Practical Prompts for Thinking

Health & Safety

These practical activities have been risk assessed using CLEAPSS's guidance.

Trainers need to risk assess practical activities for the teachers in their session following the advice of their health & safety advisor.

Teachers always need to risk assess practical activities for their children and defer to their health and safety advisor for the most up-to-date source of health and safety guidance.

This training material cannot be relied upon as source of health & safety guidance.

Materials: Icy Water

What to do in advance: Put a few ice cubes in a glass of water. If possible, try to have enough glasses of iced water so all pupils are able to carefully observe a glass for themselves (e.g. one glass per group table of pupils). Depending on conditions, it will take about 10-15 minutes before condensation is visible on the outside of the glass – and this is one of the key things that you want pupils to notice.

What to do with pupils: Ask them to look at their glass of iced water very carefully and discuss their observations with each other.

Questions to stimulate pupils' thinking:

- Do you notice anything on the outside of the glass? What do you think it is?
- Where do you think the water on the outside of the glass has come from? Can you explain how this has happened?
- Is the glass warm or cold? Why do you think this?
- Are the ice-cubes in the glass changing? What is happening to them?
- Have you ever noticed water forming on a cold surface anywhere else?

The science behind it

There is a small amount of water vapour (water in the gas state) in the air; the amount varies depending on the weather conditions. When humidity is high there is more water vapour in the air than when humidity is low. Adding ice to the glass of water will lower the temperature of the water (and therefore the glass) as the ice melts and turns into liquid water. Water vapour in the air which comes into contact with the cold glass will cool and condense into liquid water on the surface of the glass (forming 'condensation'). This demonstration really helps pupils to understand the change of state from gas to liquid (condensation).

Real world connection

Children will have opportunities to observe condensation forming in other aspects of their lives. They may also have previously noticed condensation on the outside of cold glasses of drink or on ice-cream wrappers etc. They may also have noticed it on the inside of cold windows in their house or car.

Videos

https://www.youtube.com/watch?v=bymT5AcV-C4

Materials: Expanding Gas

What to do in advance: You will need a clear glass milk bottle (or similar), a balloon, some bicarbonate of soda and some vinegar. Add about 100ml of vinegar to the milk bottle. Using a spatula (or the end of a spoon) add about 2-3 teaspoons-worth of bicarbonate of soda to the balloon. Fit the balloon over the top of the milk bottle, leaving the body of the balloon (with the bicarbonate of soda in it) hanging down the side of the bottle.
As with all demonstrations, please try it out beforehand.

What to do with pupils: Hold up the bottle and then lift up the balloon so that the bicarbonate of soda falls into the vinegar inside the bottle. You can do this without any initial explanation or you can tell the pupils that the liquid in the bottle is vinegar and that the white powder in the balloon is bicarbonate of soda (or ask them if they know). This would be useful if you wanted the pupils to make predictions in advance about what they think will happen and why.

Questions to stimulate pupils' thinking:

- What changes can you observe when the white powder is added to the liquid?
- Why do you think you can see 'fizzing' and why is the 'fizzing' rising up inside the bottle?
- Why is the balloon getting bigger? Where has the gas inside the balloon come from?
- Why does the fizzing stop and why does the balloon stop getting bigger?
- What do you think would happen if the fizzing didn't stop?
- Do you think it is possible to do anything now so that we can get the white powder and the liquid back again?
- Have you ever seen any other 'fizzing' reactions like this?

The science behind it

The bicarbonate of soda (a type of salt called sodium hydrogen carbonate) is an example of a substance which is an alkali. The vinegar is an example of substance which is an acid (acetic acid or ethanoic acid). When you mix acids and alkalis together a chemical reaction takes place and new substances are made; this is also an example of an irreversible change. Here, the new substances formed are a salt called sodium acetate (or sodium ethanoate), which dissolves in water, and carbon dioxide gas. The formation of carbon dioxide is the reason why we see both the fizzing and the expansion of the balloon.

Real world connection

Bicarbonate of soda is often used as a 'raising agent' in baking. It reacts with any acidic ingredients in the recipe to realise carbon dioxide gas; bubbles of which can be trapped in the structure of what is being baked.

Materials: Film Canister Rocket

What to do in advance: This demonstration is best done outside, in a tray, from either the ground or a table. You will need a film canister with a tight-fitting lid (ideally one where the lid fits inside the canister), a vitamin C tablet and water.
As with all demonstrations, please try out beforehand and make your own risk assessment.

What to do with pupils: Add a small quantity of water to the film canister (e.g. about a quarter full). Then add a Vitamin C table and quickly put the lid on tightly before turning the film canister upside down, placing on your tray and standing back.

Questions to stimulate pupils' thinking:

- Why does the film canister separate from the lid and fly into the air?
- What is it which is pushing the film canister up into the air?
- What do you think is happening inside the film canister when the Vitamin C is added to the water?
- Do you think the film canister (instead of another container) is important to make this work? Why?
- If you were going to investigate this reaction what sorts of things could you change about it to see how that affected what happens?

The science behind it

Vitamin C is an acid called Ascorbic Acid. There are other ingredients in the Vitamin C tablet which are alkaline. In the presence of water, the alkali ingredients react with the acid to form new substances, one of which is carbon dioxide gas. As a gas, the carbon dioxide wants to take up more space than is available inside the film canister. This increases the pressure on the inside of the film canister, causing canister to separate from the lid and fly into the air. The features of the film canister are important for this reaction to work well (and safely). You want a small container with a tight-fitting lid (so the pressure is enough for the rocket to really fly), that is pressed (rather than screwed) on so that it is possible for the container to separate from the lid as the pressure builds.

Real world connection

This is also how real rockets work, although it is a different chemical reaction (burning or combustion) that is taking place. Combustion also produces a gas and it is the force of the gas escaping (just like the carbon dioxide eventually escaping from the film canister) which provides the upwards thrust for the rocket.

Materials: Fire Extinguisher

What to do in advance: This demo is fairly reliable but it is worth trying it a couple of times in advance. Arrange a row of 5-6 candles in a metal tray or nightlights in a sand tray. Have a jug (e.g. of about 1-2l size) with 3-4 teaspoons of bicarbonate of soda in it. Have a bottle of vinegar on one side.

What to do with pupils: Light the row of candles. Pour about 200ml of vinegar into the jug and gently swirl for a few seconds. Pour the jug over the first candle, taking care not to tip the liquid contents out! Move the jug along the line of candles and they should extinguish one by one.

Questions to stimulate pupils' thinking:

- What is happening in the jug? Why does the liquid foam up and rise up the jug?
- Am I pouring anything out of the jug? What is coming out of the jug?
- Why doesn't the carbon dioxide gas go up and escape from the jug?
- Why do the candles go out?
- Do you know any other experiments that make carbon dioxide gas? Do you think they would work in the same way?

The science behind it

Vinegar and bicarbonate of soda is an example of a reaction between an acid and an alkali. One of the products of the reaction is carbon dioxide gas. Molecules of carbon dioxide have more mass than the molecules which make up most of the air (nitrogen and oxygen) and so they do not automatically rise up and escape from the jug. When you tip the jug you can pour the carbon dioxide out and because it is denser than air it falls towards the candles, pushing the air out of the way. Without the oxygen from the air to react with the wax vapour from the candles, the candles go out.

Real world connection

Red carbon dioxide fire extinguishers work in the same way, displacing the oxygen that the fire needs in order to keep burning.

Videos

Planet Science – Experiments-Chemistry Chaos- Make Your Own Fire Extinguisher

Materials: Liquid Layers

What to do in advance: Have a large clear container ready (e.g. cut the top off an empty, clear 2l plastic bottle) and have some honey, washing up liquid, water and cooking oil. You may also want to have some pieces of fruit or other objects to hand for dropping into the liquids. Fruit which is good to try includes: dates, pineapple, grapes, apple, cherry tomato. Other objects might include: ping pong ball, bottle top, beads, popcorn kernel, bolt, ice cube, paper clip, coin, marble, lego brick, pebble, blutack blob, plasticine blob, wooden block, dried pea.

What to do with pupils: *Carefully* pour the liquids into the clear container (tilting the container can help), one by one, in the following order: honey, washing up liquid, water, cooking oil. Layers which are about 2cm thick will be nice and clear for pupils to see. After talking with pupils about the layers, try dropping different objects or pieces of fruit into the liquids to see what happens. Once all other experiments are exhausted, use a spoon to mix up the layers and then let the mixture rest for 10-20 minutes and return to it later. Get the pupils to make their predictions about what they think will happen and why!

Questions to stimulate pupils' thinking:

- Why do the liquids sit on top of each other in the different layers?
- If you dropped different objects into the liquids what would happen to them? Why?
- If you try an ice cube what will happen when the ice cube melts? Why does this happen?
- What would happen if you mixed up all the layers and then allowed some time for the mixture to settle again? (you can try this once you've completed any other experiments)
- What other liquids might work like this?

The science behind it

The four liquids all have different densities (density is how much 'stuff' there is in a given volume, so liquids which are made of heavier molecules or where the molecules are packed more closely together will have higher densities). This is why you can get them to sit on top of one another if you pour the densest liquids out first. When you stir the liquids you will find that both the honey and the washing up liquid will mix with the water, but that the oil will not – this will separate out, and as the least dense liquid it will continue to sit on the top. Oil and water are a good examples of immiscible liquids, which simply means that they do not mix.

Videos

There are many nice YouTube links which link to this experiment:

Ice in oil: https://www.youtube.com/watch?v=zXykTnD_s0w

Coloured ice in oil: https://www.youtube.com/watch?v=Z9R8ZM4bJRw

Liquid layers: https://www.youtube.com/watch?v=hSorsJ-lRYk

Seven layers! https://www.youtube.com/watch?v=B3kodeQnQvU

Even 9 layers! https://www.youtube.com/watch?v=-CDkJuo_LYs

Using only water and salt: https://www.youtube.com/watch?v=ZgDnGFvEOUg

Materials: Magic Cups

What to do in advance: You will need three identical, opaque plastic cups. Put a small quantity (e.g. 2 teaspoons) of water storage gel (you can buy this from garden centres) into one of the cups. Place the cups in a row on a table. *It is worth trying out this experiment beforehand.*

What to do with pupils: You can perform this like a magic trick. Using another cup/jug/small bottle pour about 50-100ml of water into one of the *empty* cups. Ask the pupils to watch the cups and point L/R/Centre to show which cup they think the water is in. Mix up the cups, making as much of a show of it as you would like to. Choose the cup most pupils point to (this usually is the one with the water) and show them that they were right by pouring the water into the other empty cup. Repeat. This time pour the water into the cup with the water storage gel. Repeat. This time the pupils will be wrong-footed – turn the cup upside down to show them that they appear to be wrong. Allow them to choose the other two cups too – still wrong!

Questions to stimulate pupils' thinking:

- Before the experiment: Scientists need to have good observation skills – pupils need to watch this experiment very closely.
- After the experiment: What has happened to the water? It has not just disappeared, so where could it be? How does this trick work? (Think, pair, share)
- Other follow-up or prompt questions: What do you think a material like this could be used for?

The science behind it
Water storage gel is an example of a super-absorbent polyacrylamide polymer (sodium polyacrylate). A polymer is a material made from long chain-like molecules. Each granule of water storage gel is able to absorb hundreds of times its own weight in water.

Real world connection
Water storage gel is often sold in garden centres as something that can be mixed in with soil for hanging baskets or flower beds. It holds the water in the soil and stops it draining away too quickly so that the plants or flowers can make use of it. A similar material can also be found inside disposable nappies! In a related experiment you can show pupils just how much water a disposable nappy is capable of holding.

Videos
Lots of videos of this online if you'd like to see someone else do it first! E.g. google 'water gel trick' to find ones like this https://www.youtube.com/watch?v=dYjNHtF8A1M

Materials: Shelly the Swimming Egg

What to do in advance: Prepare a saturated salt solution – if you have somewhere to store it, then it can be worth preparing ~2 litre stock supply for repeated use. Boil the water before you add the salt, as using very hot water will help you to dissolve as much salt in the water as possible. Let the salt solution cool before use. To set the scene for pupils you need an egg (perhaps with a face drawn on it for character), a tray, a narrow/straight glass or water and a jug with enough salt solution in it to fill the glass.

What to do with pupils: Introduce the pupils to your egg, giving it a name of your choice e.g. Shelly. Explain that Shelly has been trying to learn to swim and she finally thinks she has mastered it. If she has then she will float in the glass of water, but if she hasn't then she will sink. Choose a pupil to put the egg in the glass of water and all observe what happens (the egg sinks). To extract Shelly from the glass, pour it out over a tray, catching Shelly in your hand (using a narrow/straight glass and extracting Shelly in this way gives you a reason to empty the glass of water). Refill the glass with the saturated salt solution from the jug. Pretend that Shelly is whispering something to you, then explain to the class, that Shelly would like to try again if there is a pupil who thinks they could use their 'magic powers' to help her. Choose a pupil and ask them to point at Shelly and say a magical word of their choice as you place Shelly into the glass. This time Shelly will float – she is 'swimming'!

Questions to stimulate pupils' thinking:

- What is really happening? Why is the egg floating now, when it sank before?
- If the egg is the same egg, what else might have changed?
- If something about the 'water' is different, then what could it be?
- If something about the 'water' is different, then why would this cause the egg to float?

The science behind it
Dissolving salt in the water, makes the water denser than the liquid inside the egg, because there is now more 'stuff' (the salt) in it for the same volume. This is why the egg sinks in water, but floats in salty water.

Real world connection
It feels easier to float in the sea, when compared to a swimming pool, for the same reason.

Videos
Google 'floating in the Dead Sea' – lots of photos or video are available.

Materials: Fizzy Travellers

What to do in advance: Have an unopened 1 litre or 2 litre bottle of fizzy water, a handful of raisins or chocolate chips and transparent container large enough to hold the water (e.g. a clear water bottle of the same size with the top cut off – you want a column of water for this experiment).

What to do with pupils: Carefully remove the top from the bottle of water and pour it out into the container. After questioning the pupils, add the raisins or chocolate chips and watch what happens.

Questions to stimulate pupils' thinking:

- What do they observe about the fizzy water that is poured out into the container? What are the bubbles that they see? How (and why) are they moving? Why are they there?
- What do they think will happen when you drop the raisins or chocolate chips into the water? Why do they think this will happen?
- What do they observe when the raisins or chocolate chips are dropped into the water? Why does this happen?
- Will the raisins or chocolate chips fall and rise forever? What might happen in the end? Why?
- What do they think might happen if other small items (e.g. pasta shapes) were dropped into fizzy water? Are there other liquids that might work? Why?

The science behind it

The raisins sink at first because they are denser than the water, but then float again as the less dense gas (carbon dioxide) bubbles collect on the surface of their folded skin. When the raisins reach the top the gas is released into the air and they sink again. Fizzy water is generally better to use than lemonade. Chocolate chips also work well and are more surprising because their surface appears smooth, but is actually still quite bumpy so gas bubbles still collect.

Real world connection

The gas bubbles collecting on the surface and the way this adds buoyancy to the object is rather like the way a life jacket works when we need to keep people afloat in water.

Materials/Electricity: Static Magic

What to do in advance: Inflate a balloon and have an empty aluminium drink can and some woollen (or e.g. fleece, sweatshirt, etc.) fabric at hand. Like all static electricity experiments this one will work best on a dry (non-humid) day.

What to do with pupils: Place the empty drink can on its side on a table. Rub the balloon on the fabric for 10-20 seconds and move it close to the can. The can should be attracted to the balloon so that if you slowly move the balloon, the can will follow it.

Questions to stimulate pupils' thinking:

- Why does that happen? Why does it stop working after a short while?
- Is it important to rub the balloon on some material first? Would other types of materials work too? What about hair?
- What happens if you change how long you rub the balloon for?
- What is important about the can? – e.g. the shape or what it is made from
- Does it remind them of any other experiments or experiences they have had?

The science behind it

Everything is made of small particles called atoms, and in turn atoms are made up of even smaller particles. Some of these particles have positive charges (protons), some are neutral (neutrons) and some have negative charges (electrons). Charged particles will repel one another if they have the same charge and attract one another if they have different charges (rather like magnets and South/North poles).

The negatively charged particles (electrons) are easily removed – e.g. by rubbing two materials together like the fabric and the balloon. When you remove electrons you leave a positive charge. Something that is charged (like the balloon) can "induce" the opposite charge in something else (like the can) and so the two objects are attracted to each other.

Real world connection

Lightning is an example of real life static electricity. It is thought that during storms, particles in the air get torn apart to form areas of separate negative and positive charge. Electrons will 'jump' between the two areas to form an overall neutral charge again (known as a discharge). As it is such a large movement of charged particles over such a small period of time though, this causes the air around to superheat, making a bright flash (lightning) and a shock wave in the air (thunder).

Videos

http://www.rigb.org/experimental/static-magic

Forces (magnetism): Magic Pennies

What to do in advance: Tape a strong magnet to the bottom of an opaque plastic box or tray. Turn the box upside down and place on a table – this is your performance platform for this 'practical prompt'. You may wish to mark the box in some subtle way (e.g. with a scratch) to show you where the magnet is located. You need three identical pots (e.g. black film canisters with lids) that are colour coded so that pupils can easily see which is which. You also need three coins, two of which are non-magnetic (e.g. pennies up to 1992) and one of which is magnetic (e.g. pennies post-1992 or 1/2/5 cent pieces in Euro currency). If using three identical coins, you will need to mark the magnetic one in some visible way.

What to do with pupils: Use up to 3 pupil volunteers to put the coins in the pots while you turn away and put your fingers in your ears! The pupils need to make it clear to the rest of the class which pot has the 'different' coin inside. Explain that you are going to perform a series of magical tests to work out which pot contains the 'different' coin. You can make as much of this as you want – picking up the pots and staring at them, shaking and listening, smelling, dropping, putting them inside a hat on top of your head and jumping around etc. You need to ensure that at some point, you put the pots on top of the box and move them around, as this is when you will be able to feel which pot holds the coin which is attracted to the magnet. Finally, you can make your (correct) choice and your pupils will be amazed!

Questions to stimulate pupils' thinking

- How did I do it? (can ask pupils to 'think, pair, share' different ideas)
- In what ways could one coin be different to the others?
- What tests did you see me do? Were all the tests I performed useful or important?
- Could you perform the same magic trick with any other objects?

A nice way to reveal the answer is to place the three pots (with coins inside) on top of the upturned tray/box above the magnet and then to turn the box over.

The science behind it

Only three naturally occurring metals are attracted to a magnet – **Iron, Cobalt and Nickel** (a lot rarer). UK pennies made after 1992 (as well as 1, 2 and 5 cent Euro coins) are magnetic because they are made of copper-plated steel. Steel is an alloy of iron mixed with carbon (and sometimes e.g. manganese, nickel, and chromium). UK pennies before September 1992 were made from an alloy of copper, tin and zinc (bronze), so they are not attracted to magnets.

Forces: Feeling Friction Force

What to do in advance: Interleave two books together about 20-30 times. It should feel impossible to pull them apart from the spines of the books.

What to do with pupils: Choose one (if doing it with you) or two (if doing it with each other) volunteers to pull in opposite directions on the spines of the books to separate them.

Questions to stimulate pupils' thinking:

- Why is it so hard to pull the books apart?
- What forces are acting on the books when we try to pull them apart?
- Can you think of any other examples where the existence of friction is not helpful?
- Can you think of any examples where the existence of friction is helpful?

The science behind it

The books are hard to pull apart because the interleaving of the two books has increased the amount of paper to paper contact, and therefore friction, between the two books. This increased friction force then opposes the motion when you try to pull the books apart.

Forces: Falling Objects

What to do in advance: You need to have two pieces of A4 paper (scrap) and two identical film canisters, one of which is filled with sand (or something else to give it more mass).

What to do with pupils (part I): Show them the two pieces of paper and explain that you are going to drop them both from the same height at the same time. Get the pupils to vote for the piece of paper that they think will hit the floor first (can include an 'option 3' of them hitting the floor together). Before you drop the paper, screw up one of the pieces into a ball. Announce the winner (to a chorus of groans!) and then discuss with the pupils.

You can also do a similar experiment looking at water resistance where you drop differently shaped pieces of plasticine (but equal mass) through water in a clear water tank.

Questions to stimulate pupils' thinking

- Some of you seem to be unhappy with the outcome of my experiment– why?
- Why did the screwed up paper hit the ground first?
- Why did changing the shape of the paper make a difference?
- Can anyone think of a situation where you'd want to increase the air resistance?
- Can anyone think of a situation where you'd want to decrease the air resistance?

What to do with pupils (part II): Show them the two film canisters, including what's inside (one is empty and one is not) and explain that you are also going to drop them both from the same height at the same time. Again, get the pupils to vote for their predictions - which canister do they think will hit the floor first (can include an 'option 3' vote of them hitting the floor together). Announce the result – that both film canisters hit the floor at the same time and then explore the science behind it through discussion with the pupils.

Questions to stimulate pupils' thinking

- Why did pupils make the predictions that they did?
- Do both film canisters experience the same amount of air resistance? Why?
- Why did both film canisters hit the ground together, even though one was heavier?

The science behind it

Objects fall because of gravity, a force that pulls things towards the centre of the Earth. When objects fall through air there is a force that pushes against the direction of motion, like friction, and it is called 'air resistance'. This is because objects moving through air have to push past the air molecules as they travel. Smaller shapes have less air to push out of the way as they move, so they experience less air resistance.

It seems intuitive to assume that in situations with identical air resistance, heavier objects fall faster, but how heavy an object is doesn’t actually affect the speed of the fall at all. The first person to notice this was Galileo. He was a brilliant scientist because he decided to check what everyone else just assumed was true. So, the story goes, he went to the top of the Leaning Tower of Pisa with two heavy balls that were the same size but different weights. He then leaned over the side and dropped them both at the same time (the nice thing about having a leaning building is that when you drop things they’re not going to knock off the side of the building). Galileo had a friend standing on the ground, watching and listening to see which one hit the ground first, and that was the first time that anyone ever actually noticed that weight doesn’t affect falling speed!

Forces: Balls in Space

What to do in advance: You need a large ball (e.g. football or basketball) and a small ball (e.g. tennis ball) and ideally more open space than a classroom (e.g. outside or in the hall).

What to do with pupils: Show the pupils the larger ball and, after questioning, drop it and let them observe what happens. Repeat this process with the smaller ball. Now hold the smaller ball on top of the larger ball and repeat the process (needs a little practice and can have unpredictable outcomes, which is why it is better as an outdoor experiment).

Questions to stimulate pupils' thinking:

- What do the pupils predict will happen when each ball is dropped? Why? What do they observe happening when each ball is dropped?
- What might happen when you drop both balls together? What do they observe happening? (get the pupils to watch the larger ball as well as the smaller ball)
- Why does the smaller ball travel much faster and further than before?
- What might happen if more balls could be stacked together and dropped at the same time?

The science behind it

The larger ball's energy is transferred to the smaller ball and this causes it to bounce a lot faster and higher than normal. In addition, the larger ball bounces slower and lower. If the balls aren't perfectly aligned when they bounce, then the smaller ball might travel in an unexpected trajectory – so this experiment is carried out more safely outside.

Real world connection

Apparently if you dropped 10 balls on top of each other in this way the top ball would bounce fast enough to go into orbit! However, you would need a perfect system in which no energy was transferred through friction, etc. (and even if this were possible the top ball would be travelling so fast that friction with the gases in the atmosphere would cause it to burn up). The same science is used in the "gravity assist" method for accelerating space probes and in the "AstroBlaster" toy. Pupils who are used to playing on trampolines with others might also have noticed the phenomenon!

Videos

Stacked Ball Drop https://www.youtube.com/watch?v=2UHS883_P60

Forces: Can Tilt

What to do in advance: Drink/pour away the coke and then put about 100ml of water inside the can (this is much less sticky/messy if anything goes wrong!). You could also have an empty can and a full (sealed) can available as part of the demonstration.

What to do with pupils: Tilt the can on a hard, flat surface so that it balances on its rim. If you give it a little push it should even be able to spin around on its rim without toppling over.

Questions to stimulate pupils' thinking:

- Before the experiment: You could start by asking pupils to predict what will happen when you try to balance a full can on its rim and an empty can on its rim. Why do they topple over? Then show pupils your prepared can both balancing and rotating.
- After the experiment: Why does that happen? Why does the can balance? Do you think there is there anything inside the can? (Think, pair, share).
- Other follow-up: You could let small groups of pupils try this experiment for themselves in a tray. Can they get an empty can to balance by adding the correct amount of water to it? How much water was needed inside to get the can to balance?

The science behind it
With about 100ml of liquid in it, the centre of mass (also referred to as the centre of gravity) of the can when you tilt it onto its rim, is directly above the pivot point of the rim. So when gravity acts on the centre of mass and pulls it downwards, the can balances on the rim rather than toppling over. Because the liquid inside the can is able to move with the can, it will stay balanced even if the can rolls around on its rim.

Real world connection
Lots of balancing toys work by altering the centre of mass of an object so that it is directly below or on a pivot point. This video shows how you can make a balancing butterfly.
http://www.youtube.com/watch?v=Q1oIZ_heQ6U

Videos
http://prop-tricks.wonderhowto.com/how-to/perform-leaning-coke-can-trick-and-balance-coin-dollar-bill-425214/

Forces: Mystery Tin

What to do in advance: You will need a circular tin with a lid (e.g. diameter about 20cm and height about 10 cm). Tape a mass to the inside of the tin (using plasticine or a bag of coins/washers for example). You may want to line the mass up with the seam of the tin to help identify its position when looking on the outside. You will also need a board for the tin to roll up – about 40-50cm in length. Prop the board up at one end to form a slope.

What to do with pupils: Position the tin on the table, near the bottom of the slope, taking care to ensure that the mass inside is positioned so that when you let go of the tin it will roll up hill.

Questions to stimulate pupils' thinking:

- Before the experiment: What will happen when I let go of the tin? Predict which way the tin will roll when I remove my finger.
- After the experiment: Why does that happen? What could be inside the tin? (Think, pair, share).
- Other follow-up or prompt questions: How could you test if your idea was correct if you weren't allowed to open the tin and have a look?

The science behind it

The extra mass that you tape to the inside edge of the tin changes the centre of mass (sometimes referred to as the centre of gravity) of the tin, which would normally be at the centre of the cylindrical tin. The centre of mass is now much closer to the extra mass on the edge. Gravity acts on the centre of mass and pulls it downwards and this causes the tin to roll up the hill rather than down.

Videos

http://sciencemagician.wordpress.com/2012/10/02/anti-gravity-tin-a-simple-science-demo/

http://www.youtube.com/watch?v=GQ4c70eRvsU

Earth and Space: Planets on a String

What to do in advance: Tape a section of string about 7.5m in length to a pencil or a short piece of dowel. About 2.78m in from the loose end use a small loop of wire or thread to mark the position of the planet Mercury. Another 2.42m in from the loose end mark the position of the planet Venus and a final 2m in from the loose end mark the position of the planet Earth. When this is complete, roll the string up around the pencil and your planets on a string prop is ready to go! All it needs to go with it is a tennis ball to represent the Sun.

What to do with pupils: Stand at one end of your classroom and hold up the tennis ball. Ask the pupils to imagine that the tennis ball is a model for the Sun. Ask pupils to imagine a straight line from the tennis ball Sun to the other side of the classroom. Ask them to stand somewhere on that line in the position they think the Earth would be ***on that scale***. To up the stakes a little, say that no two people are allowed to stand in exactly the same location. When everyone has made their decision about where to stand, hold the loose end of the string firmly against the tennis ball and use a volunteer to slowly unwind the string. The first marker they come to represents the location of Mercury, the second marker represents the location of Venus and the final marker represents the location of the Earth. This gives a real insight into just how much space there is in Space!

Questions to stimulate pupils' thinking

- On this same scale how big do pupils think the three planets really are? (~0.2mm diameter for Mercury, ~0.6mm diameter for Venus and Earth)
- On the same scale how big do pupils think the other planets really are?
- On the same scale how far away do pupils think the other planets really are?

The science behind it

It is common to have misconceptions about this because the pictures we see in books can be so misleading and because other models might show the relative sizes of the planets, but can't also show the relative distances.

Useful links - Google Maps Solar System calculator:

http://thinkzone.wlonk.com/SS/SolarSystemModel.php

This handy tool allows you to set the scale for a Solar System Model to whatever suits your purposes and gives you both the relative sizes of the planets and the relative distances. On this scale with the Sun having a diameter of about 6.7cm you can see that the sizes of the other planets are:
Mars 0.3mm, Jupiter 7mm, Saturn 6mm, Uranus 2mm, Neptune 2mm. It also shows the distances.

Earth and Space: The Beads on String Model

What to do in advance: You will need two small beads hanging by threads from a rod or pencil. One bead represents the Earth and the other the Moon. The beads need to be about 10 cm apart so that the scale is roughly correct. You will need the following hidden in a black bin bag: table tennis ball, tennis ball, football and a large inflated beach ball.

What to do with pupils: Tell them that we have reduced the Moon and Earth in size by the same amount (to scale) and then this is roughly how far apart they would be.

Hold the model up.

Question 1: ***Is the Sun larger or smaller than the Moon?***
They will probably know that the Sun is bigger. Have the bag containing the variety of sized balls and bring them out one by one to see which one they think would be about the right size for the Sun:

- Table tennis ball
- Tennis ball
- Football
- Large beach ball

The really large beach ball is about right for the size of the Sun on this scale.

Question 2: ***How far away does the beach ball need to be for this scale model?***
It can be thrown to the middle of the room, back of the room, etc. but this would not be far enough - it needs to be 40m away! It is important to estimate where this would be, e.g. the back of the car park or whatever.
It is also interesting to ask children what is between the Earth and the Sun. Admittedly, there are two other planets but these are also relatively tiny and are in constant orbit around the Sun. Children tend to have quite a crowded picture of space and think that there are other stars between us and the Sun. Mostly it is just empty space, no air – nothing at all.

Then ask them to think about all the myriad of stars seen in the night sky.

Question 3: ***Where, on this scale, would our nearest neighbouring star be found?***
Ask for suggestions. They may say in a town 1 km away, or even 30 km away…
Incredibly, on this same scale with the Sun 40 m away from the Earth, the nearest star would be 4000 km away! So if the bead model is held up in a school in the UK, the model Sun is 40 away on the same scale, and the *nearest* neighbouring star would need to be in Canada! Such is the awesome scale of our universe.

Light: Bouncing Light

What to do in advance: You need a torch, a mirror (e.g. ~ 20 x 15 cm) and a tennis ball

What to do with pupils: Explain that you are going to bounce the tennis ball on the floor in a vertical position. Ask pupils to point in the direction that they think the ball will bounce back, then carry out the action. Now repeat, but bounce the ball on the floor at an angle from your right. Repeat again, but bounce the ball at an angle from your left.

Repeat the whole sequence again, but this time use a torch and a mirror, and as before ask the pupils to predict by pointing to where they expect to see the torchlight. First shine the light vertically down on to the mirror, then shine from the right and finally from the left.

Questions to stimulate pupils' thinking:

- Why were the pupils able to predict what would happen?
- Why did the light shining on a mirror behave in a similar way to a ball bouncing on the flat floor?
- What is special about a mirror?

The science behind it

Light travels in straight lines and when it reaches the smooth surface of the mirror, it reflects off the surface of the mirror rather like a ball bouncing off a flat surface. If light is shone vertically on to a mirror it will be reflected back the *same* way it came. If light is shone on to a mirror at an angle it will be reflected back at the *same* angle, but in the opposite direction to where it came. It is because a mirror is a very smooth surface that the light reflects off it in a predictable way and such that you can see the beam still focused as a spot of light.

Light: Sun Cream Safety

What to do in advance: Prepare four transparent containers, each containing about 50ml of tonic water, and with cling film stretched over the top. Have ready a small UV torch and samples of olive oil, moisturiser (no UV protection), low factor and high factor sun cream.

What to do with pupils: Make the room darker if it's possible to do so and show pupils your UV torch. It is hard to see the light because UV light is not visible to the human eye. UV light is produced by the Sun and it what makes our skin tan and burn. Show the pupils what happens when you shine your UV torch on the tonic water. It glows! (You could also demonstrate that ordinary water does not do this.) Take one cup and spread a layer of olive oil over the cling film, then shine the UV light on to the tonic water through the oil. Repeat for the other cream samples – pupils can share their predictions each time.

Questions to stimulate pupils' thinking:

- Why does the tonic water glow?
- What do they predict will happen when you shine the UV light on the samples? Why?
- What do they notice when you do the experiment?
- What does this experiment show us?
- What other experiments could we try? E.g. different thicknesses of oil/cream, different substances or cream samples, do other liquids glow etc.

The science behind it
Ultra violet (UV) light is a type of light which also comes from the Sun but it is invisible to the human eye (the blue we can see from the torch is not actually the UV – it produces blue light *as well* so we can see it). It is UV light which makes us tan, but which also makes us burn and can cause skin cancer. Tonic water contains the chemical quinine (which is used to treat malaria) and this is able to absorb the UV light and then emit it as a visible blue-ish light.

Real world connection
UV light can kill microbes so it is used in hospitals to sterilise surgical equipment and by food companies to sterilise products. It is also used to treat some skin disorders because it stimulates the production of Vitamin D in our bodies. It can be used to detect forged bank notes too.

Safety
This type of UV torch is safe to use (it is similar to ordinary torches because of the type of UV light used). It is still better though for you to store it away and only use it yourself in this sort of demonstration. However, do warn them about being safe in the sun.