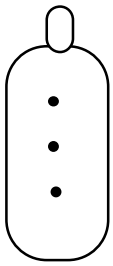
Planet Earth & Beyond

1	Under Pressure	Demonstrate how air and water pressure works with different depths

Materials needed: P.E.T. bottle, water and something to make small holes in the bottle with, tape

Procedure:

1.Take the top off a large plastic bottle and make 3 holes in one side, one above the other.
2.Tape over the holes. Fill the bottle with water. Keep lid off bottle.
3.Quickly rip the tap off and observe.



What happened:

The water spurts out but travels further the lower down the bottle the holes are.

Why did this happen:

The lowest jet of water should go farthest. Air presses down on the water at the top of the bottle. The water at the top presses down on the water beneath. This means that the water at the bottom is pushed out with the greatest force.

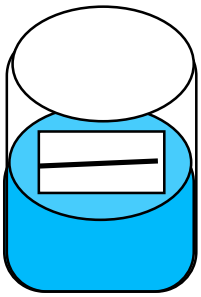
Material World

2	Floating metal	Demonstrate how a needle can float on water

Materials needed: drink glass, sewing needle, tissue paper and water

Procedure:

1. Fill the glass with water
2. Put the needle on a small piece of tissue paper and lay it gently on the water.



What happened:

Eventually the tissue paper will sink and the needle will float

Why did this happen:

The tissue paper gets heavier and sinks but the needle is so light that it is supported by the water's surface. The molecules of the water at the surface hold onto to each other with such strength that they form a kind of a skin called *surface tension.* If you look closely you will see that the needle actually dents the water's skin.

Material World

3	Hole in the ice	Demonstrate what salt does to ice

Materials needed: ice cube and table salt

Procedure:

1. Put a large pinch of salt on top of an ice cube and observe what happens

What happened:

The ice melts first where the salt is on it

Why did this happen:

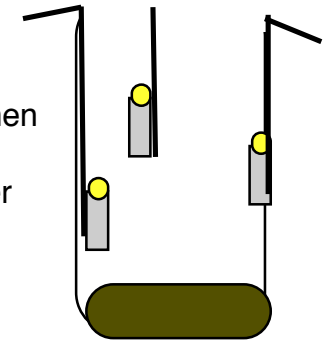
Ice made from pure water does not melt until it reaches 0°C. This is called its melting point. When you add salt to ice, it lowers the melting point so the ice starts to melt when it is colder than 0°C. The salty part of the ice changes into water while the rest stays frozen.

Material World

4	CO_2 , heavier than air	Demonstrate how CO_2 gas is heavier than air and can put out fire

Materials needed: wire, 3 candles (stubs of standard household candles), large open mouthed jar (preserving jar is ideal), vinegar (about 200mls), baking soda (about 1-2 teaspoons), teaspoon

Procedure:



1. Make 3 candle holders each with a different length stem.
2.Secure a candle at one end and make a hook at the other.
3.Fill the jar with about 200mls of vinegar and secure the candles when they are lit, at different heights from the lip of the jar
4.Slowly add the baking soda but not enough to make the foam cover the bottom candle
5.You may need to add more baking soda to extinguish the upper candle.

What happened:

The vinegar foams up. After a few minutes the lowest candle goes out and then the middle candle and eventually the uppermost candle.

Why did this happen:

Baking soda + vinegar react together and produces carbon di oxide gas (CO_2). CO_2 is an odourless, tasteless, invisible gas that is heavier than air which is why the lower candles extinguish first. It is used in fire extinguishers.

Physical World

5	Balloon eating bottle	Demonstrate how air pressure will force a balloon into a closed neck bottle

Materials needed: class bottle with a small neck, balloon, large bowl, warm water, cold water, ice

Procedure:

1. Fill the glass bottle with warm water and leave it for a few minutes
2.Stretch the balloon over the neck of the bottle
3.Stand the bottle in a bowl of very cold water

What happened:

The balloon is sucked inside the bottle

Why did this happen:

As the air in the bottle gets cooler, it contracts and takes up less room in the bottle. To make up the extra room in the bottle, air from the outside pushes into the bottle. Because the balloon is in the way, it gets pushed into the bottle too.

Physical World

6	Strong air	Demonstrate how air pressure can buckle containers

Option A

Materials needed::ice cubes, plastic bottle with screw lid,plastic bag. *Option B***:** empty drink can, water, ice, hot plate or element and frypan, tongs

Procedure:

1. Put the ice cubes in a plastic bag and crush them so that they can fit inside the bottle neck.
2. Put the ice in the plastic bottle. Screw on the lid.
3. Shake the bottle and put it down. Observe what happens as the ice cools the air inside it.

What happened:

The bottle's sides are pulled in.

Why did this happen:

As the air cools, it contracts and because it takes up less space, the sides of the bottle are pulled in.

Option AB

Materials needed: empty drink can, water, a roasting tray, ice, hot plate or element and frypan, tongs

Procedure:

1. Put the ice cubes and water in the roasting tray
2. Heat the opened drink can on the hotplate and then it feels hot, pick it up with the tongs and quickly turn it upside down (opening goes in the cold water) into the water.

What happened:

The sides of the can rapidly with a wrenching sound, collapse inwards.

Why did this happen:

As the air in the can is heated, it is forced out of the opening as it expands. When it is doused in the cold water, what air is left inside rapidly contracts. The force of the contraction is sufficient to implode the metal sides.

Material World

7	Growing crystals	Demonstrate how crystals can be grown

Materials needed: clean glass jar, piece of thread, teaspoon, either:- washing soda, salt, or sugar, paper clip, pencil, metal spoon, bowl, hot water

Procedure:

1. Put the metal spoon in the jar and almost fill it with very hot water. The spoon should prevent the hot water from cracking the glass.
2. Put several teaspoons of washing soda/salt/sugar into the water and stir until it has all disappeared. Keep adding soda/salt/sugar by the teaspoon and stir until it disappears.
3. Stand the jar in a bowl of hot water, and this should keep the jar hot.
4. Keep adding soda/salt/sugar until no more will disappear in the water.
5. Tie the paper clip onto one end of the thread and the other end to the middle of the pencil.
6. Drop the clip into the jar and wind the thread around until the clip hangs down but does not touch the bottle by at least 2cm.

What happened:

Crystals form on the end of the paper clip and as time goes, more grow.

Why did this happen:

As the water cools it can not hold the soda/salt/sugar so the soda/salt/sugar starts to form crystals around the string. The rest of the soda/salt/sugar is attracted to the crystals on the string, until a whole cluster is formed. At the same time, the water evaporates into the air which leaves even more soda/salt/sugar behind, which forms into more and more crystal. Washing soda, salt and sugar all form different shaped crystals. *If you add a few drops of poster paint or dye to the water, the crystals become coloured.*

Living World

8	Yeast balloon power	Demonstrate how yeast can blow up a balloon

Materials needed: dried yeast, sugar, jug, glass bottle with a narrow neck, balloon, teaspoon, tablespoon, warm water

Procedure:

1. Make a runny mixture of 2 teaspoons of yeast, 2 tablespoons of warm water and stir in 1 teaspoon of sugar
2. Pour the mix into the bottle and stretch the ballon over the neck
3. Stand the bottle in a bowl of warm water (not cold and not hot) for 15 minutes

What happened:

Inside the bottle the mixture starts to bubble and foam. After a while the balloon starts to expand.

Why did this happen:

As the yeast feeds on the sugar and water, it produces carbon di oxide gas CO_2 which blows up the balloon. This is how bread rises, as the yeast produces CO_2 gas that makes the dough rise. The holes you see in bread is where the CO_2 gas had been.

Physical World

9	Hole in your hand	Illustrate an optical illusion

Materials needed: sheet of stiff paper (30 x 20cm), cellotape
Procedure:
1. Make a tube by rolling up the sheet of stiff paper and tape the edge so that the tube holds together
2.Hold the tube up to your right eye and hold your left hand up beside the tube (about half way down)
3.Stare hard down the tube keeping your left eye open
What happened:
You should see a hole in your hand
Why did this happen:
One eye is looking down the tube and the other is looking at your hand. The two views mix together in your brain so you see a hand with a hole in it.

Living World

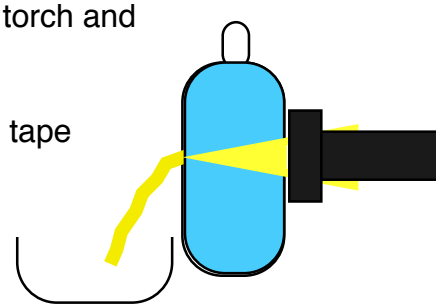
10	Colouring plants	Demonstrate how plants suck liquid up their stems out to the petals

Materials needed: jar, blue food dye, water, cut white flowers such as carnations
Procedure:
1. Fill a jar $^1/_3$ full of water and add a few drops of the blue dye
2.Put the cut stems into the water
What happened:
The stems start to show a blue tinge and eventially the white petals go blue
Why did this happen:
The dyed water is sucked up the flowers through the stems. This is because the liquid in the flower is expelled through the leaves and petals via transpiration and the liquid is replaced via the stems. If you look at the cut stem cross section you will see holes called xylem which transports liquid through the plant.

Physical World

11	Pouring Light	Demonstrate how light can bend

Materials needed: clear PET plastic bottle, pointed scissors, water, torch and large bowl, tape and a dark room



Procedure:

1. Place a small hole in a PET bottle about half way and cover it with tape
2.Fill the bottle with water
3.Darken the room
4.Shine the torch light through the bottle and allow the water to flow out of the hole into the bowl.
5.Move the torch light around

What happened:

The stream of water when the angle of the torch is correct, should become very bright. It should be the brightest thing in the room after the torch.

Why did this happen:

This is because the light from the torch gets bounced around the bending stream of water pouring out of the bottle. When the stream of water looks duller, it is because the light from the torch is bouncing out of the stream of water. This is because the light is not shining in at the correct angle.

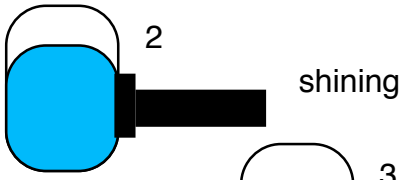
Planet Earth & Beyond/Physical World

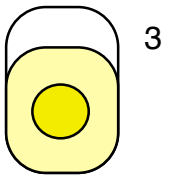
12	What makes a sunset	Demonstrate how sunrises and sunsets are formed

Materials needed: a clean glass jar, water, milk, torch, a teaspoon and a dark room.

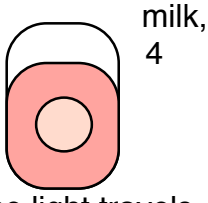
Procedure:

1. Fill the jar with cold water. Stir in 1 teaspoon of milk.
2.In a darkened room hold the torch to the side of the jar.
3. Move the torch around so that it is pointing at you and the light through the water at you.





4.Add 2 more teaspoons of milk and stir. Shine the torch from the side and then at you.



What happened:

The water should look blue when the torch is at the side. When the light is shining at you the light from the torch should look yellow. With the added the water looks blue from the side, but looks pink when shining at you.

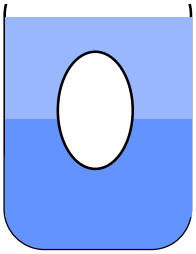
Why did this happen:

The milk makes the water go cloudy and this stops most of the light from passing through. The Earth is wrapped in a blanket of air full of tiny pieces of dust and water to small to see. When the Sun is low in the sky, the light travels farthest to reach you and only the red parts can get through the dust and water (No. 4). When the light travels straight through the air (No. 2) all of the light is scattered except the blue part of the spectrum and that is why the sky is blue.

Physical World

13	Levitating egg	Demonstrate why it is easier to float in sea water than fresh water

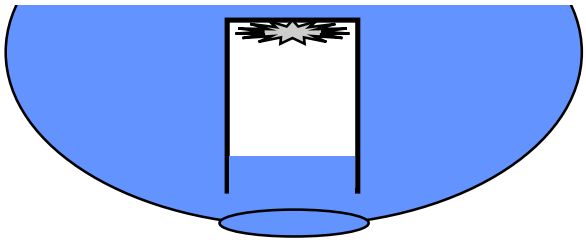
Materials needed: large glass of water, jug, raw egg, salt, tablespoon, permanent marker
Procedure:
1. Gently lower an egg into the large glass of water
2.Remove the egg and add 10 teaspoons of salt to the water and stir. The salt and water mixture is called *brine*.
3. Make a mark on the egg's highest point. Take out the egg and dry it. Draw a face with the mark near the top.
4.Pour away half the brine so that the glass is half full. Tilt the glass gently and then slowly pour cold water on top of the brine.
5. When the glass is full, carefully slide in the egg. *Does it sink to the bottom?*
What happened:
1. The egg in the cold water sinks to the bottom.
2. The egg floats on top of the water.
5. The egg floats part way down the glass but does not touch the bottom of the glass.
Why did this happen:
1. The egg is denser than fresh water so it sinks.
2. The egg is less dense than brine so it floats. The more salt is dissolved in the water, the more dense it becomes. That is why you can easily float in the Dead Sea (25% salt) than in the ocean (12.5%).
5. The fresh water is less dense than the brine so floats in a big layer on top of the brine. The egg sinks through the fresh water but sits on top of the brine.



Physical World

14	Stay dry plunge	Demonstrate how a diving bell works

Materials needed: glass, bowl of water, piece of crumpled paper
Procedure:
1. Crush the paper and push it firmly into the bottom of the glass.
2. Plunge the glass straight down into the bowl of water.
What happened:
The water rises a little way up the glass but not enough to reach and wet the paper.
Why did this happen:
Water can only get into the glass by squashing the air inside it. Air can be compressed (squashed) but only a little bit. It however can not be compressed enough to allow the water to reach the paper.
Therefore the paper stays dry.



Material World

15	Sherbet Fizz	To demonstrate that mixing materials can cause them to change

Materials needed: 4 clean glasses, paper cup, teaspoon, popsicle sticks or straws with the ends made into mini-scoops, $^1/_2$ teaspoon sodium bicarbonate (baking soda), 1 teaspoon of citric acid crystals, and 3 teaspoons of icing sugar

Procedure:

1. Mix together all of the powders/crystals in the cup
2. Get students to taste the mixture
3. Add the mixture to a glass of water and observe
4. Add a teaspoon of sodium bicarbonate, citric acid and icing sugar each to their own glass of water and observe

What happened:

The mixture bubbles on the tongue.

Why did this happen:

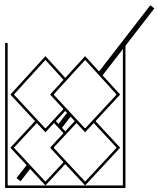
The mixture bubbles and fizzes because the citric acid, saliva and baking soda react and produces carbon dioxide gas. Citric acid is also quite tingly too. When the dry ingredients are separately put in water, there is a little carbon dioxide produced by the bicarbonate of soda but no reaction by the icing sugar or citric acid.

Material World/Planet Earth & Beyond

16	Why is the grass wet in the morning?	To demonstrate condensation

Materials needed: a clean baked bean type tin or glass, ice, thermometer (optional)

Procedure:



1. Add ice to the tin or glass.
2. Add a thermometer
3. Observe what happens on the outside of the tin/glass

What happened:

Water droplets will form on the outside of the tin/glass. The temperature inside the tin/glass will drop to 0 to 2°C

Why did this happen:

When the temperature gets cold, the water vapour (gas) in the air condenses to a liquid when it touches the cold tin. This is how dew is formed on a cool morning.

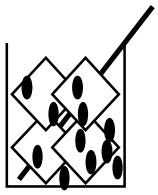
Material World/Planet Earth & Beyond

17	Frost	To demonstrate how frost is formed

Materials needed: a clean baked bean type tin or glass, ice, salt (about 2 tablespoons),thermometer (optional)

Procedure:

1. Add ice to the tin or glass.



2. Add the salt to the ice
3. Add a thermometer
4. Observe what happens on the outside of the tin/glass

What happened:

Water droplets will form on the outside of the tin/glass. This in turn will quickly freeze into a fine layer of frost/ice crystals. The temperature inside the tin/glass will drop to -8 to -12°C

Why did this happen:

When the temperature gets cold, the water vapour (gas) in the air condenses to a liquid when it touches the cold tin. As the tin is below freezing (0 °C) the water freezes. This is how frost is formed on a very cold winters morning.

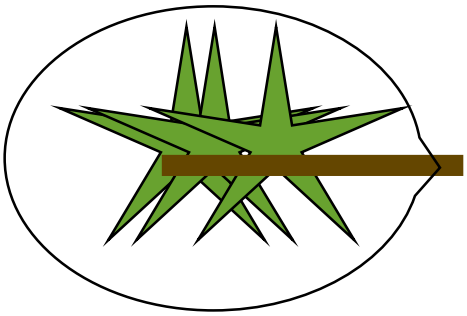
Living World

18	Leaking Leaves	Demonstrates how transpiration works

Materials needed: leafy tree, clear plastic bag, rubber band

Procedure:

1. Tie a clear plastic bag around the end of a leafy branch of a tree
2.Secure the end of the bag around the branch so that it is air tight.



What happened:

Condensation forms inside the bag after a few days

Why did this happen:

The water inside the bag has come up from the roots of the tree, up through the stem and out through pores called stomata found on the underside of the leaves.

Material World/Living World

19	Getting fat	To demonstrate rehydration

Materials needed: 20 raisins, 2 glasses and water

Procedure:

1. Do this at the beginning of the day
2. Place 10 raisins in both glasses
3. Fill one glass $^{3}/_{4}$ with water
4. Leave till the end of the day and observe what has happened

What happened:

All of the raisins look wrinkled at the beginning of the day. By the end of the day, the raisins in the dry glass have not changed appearance but the raisins in the water have increased in size and shape.

Why did this happen:

Raisins are made by dehydrating grapes where most of the water has been removed. before dehydration, the grapes are round and smooth with moist flesh. Like most plants, the outside of the grape as well as the cell walls are stiff and are quite strong. When the water is removed, the outside walls of the grape and cells are generally unchanged, but the wet softer bits inside the cells and grapes collapse when the water is gone. When the grape and cells rehydrate, the water flows through the walls and the cells/grape fills with water and resumes its original shape. A little bit like blowing up a balloon.

Rehydrating food such as dried fruit and freeze/dried tramping food is called reconstitution. This process makes the food look similar to the fresh food but can not return it to the exact original shape or taste.

Material World

20	Slime	To demonstrate a non-Newtonian fluid

Materials needed: cornflour (about 3 tablespoons), water, teaspoon and a bowl

Procedure:

1. Add the cornflour to the bowl
2. Add the water a bit at a time, stirring it with the teaspoon

3.STOP adding water when the fluid remains fluid as you slowly stir it but goes hard when you quickly stir it or hit the fluid.

NOTE: do not add too much water otherwise it will remain liquid.

What happened:

The fluid will drip through your fingers but when moved quickly will go hard. The hard material can be rolled into a ball but it will soon ooze through your fingers.

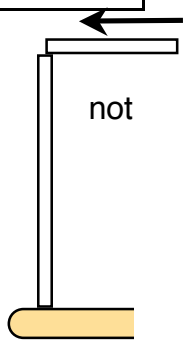
Why did this happen:

A fluid is a substance that can flow such as a gas or liquid. A non-Newtonian fluid has the properties of both solids and liquids. It acts as a solid but breaks easily when pressure is applied. When left alone it behaves like a liquid and oozes everywhere.

Physical World

21	Straw flute	To demonstrate the difference in pitch between open and closed wind instruments

Materials needed: scissors, ruler and plastic drinking straw



Procedure:

1. About 5cm from the end of the straw, make a cut through $^3/_4$ of the straw. Do not cut the straw apart.
2. Bend the straw at the cut so that the 2 sections are at a 90^o angle to each other.
3. Place the shorter end in your mouth and cover the longer end with your finger
4. Blow through the straw and listen to the sound
5. Remove your finger from the lower section and blow through the straw. Compare the sound to 4.

What happened:

The sound is higher when the end of the straw is open.

Why did this happen:

Both ends of the straw tubes are filled with a column of air. When you blow through the straw, the air in the top tube moves forward, which causes the air in the bottom tube to vibrate. As the air vibrates faster in an open tube than in a closed tube, it produces a higher pitch. In wind instruments such as the trumpet, clarinet, French horn, trombone, and pipe organ each have different sized tubes and hence the vibrations in their column of air are different, and produce different pitches. If the instrument is closed for example when covering the opening of a trumpet, a sound with a lower pitch is produced.

Material World

22	Bulge	Demonstrates why the surface of water bulges in the center

Materials needed: paper hole punch, photocopying paper, small glass of water no more than 5cm in diameter (candle holder or egg cup), saucer/small bowl, water, jug and a toothpick

Procedure:

1. With the hole punch make 3-4 circles from the photocopying paper
2. Put the glass in the saucer/bowl and fill it to overflowing with water from a jug. The surface of the water should bulge above the sides of the glass
3.When the water has stopped moving, gently place the paper circles on the surface of the water in the center
4. Use the toothpick to move the circles towards the edge and gently release them. Take care that you do not break the bulge.
5. Repeat step 4.

What happened:

The paper circles continue to move towards the centre of the bulge.

Why did this happen:

The surface water molecules in the overfilled glass pull on each other. The direction of the pull creates the bulge on the water's surface and pulls the paper circles towards the peak of the bulge.

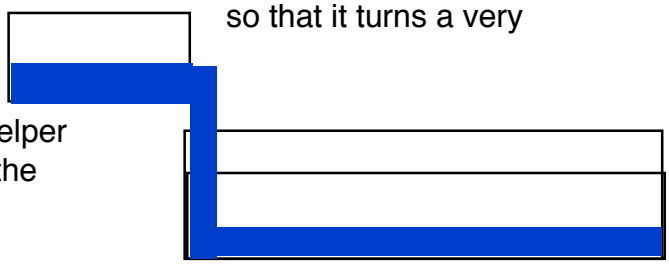
Living World/Material World

23	Heavy water	To demonstrate how density affects water movement in the sea

Materials needed: 250ml measuring cup, $^1/_3$ cup table salt, spoon, blue food colouring, 2 litre glass high walled container such as glass oven dish (preferably rectangular), helper

Procedure:

1. Fill the measuring cup with 200mls water, add the salt and stir
2. Add enough food colouring to the salty water so that it turns a very deep blue
3. Fill the large glass container with water
4.Observe the container from the side while your helper slowly pours the blue salty water down the side of the container
5.Observe what happens



What happened:

The coloured water sinks to the bottom, forming waves under the clear water above it.

Why did this happen:

Salty water is more dense than fresh water and sinks below the fresh water. When swimming in a river mouth in the sea, the water becomes more salty the deeper you dive. A density current is the movement of water due to the difference in density of the water. The salty more dense water can move as a body underneath the less dense fresh water.

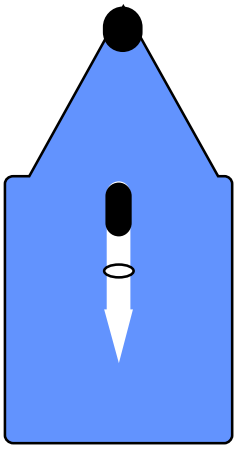
Physical World

24	Cartesian Diver	To demonstrate how density and pressure affects the ability to float

Materials needed: 2-2.5litre drink bottle with cap, water, eyedropper or pencap and blutac

Procedure:

1. Fill the drink bottle to overflowing with water
2.Partially fill the eyedropper with water or add some blutac to the bottom of the pencap
3.a) Drop the eyedropper into the bottle of water and if it sinks remove it and squeeze some of the water out and drop it back in
3.b) Drop the pencap into the bottle of water and if it sinks remove it and remove some of the blutac and drop it back in
4. Make sure the bottle is full of water and then secure the cap on the bottle
5.Squeeze the sides of the bottle with your hands
6.Observe the eyedropper and the water level inside it
7. Release the bottle and observe the eyedropper and the water level inside it



What happened:

Squeezing causes the water to rise in the eyedropper and it sinks. When the bottle is released, the water level lowers inside the eyedropper and the eyedropper rises.

Why did this happen:

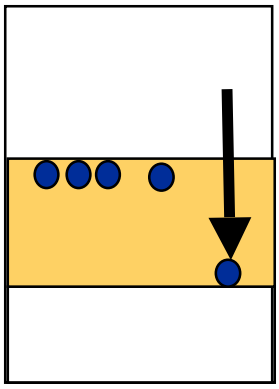
Squeezing the bottle increases the pressure inside, forcing the water to move into the open eyedropper/pencap. The extra water inside the eyedropper/pencap makes it heavier/denser and it sinks. The eyedropper rises when the pressure drops and water leaves it and makes it lighter or less dense. Submarines add or expel water which makes them heavier or lighter and it moves down or up. The submarine takes the water into side tanks to sink and blows the water out to make it rise.

Material World

25	Floating Spheres	To observe that some liquids will mix or not mix together and can have different densities

Materials needed: clear drinking glass, 125mls of water, cooking oil, blue food colouring, eyedropper, and pencil

Procedure:



1. Pour the water into the glass
2. Slowly add the cooking oil until the glass is about $^{3}/_{4}$ full.
3. Add 5 drops of blue food colouring gently to the oil
4. While looking at the underside of the oil's surface, use a pencil to push the drops of food colouring into the water

What happened:

The oil floats on top of the water. The balls of food colouring float just below the surface of the oil. Some of the coloured balls may sink and sit just above the surface of of the water. When the coloured balls touch the water, they break apart and dissolve into the water.

Why did this happen:

The oil and water are immiscible liquids which means they do not mix and will separate into layers. As the oil is less dense than the water, it will float on top. Food colouring does not mix with the oil and will float if the drops are small enough. The oil that surrounds the balls will prevent the food colouring from touching the water but pushing them through this barrier allows them to touch and mix with the water. Food colouring and water are miscible liquids in other words are able to be mixed.

Material World

26	Cottage Cheese	To show how cheese is made

Materials needed: lemon juice (cottage cheese) or rennet (normal cheese) or white vinegar (curds), full fat milk 75mls (grey top/farmers milk is best), spoon, bowl, clock or timer, muslin cloth, string, 2 stools, broom handle

Procedure:

1. Pour the milk in the bowl
2. Add about 35mls of lemon juice/vinegar or follow instructions on rennet packet
3. Allow the mixture to stand for about 5 minutes
4. Observe
5. Pour the contents of the bowl into the muslin bag, tie the end onto a broom handle and suspend it over the sink for a few hours

What happened:

The milk separates into white solid lumps mixed with a thin, yellowish watery liquid. Most of the lumps sink to the bottom. After the mix has been left hanging in the muslin bag and you have opened it, there will be some crumbly white solid stuff.

Why did this happen:

The milk contains casein (milk protein) which when combined with the acid (lemon juice/vinegar/rennet) forms lumps. This can also occur when the milk gets hot as the sugar in the milk changes into an acid. The milk separates into the lumps called curds from which cheese is made, and the thin liquid called whey.