STEP INTO SCIENCE

FORCES AND MAGNETS

Peter Riley

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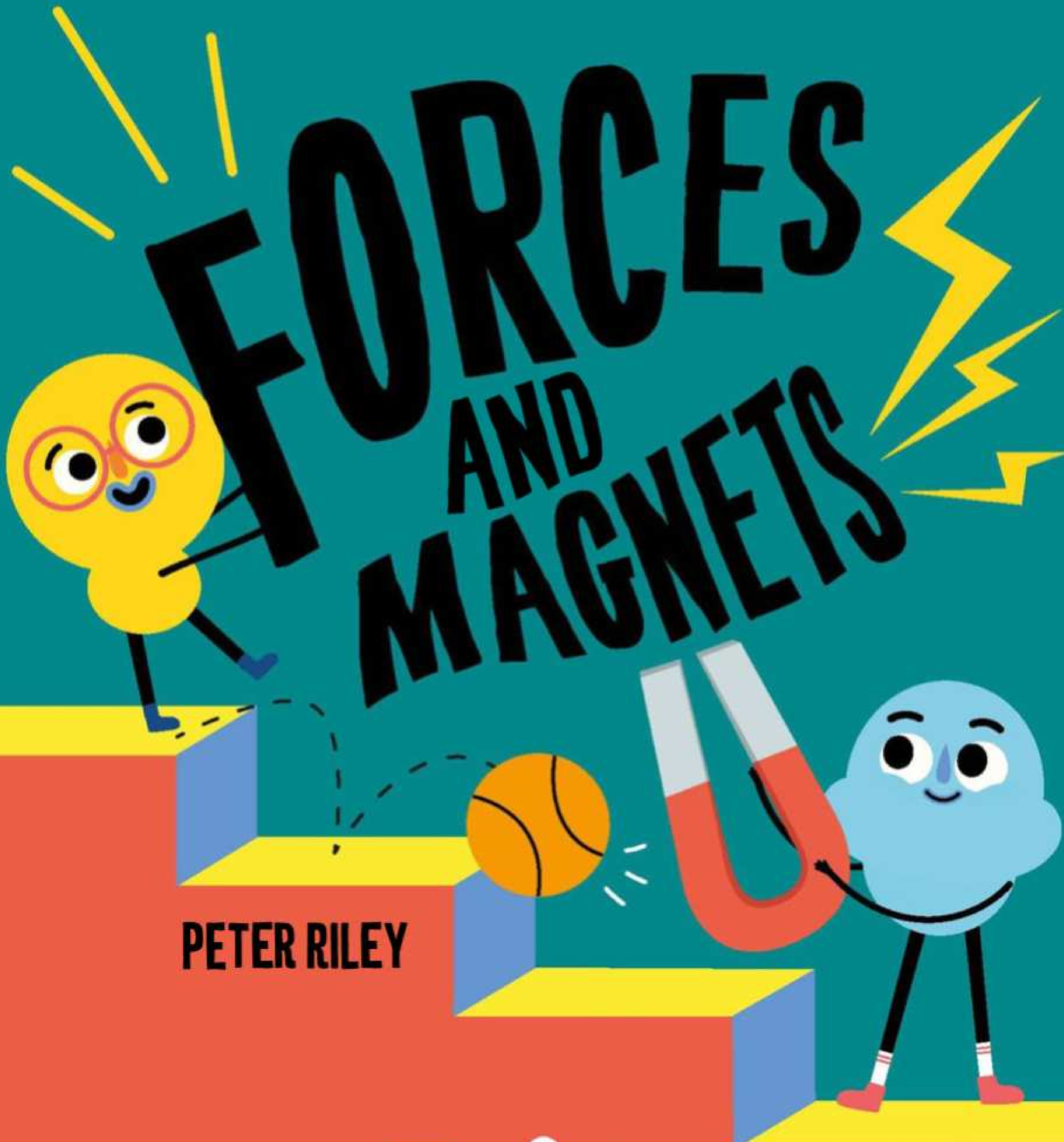

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To my granddaughter, Holly Jane.

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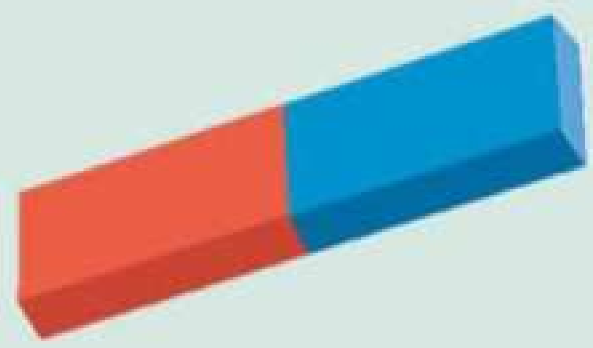

We recommend adult supervision at all times while doing the activities in this book. Always be aware that craft materials may contain allergens, so check the packaging for allergens if there is a risk of an allergic reaction. Anyone with a known allergy must avoid these.

- Wear an apron and cover surfaces.
- Tie back long hair.
- Ask an adult for help with cutting.
- Check materials for allergens.

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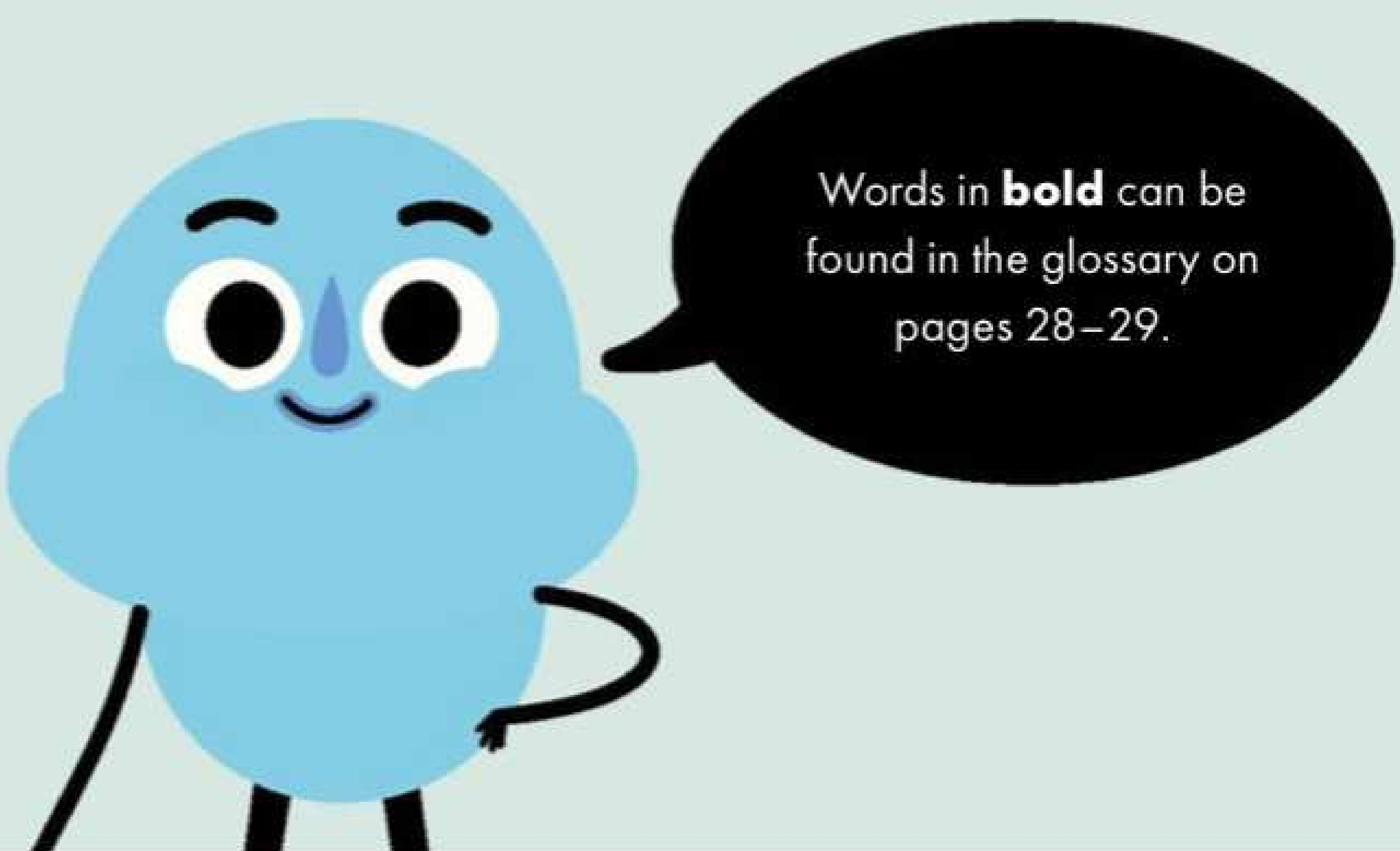


WHAT IS A FORCE?

A force is a push or a pull. You cannot see a force but you can see what happens when a force has been used. Some forces make things move.

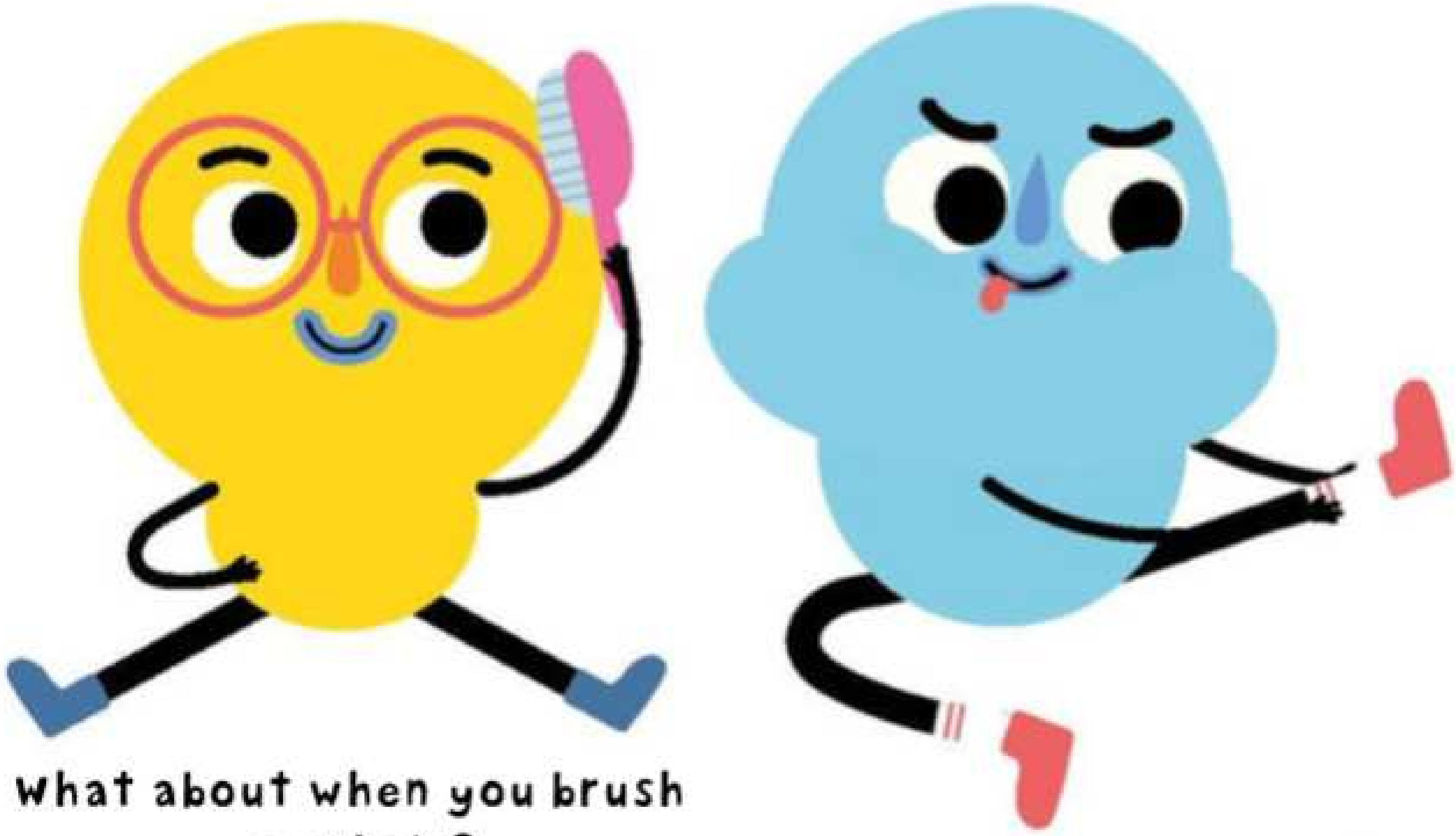
PUSH OR PULL?

Here are some more examples of pushes and pulls. Look at each picture carefully and decide whether a push or a pull has been used.

When you kick a ball, a pushing force gets the ball moving.

When you take a book out of your bag, a pulling force moves the book up.

Pressing the keys down on a keyboard plays a tune.



What about when you brush your hair?

or put on your socks?

WHAT HAPPENS?

When you brush your hair, your hand pulls the brush through your hair. Your hands pull your sock up your foot.

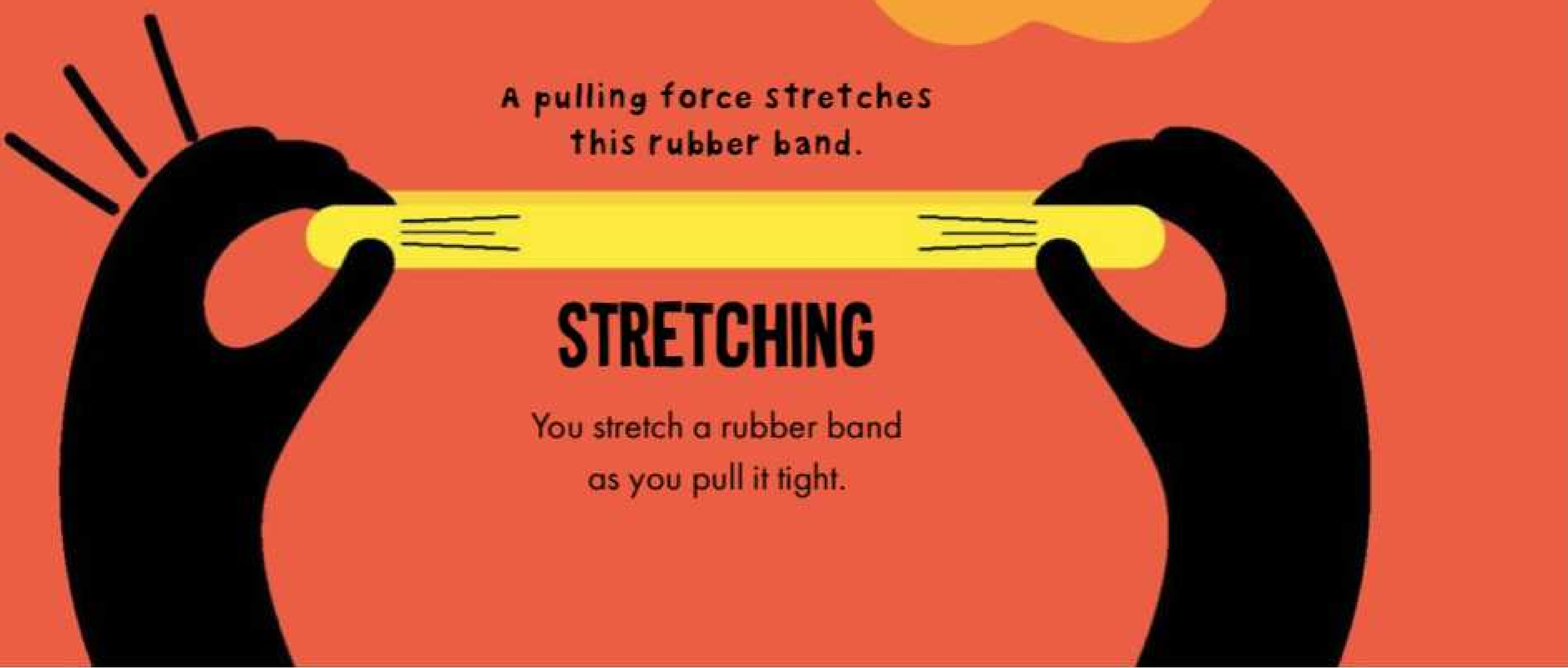
CLOSE THIS BOOK AND THEN OPEN IT AGAIN. WHEN DID YOU USE A PUSH AND WHEN DID YOU USE A PULL? WRITE A LIST OF ALL THE TIMES YOU USE A PUSH AND A PULL DURING YOUR DAY.

SQUASH, STRETCH, TURN, TWIST

We use a pushing or pulling force in almost all the things we do. When we use a push or a pull we can change the shape of objects or move them by squashing, stretching, turning, or twisting them.

SQUASHING

You squash a piece of clay by pushing it down with your hand.

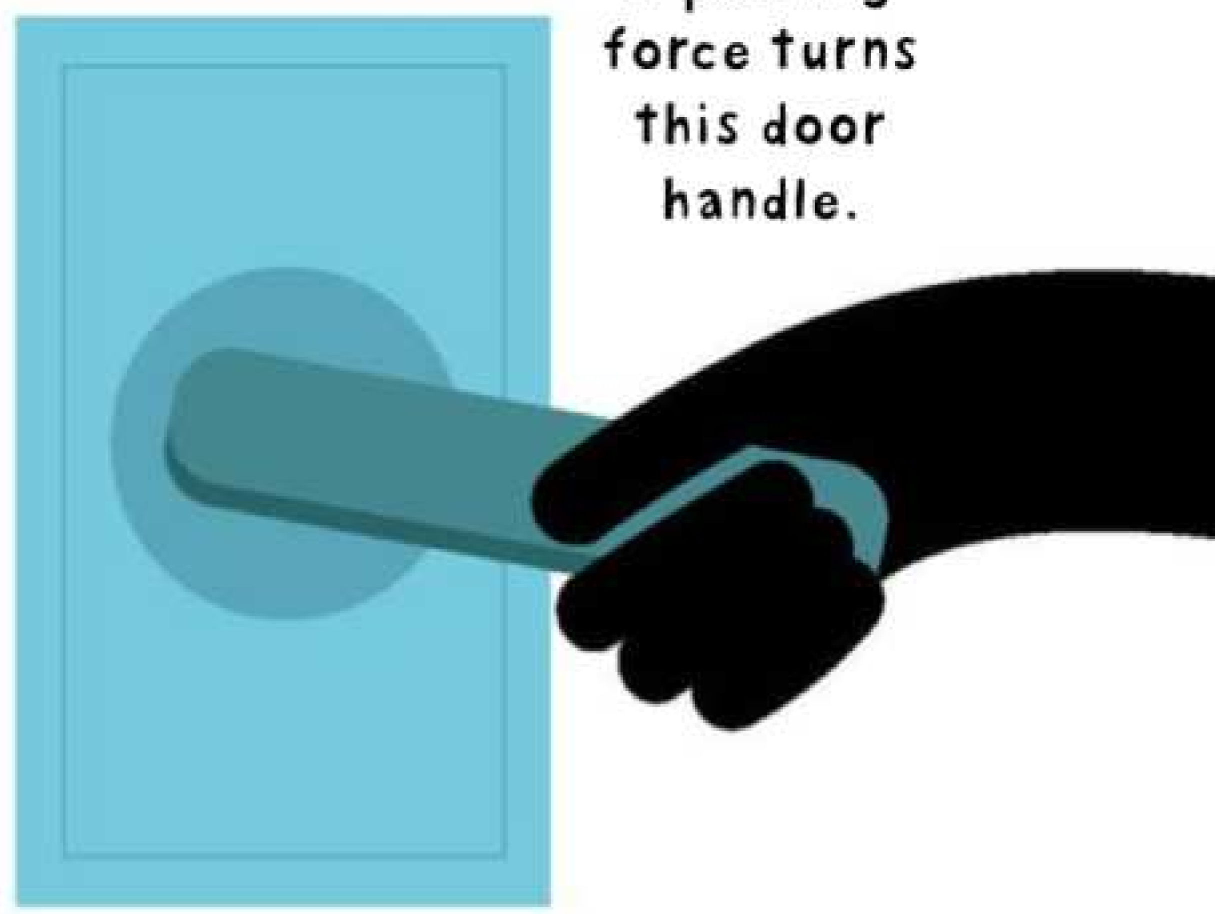


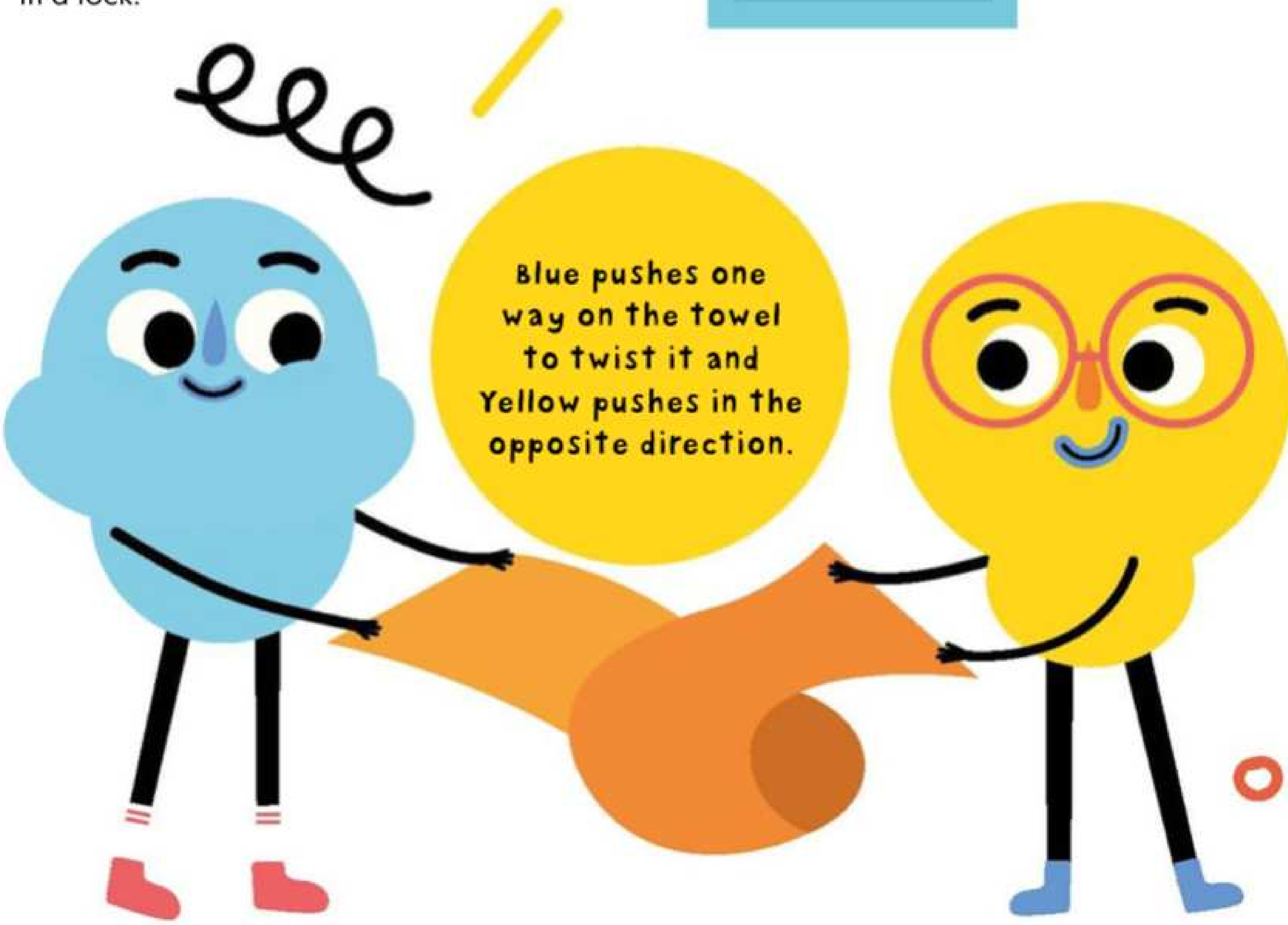
STRETCHING

You stretch a rubber band as you pull it tight.

TURNING

You turn a door handle by pushing it down. You turn the wheel on your bicycle by pushing down on the pedals. You push as you turn a key in a lock.



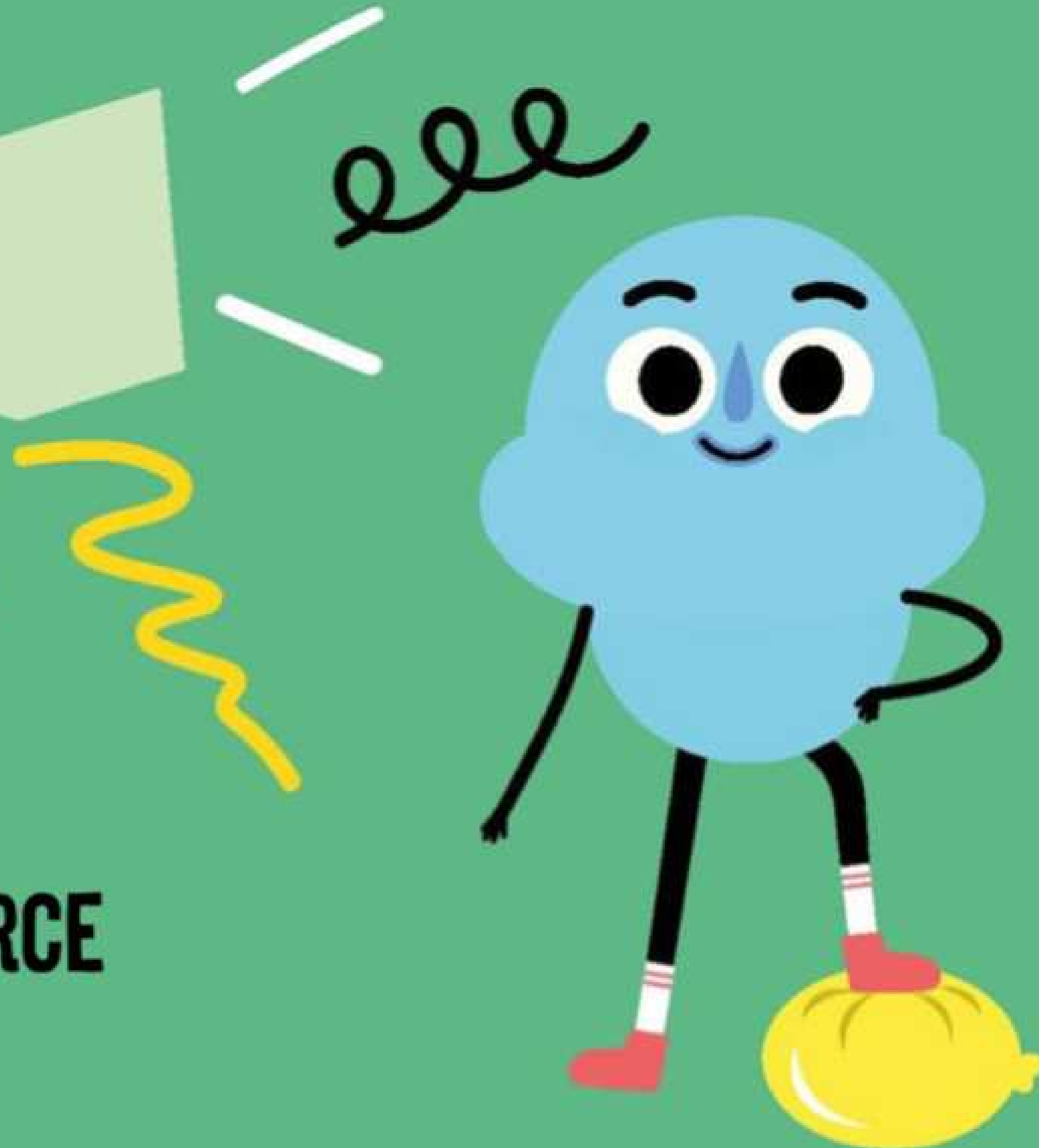


TWISTING

We use forces to twist things. You use a pushing force as you twist a bottle top onto a bottle, for example.

GRAVITY

Look at this picture. What will happen to the balloon as Blue pushes their foot down?



NON-CONTACT FORCE

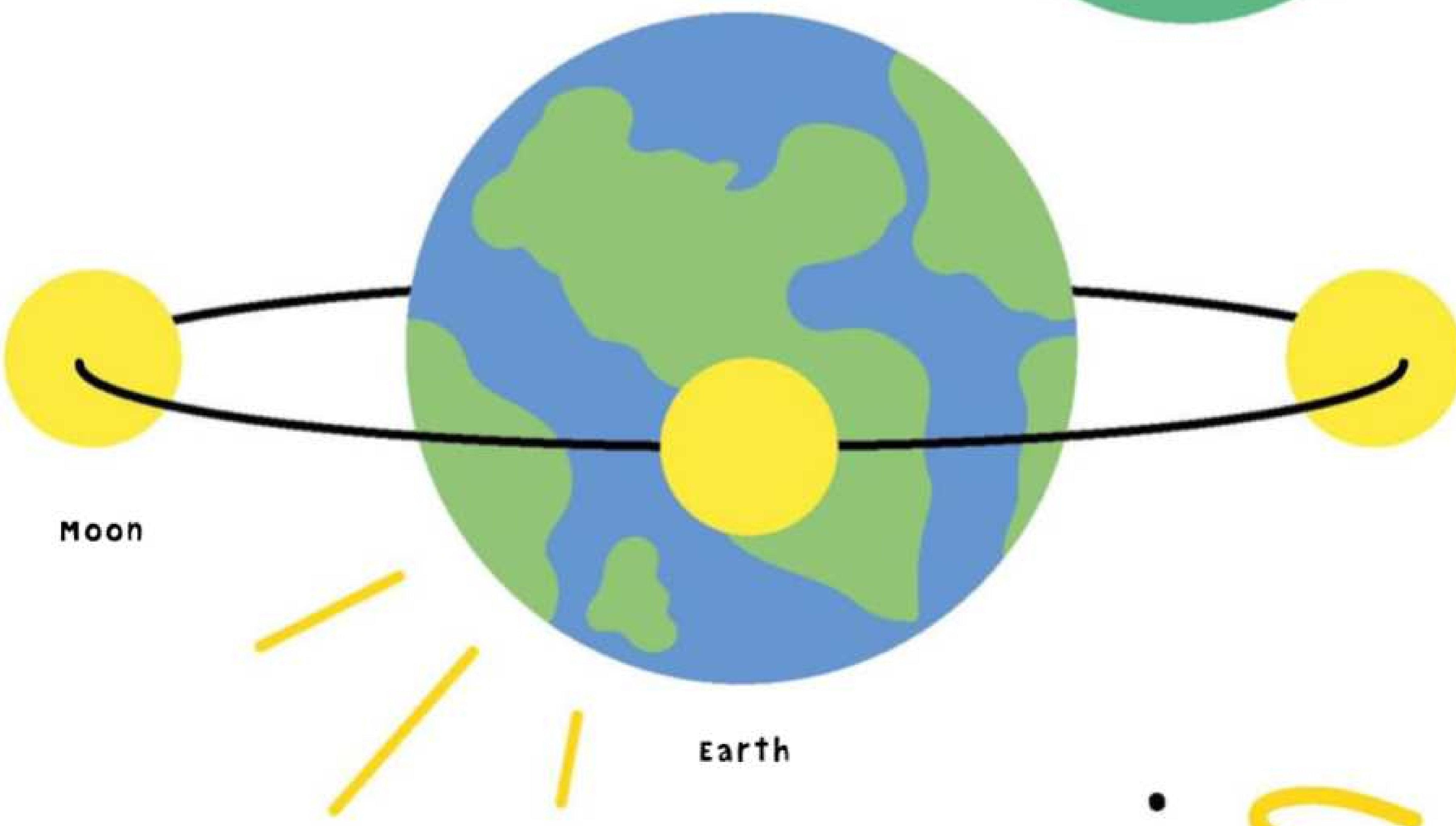
The push as Blue stamps down is too strong for the balloon. The balloon pops. Another force pulls Blue's foot to the ground. This force is called **gravity**. Gravity is different from the other forces we have looked at. With other pushes and pulls, the forces touch the objects they are moving or changing. They are called **contact forces.** Gravity does not touch the object it is pulling. It is called a **non-contact force.**

Gravity is the force pulling us and our bikes back to Earth.

THE EARTH

You might think that gravity pulls everything down to the **surface** of Earth, but this is not really the case. Gravity pulls everything down to the center of Earth. This is why objects fall down holes. If we throw a pebble down a well, for example, the pebble falls right to the bottom.

Gravity from Earth pulls on the moon so that it moves around Earth.



GRAVITY IN SPACE

Other **planets** and **stars** also have a **gravitational pull**. There is a pull of gravity between the sun and the planets in the **solar system**, for instance. It keeps the planets moving around the sun.

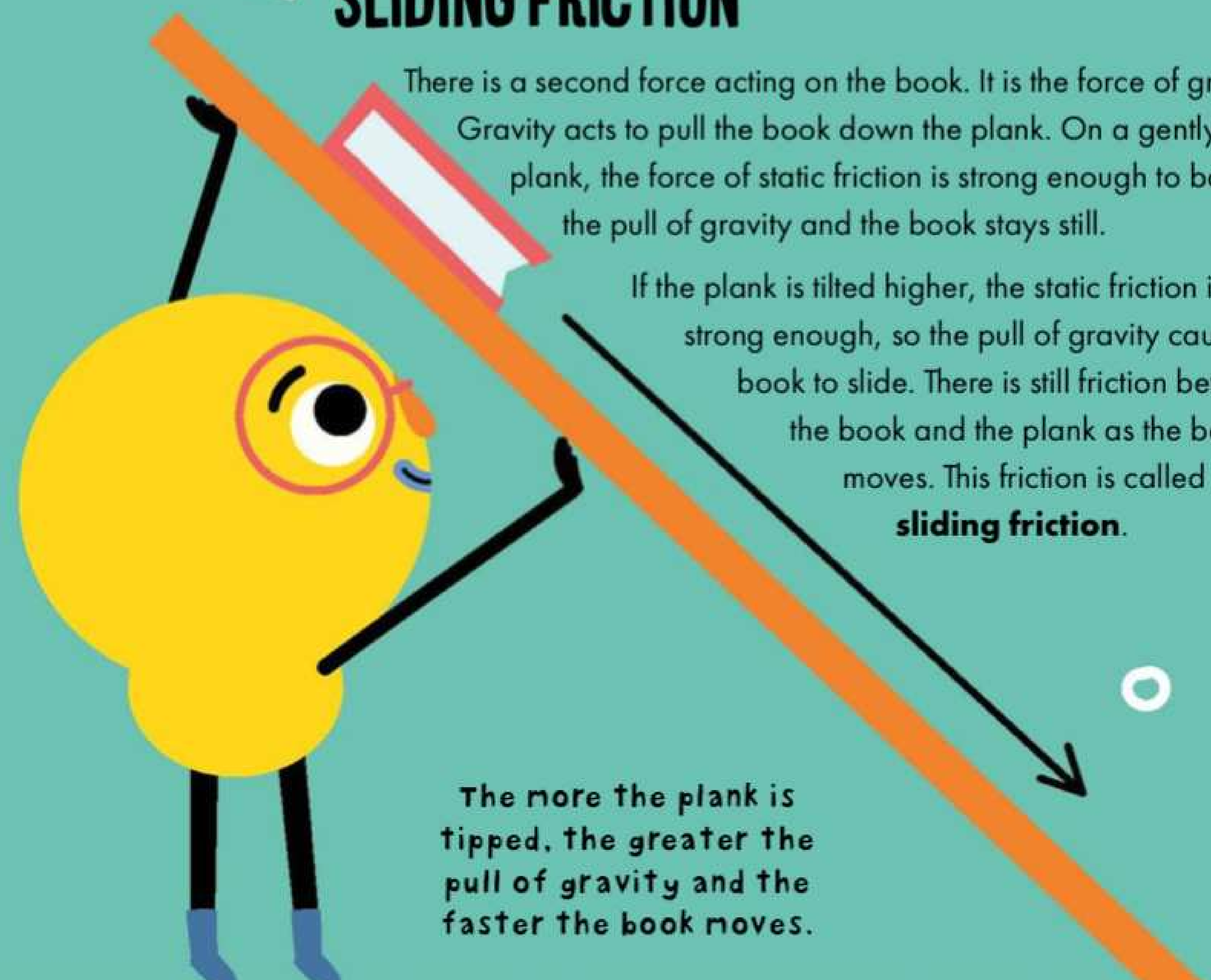
FRICTION

If you put a book at the top of a plank of wood and slowly start to tip the plank, you will see that at first the book stays still. It is held in place by a force between the book and plank. This force is called friction. As the book does not move, the friction is called static friction.

SLIDING FRICTION

There is a second force acting on the book. It is the force of gravity. Gravity acts to pull the book down the plank. On a gently sloping plank, the force of static friction is strong enough to balance the pull of gravity and the book stays still.

If the plank is tilted higher, the static friction is not strong enough, so the pull of gravity causes the book to slide. There is still friction between the book and the plank as the book moves. This friction is called **sliding friction**.



The more the plank is tipped, the greater the pull of gravity and the faster the book moves.

FRICTION AND FEET

When you walk, your feet push on the ground to move you forward. If you look at the soles of your bare feet with a magnifying glass, you can see lines with grooves between them. These lines make a rough surface that builds up static friction between your foot and the ground and holds your foot steady as you move.

When your feet get wet, water fills the grooves and makes them smooth. This reduces the static friction and your feet start to slip and slide.

RUB YOUR HANDS TOGETHER, THEN PUT ON SOME HAND CREAM AND RUB AGAIN. WHAT HAPPENS TO YOUR HANDS?

INVESTIGATING FRICTION

You can investigate the strength of friction in different ways.

TESTING FRICTION WITH SHOES

If you walk around a smooth, polished wood floor in your socks you may slip, but if you put on your sneakers you will not.

This difference is due to the friction between what's on your feet and the floor. Your sock is soft and smooth, while your sneaker sole has lots of grooves. When you wear sneakers that have a greater force of static friction than your socks, you are less likely to slip around, even while running on smooth floors.

SMOOTH, ROUGH, BUMPY

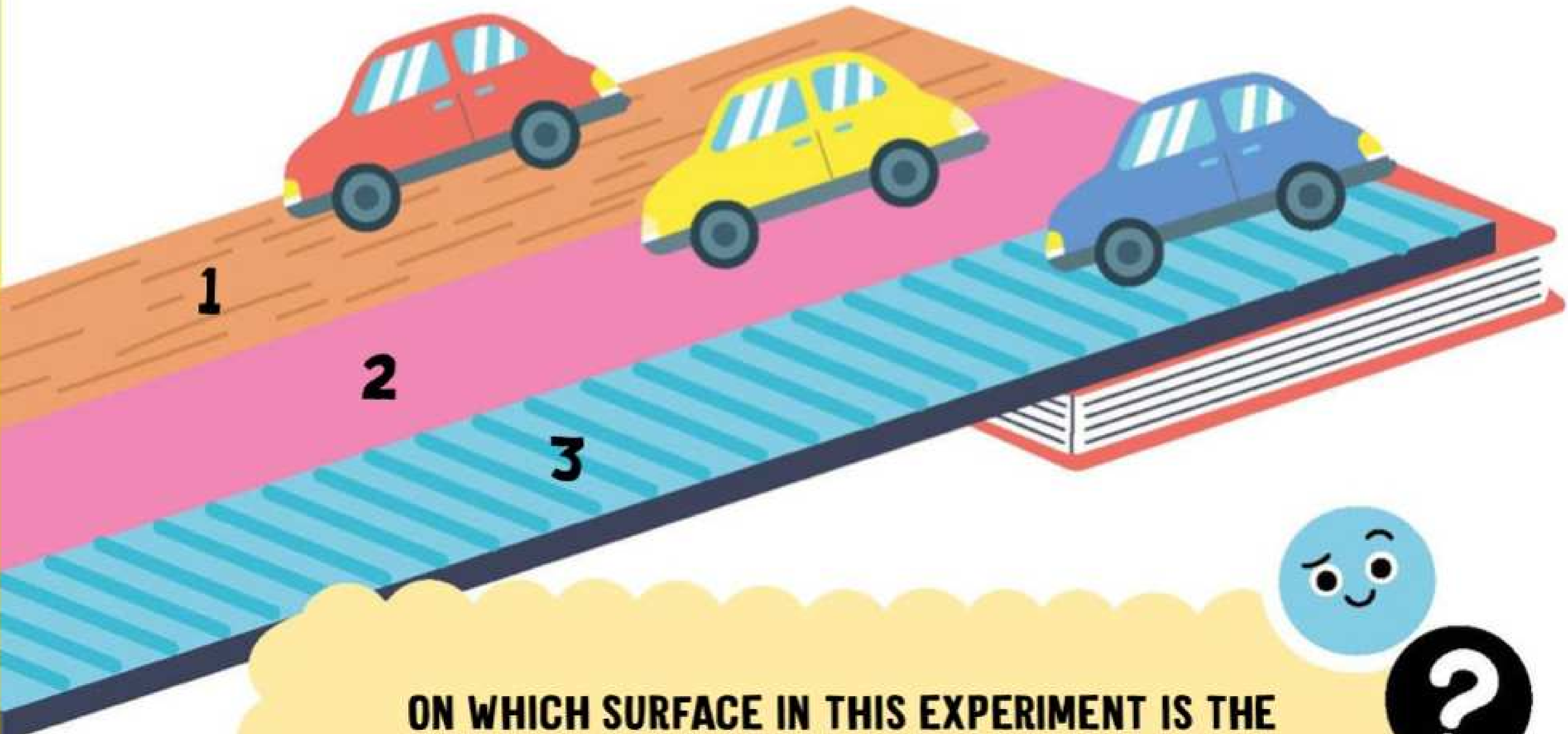
Different surfaces affect friction. You can investigate them by letting toy cars roll down ramps with different surfaces.

Gravity pulls the cars down the ramp. Friction between the car wheels and the ramp's surface slows the cars down. If three identical cars are placed at the top of the ramps and let go at the same time, the picture below shows what will happen.

EQUIPMENT:

- three identical toy cars
- a smooth piece of wood with a strip of foam and a piece of bumpy cardboard attached

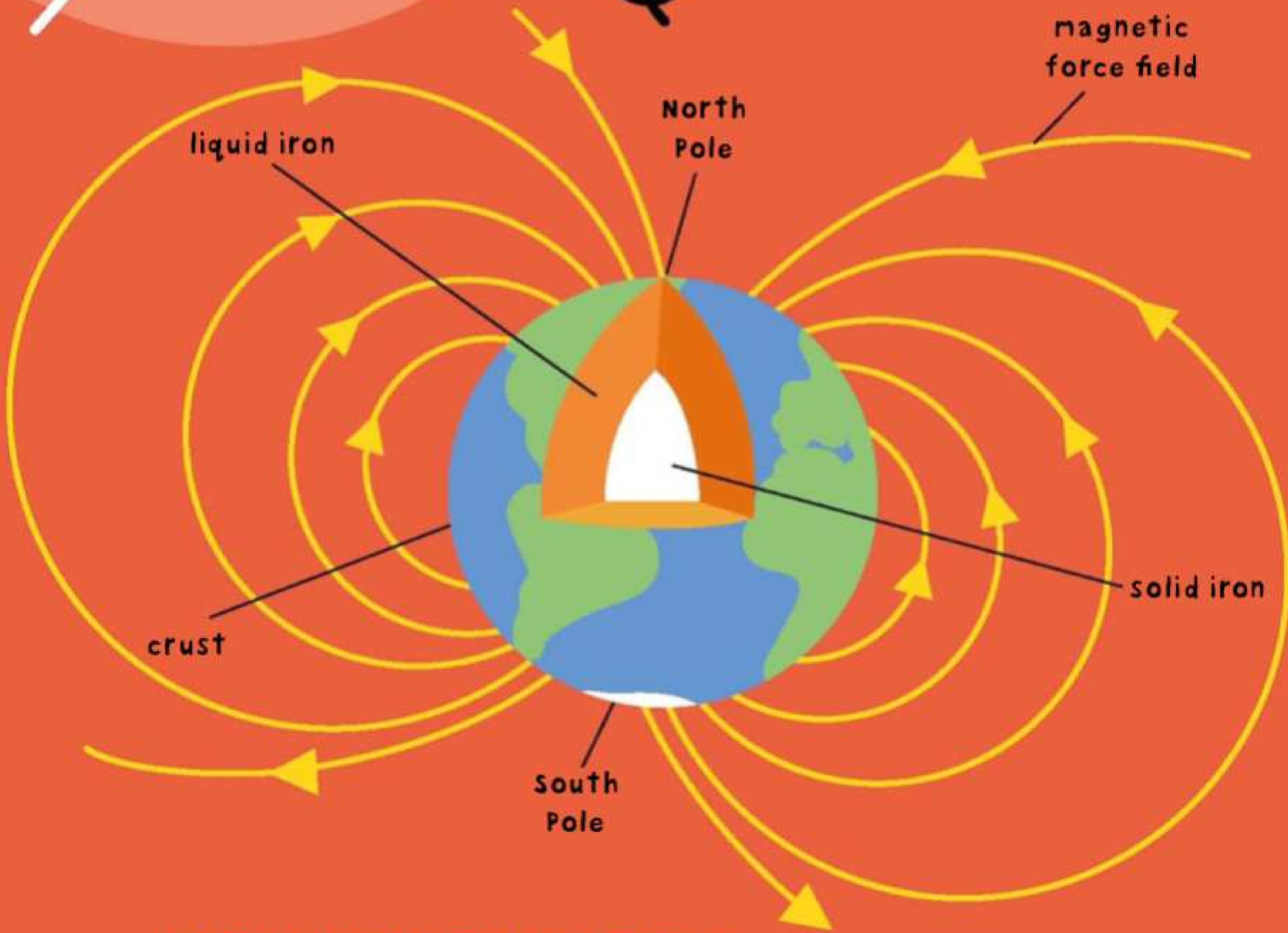
1. The car travels down the smooth wooden surface the fastest.
2. The car travels down the rough foam surface the next fastest.
3. The car travels down the bumpy cardboard surface the slowest.



ON WHICH SURFACE IN THIS EXPERIMENT IS THE FORCE OF FRICTION STRONGEST? ON WHICH SURFACE IS THE FORCE OF FRICTION WEAKEST? WHAT DOES THIS EXPERIMENT TELL YOU ABOUT FRICTION AND SPEED?

FORCE FIELDS

A force field is the place where a non-contact force can pull or push on things around it.

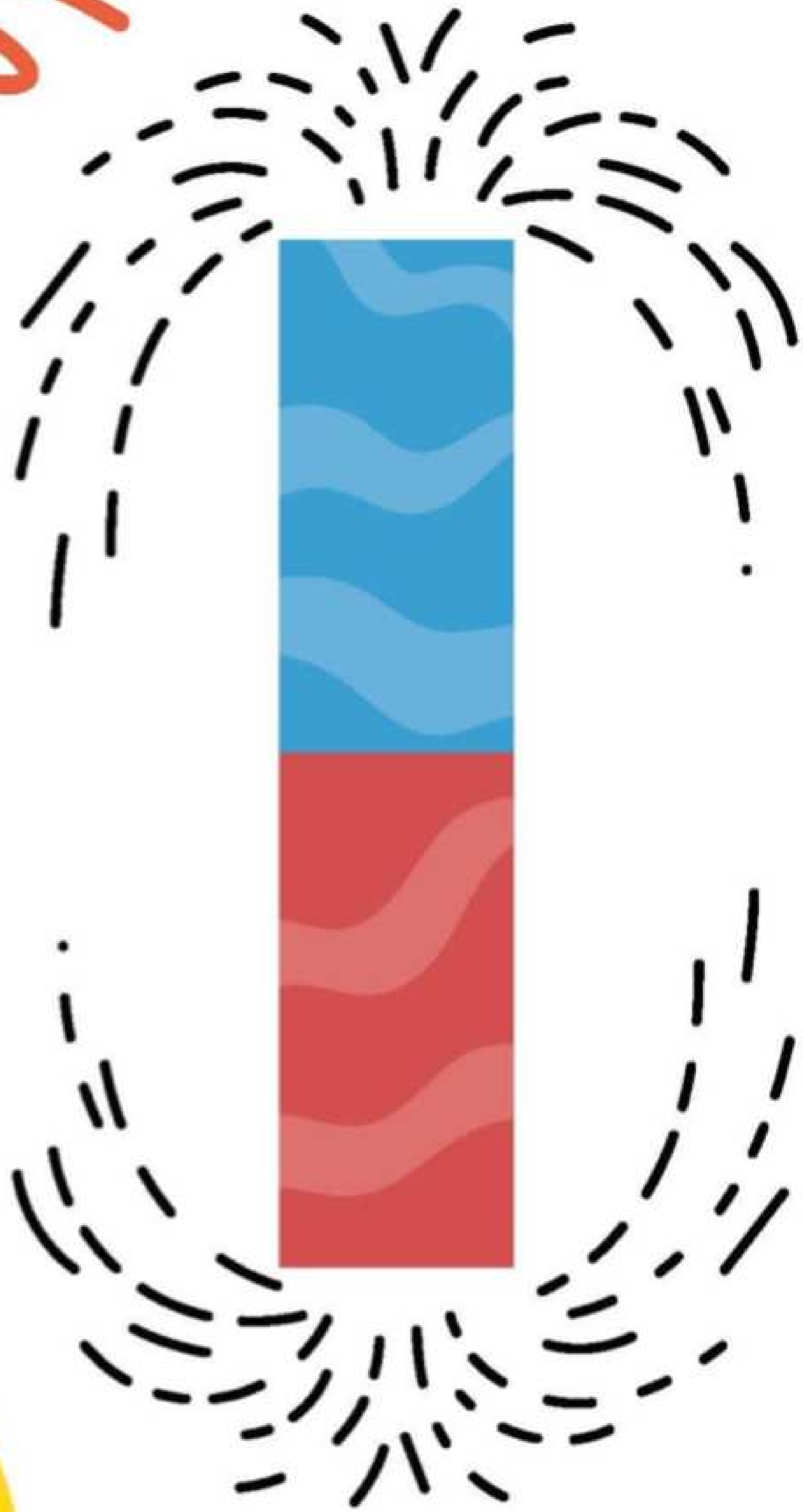


THE EARTH'S FORCE FIELD

You are in Earth's gravity force field. When you jump up, Earth's gravity pulls you back down. Scientists believe that at the center of Earth there is a ball of metal made mostly of solid iron. It is very hot at the center of Earth and this ball is surrounded by molten metal. As Earth turns on its **axis**, the solid iron ball spins in the hot liquid. This makes a **magnetic** force field around Earth. The **North and South Poles** are the ends of the axis on which the Earth turns.

MAGNETIC FORCE FIELD

Earth is a bit like a huge magnet. All magnets have force fields around them where they can pull on **magnetic materials**. The force field is strongest at the magnet's two **poles**. The pole is the place at the end of the magnet where the magnetic force comes from. Each magnet has a north and a south pole.



Tiny iron filings show the magnetic force field around this bar magnet. The filings have gathered around the poles where the force field is strongest. The plastic cover keeps the iron filings off the magnet.

MAGNETIC FORCE

You can feel the power of a magnetic force with this quick experiment.

1 Take the bar magnet in one hand and the steel spoon in the other hand and start to slowly move the two objects together. As you bring the spoon closer you might feel it wobble as the magnet's force begins to pull on it.

EQUIPMENT:

- bar magnet
- steel spoon

2 The magnet's force will **attract** the spoon to the magnet. It also makes the spoon stick to the magnet.

TESTING THE MAGNETIC FORCE

Another way to test magnetic force is to put the spoon on the table. Hold the magnet over the spoon handle and start to lower it. When the magnet is very close, the magnetic force may pull the spoon handle towards the magnet. To take the spoon away from the magnet you have to pull them apart with both hands. Your pulling force must be stronger than the magnetic force to take the spoon away from the magnet.

MAGNETIC TEST

To see if all materials stick to magnets, try the following experiment with a collection of objects made from different materials. Which materials do you think will stick to the magnet?

EQUIPMENT:

- bar magnet
- copper scourer
- brass doorknob
- iron pan
- plastic car
- aluminium foil
- steel bowl
- pottery mug
- any other objects made from different materials

Take a bar magnet and bring it near each of your chosen items in turn. If the magnet sticks to the material, we say the material is a magnetic material. If the magnet does not stick to the material, we say the material is a **nonmagnetic material.**

The objects made from iron and steel are magnetic.

The objects made from aluminium, brass, copper, plastic, and pottery are nonmagnetic.

ARE ALL METALS MAGNETIC?

Experiments sometimes show surprising results. A metal is a hard and often shiny material that lets electricity and heat pass through it. Iron and steel are metals. When you test them with a magnet they stick to it. They are magnetic materials. But not all metals are magnetic. Copper, aluminium, and brass are metals too, but these are nonmagnetic.

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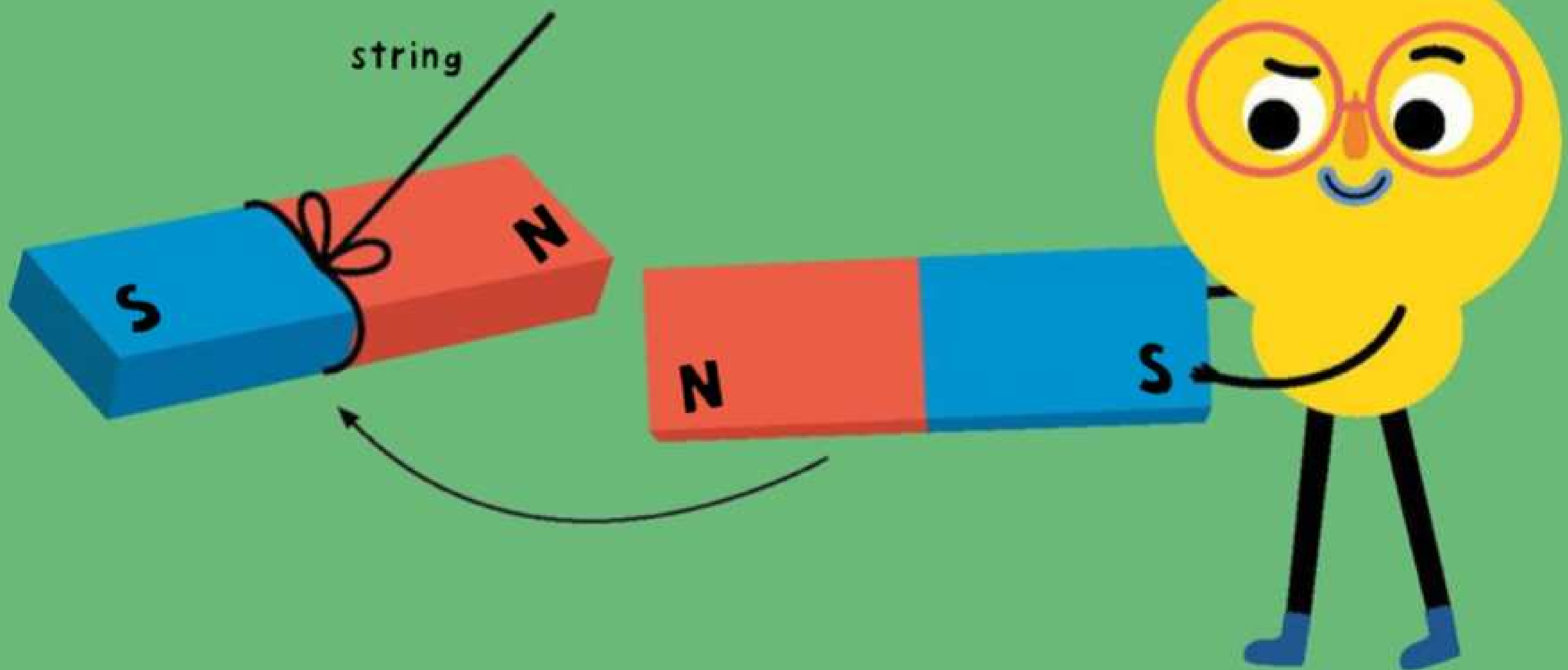
MAGNETIC POLES

Magnets have a north pole and a south pole where the magnetic pull is strongest. The north poles of these magnets are red and the south poles are blue. Try these experiments to find out what happens when the poles of two different magnets are brought together.



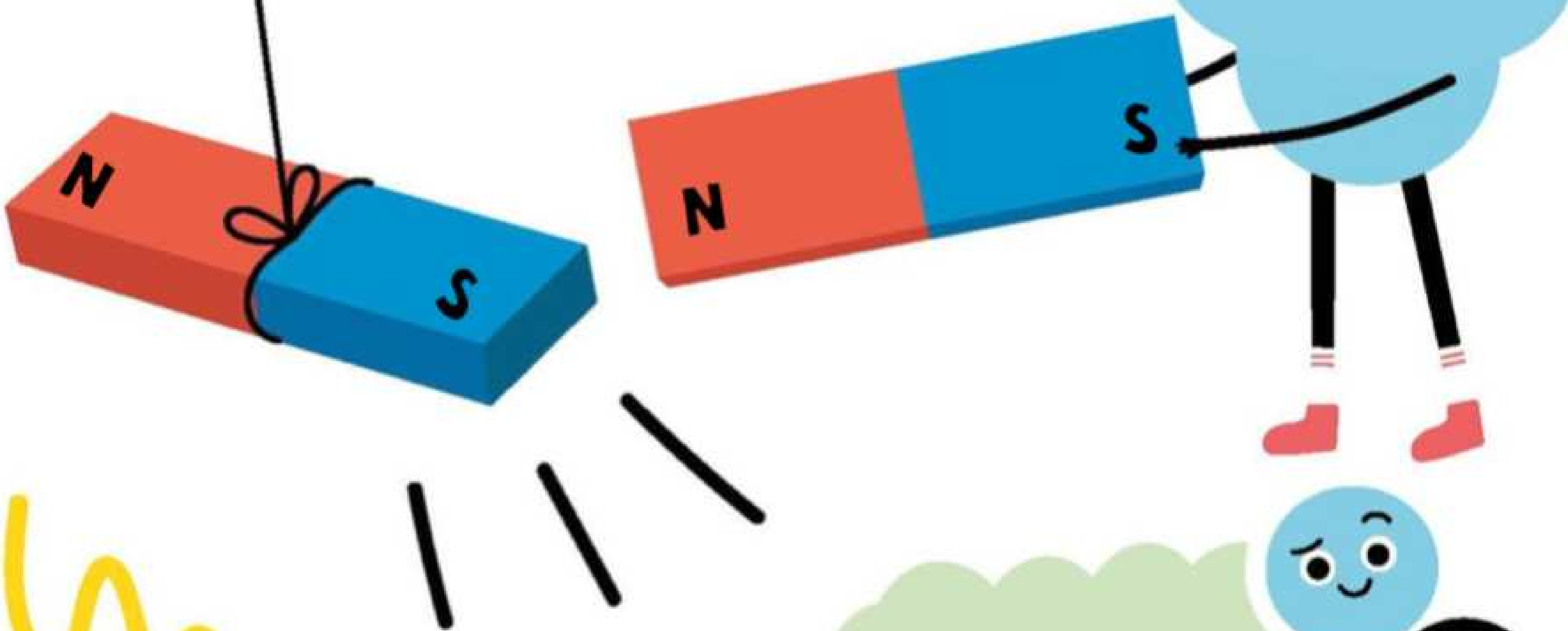
REPELLING AND ATTRACTING

1 Bring the north pole of the magnet in your hand close to the north pole of the hanging magnet. The north pole of the hanging magnet moves away. We say it is **repelled** by the north pole of the second magnet.

EQUIPMENT:

- bar magnet hung from piece of string
- bar magnet held in your hand

2 Move the north pole of the magnet in your hand towards the south pole of the hanging magnet. The south pole of the hanging magnet will move towards the north pole of the second magnet. We say that it is attracted to the magnet's north pole.



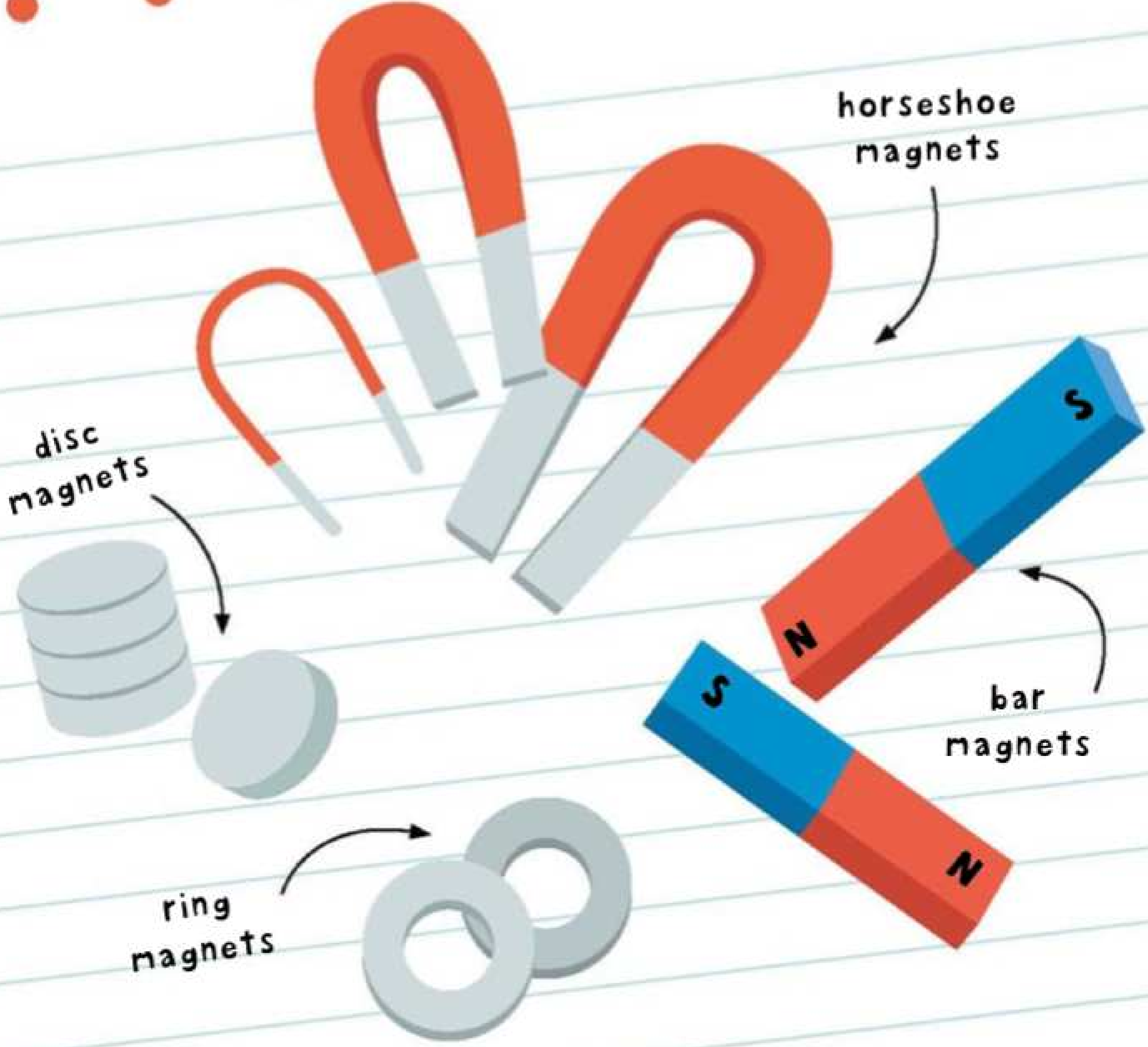
WHAT DO YOU THINK WOULD HAPPEN IF YOU BROUGHT TWO SOUTH POLES TOGETHER? WHICH POLES ATTRACT EACH OTHER – THE OPPOSITE OR THE SAME? WHICH POLES REPEL EACH OTHER – THE OPPOSITE OR THE SAME?

FEELING THE MAGNETIC FORCE

You do not need to hang up a magnet to see how the poles pull and push each other. You can simply bring two magnets together with your hands. You will soon see and feel the magnetic forces at work.

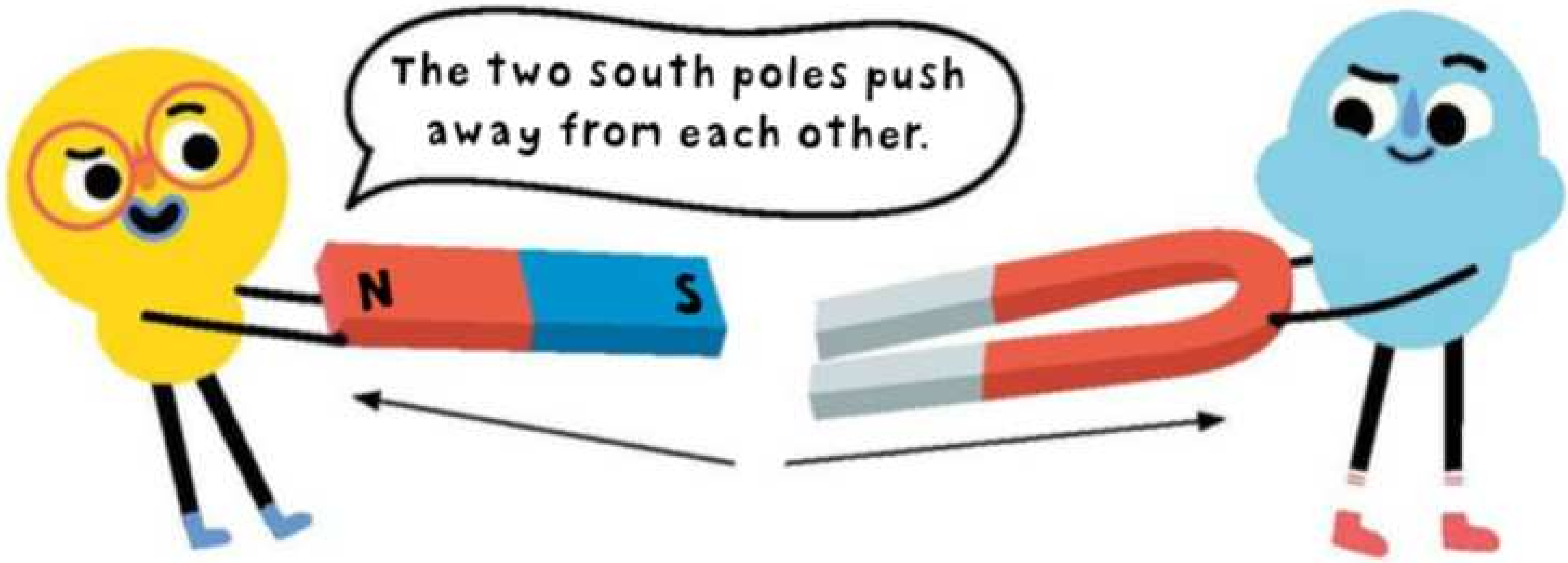
FINDING THE POLES

There are many kinds of magnets. Bar magnets with red and blue ends show you their north and south poles. A horseshoe magnet does not have colors to show you its poles. You can find them by testing the horseshoe magnet with a bar magnet.



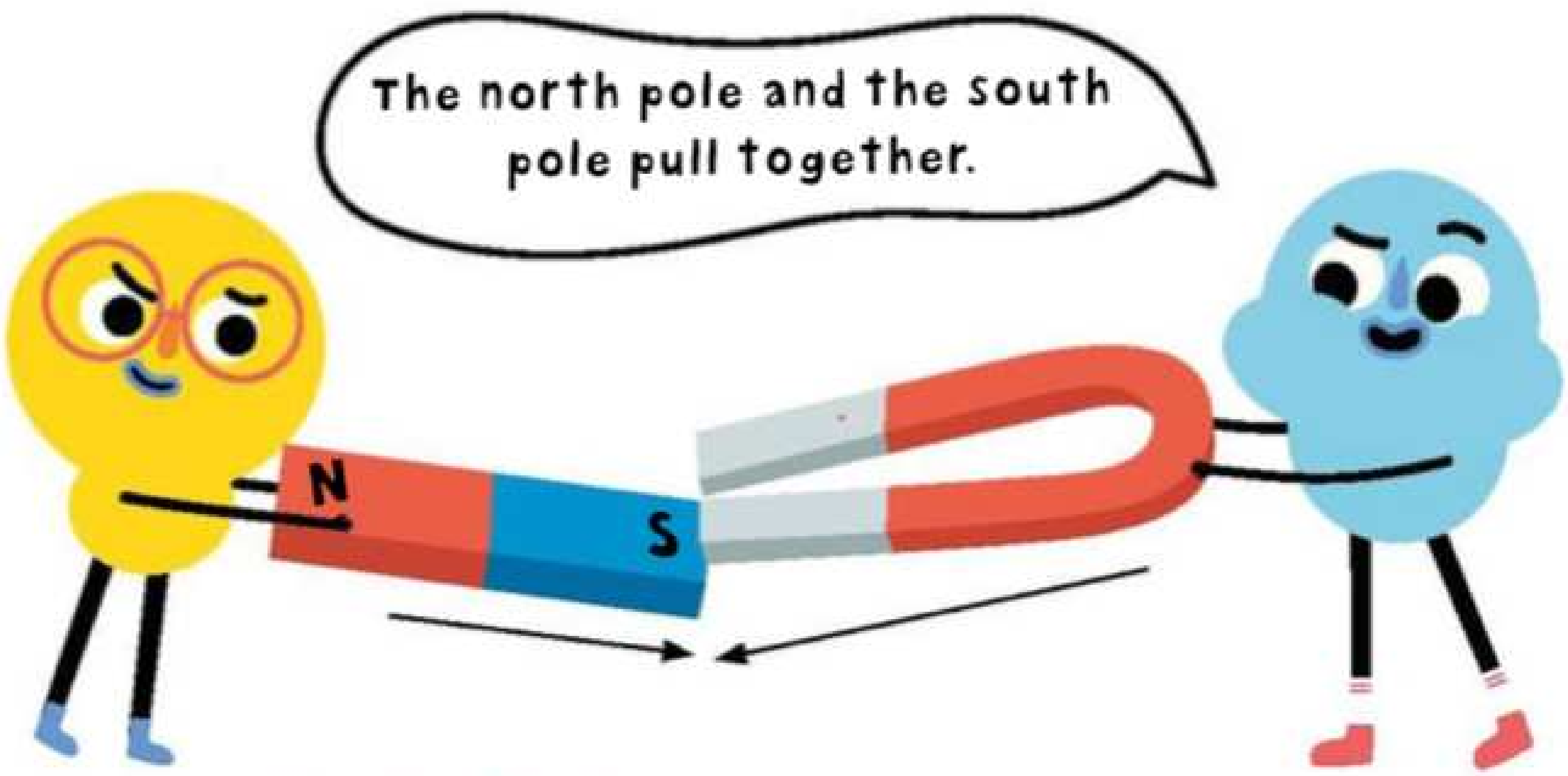
SOUTH POLE

Bring the south pole of a bar magnet towards one of the poles of the horseshoe magnet. If the two magnets push away from each other, the pole of the horseshoe magnet is a south pole. Two south poles are similar, so they repel each other.



NORTH POLE

Bring the south pole of the bar magnet towards the other pole of the horseshoe magnet. If the two magnets pull each other together, the pole of the horseshoe magnet is a north pole. The north and the south poles are opposite, so they attract each other.



HOW WOULD YOU USE A BAR MAGNET TO FIND THE POLES ON A FRIDGE MAGNET?

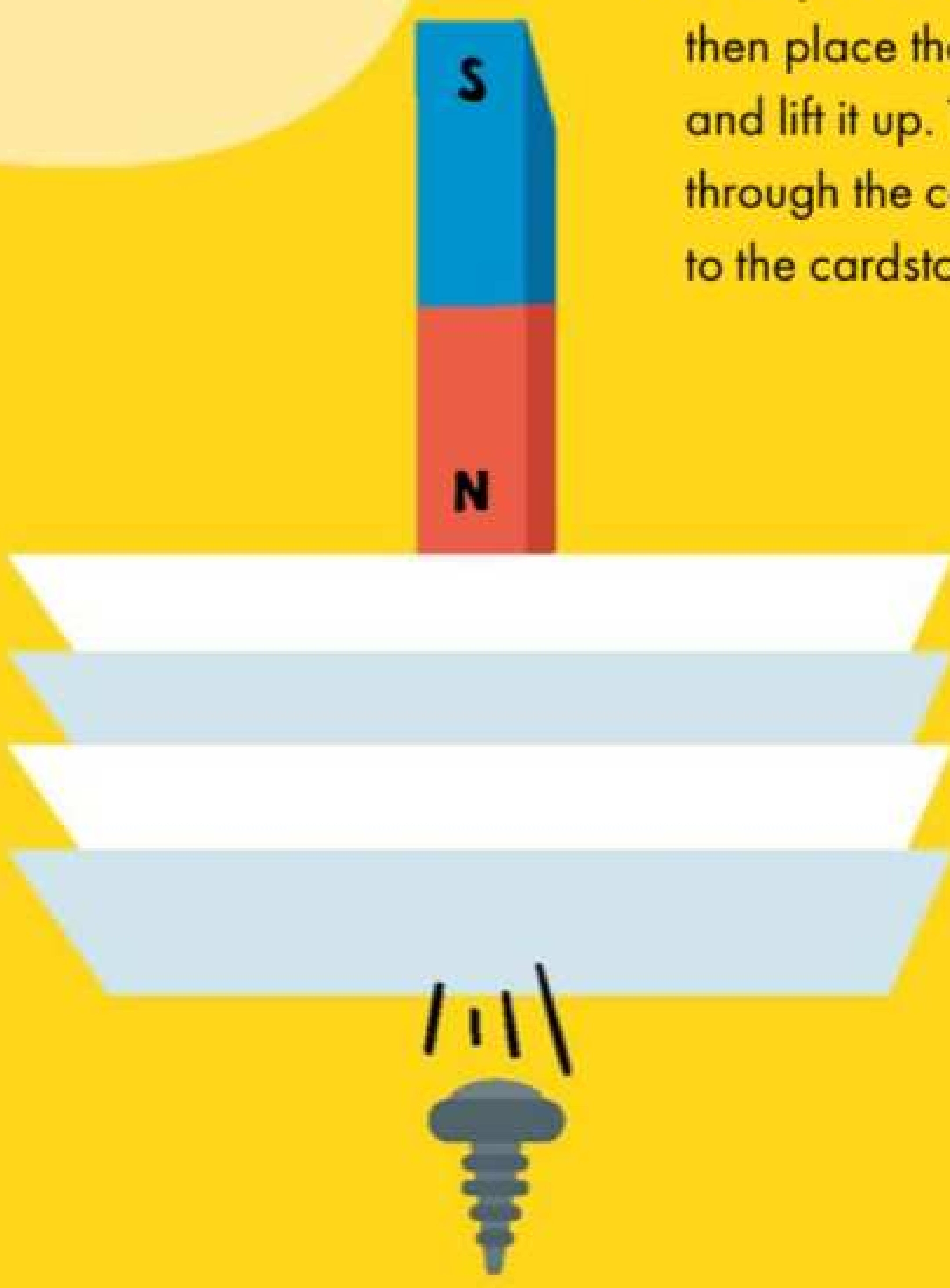
TEST THE FORCE

EQUIPMENT:

- steel screw
- pieces of cardstock
- bar magnet

Cardstock is nonmagnetic. A steel screw is magnetic. What happens if you put a piece of cardstock next to a magnet and a screw next to the cardstock? Will the magnetic force still work through the cardstock?

1 Put a piece of cardstock over the screw, then place the magnet over the cardstock and lift it up. The magnetic force goes through the card and makes the screw stick to the cardstock.

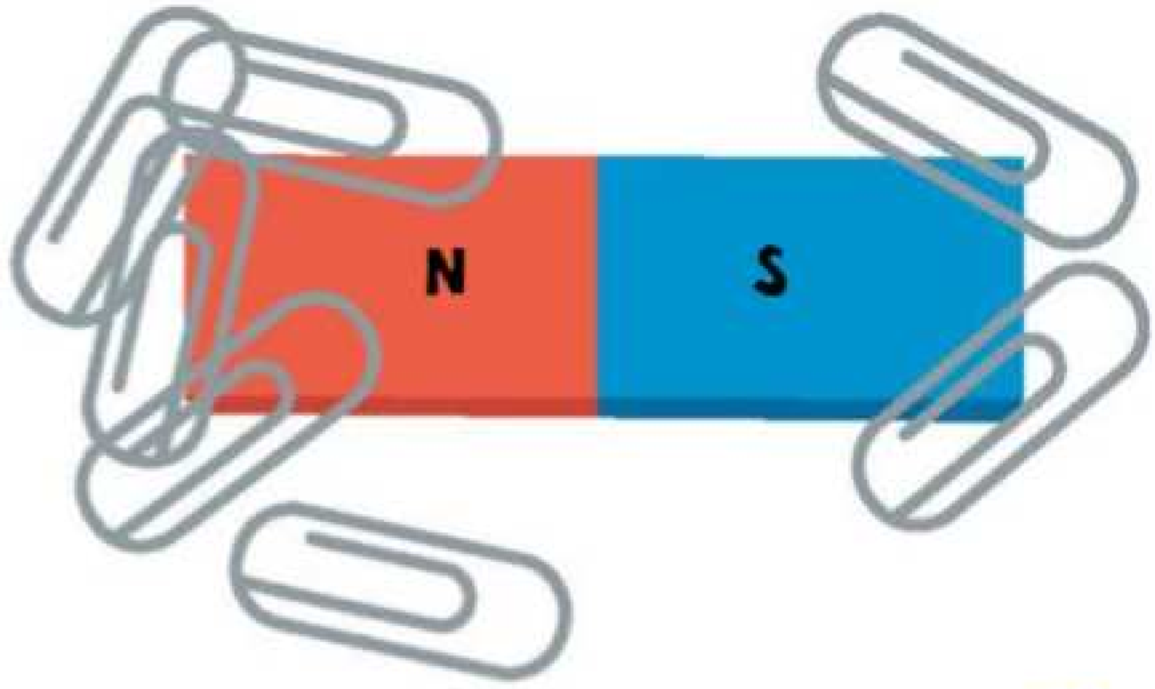


2 Add another piece of cardstock to test the strength of the magnetic force further. Place two pieces of cardstock between the magnet and the screw. The screw still sticks to the magnet through the two pieces of cardstock.

3 Keep adding pieces of cardstock to test the magnet's strength. How many pieces do you need to add before the screw falls away? Eventually, the force of the magnet will not be strong enough to pull through all of the pieces of cardstock.

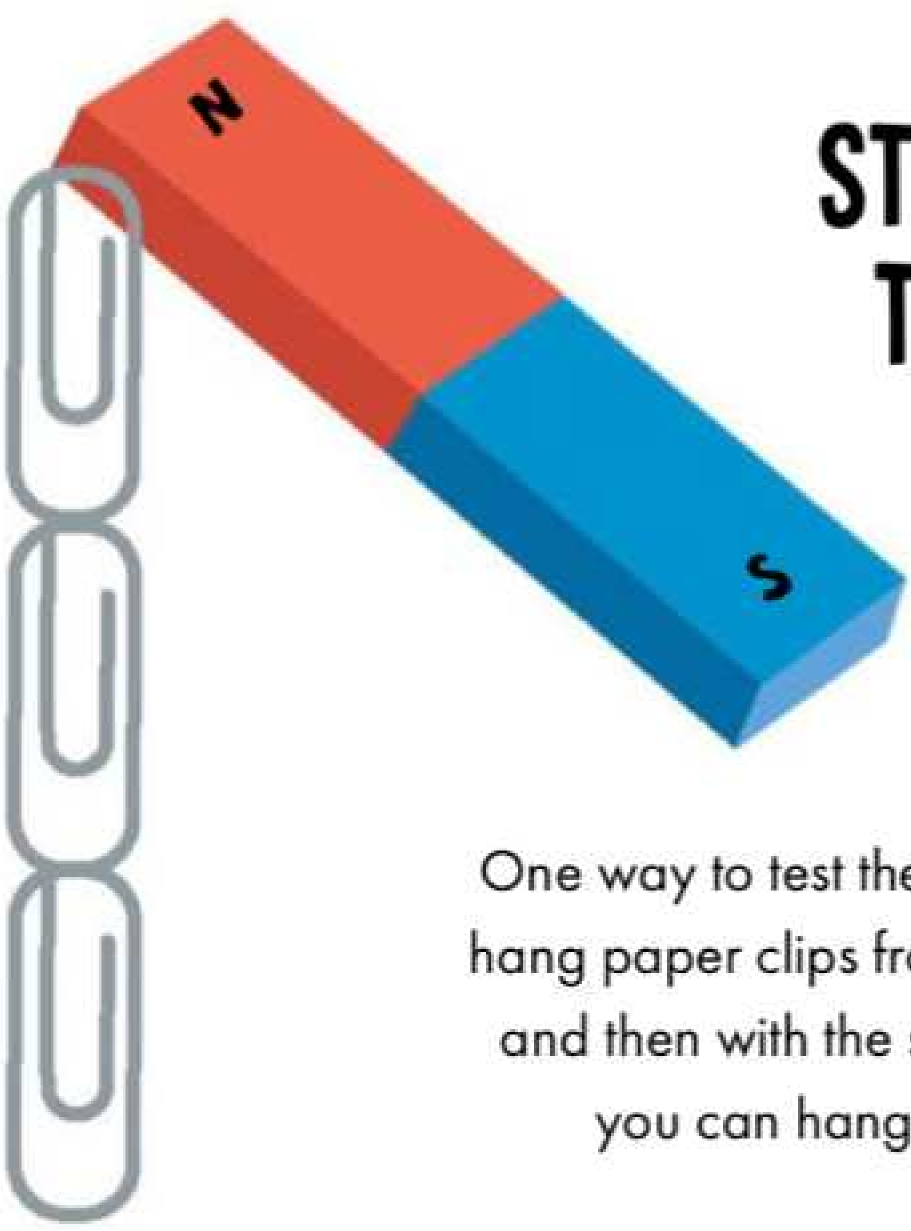
EQUIPMENT:

- bar magnet
- steel paper clips

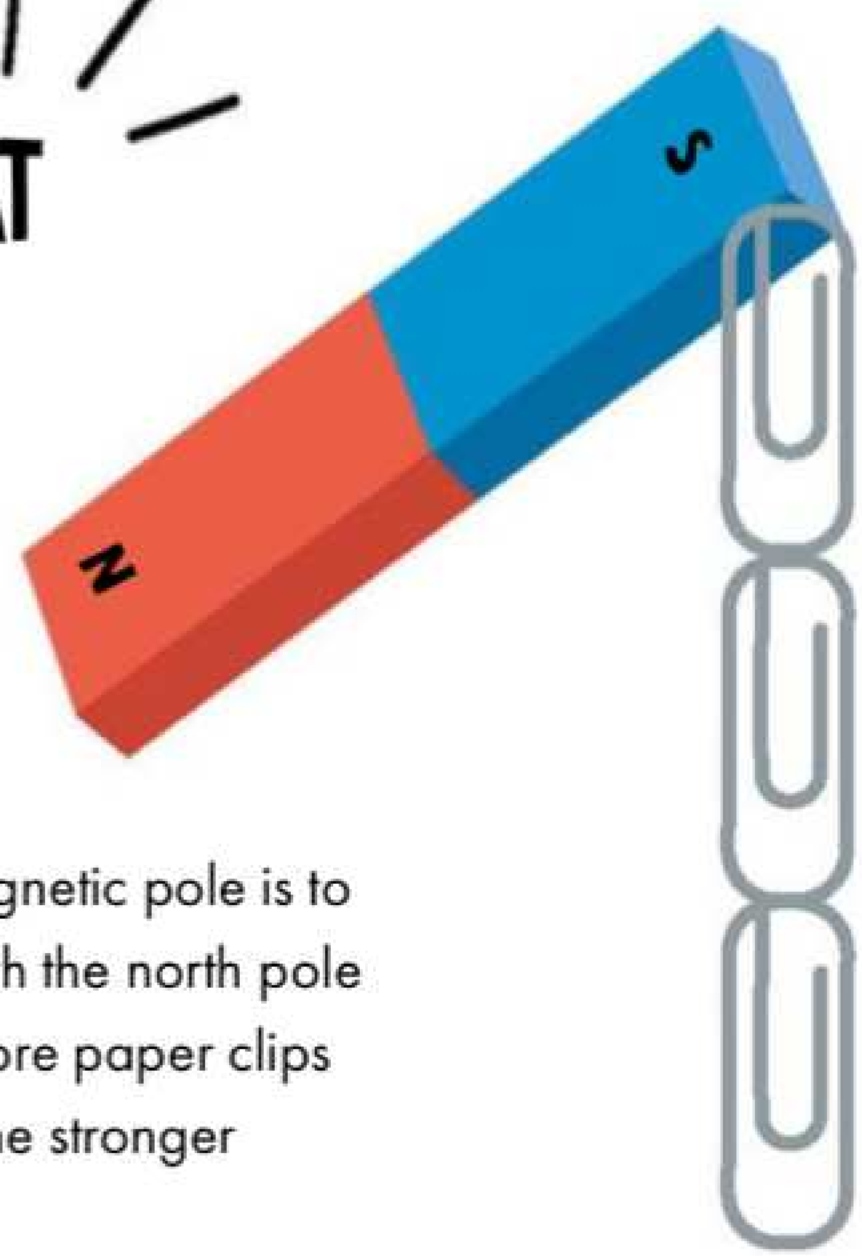


THE FORCE AT THE POLES

Do all parts of a magnet have a strong magnetic force? You can test this by putting a bar magnet on a table and covering it with steel paper clips. If you lift up the bar magnet, the paper clips move towards the poles. The magnetic force is strongest at the magnet's poles.



STRENGTH AT THE POLES



One way to test the strength of a magnetic pole is to hang paper clips from it. Try it first with the north pole and then with the south pole. The more paper clips you can hang on the magnet, the stronger the pole.

USING MAGNETS

We use magnets every day. Inside a refrigerator door is a magnetic strip. When the door is closed, the strip makes the door grip the metal in the doorframe and holds it shut.

COMPASSES

A **compass** has a magnetic needle that is free to move. When you place it on a flat surface, the needle is pulled into line by Earth's magnetic field and it points north.

EQUIPMENT:

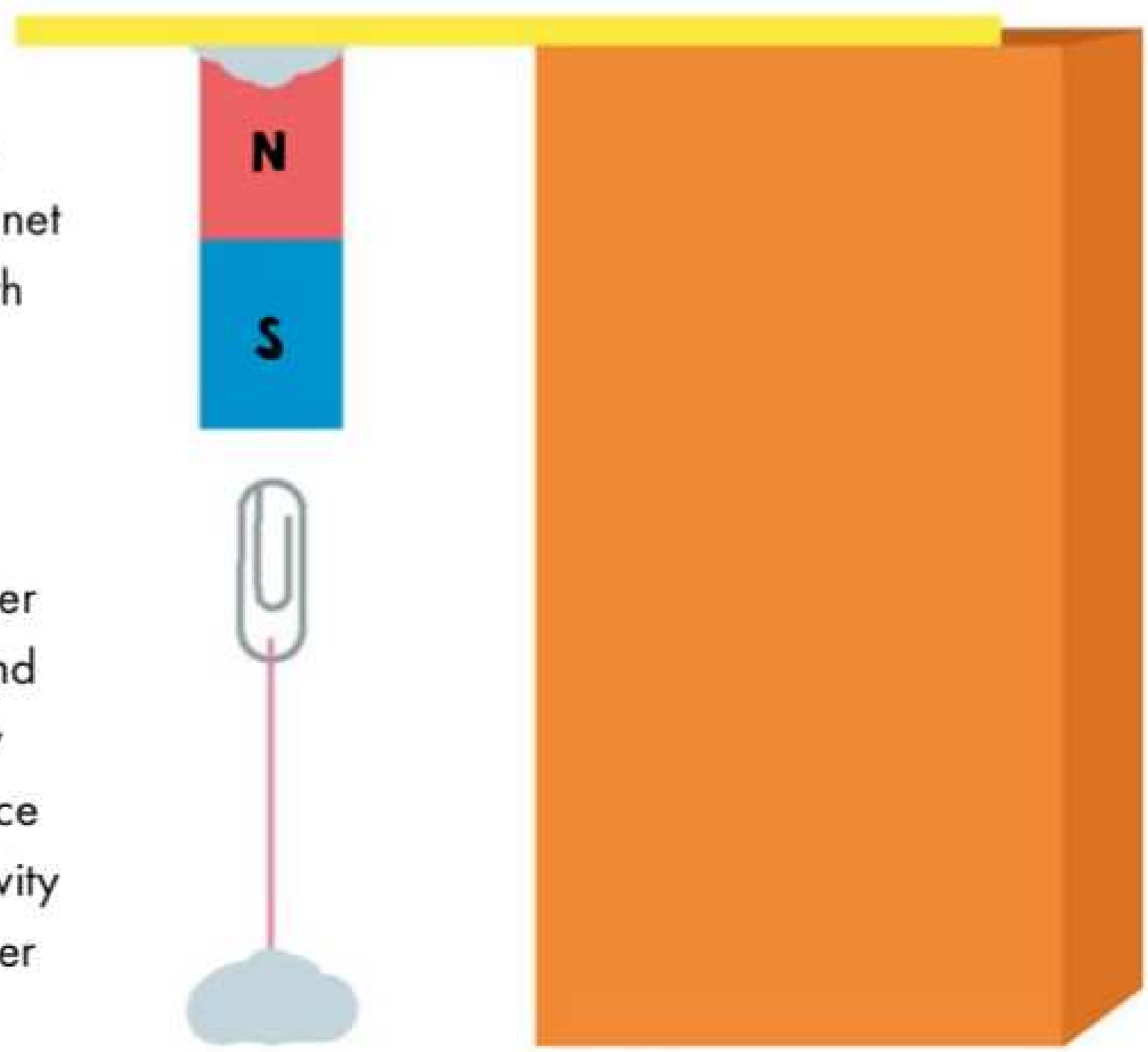
- shoebox
- ruler
- clear tape
- two pieces of **adhesive tack**
- bar magnet
- steel paper clip
- thread

MAKE A HOVERING MODEL

You can use a magnet to make a model of something hovering in the air.

1 Stick the ruler to the shoebox with the tape. Attach the magnet to the free end of the ruler with the adhesive tack.

2 Loop the thread through the paper clip and attach the other end of the thread to the second piece of adhesive tack below the magnet. The magnetic force is greater than the pull of gravity on the paper clip, so the paper clip hovers in the air.



GLOSSARY

Adhesive tack a sticky substance used to join items together

Attract to make something come nearer

Axis an imaginary line running through the center of Earth around which the planet spins

Compass an instrument with a magnetic needle that moves to show the position of the North and South Poles

Contact force a push or pull that occurs when one object touches another

Force field a place where a non-contact force can push or pull on things around it

Friction a force that acts between two surfaces that are touching each other. When one surface moves, a friction force pushes on it in the opposite direction.

Gravitational pull the pull of gravity of a large object, like a star, on a smaller object, like a planet

Gravity a force that pulls objects down to the center of Earth. It also pulls planets around the sun and the moon around Earth.

Magnetic used to describe something that is attracted to a magnet

Magnetic material a material that is attracted to a magnet and can be made into a magnet. Iron and steel are examples of magnetic materials.

Non-contact force a push or pull that occurs between two objects that are not touching each other

Nonmagnetic material a material that is not attracted to a magnet. Pottery and wood are two examples of nonmagnetic materials.

North and South Poles the northernmost and southernmost points on Earth

Planet a large, spherical object made from rock or gases that moves around a star

Pole the place at the end of a magnet where the magnetic force is sent out

Repel to push away

Sliding friction a force that acts between two surfaces that are touching each other, while one surface is in motion

Solar System the sun and the planets, moons, and asteroids that revolve around the sun

Star a huge ball of gases that gives out heat and light.

Static not moving, staying still

Surface the top or upper layer of something

ANSWERS TO THE ACTIVITIES AND QUESTIONS

Page 5: What is a force?

Answer: You push the covers of the book to close it. You pull the covers of the book to open it.

Page 11: Friction

Answer: When cream is put on your hands, they slide over each other more easily. This is due to the cream filling the tiny grooves in the skin, making the skin smoother and reducing friction at the same time.

Page 13: Investigating friction

Answer: The strongest force of friction is on the bumpy cardboard surface. The weakest force of friction is on the smooth wooden surface. The greater the friction between the car and the surface it runs on, the slower the car moves.

Page 17: Magnetic force

Answer: Lifting cars and waste metal in a scrapyard.

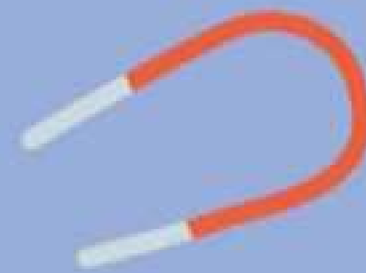
Page 21: Magnetic poles

Answer: They would push each other apart. Opposite poles attract each other. Similar poles repel each other.

Page 23: Finding the poles

Answer: Bring the north pole of the bar magnet up to the refrigerator magnet. If you feel a pushing force, you have found the north pole of the refrigerator magnet. If you feel a pulling force, you have found the south pole of the refrigerator magnet.

FURTHER INFORMATION



BOOKS TO READ

Be a Scientist: Investigating Forces by Jacqui Bailey, Wayland

100% Get the Whole Picture: Forces and Matter by Paul Mason, Cavendish Square

A Question of Science: Why doesn't the moon fall down? by Anna Claybourne, Wayland

Discover and Do!: Forces by Jane Lacey, Enslow

WEBSITES

Try your hand at some force experiments:

www.fizzicseducation.com.au/category/150-science-experiments/force-movement-experiments

Questions and answers about forces:

www.pbs.org/video/science-trek-force-and-motion

Lots of helpful information on magnetic and nonmagnetic objects, poles, and electromagnets, including a quiz:

www.dkfindout.com/uk/science/magnets/

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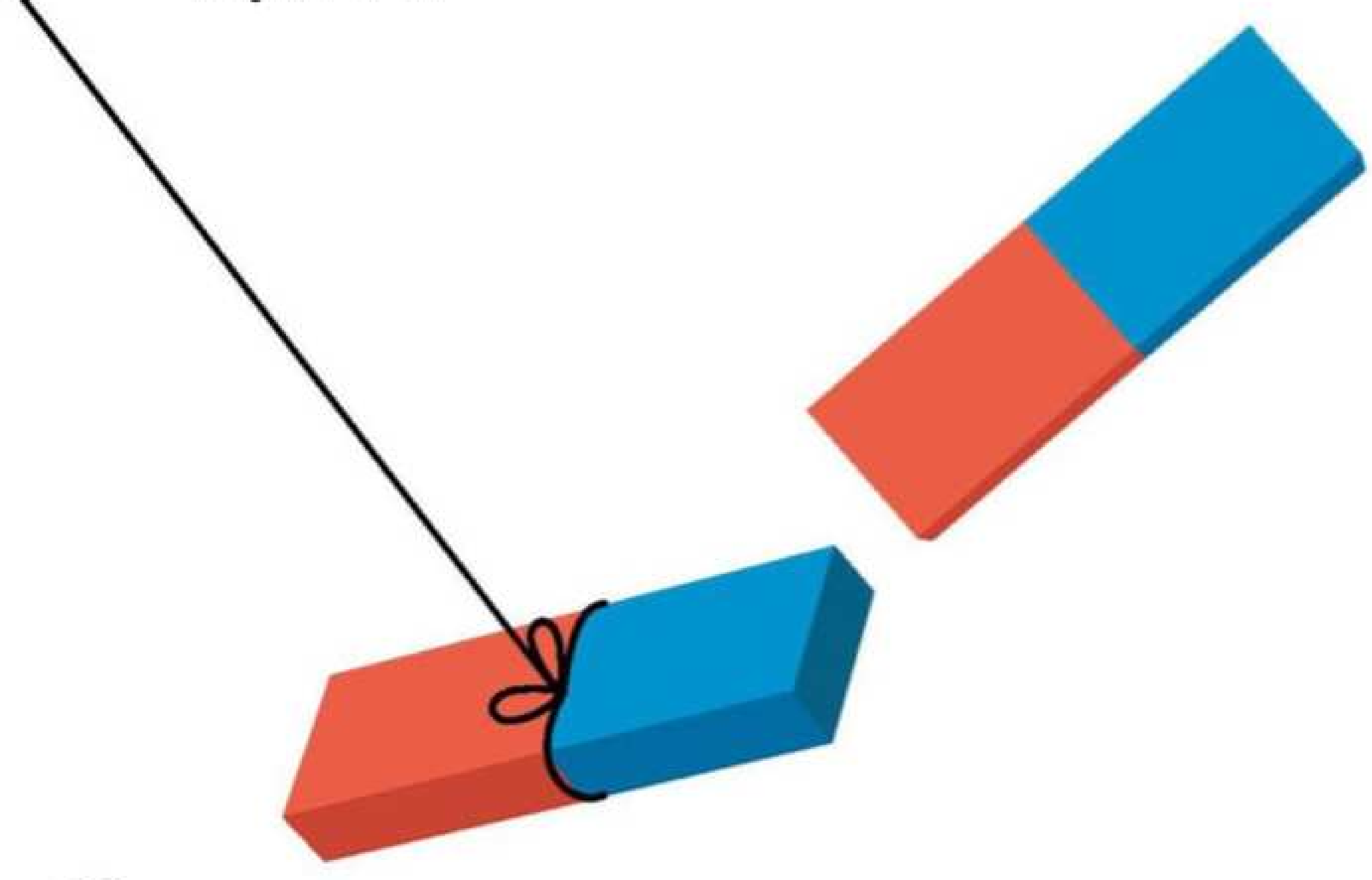

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