The Blue Bottle

ENGAGE:	Ask the pupils to guess what is causing the colour change. Apparatus: • Plastic Bottle • Glucose 10 g • NaOH – 10g • Methylene blue, 3-4 drop • Water This activity can be set up very quickly (in ~ 5 minutes) and will last long enough for a single or double period. ~5g each of NaOH and glucose should be weighed out. A 500 cm3 flask should be half filled with water and the NaOH added. Shake to dissolve. When dissolved add the glucose, shake to dissolve. Add a drop of methyl blue solution or a few crystals to give a blue colour (do not add too much). Stopper the bottle and allow the blue colour to disappear. The blue bottle is now primed for use. What are the differences between the two bottles? What causes the colour change? Why does the colour change when you shake it? Why does the colour change back when you leave it standing? Does the shaking matter? Does the amount you shake the bottle effect how the colour changes or how quickly it changes back? Why does the stoppered bottle turn blue when shaken? Why is the blue colour stronger the more it is shaken and takes longer to disappear? What is going on? How could you test your ideas? http://www.youtube.com/watch?v=a_4LUaaL6FU

EXPLORE:	To confirm that oxygen is responsible for the colour change, nitrogen can be bubbled through the solution for a couple of minutes to displace air from the solution and the flask. If the stopper is now replaced and the bottle shaken, no colour change will occur. Reintroducing the air by pouring the solution into another flask and shaking will restore the system. Or you could add water to the top of the bottle and stopper it again. The solution will turn blue initially and will then go to colourless after all the oxygen has been used up.
EXPLAIN:	The blue bottle experiment is an old favourite "chemical magic" demonstration. In the demonstration, a bottle of colourless liquid is shaken for a few seconds until the liquid turn's blue. An alkaline solution of glucose is a reducing agent and reduces methylene blue from a blue to its colourless form. • Shaking the solution causes oxygen to dissolve and this oxidises the methylene blue back to blue. • When the dissolved oxygen has been used up, the methylene blue is slowly reduced back to its colourless form by the remaining glucose. • The cycle can be repeated many times by further shaking. • When tap water is added it turns blue due to dissolved oxygen in the water. • If filled to the top with water, and left to go colourless it does not turn blue on shaking because there is no air (oxygen) left.
ELABORATE:	Connects to redox chemistry, chemical kinetics (rate it decolorizes), dissolved oxygen in water.
EVALUATE:	Richness of the student discussion and possible answers they come up with. Recognition that the production of the blue colour and its disappearance indicates a chemical reaction. The amount of reation is linked to the amount of shaking. Design of suitable experiments to test their hypotheses. Plausible explanation even if they do not know the chemicals involved.

3 CUP TRICK

ENGAGE:

Method:

1 cup contains hydrogel and 2 contain nothing.

1. Use the white cup first so students can't see what is happening.
2. Place hydrogel in a cup.
3. This is the cup that the water will be added to. 100mL will be added by the teacher.
4. Teacher will then switch the places of the cup with the other two that will be present (that contain no water and no hydrogel.) numerous times so the students will have to follow the cup.
5. Teacher will then ask students to pick the cup containing water.
6.

What has happened?

What is in the cup? (Pupils can't see in to it)

Let the pupils come up with a few answers that may or may not be correct – then move on tho the explore phase without telling them the answer.

EXPLORE:	Do it in a clear cup and see what happens. The students can see there is something in the cup, but what could it be? Let them touch it and come up with ideas of how it works. Ask them think of similar products that could have this material.
EXPLAIN:	The material used is that used in nappies. This material is known as a hydrogel polymer. Polymers are long chained monomers (Showing the students an example of this will be more effective than just stating it. Use the analogy of people e.g. 1 person =monomer 5= polymer). The hydrogel attracts water as it holds a slightly negative charge and a hydrogen bond then holds the water to the hydrogel.
ELABORATE:	Set up a test: students have to test different nappies e.g. brands, different age groups, against each other. This requires students carrying out a fair test and comparing their results as a class to come up with a conclusion
EVALUATE:	This carried out through questioning, the results and conclusions of the experiments and their ability to explain what they have learned,

ROLLING TIN

ENGAGE:

This will take 5 minutes to make with simple to find materials. You need the following:

- -A sweet or biscuit tin. Mine has a 23cm diameter and a depth of 7cm.
- -A weight

1. Attach the weight to the edge of the tin on one side.
2. Secure it in place using tape/glue or anything that will work.
3. Place holes in the back of the tin.
4. Close the tin and you are ready to begin the demonstration.

5. Place the tin on a ramp with the counter weight on the uphill side. You will need to experiment to find the best incline. Let go of the tin and see which direction it goes.

EXPLORE:	What would happen if I change the wood? What would happen if I place the weight at the other side? Can I get the tin to stay in one position?
EXPLAIN:	The added weight changes the centre of gravity (COG) of the tin which would normally be at the centre of the cylindrical tin. The COG is now situated close to the extra weight on the edge of the tin. Gravity acts on the COG and pulls it downwards. In order for the COG to move downwards, the tin has to roll up hill. Physics and not magic.
ELABORATE:	Find the centre of gravity of different objects. Discuss different sports and how the centre of gravity for each sport is different and sometimes it lies outside of the actual body. Discuss the effect of pregnancy on the centre of gravity.
EVALUATE:	Pupils will be verbally questioned and probed throughout the lessons. Pupils will be asked to explain the theory behind the mysteries, to assess their understanding.

ARROW THROUGH WATER

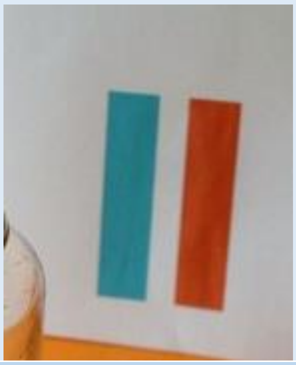
ENGAGE:

- A glass
- Water
- A note card
- A marker

1. Place the glass in front of the arrow as shown above.
2. Pour the water in to the glass and note what happens.

Why is this happening?
What could cause this to happen?

Place two arrows pointing the same direction and hald fill the glass with water to cover the first arrow to see what happens.

EXPLORe:	Try using differently shaped glasses. Does the shape of glass affect when the arrow reverses? Try it using convex/concave lenses Try it using diagram shown below and note the difference 
EXPLAIN:	You have just demonstrated a physics concept called refraction, the bending of lightWhen the arrow is behind the glass, it looks like it reversed itself. When light passes from one material to another, it can bend or refract. In the experiment that you just completed, light travelled from the air, through the glass, through the water, through the back of the glass, and then back through the air, before hitting the arrow. Anytime that light passes from one medium, or material, into another, it refracts. Just because light bends when it travels through different materials, doesn't explain why the arrow reverses itself. To explain this, you must think about the glass of water as if it is a magnifying glass. When light goes through a magnifying glass the light bends toward the centre. Where the light all comes together is called the focal point, but beyond the focal point the image appears to reverse because the light rays that were bent pass each other and the light that was on the right side is now on the left and the left on the right, which makes the arrow appear to be reversed.
ELABORATE:	TO MEASURE THE REFRACTIVE INDEX OF A GLASS BLOCK PROCEDURE 1. Place a glass block on the page and mark its outline. 2. Shine a ray of light from the ray-box into the glass block. 3. Mark two dots on the incident ray and exit ray and draw the outline of the block. 4. Remove the block and complete all lines including the normal, as indicated on the diagram. 5. Measure the angle of incidence i and angle of refraction r using the protractor
EVALUATE:	Pupils will be verbally questioned and probed throughout the lessons. Pupils will be asked to explain the theory behind the mysteries, to assess their understanding.

THE LEAKING BAG

ENGAGE:

1. **Different Diffusion Prior to the lesson,** the teacher will spay an air freshener / perfume at the back corner of the science lab. The teacher may lead a discussion on how the scent of the air freshener has spread throughout the room. If necessary, a demonstration to show food dye spreading throughout water can easily be set up.

Materials:

- ziplock bags/visking tubing
- iodine solution
- starch solution
- beaker

2. **The Leaking Bag**

The teacher half fills a plastic zip-lock/visking tubing bag with a starch solution.

The class will agree that the bag does not allow any solution to leak out.

This bag will then be placed in a beaker of iodine (before doing so, the pupils will recap on the effect of starch on iodine in terms of a colour change – iodine turns blue/black in the presence of starch).

What will students expect to happen?

EXPLORE:	The blue black colour will be seen to spread out inside the bag, linking to the first activity. How did the iodine pass through the bag if the starch and water could not? Probing Questions: - What happens over time when perfume is sprayed in the corner of a room? What result would you expect if you place the iodine in the bag and the starch solution on the outside of the bag? Link: http://www.youtube.com/watch?v=WYC3mz8nwlQ The
EXPLAIN:	The bag does not allow starch molecules to pass through. However, the iodine and water molecules are small enough to pass through the tiny pore spaces in the bag. This activity may then be used to describe a semi-permeable membrane as well as the effect of diffusion (the iodine will diffuse throughout the starch solution).
ELABORATE:	The pupils could explore and investigate the movement of substances of varying concentration across a semi-permeable membrane. The teacher will encourage pupils to form an experimental procedure 'To investigate the direction of movement of water molecules across a semi-permeable membrane between two solutions (of different concentration).' The teacher may introduce visking tubing. The pupils must recap on the difference between high concentration and low concentration.
EVALUATE:	Verbal Questioning (It is important to use probing questions to encourage pupils to think deeper about the topic. However, the teacher may assess whether or not the pupils understand the topic by directing questions to pupils during the lesson also). Observation of experimental procedure (The pupils must devise the experimental procedure. However, the teachers must guide this experiment. The teacher can assess learning objectives in this way).

LEAKING BOTTLE

ENGAGE:

Ask pupils who is brave enough to open the bottle of water Once pupils volunteers ask one of them up to the front and hand them the bottle.

Allow them to open it with the whole class observing.

Once opened ask them to close it again.

Ask the class to come up with an explanation as to what has just happened.

EXPLORE:	There is a hole in the bottle and that's what causes it to leak • Experiment by poking different numbers of holes in the bottle. • Do you get the same result with twenty holes as you did with just five holes? • Try poking holes in different areas of the bottle. • Do holes in the top of the bottle leak the same amount of water as holes in the bottom of the bottle? • Does the size of the hole matter?
EXPLAIN:	You might think that poking a tiny hole in the bottom of a bottle would cause it to leak, and it does if air molecules can sneak into the bottle. When the lid is on the soda bottle, air pressure can't get into the bottle to push on the surface of the water. The tiny holes in the bottom or sides of the bottle are not big enough for the air to sneak in. Believe it or not, the water molecules work together to form a kind of skin to seal the holes—it's called surface tension. When the lid is uncapped, air sneaks in through the top of the bottle and pushes down on the water (along with the force of gravity), and the water squirts through the holes in the bottle.
ELABORATE:	Show Relationship Between Water Pressure and Depth Try to poke holes at different heights in a bottle, and see which one shoots out the furthest. Explain why. Compare results as a class using different heights.
EVALUATE:	Pupils will be verbally questioned and probed throughout the lessons. Pupils will be asked to explain the theory behind the mysteries, to assess their understanding.

TEST YOUR LUNG CAPACITY

ENGAGE:	 • Have two volunteers come up to the front of the class. • Hand them a bottle with a balloon in it each, as in picture above. • Ask them to blow up the balloon. • Get the class thinking about what they are seeing and what the difference between the two could be • Get the volunteers to switch bottles and test it. What happens? Why is this happening? What could be the cause of this?

EXPLORE:	Once the students realise what is going on – one bottle has a hole on it. They can test different scenarios, fill the bottle up with water and try blow it up. Poke more holes in the bottle and see does it affect the ease at which the botte is clown up.
EXPLAIN:	The balloon won't inflate much the first time because the bottle is already filled with air. There's no room for the balloon to expand inside the bottle. However, when you punch a hole in the bottle, the air molecules in the bottle have an exit. They're pushed out as the balloon fills the space inside. As long as you plug the hole, the balloon stays inflated. When you take your thumb off the hole, outside air flows back into the bottle as the balloon collapses. Because of the elasticity of the rubber or latex, the balloon shrinks to its original size as the air rushes out the top of the bottle.
ELABORATE:	How could you blow this balloon up without actually touching the top of the bottle?
EVALUATE:	Pupils will be verbally questioned and probed throughout the lessons. Pupils will be asked to explain the theory behind the mysteries, to assess their understanding.

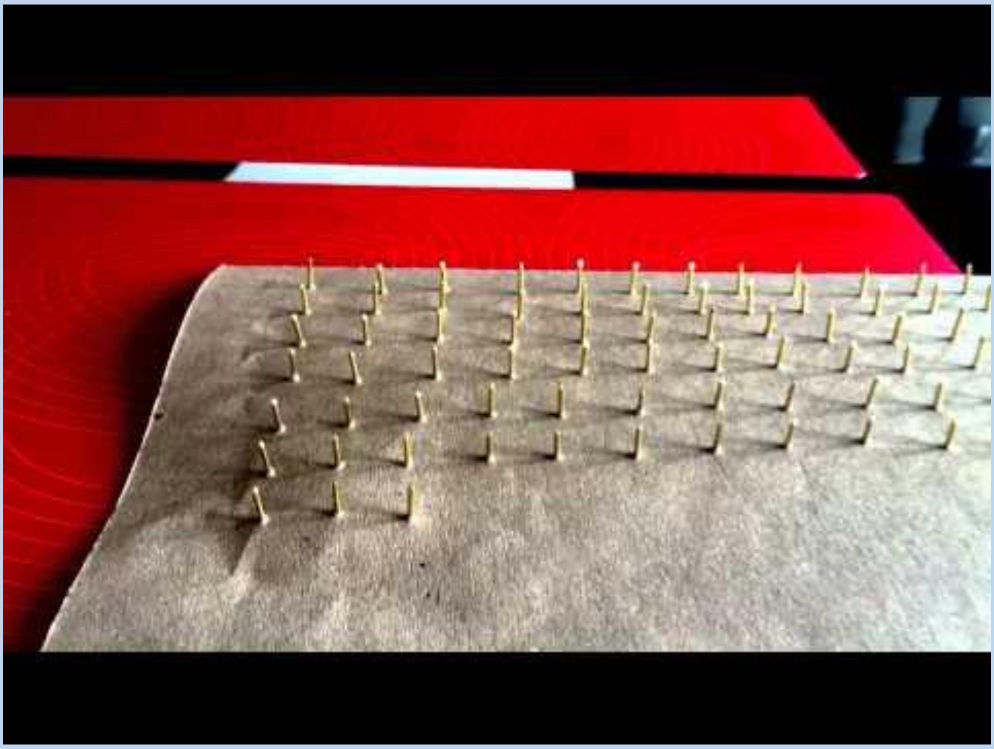
BURST YOUR BALLOON

ENGAGE:

- Laminated piece of paper or card
- 1 pack of thumb tacks
- Ballons

Method:

1. Place the thumb tacks closely together in a square through the card/paper. (this may take 5 minutes so have it prepared before the class.
2. Place 1 single thumb tack on the sheet beside it.
3. Blow up two balloons.
4. Using the bed of thumb tacks try and burst the balloon.
5. Then try burst the balloon using a single thumb tack



Observe the differences

Ask the students to come up with reasons for the results and ask them can they explain what is happening.

EXPLORE:	Is there more pressure under a woman's stiletto high heel shoe than an elephants foot? Why? What causes this to happen? Which one would make a larger imprint on the ground?
EXPLAIN:	When you pop the first balloon with the nail, all of the pressure is concentrated on one point on the balloon so the balloon easily pops. When you place the balloon on the bed of nails, the pressure points are spread all across the surface of the balloon. Just like the balloon, when a person lies on a bed of nails, their body is evenly distributed across the surface of the nails. The only real danger of being punctured by a nail is if the performer doesn't lie down or get up correctly and pressure points of the nails are concentrated on one area of the body. Now you know the circus secret!
ELABORATE:	Fill a flat tray with soft, damp sand and stand on the sand. How deep is the imprint that you make in the sand? Now put a block of wood on the sand and stand on the block and measure how far it sinks in. This can be extended to try different examples of shoes; • Wellingtons • Boots • High heels • Sports boots • Running shoes • Slippers Get students to use their previous knowledge to make an educated guess as to the results. Get them to compare their answers after the tests.
EVALUATE:	Pupils will be verbally questioned and probed throughout the lessons. Pupils will be asked to explain the theory behind the mysteries, to assess their understanding.

GLOWING REACTIONS

ENGAGE:

- 3 glow sticks (the short ones are ideal, but you can use any size)
- glass of ice water
- glass of hot water
- Glass of room temp water.

Activate the three glow sticks by snapping them to break the container inside the tube and allowing the chemicals to mix? What colour is the glow? It's a good idea to write down observations.
2. Place the glow sticks in the 3 different beakers/glasses at room temperature and hot water. What do you think will happen?

Pupils will not know that there is a difference in the water temperature; it is up to them to come up with it.

Ask pupils what the difference might be and get them come up with ideas to test their hypothesis.

EXPLORE:	You can explore this further by swapping the hot and cold water glow sticks. Will this make a difference? Will the glow sticks change colour again? Why would this happen? Why might it not happen?
EXPLAIN:	Increasing temperature typically increases the rate of the chemical reaction. Increasing temperature speeds up the motion of molecules, so they are more likely to bump into each other and react. In the case of glow sticks, this means a hotter temperature will make the glow stick glow more brightly. However, a faster reaction means it reaches completion more quickly, so placing a glow stick in a hot environment will shorten how long it lasts. On the other hand, you can slow down the rate of a chemical reaction by lowering the temperature. If you chill a glow stick, it won't glow as brightly, but it will last much longer. You can use this information to help glow sticks last. When you are done with one, put it in the freezer to slow down its reaction. It may last until the next day, while a glow stick at room temperature would stop producing light.
ELABORATE:	Using alka selzer test if there is a difference between hot and cold water; • Alka-Seltzer tablets (6) • Jar, drinking glass, or vase with hot water (1) • Jar, drinking glass, or vase with ice-cold water (1) • Timer or clock that shows seconds (1) 2.Boil water and pour in cup then pour cold water/ice water in another cup 3.Get Alka seltzer tablets 4.With thermometer check water temp 5.Open alka seltzer tablets. 6.Get timer ready and drop Alka Seltzer in hot water do this 3 times 7.Do the same thing for cold water Can be extended by changing the temperature of the mixtures.
EVALUATE:	Pupils will be verbally questioned and probed throughout the lessons. Pupils will be asked to explain the theory behind the mysteries, to assess their understanding.

EXPANDING MARSHMALLOWS

ENGAGE:	Vacuum coffee pump – available on amazon 1. Fill the storage container jar with marshmallows and replace the lid. 2. Attach the special vacuum hose that came with the unit. 3. Place the hose over the vacuum port on the lid and start the vacuum packer. 4. Don't take your eyes off those marshmallows!  What is happening? Why is this happening? Am I pumping air in? or am I taking it out? Don't try to re-use the same marshmallows too much or they'll stretch and stop working properly.

EXPLORE:	Try using a small balloon in place of the marshmallows. What would happen if you placed a small bag of potato chips into a large storage container and removed the air? Let's say the goal was to shrink the marshmallows – how would you do it? Place the marshmallows into a plastic storage bag that come with a vacuum packer. When the air is removed from inside the bag, you get to see the power of the air in the atmosphere as it compresses the marshmallows.
EXPLAIN:	The job of the vacuum packer is to remove the air from inside the storage container. Under normal conditions, molecules of air from the atmosphere (called atmospheric pressure) are pushing on the outside of the marshmallow. When the vacuum packer removes the air that was once pushing on the outside of the marshmallow, the air trapped inside the marshmallow pushes out (expands) causing it to get larger. The marshmallows shrink when the vacuum seal is broken and air rushes back into the container.
ELABORATE:	Although aircraft cabins are pressurised, they are not kept at sea level pressure. A similar effect to the marshmallow experiment can be observed by drinking half a bottle of water during a flight. When the aircraft lands you will see that the sealed plastic bottle is slightly crushed by the higher atmospheric pressure at about the same time as your ears pop on the approach to landing. Discuss a packet of crisps on the aircraft and test it using the vacuum pump.
EVALUATE:	Pupils will be verbally questioned and probed throughout the lessons. Pupils will be asked to explain the theory behind the mysteries, to assess their understanding.

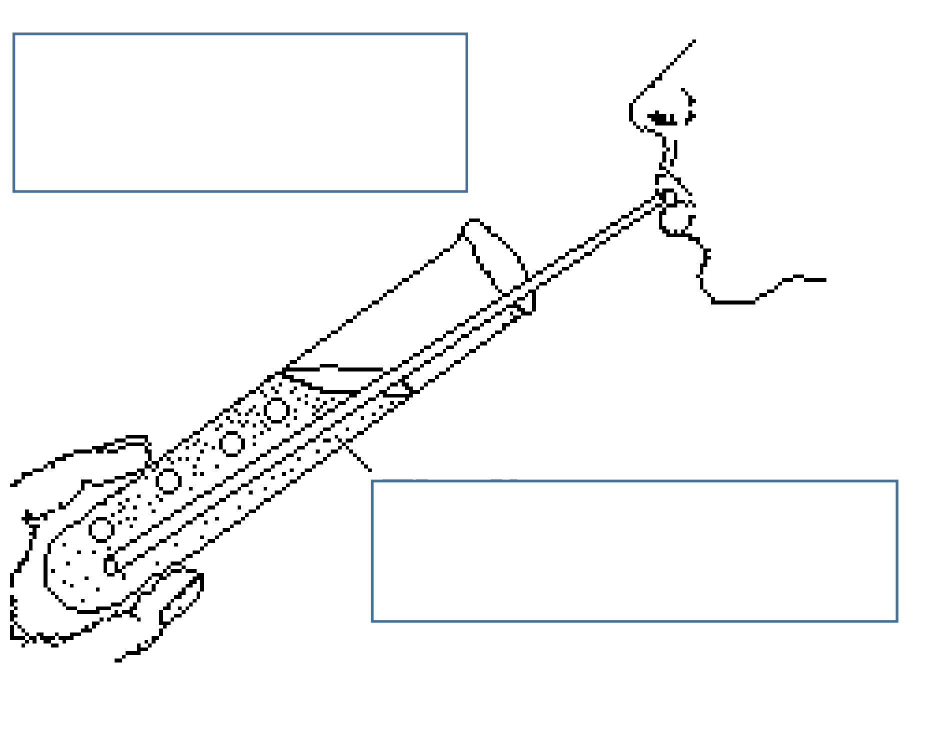
MILKY WATER

ENGAGE:

Make lime water. Add a small amount of calcium hydroxide to a test tube and add water. Add bung and shake. Allow to settle. Decant the clear solution into a beaker: lime water.

Set up the experiment as shown in the diagram:

1. Place limewater in to the boiling tube.
2. Place straw in to the boiling tuvbe
3. Blow in to the boiling tube
4. Note what happens.



Using your observations what has happened in the boiling tube?

What could be the cause of the change?

EXPLORE:	Keep blowing CO_2 in to the test tube and note what happens . Why does this happen? What might cause this ti happen? Where in nature would something similar to this happen?
EXPLAIN:	Limewater is created with calcium hydroxide, or $Ca(OH)_2$. Named for the mineral, not the fruit, lime reacts with CO_2 in water to form calcium carbonate, which is white and does not dissolve in water, causing the water to turn cloudy. Similarly, when we exhale we are removing CO_2 from our bodies, so breathing CO_2 into the lime water will produce the same reaction, though probably not as quickly due to the smaller amount of CO_2 in your breath. As you continue to bubble, carbon dioxide dissolves in the water to form carbonic acid, which dissolves the calcium carbonate, so the milkiness disappears. Here are the reactions: $Ca(OH)_2 + CO_2 \rightarrow CaCO_3 + H_2O$ forming the milkiness $2H_2CO_3 + CaCO_3 \rightarrow Ca(HCO_3)_2 + H_2O + CO_2$ removing the milkiness again This second reaction is the same one as for rainwater flowing over limestone rocks.
ELABORATE:	Discuss the effects of lime scale hard and sift tap water. Tap water that is "hard" because it comes from wells and has been in contact with limestone for a long time contains relatively large amounts of calcium and bicarbonate ions. When this water is heated in coffee pots or water heaters and allowed to cool, limy deposits called "boiler scale" build up.
EVALUATE:	Pupils will be verbally questioned and probed throughout the lessons. Pupils will be asked to explain the theory behind the mysteries, to assess their understanding.

DANCING RAISINS

ENGAGE:

1. 1.Fill the glass with soda.
2. 2.Drop 10-15 raisins into the soda.
3. 3.Focus all of your attention on those raisins.

Are they moving?
What happened when you first dropped the raisins in the glass?
Did they sink?
Once they started "dancing" did the raisins stay at the top?
What else did you notice happening to the raisins? Did they look different?
Do you think the same thing would have happened it you put raisins in water?
What other objects do you think would "dance" in soda?

EXPLORE:	1.Set up your drinking glasses with different types of soda. 2.See which type of soda makes the best dancing raisins. 3.Try using all of the same type of soda but different kinds of raisins.
EXPLAIN:	Since the surface of the raisins is rough, tiny bubbles of carbon dioxide gas are attracted to it. These bubbles increase the volume of the raisin substantially, but contribute very little to its mass. As a result, the overall density of the raisin is lowered, causing it to be carried upward by the more dense fluid surrounding it. Archimedes' Principle states that the buoyant force exerted on a fluid is equal to the weight of fluid displaced. Since the raisins now have a greater volume, they displace more water, causing the fluid to exert a greater buoyant force. The buoyant force of the surrounding fluid is what pushes the raisins to the top Once the raisins reach the top, the bubbles pop upon exposure to the air. This makes the raisins more dense, causing them to sink. As more bubbles adhere to the raisins, the density of the raisins decreases and they rise to the surface again. This experiment very clearly shows that an increase in volume (as long as the mass increase is negligible) will lead to a decrease in density. The bubbles that attach themselves to the raisins are like little life jackets that make the raisins more buoyant by increasing their volume.
ELABORATE:	Another way to do this experiment is to generate the carbon dioxide gas using the reaction of baking soda and vinegar. Fill your glass about 1/2 full with water. Add one teaspoon of baking soda and stir until it is dissolved in the water. Add 6 or 7 raisins to the glass. SLOWLY pour in vinegar until the glass is about 3/4 full. The vinegar and baking soda react to form carbon dioxide bubbles, and the raisins will dance just as in the soft drink!
EVALUATE:	Pupils will be verbally questioned and probed throughout the lessons. Pupils will be asked to explain the theory behind the mysteries, to assess their understanding.

SINK OR FLOAT

ENGAGE:

Required Materials:

- Two oranges: one peeled, and one whole
- Large glass bowl
- Water (to fill the bowl)
- Can of diet coke
- Can of coke
- Lemon and lime optional

1. Before students come in to the Lab, place large clear tank/container with water on the teachers bench.
2. Place one can each of “Coke” and “Diet Coke” into the water.
3. Ask the students to think about what they see happening here.
4. Get them to write down the possible reasons.
5. Lead the students towards a direct comparison of the ingredients (see table).

EXPLORE:	Show a 1 kg or 500g bag each of sugar (sucrose) and sugar substitute (sucralose eg Splenda) – there's a very marked visual difference in the volume of the same masses. Connect to the coke discussion. Ideas about connections between mass & volume should emerge Place an orange in to the container. Peel the orange and see does it sink or float? What is the difference between the orange? Is the weight not gone down since it is peeled? Place a lemon and lime in to the container.
EXPLAIN:	The unpeeled orange floats because the rind is very porous and filled with tiny pockets of air. Even though you're removing mass when you peel the orange, the peeled orange is more dense and sinks in the water. But the lemon lime mystery is a little different.
ELABORATE:	The Float / Sink challenge... Each group gets two identical pieces of modelling clay. Each group works near a sink of water or has a trough of water. The challenge is to plan how to make one piece float and one piece sink in water. Teacher allows one minute for thinking / planning / discussion
EVALUATE:	Pupils will be verbally questioned and probed throughout the lessons. Pupils will be asked to explain the theory behind the mysteries, to assess their understanding.