SOLIDS, LIQUIDS AND GASES

Science background for teachers

VOCABULARY

Words to describe the different states of matter; solid, rigid, liquid, fluid, flow, pour, gas, gaseous state, melting, freezing

Names of solids, liquids and gases; ice, water, vinegar, oil, lemonade, oxygen, carbon dioxide, methane, helium

A solid has a definite shape that remains the same unless a force is acting upon it. The particles in a solid are rotating, vibrating or moving about a fixed position, close to each other. A solid normally occupies a slightly smaller space than the liquid, (except for ice, which takes up more space than liquid water). Some solids are made up of small particles eg sand. They can be poured like a liquid but the shape can be changed within the container, for example, when flour is put into a bowl, a well can be made in the middle.

A liquid has no fixed shape but a fixed volume and takes on the shape of its container. The molecules in a liquid move more and have more energy than particles in a solid but still remain in close contact with each other. Children often only think of water when talking about liquids, so it is worth beginning by brainstorming all the liquids that they know. Different liquids behave in different ways, some move more easily than others – they are less viscous.

A gas has no fixed shape or volume and will always spread out to fill the container it is in. The particles have a lot of energy, moving around in a random way, hitting other particles and the walls of the container.

All matter is made up of particles which have energy and move, the more energy they have the more movement there is. When a solid is heated it gains energy, the particles move more and it changes to a liquid state. If even more energy is supplied, more movement occurs and it changes to a gaseous state. If a gas is heated it gains more energy and takes up more space (expands). The concept of **gases** is difficult for young children. Older children can discuss gases with which they should be familiar as suggested below.

Methane is natural gas, a by-product of oil made under the sea from the decomposition of small plants and animals. It is the gas that is used as a fuel in our homes.

Steam is the name given to the gaseous state of water at or above 100 °C and is not visible. Water vapour is the gaseous state of water below 100 °C and is visible as tiny water droplets.

Helium is a gas that is completely non-reactive and has a low density which is why it is used as a lifting gas in fun balloons and airships.

Carbon dioxide is easily produced in the classroom. It is non-toxic, soluble in water and forms 'dry ice' at low temperatures. It is a product of respiration by plants and animals and used by plants to photosynthesise.

SKILLS

- Recognising and carrying out a repeat procedure fair test.
- Choosing and using equipment accurately – reading a thermometer and stopwatch.
- Working cooperatively in a group.
- Careful observation and recording.

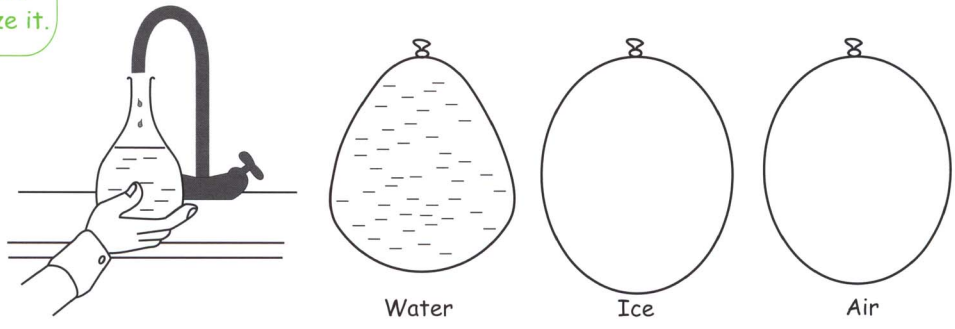
Key ideas and activities

To know that materials can be classified as solids, liquids and gases and recognise the difference

Exploring solids and liquids can begin for children at an early stage, the concept of gases is more complex and probably better left until further into primary. The ideas and activities associated with solids, liquids and gases are obviously linked closely with the concept of change of state and heating and cooling materials which will also be dealt with on pages 81-85.

Solid, liquid and gas Have three identical balloons, the day before fill one with water and freeze. Fill one with water, and blow one up. The best way to fill a balloon with water is to put the end over the tap, turn the tap on and support the balloon underneath as it fills. Discuss the solid, liquid and gas.

Measure the circumference of the balloon with water before and after you freeze it.



Using the balloons pictured above, undo/cut the top off the 3 balloons. Peel the balloon off the ice. Pour the water one into another container and let down the blown up one. Discuss the behaviour of each one.

Some solids have air trapped inside them Look at the spaces in a sponge and pumice stone closely with a magnifying glass. What do you think is in the spaces? Immerse the sponge in water and squeeze, what are the bubbles? (Also refer to the air/soils activity in the Rocks and Soils section.)

SOLIDS

Database

(a) Looking at solids Make a collection of a variety of solids to draw and discuss. Use this as an opportunity to develop descriptive language. Include solids of different 'hardness' such as a piece of wood and a sponge and pouring solids such as salt.

(b) Some solids have similar properties to liquids, they can be poured Using salt, sand, rice, lentils, etc, let the children explore the flowing behaviour of solids which are finely divided. Discuss the similarities and differences with liquids.

Use the concept cartoon ***Is it a solid?***

LIQUIDS

(a) There are liquids other than water

Draw, discuss and collect a variety of liquids and with older children discuss the viscosity or thickness of the liquid.

(b) Race the liquids

Investigate which liquid moves the fastest.

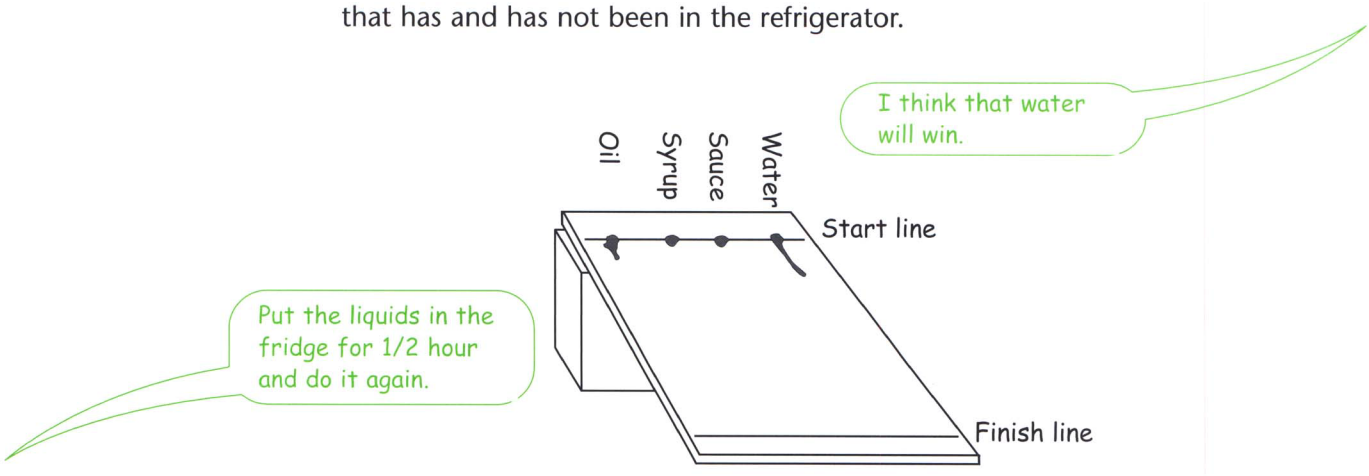
Choose a variety of different liquids eg water, syrup, tomato sauce, vegetable oil, glycerine, cream and put a measured spoonful of each at the top of a tray. Tip the tray and lean it against a brick allowing the liquids to run down the tray.

Spreadsheet

Which is the fastest? Older children could time the activity.

What happens if you cool all the liquids first in a refrigerator?

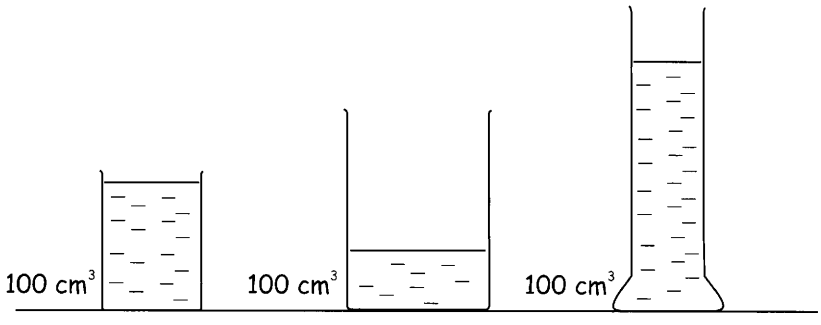
Compare different temperatures of the same liquid eg tomato sauce that has and has not been in the refrigerator.



(c) Conservation of volume of liquids with change of shape

Using a given volume of water let the children pour it into a variety of different shaped containers and draw and observe the change of shape. Ask them to predict each time how far up the container they think it will go. Repeat the task with different volumes, as this gives younger children practice at measuring volume.

Modelling



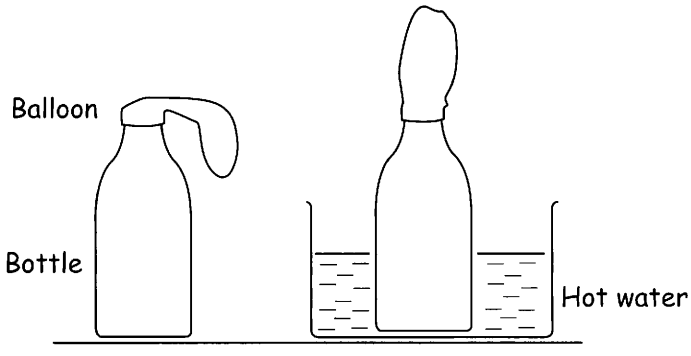
GASES

(a) Air is a gas, you can feel it and it has weight Blow up a balloon and then let it down, feel the air escaping.
If you have a digital balance, weigh an inflated and deflated balloon. Another way to show that air has weight is to balance an inflated balloon against a deflated one. Use a piece of lightweight dowel and thread and balance it first with two deflated balloons. Then blow one up and retie, the inflated one just tips the balance.

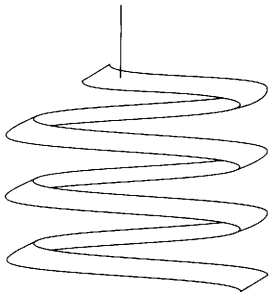
Balance the balloons on thin dowel

The balloon filled with air is heavier.

(b) Warm air expands and rises Put a balloon on the top of a small plastic bottle. Stand the bottle in a bowl of warm water and observe what happens. Why? Now take the bottle out of the water. What happens? Discuss hot air balloons with the children.

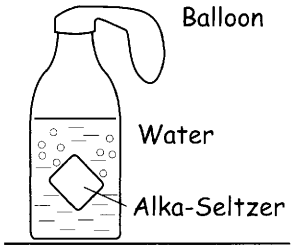


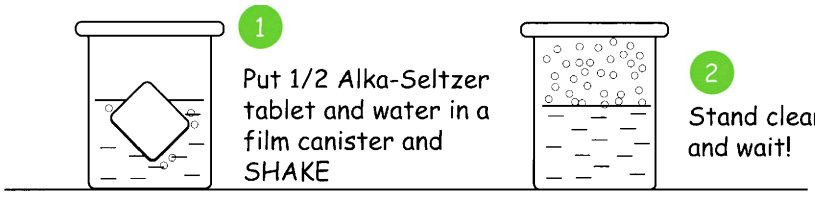
Hang a paper 'snake' over warm air and watch it turn.



Investigate some variables, eg temperature, does hotter water blow the balloon up more or for a longer time? Does the size of the bottle make any difference? Make snake shapes by cutting a continuous spiral out of paper and hang them on string on a hanger over a warm radiator, what happens and why?

(c) Carbon dioxide There are a variety of ways to make carbon dioxide. The one chosen may depend on the cross-curricular context of the lesson. In each case the gas is made by a chemical reaction and can be collected in a balloon that fits over the top of the bottle.





Safety!

- Care when handling any glass-ware.
- Spirit thermometers should be used.
- Care when handling hot water.

- Alka-Seltzer tablet and water. This is fast reacting and explosive and will blow the top off a film canister! The carbon dioxide can also be collected in a ballon on top of a bottle.
- Sodium hydrogencarbonate (bicarbonate) and vinegar, produces lots of 'froth'.
- Sodium hydrogencarbonate (bicarbonate) and lemon juice, which is an endothermic reaction. (The temperature of reaction mixture will decrease as heat from the surroundings is used up.)
- Baking powder and hot water. (The reaction that often occurs in cake making.)
- Dried or fresh yeast, sugar and warm water. This reaction takes 5-10 min. It is used in bread and pizza baking.
- Lemonade 'fizz' is carbon dioxide. Drop currants in new, fizzy lemonade and watch them dance up and down as the gas lifts them to the surface, pops, escapes and allows them to drop to the bottom.

Investigate the variables in any of the carbon dioxide reactions:
Temperature of the water in the yeast activity, try cold through to very hot.
The amount of sugar, does it affect the speed of the reaction?

Does the balloon blow up twice as big with two Alka-Seltzer tablets?

(d) Helium Buy a helium balloon and allow it to sit on the ceiling of the classroom until it falls. Why does it float? Why does it fall?

(e) Smells in the air! Air fresheners, perfume, perfume oil burners, food and cooking smells, why can we smell them in different parts of the room and the house? The particles that cause the smell are gaseous and reach our noses. You can demonstrate this for children and discuss what is happening.

Steamy Shower Water changing to water vapour and back again.

Yellow Door The gas that is used in our homes.

Floating Balloon What is the gas in the 'floating balloon' and why does it end up on the ground?

Drizzy Fink The 'fizz' in lemonade is carbon dioxide.

Pouring You cannot pour a teapot but you can pour from one!

Steamy Shower

I love a dreamy, steamy shower
hanging about
for over an hour
just before bed
getting hot and red
in the steam
standing there
with time to dream
water-running-over-me feeling
drips dripping off the ceiling
mum says it's my fault it's peeling
nothing can beat
the hot wet heat
nothing wetter nothing better
I love a
dreamy steamy streamy shower

Yellow Door

I've often wondered where gas
comes from.

Now I know.

I was walking down the street
and I looked down
at the pavement
and I saw
a little yellow door.

I thought:
why is there
a little yellow door in
the middle of the
pavement?

And then I saw it.

On the door
it said:
'GAS'.

Now I know where
gas comes from.

Floating Balloon

My balloon from the
fair hangs in the air
nosing the ceiling.
It's string hangs down
like a tail to the floor

I lie in bed watching
it tremble and it
quivers when I give a
blow.

I dream of peaches
that float round trees

But in the morning
my balloon from the
fair squats on the
floor its tail snaking
over the carpet

I get out of bed
watching it roll and it
bounces when I give
it a kick.

Drizzy Fink

Hail! Hail!
I come from another galaxy
I have been learning English
I find some of your words
very hard to say.
I will now try to talk about
your fizzy drinks.
I like your fizzy drinks.
I think I will drink lots
of fizzy drinks and
collect lots of bottles
and lots of tottle bops
er
bopple tots
topple stobs
pobble lots
no
stottle pobs
tobble spots
lottle slobs
lobble slops
Please
can you help me with this?
And please
can I have a drizzy fink?

Pouring

Whether it's hot,
or whether it's not
I don't see how
you pour a tea-pot.

I can see
you **can** pour tea,
but you surely cannot
pour a tea-pot.

IS IT A SOLID?

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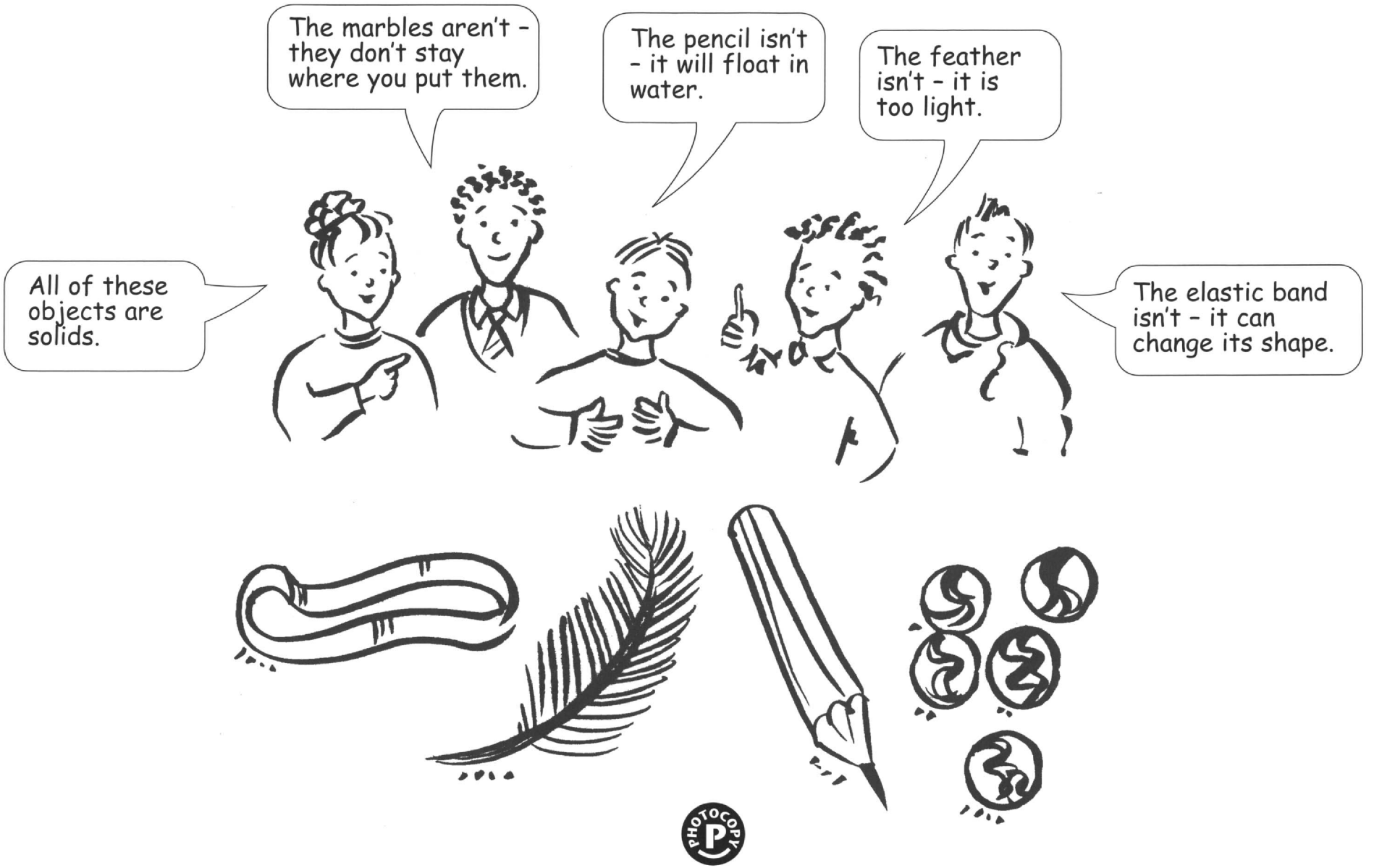

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CONCEPT CARTOONS

Is it a solid?

The children will have intuitive ideas about what they mean by a solid. However they will not find it easy to apply their ideas in a consistent way. They will find it difficult to separate the object from the material it is made from, and they will tend to associate properties such as heaviness and rigidity with solids. The concept cartoon provides an opportunity for them to rethink their definitions and to make more systematic judgements. Introducing more challenging materials such as sand or dough is probably best left until after their ideas about solids are reasonably well developed.