots with smooth soles on wet grass (B2)
- construct force arrows on a pushed box (B3)

Part A — 8 marks

Eight questions, each worth 1 mark. A question gets its mark, or no mark.

A1. *(1 mark · `VC2S4U09`)* Name **two** sources of heat energy.

A2. *(1 mark · `VC2S4U09`)* Your skin can be fooled about heat. Identify the tool we use to measure temperature, so we are not fooled.

A3. *(1 mark · `VC2S4U09`)* Classify each one as **a source of heat energy** or **not a source of heat energy**:

(a) a toaster, switched on
(b) a wool beanie

A4. *(1 mark · `VC2S4U09`)* Read the box, then answer the question.

A hot January day in Mildura. Mildura is far inland in north-west Victoria. In January, the daytime temperature is usually about 33 °C.

Source: Bureau of Meteorology climate averages for Mildura (January daytime temperature), as shown in Wikipedia, “Mildura”, en.wikipedia.org — retrieved 2026-08-22.

On a January day like this, a cup of cold water sits outside. The air is warm and the water is cold. Identify which way heat moves: from the air to the water, or from the water to the air?

A5. *(1 mark · `VC2S4U10`)* Name the **four** forces you learned in 6B.

A6. *(1 mark · `VC2S4U10`)* Classify each force as **direct contact** or **at a distance**:

(a) a hand pushing a door shut
(b) a magnet pulling a paper clip across a gap

A7. *(1 mark · `VC2S4U10`)* Match each event to the force doing the work. Draw a line from each event to the right force.

Events: **1.** an apple falls from a tree **2.** a rubbed balloon lifts little bits of paper **3.** the grass slows a rolling ball until it stops

Forces: **A.** frictional force **B.** gravitational force **C.** electrostatic force

A8. *(1 mark · `VC2S4U10`)* A ball rolls across the grass and slowly comes to a stop. Identify the change of motion the frictional force makes: does the ball speed up, slow down, or change direction?

Part B — 7 marks

Three questions. B1 is worth 3 marks, B2 is worth 2 marks, and B3 is worth 2 marks. Write your answers in your own words.

B1. *(3 marks · `VC2S4U09`)* A class does the two-cups investigation from 6A. The cold water reads 10 °C and the warm water reads 40 °C. An adult pours the cold water into the warm water, and the class measures the mix.

(a) The mix reads about 25 °C. By how many °C did the warm water cool down? (1 mark)
(b) Explain why the mix ends up at one temperature, between 10 °C and 40 °C. Use the words *heat*, *warm* and *cool* in your answer. (2 marks)

B2. *(2 marks · `VC2S4U10`)* After rain, the grass oval is wet. One player wears football boots with studs on the bottom. Another player wears shoes with smooth soles. Use friction to compare the two kinds of shoe on the wet grass, and say which player is more likely to slip and why.

B3. *(2 marks · `VC2S4U10`)* A box sits on the floor. Mia gives the box a strong push to the right. Friction pushes back to the left, but the push is stronger than the friction.

(a) Construct two force arrows on the box: one for the push and one for the friction. Label each arrow, and draw the stronger force with the longer arrow. (1 mark)
(b) Describe what happens to the motion of the box. (1 mark)

Mark record

Question	Code	Worth	Given
A1 — name two sources of heat	`VC2S4U09`	1	
A2 — the tool that measures temperature	`VC2S4U09`	1	
A3 — a source of heat, or not	`VC2S4U09`	1	
A4 — which way the heat moves	`VC2S4U09`	1	
A5 — the four forces	`VC2S4U10`	1	
A6 — contact or at	`VC2S4U10`	1	

Question	Code	Worth	Given
a distance			
A7 — match the event to the force	VC2S4U10	1	
A8 — the change of motion	VC2S4U10	1	
B1 — the two-cups mix, and why	VC2S4U09	3	
B2 — footy boots against smooth soles	VC2S4U10	2	
B3 — force arrows on the box	VC2S4U10	2	
Total		**15**	

Marking guide

Teacher guidance — Chapter 6 check-up · 15 marks. This guide is written so a teacher without a science background can mark the check-up. Every acceptable answer is written out below, and every mark is allocated per response.

About this instrument

- The check-up is a **school instrument**, not a VCAA exam. Science Levels 3 and 4 has no external examination and no external assessment.
- Completion is **untimed** — a student may take as long as they need.
- **Reading support** is permitted: the teacher may read any question aloud on request. Reading is not being assessed.
- A mark is a record that the evidence was seen. Marks are for reporting against the achievement standard, not for ranking students.

The extracts evidenced

Each question is tagged with the code it traces to. The two extracts from the Levels 3 and 4 achievement standard, quoted at the head of the check-up:

- `VC2S4U09` (6A): "They identify different sources of heat energy and measure temperature changes that may occur when heat is transferred from one object to another."
- `VC2S4U10` (6B): "They identify forces acting on objects and describe the effects of these."

Marks at a glance

Part	Questions	Code	Marks
Part A	A1–A4	`VC2S4U09`	4
Part A	A5–A8	`VC2S4U10`	4
Part B	B1	`VC2S4U09`	3
Part B	B2–B3	`VC2S4U10`	4
		Total	**15**

General marking rules

- Accept answers in the student's own words. The acceptable answers below are wide by design — if the response shows the understanding, give the mark.
- Spelling does not lose marks.
- Part A items are marked all-or-nothing: each gets its 1 mark, or 0.
- Part B items are part-marked exactly as shown with each question.
- If an answer is right but the reason is unclear, ask the student to say more — once. If the follow-up shows the understanding, give the mark. If it shows a guess with nothing behind it, record 0 and move on without comment.

Part A — answers

A1 · `VC2S4U09` · 1 mark

- **Accept:** any **two** of the four sources taught in 6A: **the Sun**; **fire** (a campfire, a wood heater); **electrical devices** (a heater, a kettle, a toaster — accept any electrical device that makes heat); **hot water from deep underground** (accept *a geothermal spring* or *a hot spring*).
- **Marks:** 1 for two correct sources; 0 otherwise.
- **Evidences:** "identify different sources of heat energy" — the four sources 6A teaches are the Sun, fire, electrical devices, and hot water that comes up from deep underground.

A2 · `VC2S4U09` · 1 mark

- **Accept: a thermometer**.
- **Marks:** 1 for thermometer; 0 for skin, hands or any other answer.
- **Evidences:** “measure temperature changes” — 6A teaches that skin can be fooled (the three-bowl trick), and the thermometer is the tool that reads the true temperature.

A3 · `VC2S4U09` · 1 mark

- **Accept:** (a) the toaster, switched on — **a source of heat energy** (an electrical device gives out heat when it is switched on); (b) the wool beanie — **not a source of heat energy** (a beanie keeps your head warm, but it does not give out heat — it only traps warm air).
- **Marks:** 1 for both classified correctly; 0 otherwise.
- **Evidences:** “identify different sources of heat energy” — 6A teaches the beanie case on purpose: a thing can keep you warm without being a source of heat.

A4 · `VC2S4U09` · 1 mark

- **Accept: from the air to the water**. Accept any wording that says the heat moves from the warm air into the cold water.
- **Marks:** 1 for air to water; 0 for water to air.
- **Evidences:** “heat is transferred from one object to another” — the big rule of 6A: heat moves from the warm thing to the cool thing, never the other way around. The Mildura temperature in the box is real Bureau of Meteorology data; the source line is printed with the question.

A5 · `VC2S4U10` · 1 mark

- **Accept: frictional**, **gravitational**, **magnetic** and **electrostatic** — all four, in any order. Accept *friction*, *gravity* and *magnetism* as the same ideas.
- **Marks:** 1 for all four named; 0 otherwise.
- **Evidences:** “identify forces acting on objects” — the content description names all four force types, and 6B teaches all four.

A6 · `VC2S4U10` · 1 mark

- **Accept:** (a) a hand pushing a door shut — **direct contact** (the hand and the door touch); (b) a magnet pulling a paper clip across a gap — **at a distance** (the pull works with a gap, no touch needed).
- **Marks:** 1 for both classified correctly; 0 otherwise.
- **Evidences:** “identify forces acting on objects” — identifying a force includes saying how it acts: the one-question test 6B teaches is *are the two things touching when the force works?*

A7 · `VC2S4U10` · 1 mark

- **Accept:** 1–B (the falling apple → gravitational force), 2–C (the rubbed balloon lifting paper bits → electrostatic force), 3–A (the grass slowing the ball → frictional force).
- **Marks:** 1 for all three matched; 0 otherwise.
- **Evidences:** “identify forces acting on objects” — the four named forces of 6B matched to the everyday scenes the subtopic uses to teach them.

A8 · `VC2S4U10` · 1 mark

- **Accept: slow down** (accept *it slows the ball*, *slow down and stop*).
- **Marks:** 1 for slow down; 0 for speed up or change direction.
- **Evidences:** “describe the effects of these” — 6B teaches that friction pushes against the motion, so its effect is to slow a moving thing and can stop it.

Part B — answers

B1 · `VC2S4U09` · 3 marks

- **(a) — 1 mark.** The warm water went from 40 °C to about 25 °C, so it cooled down about **15 °C** (40 − 25 = 15). Accept *15*, *about 15* or *15 °C*.
- **(b) — 2 marks.** Award 1 mark for the direction of the heat — accept *heat moved from the warm water to the cool water*, or *the heat went from hot to cold*. Award 1 mark for linking the heat move to both changes — accept *the warm water lost heat and cooled down, and the cold water gained heat and warmed up, until there was one temperature*, or words to that effect. The response must carry both ideas: heat travels warm to cool, and that is why the two waters meet at one in-between temperature.
- **Do not award** the second idea if the response says heat moved from the cold water to the warm water.
- **Evidences:** "measure temperature changes that may occur when heat is transferred from one object to another" — this is the two-cups investigation of 6A: (a) measures the temperature change, and (b) explains it with the warm-to-cool rule.

B2 · `VC2S4U10` · 2 marks

- **The football boots — 1 mark.** Accept any wording that says the studs dig into the grass, giving **more friction** (accept *grip*), so the player does not slip. Example: *the studs dig into the wet grass, so there is more friction and the player can run without slipping*.
- **The smooth soles — 1 mark.** Accept any wording that says a smooth sole gives **little friction** on the wet grass, so that player is the one likely to slip. Example: *the smooth sole has nothing to dig in, so there is very little friction, and that player slips*.
- **Evidences:** "identify forces acting on objects and describe the effects of these" — this is the shoe-sole case 6B teaches: the pattern on the bottom changes the friction, and friction's effect is grip (or the lack of it).

B3 · `VC2S4U10` · 2 marks

- **(a) — 1 mark.** Accept a drawing of the box with two arrows that both start on the box: one pointing **right**, labelled as the push (accept *Mia's push*, *push*), and one pointing **left**, labelled as friction (accept *frictional force*), with the **push arrow drawn longer** than the friction arrow. If the arrows are right but the lengths are the same, ask once which force is stronger; if the student says the push, and says a stronger force gets a longer arrow, give the mark.
- **(b) — 1 mark.** Accept any wording that says the box **starts moving to the right and speeds up** — accept *it moves right and goes faster*, *the stronger push wins, so the box speeds up to the right*.
- **Evidences:** "identify forces acting on objects and describe the effects of these" — the arrows identify the forces the way 6B teaches them (direction from the way the arrow points, strength from its length), and part (b) describes the effect of the stronger force on the box's motion.

Total

Part A: 8 marks. Part B: 7 marks (3 + 2 + 2). **Total: 15 marks.**

Chapter 6 Investigation task — A friction fair test

About this task

This is a school instrument made for this workbook. It is **not** a VCAA examination, and it is not marked by VCAA.

- **Time:** there is no time limit. You may take more than one lesson to finish.
- **Reading support:** if you need help reading a question, your teacher can read it with you. Your teacher will not help with the answer.
- **Working together:** you will work in a small group, but each student fills in their own sheet.
- **Answer every question.** The marks for each question are shown in [brackets].

In this task you use the inquiry skills from Chapters 1 and 2, in the content of Chapter 6: **6A** Heat sources and heat transfer · **6B** Forces: contact, and at a distance.

Total: 20 marks. Question and prediction 3 · Planning 5 · Measuring and recording 4 · Representing 4 · Comparing and evaluating 2 · Communicating 2.

What you will find out

In Chapter 6 you learned that a **force** is a push or a pull, and that the **frictional force** shows up when one surface rubs or slides on another. Friction pushes against the motion: it slows things down, and can stop them. Rougher surfaces give more friction.

In this task your group will run a **fair test** — a test where only one thing is changed, so the result is fair. You will let a toy car roll down a ramp and across the floor, and measure how far it rolls. Then you will change the surface the car rolls on, and test again. The one thing you change is the surface. Your group will find out which surface gives the most friction. Each group works on its own ramp, so at the end you can compare your findings with another group's.

You will: ask a question and make a prediction → plan → measure and record → represent → compare → communicate.

What you will need

- a ramp — a smooth board about 1 metre long, or a length of toy-car track
- a stack of blocks or books, to lift one end of the ramp
- a toy car
- three surfaces to roll onto: the smooth classroom floor, a square of carpet, and a sheet of sandpaper
- a tape measure or a metre ruler, to measure in centimetres (cm)
- sticky tape or a texta, to mark the start line and the ramp's place
- a pencil and something hard to write on

Working safely

Your teacher, or another adult, stays with your group the whole time. Before you start, read each **hazard** (anything that could hurt someone) and its **control** (what you do to stop the hurt).

- **A car that rolls away.** Keep the rolling path clear of bags, feet and people. Walk to fetch the car — do not run.
- **A ramp that falls over.** Check the stack of blocks is steady before you let go. Keep the stack low. If it wobbles, build it again.
- **Rough sandpaper.** Hold the sandpaper by its edges. Do not rub your skin on it.
- **Fingers in the way.** Keep your hands clear of the rolling path while the car moves.
- **The car is for rolling, not for throwing.** Let it go gently, at the start line.

Part 1 — Question and prediction [3 marks]

Q1.

(a) Write a question that your group can answer with this test. You could start with: “Does the surface change how far the toy car rolls?” or “On which surface does the car roll the longest way: ______, ______ or ______?” [1 mark]

(b) Write your **prediction** — what you think you will find. [1 mark]

(c) A prediction is based on something you have seen before; a guess is not. Write the observation your prediction is based on. [1 mark]

Part 2 — Planning [5 marks]

Q2. Complete this planning scaffold with your group.

Our plan	What we will do
What will we change? (Which surface will we roll onto?)	
What will we measure?	
Two things we will keep the same	1.
	2.
One hazard in our test, and its control	Hazard:
	Control:

The marks for the plan: **1 mark** for what to change · **1 mark** for what to measure · **2 marks** for the two things to keep the same (1 mark each) · **1 mark** for one hazard and the control that matches it. You may use a hazard from the safety list above, or one your teacher names at your ramp.

Part 3 — Measuring and recording [4 marks]

Q3.

(a) **Estimate first.** An **estimate** is a sensible guess at a number, made *before* measuring, using what you know. Before you let the car go, estimate how far it will roll on the smooth classroom floor. Write your estimate with its unit. [1 mark]

(b) Now test the smooth classroom floor. Put the car at the start line and let go — do not push. When the car stops, measure how far it rolled, from the bottom of the ramp to where the car stopped. Write what you measured, with its unit. [1 mark]

(c) **Draw your results table before you test the other surfaces.** Give your table three rows, one for each surface: the smooth classroom floor, the carpet and the sandpaper. Then test each surface, letting go from the same start line every time, and write each measurement in your table. [2 marks]

You may add extra rows if you wish — for example, your estimate for each surface, or a second try.

Part 4 — Representing [4 marks]

Q4.

(a) Draw a **column graph** of the distances in your table. Draw one column for each surface: the smooth classroom floor, the carpet and the sandpaper. Give your graph a title, label each column, and put numbers along the side so your distances can be read. Draw it here, on grid paper, or in your workbook. [3 marks]

(b) Write one **pattern** you can see in your graph. A pattern is what the data shows — for example, which surface let the car roll the longest way, and which stopped it the soonest. [1 mark]

Part 5 — Comparing and evaluating [2 marks]

Q5.

(a) Swap your table with another group's. Write one way your findings were the same as theirs, or one way they were different. [1 mark]

(b) Think about your investigation. Was it fair? Write one thing you kept the same to make it fair, or one thing you would change next time to make it fairer. Then write one further question you would like to investigate. (Answer both parts.) [1 mark]

Part 6 — Communicating [2 marks]

Q6. Your school newsletter has asked for a short piece for families about friction. Your **audience** — the people you share with — is the school families. Your **purpose** is to tell them what your group found, and one way friction helps them.

Write the piece in two or three sentences. Use at least two of the words of Chapter 6 — for example: *force*, *frictional force*, *friction*, *surface*, *rough*, *smooth*, *grip*, *slows down*, *motion*, *fair test*, *predict*, *estimate*. [2 marks]

Marking guide

Teacher notes. This is a school instrument, not a VCAA examination. It is completed untimed, and reading support is permitted: a teacher may read any question to a student who needs it, but may not help with the answer. Students work in small groups (three or four students works well), but each student is marked on their own sheet. Accept any response that carries the right idea in the student's own words. Spelling of scientific words does not have to be exact.

Running the task. Each group needs a ramp — a smooth board about 1 metre long, or a length of toy-car track — lifted on a low stack of blocks or books, and three surfaces: the smooth classroom floor, a square of carpet, and a sheet of sandpaper (rough side up). The car must be let go, not pushed: hold it at the start line and release it. Measure each roll from the bottom of the ramp to where the car stops, and have every group measure from the same place. If floor space is short, lower the ramp stack and record the rolls anyway. One lesson suits Parts 1 and 2 and the testing (Part 3); Parts 4–6 can follow in a later lesson. Different groups may find different distances on the same surface — a different ramp height, release point or measuring point will each change the numbers. That is welcome: the difference is the material for Part 5.

Total: 20 marks. Part 1: 3 marks. Part 2: 5 marks. Part 3: 4 marks. Part 4: 4 marks. Part 5: 2 marks. Part 6: 2 marks.

Part 1 — Question and prediction — 3 marks

Q1(a) [1 mark]. A question the test can answer. Acceptable responses include: "Does the surface change how far the toy car rolls?"; "On which surface does the car roll the longest way: the floor, the carpet or the sandpaper?"; "Which surface slows the car down the most?" Do not award the mark for a question the test cannot answer ("Does the car like rolling on carpet?") or for no question.

Q1(b) [1 mark]. A prediction that answers the question in (a). Acceptable responses include: "I predict the car will roll the longest way on the smooth floor"; "I predict the car will roll the shortest way on the sandpaper, because it is rough". The prediction must match the question: a prediction about colour when the question is about distance does not earn the mark.

Q1(c) [1 mark]. An observation the prediction is based on — something the student has seen before. Acceptable responses include: "When I pushed a box across the carpet it was hard to move and stopped quickly"; "My ball rolls a long way on the smooth hall floor"; "My shoes grip on the rough path, so I do not slip". This is the idea taught in 1A: a prediction is grounded in a prior observation, a guess is not. Do not award the mark for a bare guess with no observation behind it.

Part 2 — Planning — 5 marks

What to change [1 mark]. The surface the car rolls onto. Acceptable responses include: "The surface — the floor, the carpet or the sandpaper"; "What the car rolls on: we change the surface each try". The surface is the one thing changed; that is what makes this a fair test.

What to measure [1 mark]. How far the car rolls. Acceptable responses include: "How far the car rolls on each surface, in centimetres"; "The distance the car travels after it leaves the ramp".

Two things to keep the same [2 marks, 1 each]. Any two that make the tries comparable. Acceptable responses include: the same ramp and the same ramp height (the same stack of blocks); the same car; the same start line (let go from the same place every time); letting go without pushing; measuring from the same place (the bottom of the ramp). Do not award a mark for a "same" that does not matter to the test.

One hazard and its control [1 mark]. Award 1 mark for a matched pair — a hazard and a control that really addresses it. Acceptable pairs include: a car that rolls away → keep the rolling path clear of bags, feet and people, and walk to fetch the car; a ramp that falls over → check the stack of blocks is steady before letting go, and keep the stack low; rough sandpaper → hold it by the edges, do not rub skin on it; fingers in the way → keep hands clear of the rolling path while the car moves. A hazard with no control, or a control that does not match the hazard (clearing the path for rough sandpaper), earns 0 marks.

Part 3 — Measuring and recording — 4 marks

Q3(a) [1 mark]. An estimate of the roll distance on the smooth floor, written with its unit. Award the mark for a sensible number with a length unit, for example “100 cm” or “about 1 m”. The estimate is not marked for being right — it is the habit of expecting a number before measuring, so a silly reading is noticed. An absurd estimate (“10 km”) earns 0 marks.

Q3(b) [1 mark]. The measured roll distance, read from the tape measure or ruler and written with its unit, for example “132 cm”. Award the mark for a reading taken by following the procedure with the unit written. Readings to the nearest mark, or between two marks to one decimal place (for example “132.5 cm”), are both acceptable — reading between the marks is taught in 1C.

Q3(c) [2 marks].

- **1 mark:** the student’s own table has one row for each surface tested (three rows) and a number with its unit written in each row.
- **1 mark:** the table has a title or labels that say what it shows, for example “How far our car rolled on each surface”.

Award 0 marks for this part if the distances were recorded with no table at all — the table is drawn *before* the data arrives, as taught in 1C.

Part 4 — Representing — 4 marks

Q4(a) [3 marks]. The column graph of the table’s distances.

- **1 mark:** one column for each surface (three columns), with the heights of the columns matching the numbers in the table.
- **1 mark:** a title that says what the graph shows, and each column labelled (with the surface’s name or a picture of it).
- **1 mark:** numbers along the side (a scale), so the distances can be read.

Accept a graph drawn on grid paper, in the workbook, or in the space provided. The column graph is the representation taught in 2A; line graphs are not used at this band. If a group constructs a physical display instead — for example, a paper strip cut to the length of each roll, with each strip labelled with its surface — award the three construction marks for a display that organises the distances by surface, with one strip or grouping per surface and the distances shown.

Q4(b) [1 mark]. A pattern read off the graph. Acceptable responses include: “The car rolled the longest way on the smooth floor, and the shortest way on the sandpaper”; “The rougher the surface, the shorter the roll”; “The car rolled further on the carpet than on the sandpaper”. Award the mark for a statement that compares the distances or says which was longest or shortest. Do not award it for reading one number off a single column (“The car rolled 132 cm on the carpet”) — a pattern looks across the data.

Part 5 — Comparing and evaluating — 2 marks

Q5(a) [1 mark]. One way the two groups’ findings were the same, or one way they were different. Acceptable responses include: “Both groups’ cars rolled the longest way on the smooth floor”; “Our car rolled 132 cm on the carpet, but theirs rolled only 95 cm — their ramp was lower”; “We found the same order, but their rolls were longer than ours”. Any true comparison of the two sets of findings earns the mark.

Q5(b) [1 mark for both parts together]. Award 1 mark if the student answers both parts sensibly; award 0 marks for one part only, or for neither.

- *The fairness judgement.* Acceptable responses include: “Yes — we used the same start line and let go without pushing every time”; “Not quite — we gave the car a little push on the carpet, so next time we would let go without pushing”. A judgement with no reason (“Yes, it was fair”) does not earn the mark.

- *The further question.* Acceptable responses include: “Would the car roll further if the ramp was higher?”; “Would a heavier car roll further on the sandpaper?”; “Which surface in our school has the most friction?” Any question that could be investigated earns the mark.

Part 6 — Communicating — 2 marks

Q6 [2 marks].

- **1 mark:** the piece is shaped for the stated audience and purpose — two or three sentences that school families can read, saying what the group found and giving one way friction helps. Acceptable friction-helps ideas include: “The grip under your shoes stops you slipping”; “Bike brakes squeeze the wheel so friction slows it down”; “Friction between your fingers and a pencil stops it sliding out of your hand”. Sentences with a labelled drawing count.
- **1 mark:** at least two words of Chapter 6 used correctly — for example *force*, *frictional force*, *friction*, *surface*, *rough*, *smooth*, *grip*, *slows down*, *motion*, *fair test*, *predict*, *estimate*. Award the mark for correct use in the piece, not for listing the words.

Award 0 marks for a piece with no audience sense (a list of numbers for nobody), or for words used without meaning.

Where each part traces in the curriculum

Every part assesses one Science inquiry content description, in performance, in the content context of Chapter 6. The Chapter 6 content — frictional force, and the idea that rougher surfaces give more friction — is the setting of the task; it is assessed directly in the Chapter 6 Check-up, and is not marked separately here. The four investigation tasks of this book (Chapters 3, 4, 5 and 6) share the same mark split, so the four tasks are comparable, and each inquiry content description is assessed four times. The extracts below are quoted verbatim from the Victorian Curriculum F–10 Version 2.0, Science, Levels 3 and 4 achievement standard.

Part	Marks	Assesses	Achievement-standard extract (verbatim)
Part 1 — Question and prediction	3	`VC2S4I01`	“Students pose questions to identify patterns and relationships, and make predictions based on observations.”
Part 2 — Planning	5	`VC2S4I02`	“They plan investigations using planning scaffolds, identify key components of fair tests and describe how they conduct investigations safely.”
Part 3 — Measuring and recording	4	`VC2S4I03`	“They use familiar classroom instruments and simple procedures to record observations and results, including formal measurements.”
Part 4 — Representing	4	`VC2S4I04`	“They construct representations to organise data and information, and identify patterns and simple relationships.”
Part 5 — Comparing and evaluating	2	`VC2S4I05`	“They compare their findings with those of others, assess the fairness of their investigations,

Part	Marks	Assesses	Achievement-standard extract (verbatim)
			propose further questions for investigation and draw conclusions.”
Part 6 — Communicating	2	`VC2S4I06`	“They communicate observations, findings and ideas for an identified purpose and audience, using scientific vocabulary and digital tools where appropriate.”
Total	**20**		