WACKY SCIENCE LAB

DIY
EXPERIMENT BOOKLET

Waters

THE SCIENCE OF WHAT'S POSSIBLE.®

About Waters

Waters Corporation designs and produces scientific instruments that are used by laboratories around the world to analyze composition of samples. Our site in Manchester develops Mass Spectrometry. Although you may not have heard of Mass Spectrometry, it is widely used for a variety of reasons that will be very close to you…

HEALTH

Anyone born in or after the late 90s will have had their blood tested using Mass Spectrometry to look for possible future health problems by analysing the blood spots taken from new born babies.

Almost all medicines on the market will have been developed using Mass Spectrometry. Mass Spectrometry is widely used to monitor patients in hospitals to ensure right level of medicine is being administered.

FOOD AND ENVIRONMENT

A majority of food produce and drinking water is tested using Mass Spectrometry which helps ensure consumption is not harmful to human health or the environment. Even the containers your food comes packaged in will have been tested using Mass Spectrometry.

SPORT AND LEISURE

During the Olympics and other major sporting events, we almost always have press coverage of doping scandals and testing. Urine samples from athletes are tested using Mass Spectrometry to ensure everyone is free from performance enhancing drugs.

The liquid crystals in LCD TVs were developed and tested using Mass Spectrometry, as well as a majority of the chemicals used to make the plastics and other components.

ENERGY

Mass Spectrometry is used to produce better fuels, more efficiently from Oil and Gas. It has been important in the development of new solar cells, batteries, and treatment of chemical waste.

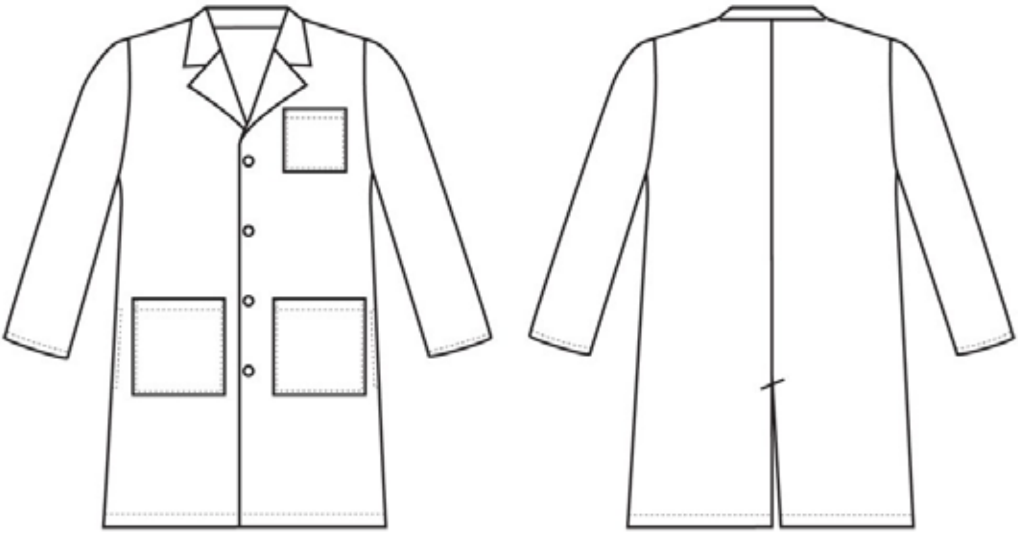
Mass Spectrometry is used due to is ability to find and identify chemicals at amazingly low levels, routinely down to less than 1 part in a billion (1 ppb). To understand how little that is, it's roughly the same as trying to detect 1 drop of food dye in a 50m swimming pool, find one specific grain of sand in a bucket of sand or about 3 seconds out of a century.

Contents

We have compiled our favourite experiments that can be done safely at home, using everyday items. Each of these demonstrates a scientific principle and is designed to make science fun for children of all ages.

ACTIVITY

Design your own labcoat



EXPERIMENT

Chromatography of Sweets (and Pens)

This is a practical demonstration of chromatography showing the separation of coloured dyes in sweets and felt-tip pens.

WHAT YOU'LL NEED:

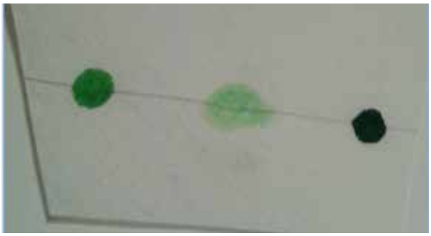
- Sweets such as Skittles, Smarties or M&Ms
- Felt-tip pens
- Filter paper, for example a coffee filter
- Pencil
- Ruler
- Plastic bowl
- Water

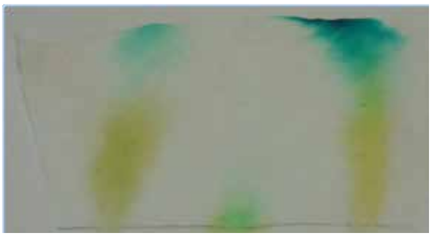
INSTRUCTIONS

1. Draw a pencil line about 2 cm from the edge of the filter paper.
2. Choose a sweet.
3. Lick the sweet and transfer colouring to the paper to make a spot ON THE PENCIL LINE.
4. Choose 2 felt pens.
5. Make spots on the pencil line either side of the sweet spot.
6. Pour about 2 cm of water in to the bowl.
7. Place the bottom of the paper into the water. Ensure the spots DON'T go into the water.

WHAT'S HAPPENING

This experiment replicates the process of Chromatography. Think of the filter paper as a sticky pipe (or a chromatography column). Some things stick well and take a long time to come through. Others don't stick well and come through quickly. Consequently the colours separate and we can see the constituent parts.





ACTIVITY

Design your own science sticker

EXPERIMENT

Make your own quicksand

Quicksand is a fascinating substance, make some of your own and amaze your friends by demonstrating how it works.

WHAT YOU'LL NEED:

- 1 cup of cornflour
- Half a cup of water
- A large plastic container
- A spoon

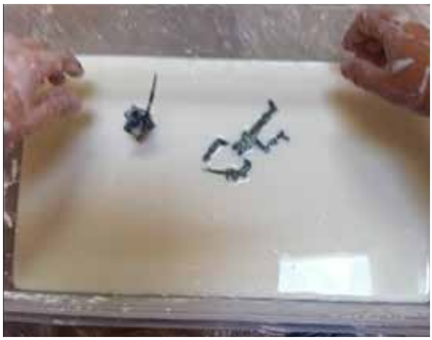
INSTRUCTIONS

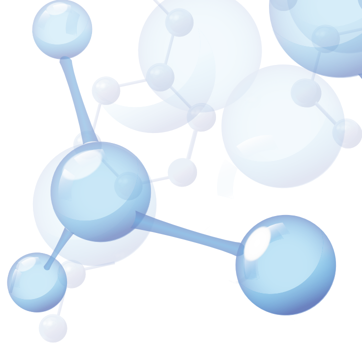
1. Mix the cornflour and water thoroughly in the container to make your own instant quick sand.
2. When showing your friends how it works stir slowly and drip the quicksand to show it is a liquid.
3. Stirring it quickly will make it hard and allow you to hit or poke it quickly.
4. You can then drop figures in your quicksand to see it in action!

Tip: Remember quicksand is messy — try to play with this outside. Always stir your quick sand before you use it.

WHAT'S HAPPENING?

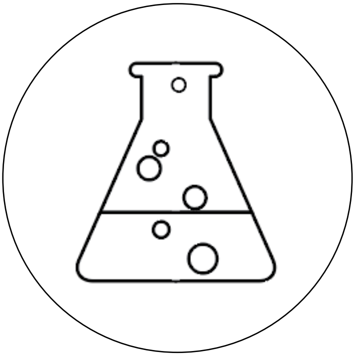
If you just add the right amount of cornflour to water, it becomes very thick when you stir it quickly. This happens because the cornflour grains are mixed up and can't slide over each other due to the lack of water between them. Stirring slowly allows more water between the cornflour grains letting them slide over each other much easier.

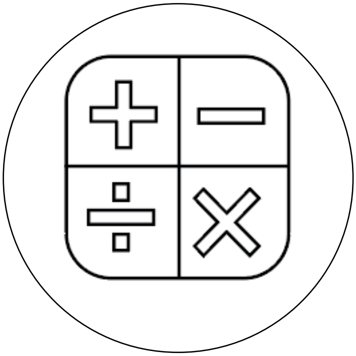


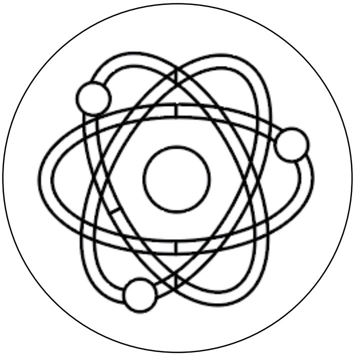


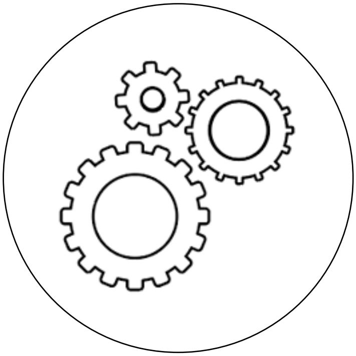
ACTIVITY

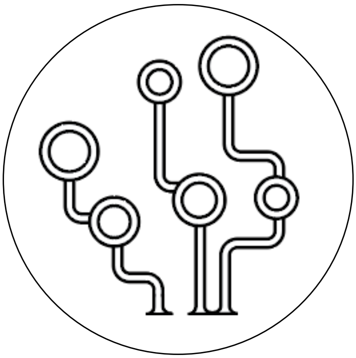
Color in our Waters stickers











EXPERIMENT

Film canister rocket

Most rockets create thrust—the force that propels them forward— by burning fuel and oxygen that generates hot gas which is pushed.

WHAT YOU'LL NEED:

- One empty 35mm plastic film canister and lid.
- These are getting harder to find, but stores that develop film should have some. (The white canisters work much better than the black ones do.)
- One fizzing antacid tablet (such as Alka-Seltzer or Effervescent Vitamin C tablet).
- Water.

INSTRUCTIONS

1. Break the antacid tablet in half.
2. Remove the lid from the film canister and put a teaspoon (5 ml) of water into the canister. **Do the next 2 steps quickly**
3. Drop the tablet half into the canister and snap the cap onto the canister (make sure that it snaps on tightly.)
4. Quickly put the canister on the ground CAP SIDE DOWN and STEP BACK at least 2 meters.
5. About 10 seconds later, you will hear a POP! and the film canister will launch into the air!

WHAT'S HAPPENING

When you add the tablet to the water, it starts to dissolve. This creates a gas call carbon dioxide. As the carbon dioxide is released, it increases the pressure inside the film canister. The more gas that is made, the more pressure builds up until the cap and water are blasted down and the rocket is blasted up.

This system of thrust is how a real rocket works whether it is in outer space or here in the earth's atmosphere. Of course, real rockets use rocket fuel.

EXTRA

The project above is a DEMONSTRATION. To make it a true experiment, you can try to answer these questions:

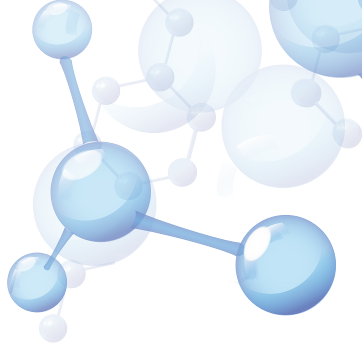
a. Does water temperature affect how fast the rocket launches?

b. Does the size of the tablet piece affect how long it takes for the rocket to launch?

c. Can the flight path be controlled by adding fins or a nosecone to the canister?

d. How much water in the canister will give the highest flight?

e. How much water will give the quickest launch?



ACTIVITY

Science word search

M	X	O	P	U	O	M	R	M	B	L	I	T	S	S
T	A	R	I	O	N	R	L	E	D	C	A	K	P	R
L	R	S	F	S	G	K	I	D	S	G	C	X	J	E
B	C	V	S	X	Z	E	A	D	G	E	L	D	N	T
K	R	M	S	S	C	I	E	N	C	E	A	Z	Y	A
V	D	A	T	X	P	P	T	D	H	A	R	R	I	W
B	F	O	T	E	V	E	G	B	E	C	Y	B	C	O
I	F	O	T	G	V	D	C	O	M	F	V	B	A	H
O	S	T	H	J	K	D	E	Q	I	B	X	P	U	R
L	M	E	A	S	U	R	E	G	S	V	D	D	R	S
O	C	V	E	A	R	V	P	X	T	W	D	S	A	P
G	B	R	S	A	M	P	L	E	R	G	F	D	R	K
Y	D	V	T	E	Y	H	L	J	Y	X	L	A	B	N
J	N	T	F	E	U	F	D	F	U	P	E	G	L	A
H	D	P	H	Y	S	I	C	S	C	B	H	L	T	P

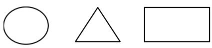
- WATERS
- LAB
- MASSSPEC
- SCIENCE
- SAMPLE
- CHEMISTRY
- PHYSICS
- BIOLOGY
- RESEARCH
- MEASURE
- ION
- TOF

answers on page 19

EXPERIMENT

How to build the mega structures of the future at home

Have you ever wondered how mega structures like The Shard and The Sydney Harbour Bridge are built? How do they build structures which look so complex and beautiful with engineering still in mind? This little activity will allow you to explore the build of your very own mini mega structure. What shapes make up the structure of a building?



WHAT YOU'LL NEED:

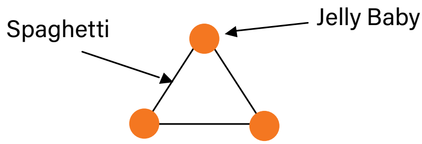
- A pack of spaghetti
- A pack of Jelly Babies (or other jelly sweets)

The modeling and design toy Kinex can also be used to construct a more permanent and less edible structure

INSTRUCTIONS

The aim of this task is to build the strongest free standing structure only using spaghetti and jelly babies in 5 minutes.

1. Use the spaghetti to make a series of triangle shapes, fixing the spaghetti in place with a Jelly Baby stuck in the end.
2. Use the triangles to build your mega structure by sticking the triangles together in different orders.
3. Build either a bridge or a tower.
4. Once you have built your mini mega structure, see if it has the strength to stand on its own.



WHAT'S HAPPENING

The triangle shape allows the structure of your mini mega structure to have stability due to the weight distribution in the shape itself. If a force is applied to the tip of the triangle, that force is sent down the sides to the base. By joining a series of triangles together to make a square, you are making an otherwise weak structure strong. Any force applied to the top of the engineered square (containing triangles) allows the sides of the square to be much stronger.

This is why structures around the world use a series of triangles in buildings for strength and rigidity.

Research mega structures from all over the world and see what shapes are used. Then re-build your structure and see how strong and big you can make it.

EXPERIMENT

Sink or swim

Oil and water don't mix because they have very different polarities, and oil will settle on top of water because it is less dense. This experiment will show you how different foods have different densities. Can you guess which will sink and which will swim?

WHAT YOU'LL NEED:

- A clean, empty jar
- Water
- Vegetable oil
- A chopstick or some tongs
- Selection of food, suggest: grapes, skittles, lemon pieces, biscuits/crackers, marshmallow

INSTRUCTIONS

1. Fill the jar half with water, then fill to near the rim with the vegetable oil.
2. You can demonstrate how the two liquids will not mix by putting a lid on the jar and giving it a shake.
3. Ask the participants how dense they think each piece of food is and if they think it will sink or swim, then get them to drop the food into the jar.

Tip: Lemon will float between the two layers and is a good one to leave till last. Also for food denser than water, you can see it speed up its rate of descent when it hits the layer of water and it usually pulls some oil through in its wake. The tongs are for fishing the food out afterwards! Some tissues can be handy for cleaning up.

WHAT'S HAPPENING

The different foods have different densities relative to the two liquids. The lemon has density somewhere between that of the oil (0.93g/cm3) and the water (1.00g/cm3) so will settle between the two layers.

EXPERIMENT

Under pressure

What is air pressure? We can't always feel it but it's always there pushing down on us. Learn about the effects of pressure by seeing what happens if you remove it.

WHAT YOU'LL NEED:

- Empty, clear glass wine bottle.
- 1 wine pump
- Marshmallows

INSTRUCTIONS

1. Make sure your glass bottle is clean and dry.
2. Carefully push a marshmallow through the bottle neck and into the bottle.
3. Place the pump on the bottle neck and start pumping to remove some air.
4. Keep watching the marshmallow to see it expand!

WHAT'S HAPPENING

The air in the bottle is pushing down on the marshmallow from all directions. The 'pushing' from the air is what we call pressure. The marshmallow has its own pressure pushing back against the air in the bottle, meaning that it cannot be squished. Using the pump removes some air from the bottle, meaning there is less pressure pushing down on the marshmallow. This means the marshmallow can push back more easily with its own pressure and it begins to expand! When you let the air back into the bottle, the air can push on the marshmallow again, forcing it to shrink back to its normal size.

We can see the effects of pressure every day, from the wind outside to drinking through a straw. You may also feel it when your ears pop on an aeroplane!

EXTRA
What do you think would happen if we could pump air into the bottle to increase the pressure on the marshmallow?

EXPERIMENT

Musical tray

Ever wondered why your voice sounds different recorded to what you hear when you speak? With this experiment you will learn how sounds are different when they travel in different ways.

WHAT YOU'LL NEED:

- Metal oven shelf
- Metal fork
- String
- Scissors

INSTRUCTIONS

1. Tie a piece of string onto each end of the oven shelf.
2. Wrap the other end of each piece of string around the index finger on each hand.
3. Get a friend to tap the oven shelf with the fork. How does it sound?
4. Put your fingers in your ears and get your friend to tap the shelf again. Does it sound different?

WHAT'S HAPPENING

Sounds from the oven shelf travel to your ears as sound waves. Low frequency vibrations don't travel very well in air so the oven shelf usually sounds high pitched.

When you put your fingers in your ears, it creates a solid path from the shelf to your ears. Sound waves travel faster through solids than in air, so all of the frequencies get to your ears and it sounds different.

This is why your voice sounds different to everyone else and when you hear it recorded; everyone else hears you through the air but you hear the sound that's travelled through your bones and skull.

EXPERIMENT

Balloon Kebab

Can you make a balloon kebab? Can you push a wooden skewer all the way through a balloon without popping it? Well in this experiment we will show you how!

WHAT YOU'LL NEED:

- Balloons
- Wooden kebab skewers

INSTRUCTIONS

1. Blow up the balloons (not quite full) and tie them
2. Challenge your friends to make a balloon kebab – insert a wooden skewer all the way through the balloon without popping it.
3. Let a few people try (and fail) before showing them how it works.
4. Start by lining up the skewer with the darkest patch on the balloon (opposite the tie end). Gently push the skewer through; you may find a twisting motion works best.

   — Once the skewer is through one side, push it gently through the balloon until the skewer is at the opposite end (the darker area around the tie end).

   — Insert the skewer gently through the soft part of the balloon where the tie end of the balloon is; again use a twisting motion if it helps.

WHAT'S HAPPENING

This trick works through an understanding of surface properties.

A balloon is inflated by blowing air in to what is effectively a rubber sheet – most of the balloon is stretched evenly but there are 2 points where the rubber is less stretched, creating less surface tension (the dark patches indicate less surface tension).

Where there is high surface tension, if you try to push an object through, the surface will break – or pop! Where there is less surface tension, is it possible to make a hole without breaking the surface – or without popping the balloon!

Tips: The trick works best with round balloons with less air in (so don't blow up the balloon as much as you usually would). Make sure you use sharp skewers; blunt ones may pop the balloon even if you do it correctly. And finally, you may find that even when you do everything correctly, the balloons burst anyway – sometimes it can be the balloon quality, or sometimes things just go wrong, but remember to laugh it off and try again!

EXPERIMENT

Lemon battery

Lemons and other fruits can be used to power low voltage devices such as an LED.

WHAT YOU'LL NEED:

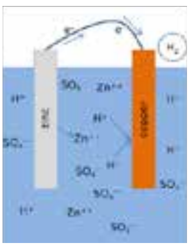
- 4-6 lemons
- Empty egg carton
- An LED
- Two test leads with clips
- Some zinc plated screws or nails
- Lengths of stiff copper wire

INSTRUCTIONS

1. Place the lemons in an egg carton to stop them rolling around.
2. Attach a length of copper wire to a zinc screw/nail – this may require some ingenuity! In the example below, a loop has been made in the end of the copper wire and the zinc screw has been screwed through the loop. You will need one of these for each lemon used.
3. Insert the screw/nail through the skin of the lemon and insert the end of the adjoining wire next to it – make sure they are close but not touching.
4. Connect all the lemons in series and then attach the test leads to the wires in the outer two lemons.
5. Finally connect the test leads to either side of the LED to complete the circuit.

WHAT'S HAPPENING

The juice inside the lemons acts as an electrolyte in a similar fashion to the liquid inside a normal battery. The zinc plating of the screws dissolves in the citric acid of the lemon as an electrically charged ion, leaving behind negatively charged electrons (a process known as oxidation). At the surface of the copper, positively charged hydrogen ions in the electrolyte are combining with electrons to form neutral hydrogen (called reduction). By connecting the zinc to the copper, a current (i.e. the electrons) flows between the two, which we can use to power our LED.



Interesting fact: you would need 6 million lemons to provide the same power as in a normal car battery!

Tip: A voltmeter can be very handy when setting up this experiment, to check that everything is ok. You will need around 2V across the LED to make it work – and remember the polarity needs to be correct! One lemon typically provides between 0.5 and 0.9V.

EXPERIMENT

Does it sink or float?

Drop things in water to see if they float or sink.

WHAT YOU'LL NEED:

- A container filled ¾ full of water,
- Paper towels (lots),
- A ladle or slotted spoon to fish out the objects (long gloves)
- Objects to float or sink

INSTRUCTIONS

1. Try and guess whether something will sink or float before dropping it into the water.

WHAT'S HAPPENING

Different objects have different densities (Density = Mass/volume).

Density is a measure of how solid something or how heavy compared to its size. Imagine a box filled up with cotton wool balls and a box the same size filled up with marbles. Which box will be heavier?

The marbles box has less air in it and the marbles are solid with no air gaps. The cotton wool is filled with air and this means there is less material there.

To float, something has to be less dense than the thing it is floating in. So is it more dense than water?

Tip: Here are some good objects to try: whole orange, a peeled orange, apple, polystyrene, a rubber, a pencil, paper clips, a tightly screwed up ball of foil, a loosely screwed up ball of foil, wooden blocks of different sizes, plastic toy, solid ball, hollow ball, a bouncy ball, marbles, pebbles, a plastic drinks bottle with a few stones/marbles in it, diet-coke can and full fat coke can.

EXPERIMENT

Melting hands/Spinning disc

Watch the spinning disc then see how it changes how the world looks.

WHAT YOU'LL NEED:

- The spinning spiral card. This can be made by printing a spiral graphic onto card, and putting a pin (or sock darner) through it as a spinner.

INSTRUCTIONS

1. Spin the disc for twenty seconds and stare at it without looking away.
2. Start the disc spinning and count down from twenty to zero out loud.
3. At zero, quickly look at your hand.
4. You should see your hand growing larger. Ask them what they saw.

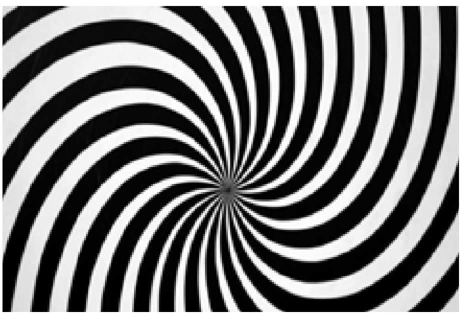
WHAT'S HAPPENING

Your eyes and brain react to movement and try to make sense of it.

When the movement stops, your eyes are still adjusting for the movement so they adjust anything not moving in the same way for the moving object. This is called a motion after effect.

The same happens if you watch the water in a waterfall. Looking at the rocks or trees to the side makes them seem to be rushing upwards.

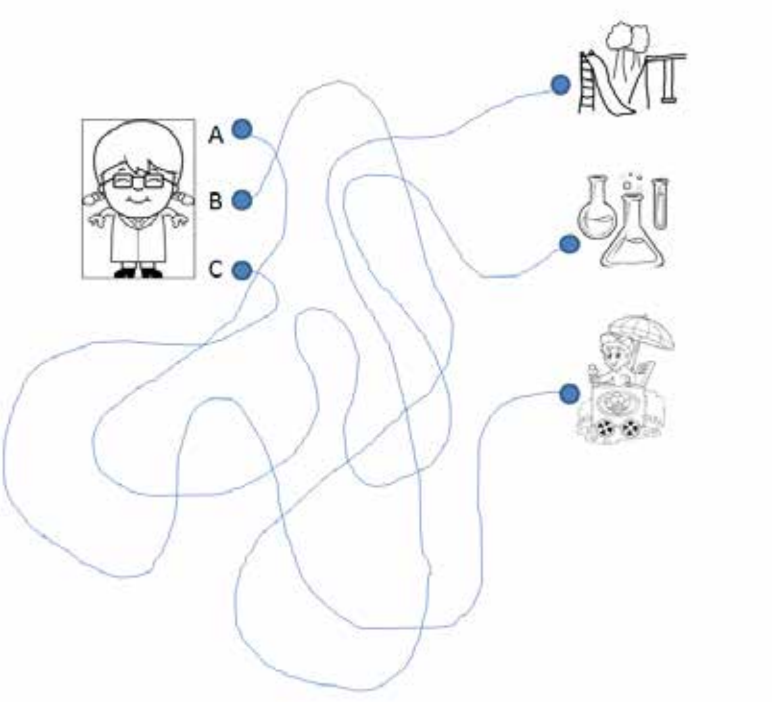
Note: Aristotle said "Our senses can be trusted but they can be easily fooled."



ACTIVITY

Problem solve

Help Sally find her science lab...
Which route should she follow?



answer: A

Answers to Science word search puzzle on page 1.

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