Exploring Chemistry in SEND Schools

Six lesson plans

for mixed ability KS2 & 3 classes

Developed by

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with

The Staff and Students

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Sarah's Adventures in Science

John Watson School
a community special school

Supported by ROYAL SOCIETY OF CHEMISTRY

Contents:

Important note:

You should carry out an appropriate Risk Assessment before starting this work. Please check for allergies amongst your pupils and monitor them closely while working.
All lessons are done at your own risk.

This work was completed with the support of the Royal Society of Chemistry Outreach Fund.

WELCOME!

We are so glad you decided to take a look at our lesson plans.

I have personally tested each of these lessons in mixed ability KS2 and KS3 classes in John Watson School, an Oxfordshire community special school. They have also been tested independently by the staff and students at Frank Wise School, another community special school in Oxfordshire. Thank you to everyone who has tested the sessions to their limits! We think that between us, we have created a resource which teachers can pick up and use with minimal preparation.

The lessons are designed to fit KS2 national curriculum chemistry topics but also support other areas of learning throughout school. The activities are suitable for pupils with a wide range of needs across a wide range of ages from nursery upwards!

Each lesson plan has a **Key Vocabulary** list and supplemental list. The **Activity** section gives a suggested running order with questions to ask as you work. We have included a range of adaptations so that every pupil can get "hands-on". The **cost** information is based on a class of ten pupils using mainly supermarket value brands in January 2017.

The **Extension and Repetition** section is designed to help you embed knowledge and stretch your pupils. An **Assessment** section is included at the request of teaching staff. This is based upon the updated science P Levels (June 2017).

Please check for allergies amongst your pupils before you start the work and monitor pupils closely while working. All lessons are done at your own risk and you must complete your in-house Risk Assessment before starting the work.

We hope you enjoy these lessons as much as we have enjoyed developing them. Please share any feedback (positive or negative!) and please, PLEASE send us your photos: we would love to see your class in action!

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Lesson 1

Exploring Materials: Solids

Hard Work

Aims

To discover and explore a range of familiar solids.

To learn and use scientific vocabulary.

To investigate the properties of solids.

To SEE how solids remain unchanged, to HEAR the sound a solid makes when it is tapped, to TOUCH different textures, to SMELL...not a lot!

Key vocabulary

science, chemistry, materials, solid, liquid, liquify/melt, hard, plastic, glass, rock, metal, wood

Vocabulary

photograph, pen, write, hot, cold, hard, soft, light, heavy, rough, smooth, tap, squeeze, bend, stretch, ice

Materials

Class

- A selection of familiar solids from the classroom and home: building bricks, spoons, plates, trays, toys, foil pie dishes. Use contrasting shapes, textures and colours. Use man-made and natural materials. Avoid soft "solids" like playdough (made of solid particles in a small amount of liquid). Have examples of metal, plastic, wood, stone and glass (window), ideally at least three items per child.
- Writing equipment
- Jug
- Camera
- Symbol sheet for vocabulary
- Water frozen in a variety of containers (silicone cake moulds, jelly moulds, bowls) Fill 1/3 with water and freeze. Add glitter/confetti and further 1/3 fill with water and freeze. Top up with water and freeze again. The glitter should be truly trapped.
- Individual spill trays or one large tray

Cost for a class of 10

Use materials in class already. You can buy a bag of ice cubes at the supermarket for £1 but varied shapes provide more interest. Glitter/confetti £1

Total £2.00

Activity

- Show the pupils a solid item. Tap it on the table to show that it is hard - listen to the sound it makes. Can they describe it?

  - Can you squeeze it to make it smaller? Even a flexible plastic spoon always takes up the same space.

  - If you pour it into a jug, it stays the same shape. Does it smell? Most solids do not smell much because it is difficult for the scent molecules to escape into the air.
- Put out a range of solid items. Ask pupils to test them: tap, squeeze, bend, stretch, smell. Encourage pupils to notice that even if they are a bit distorted by enthusiastic scrunching, solids keep their shape and don't get bigger or smaller. Ask them to predict what will happen with similar materials.
- Help pupils to select a symbol, write or sign "solid". Take a photograph of all the materials together on the table with their written signs. This can be used in future weeks to remind pupils about solids.

- Clear the items away
- ACTIVITY CONTINUES ON NEXT PAGE

Activity(cont.)

- Give each pupil some ice shapes in a tray. Ask them if ice is a solid. Can they do the same tests? Tap, squeeze, bend, stretch. What will happen if you hold the ice in your hand? Observe what happens to it as they explore it. The heat from their hands and the classroom gives the particles in the ice more energy. If the particles get enough energy, the solid melts and becomes a liquid. We will explore liquids in Lesson 2.
- Questions to ask: Is it hard or soft? Is it hot or cold? Can you melt it? Can you get the glitter out? What happens if you squeeze it in your hand? Can you see the water dripping out? If you smash it, does the ice melt faster or slower? When it has been smashed it is easier for the warm air to reach all of the ice - it will melt more quickly.
- This activity works with pupils seated at the table with individual trays or working in a large water tray together.

Repetition and Extension

- Give each pupil an example of plastic. Get them to test it and repeat the words "plastic" and "solid". Ask pupils to help describe items. Hot/cold, rough/smooth, light/heavy, hard/soft. Help pupils to select a symbol, write or sign "plastic". Take a photograph of all the plastic materials together on the table or a tray with the written signs. Remove all the plastic items. Repeat for other materials: wood, stone, metal, glass.
- Challenge pupils to find more solids in the classroom or outside and bring them back to the table. Now ask pupils to sort them into piles of different materials (eg metal, plastic, wood). Is there a pile you do not have much of? Can you think of any solid material which you do not have an example of? Ask pupils to help find something else made of that material. Repeat the labelling and photography exercise.

Repetition and Extension (cont.)

- Think about which material is best for different jobs. Try the Chocolate Teapot card game, taught to me by Natalie Ford. Print and cut the templates provided online . Make a pile of cards with objects (red edged) and a pile of cards with materials (blue edged). Shuffle each pile. Now draw one from the top of each pile. For example if you draw

  Material = chocolate

  Object = chair

  Say one good thing and one bad thing about a chocolate chair. It would melt from the warmth of your body but you could eat it if you got hungry in lessons!

- Discover what happens when you break a solid. Give each pupil a re-sealable plastic bag then give them four biscuits (digestive or similar). Ask them if the biscuits are solid. Now ask pupils to place them in the bag and seal it. Can they crush them into tiny pieces (use rolling pins, cars, books, hands, feet, wheels of chair). Now look again. Is it still a solid? Yes, but the pieces are small so it moves like a liquid - it will fill the bottom corner of the bag and they can pour it like a liquid. Can they find anything else which does this? Sand, flour, sugar move like liquids but are actually small pieces of solid.
- Help pupils to understand that in a solid the particles are packed very closely together. You can do this by getting the pupils to stand very closely together with their arms by their sides. Staff should join in around the outside to keep the space restricted. Explain that just like in a solid, the pieces (pupils and staff) cannot move freely.
- Make a model of a solid. Fill a transparent box with small balls (eg takeaway box with craft pompoms). Make sure the individual pieces cannot move around. Each ball is a particle which makes up the solid.

Lesson 2

Exploring Materials: Liquids and Gases

Sensory Sensations

Aims

To discover and explore a range of familiar liquids and gases.

To learn and use scientific vocabulary.

To investigate the properties of liquids and gases.

To SEE how liquids and gas move, to HEAR splashes, and bubbles popping, to FEEL liquids and gas move through fingers, to SMELL the different liquids.

Key vocabulary

Science, chemistry, materials, solid, liquid, gas, move, flow, hard, bubbles, squeeze, rise

Vocabulary

Tray, jug, photograph, pen, write, soft, lumpy, smooth, tap, squeeze, bend, stretch, touch, sponge, bowl water, milk, syrup, squash, bubble bath, float

Materials

Class

- A selection of familiar liquids in trays or on plates for pupils to explore by touch: water, milk, syrup, paint, squash, minty mouthwash, baby lotion, shampoo, washing up liquid. Use contrasting thicknesses, scents and colours. Do not use cornflour/water oobleck. At least one item per child.
- Solid item like a stone
- Bowls for water
- Small sponges
- Magnifiers
- Whiteboards/paper and pens
- Jug
- Camera
- Symbol sheet for vocabulary

Cost for a class of 10

Squash (50p/litre), milk (75p/litre), syrup (£1.18/680g), washing up liquid (33p/500ml), shampoo (50p/litre), baby lotion (25p/500ml), mouthwash (65p/500ml), paint and glue (class supply), small sponges (20 value washing up sponges 80p, remove the scourer)

Total £4.56

Activity

Liquids

- Revise with the pupils what happens when you tap, squeeze, bend, stretch a solid. Show the pictures of last week's exercise to remind them of the solids they found and what materials they were made from.
- Show the pupils one of the liquids.

  - What happens if you tap it? Listen to the sound, watch for the splash!

  - Can you squeeze it to make it smaller? It will ooze between your fingers. The particles in a liquid are not as closely packed as in a solid but they have little room to move. They can slide past each other though.

  - If you pour it into a jug, the liquid flows and changes shape. Flat on the tray, now deeper in a narrower container. Liquids take up the shape of their container.

  - Does it smell? Liquids often smell because tiny particles can escape into the air and reach our noses. Especially when they get warm in our hands.

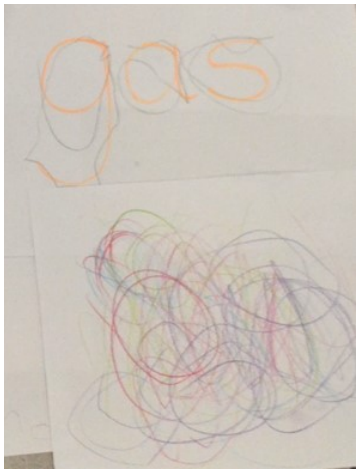
  - Can you write your name in it? It only works in thicker liquids. We found some pupils enjoyed mark-making by squeezing out golden syrup into a tray.
- Put out a range of liquids (the pupils will enjoy pouring them out into trays for themselves). Ask pupils to tap, squeeze, bend, stretch and test them. Encourage pupils to notice how they change their shape but don't get bigger or smaller (though some might be on the floor!). Encourage mixing and choices.
- Seal contrasting liquids in ziplock bags or in half-filled bottles and place them on hands or knees. Help pupils to explore how the liquids move, can they mix them? Alternatively, give pupils gloves to wear. You can cut a tiny hole in one to gradually increase exposure!
- Clean up.
- Name each of the liquids and help pupils to select a symbol, write or sign "liquid". Take a photograph of all the liquids together with their signs. These pictures can go on the classroom wall or be laminated as reminders.
- ACTIVITIES CONTINUED ON NEXT PAGE

Place two different liquids in a ziplock bag (e.g. two types of bubble bath), squeeze out the excess air and seal it. Ask your pupil to mix the two liquids.

It's a great opportunity to discuss colours and works really well on a lightbox. Adding glitter will really appeal to some pupils!

Activity (cont.)

Gases



- Show pupils that if you hold a dry sponge in a bowl of water, you can squeeze it out and make bubbles appear. Where did they come from? They were trapped in the holes in a sponge. Give each pupil sponge and magnifier to look at the holes then give them a bowl of water to test for themselves.

  Where do the bubbles go? Upwards, this is because they are less dense than the liquid. You can call them "lighter" if it conveys the meaning more easily.
- Add a couple of drops of washing up liquid to the water, now repeat with the sponge. This time the bubbles of gas are getting trapped in the soap.
- Help pupils to write or sign "gas". Take a photograph of the bubbles with the signs.
- These pictures can go on the classroom wall or be laminated as reminders.

Repetition and Extension

Liquids

- Ask pupils to find more liquids in the classroom or outside and bring them back to the table. Value ranges in the supermarket are useful for "hiding" around the room. Check the beauty aisle: shampoo is thick, mouthwash is minty and thin, baby lotion is smooth and silky. Send them on their hunt with buckets/cups.
- Ask pupils to sort the liquids into groups of different materials by character. Sticky, runny, oily, watery etc. Some will fit into more than one category. Ask pupils to select a symbol, write or sign each different category. Take photographs of each set with their written signs.
- Measure a sample of very runny liquid in a variety of differently shaped cylinders, jugs, beakers to show the volume stays the same when shape changes.
- Make a model of a liquid. Half-fill a transparent box with small balls (eg takeaway box and craft pompoms). Each ball is a particle which makes up the liquid. See how it changes shape when you move the box. It fills up the bottom part of the container which ever way up you hold it.

Repetition and Extension (cont.)

Gases

- Ask pupils how you could collect different gases. What would they need? Show them a sandwich box of air. Have balloons ready too. Tell them that flatulence is made of gas too!
- Give pupils a bowl of value lemonade (40p/2litres) let them watch the bubbles in it and explain that they are made of gas. Watch how the bubbles rise to the surface because they are less dense or lighter than the liquid. Next put a spoon in and see how the bubbles form on it. Next ask the pupils to put their hands in. How do the bubbles feel? Do they travel up towards the surface?
- Make a model of a gas. Put a small number of balls in a transparent box (about 20 craft pompoms in a takeaway box). Shake the box to show the gas has more energy and the particles are pinging around all over the box. They take up all the space available.

Solids, Liquids and Gases

- Help pupils to understand that in a liquid, the particles are packed very closely together but can move. You can do this by getting them all to stand in a limited space, about 50cm apart with their arms out about 10cm at their sides. Use adults around the outside to limit movement. Ask them to move around. Now help pupils to understand packing in a gas by giving them the freedom of the whole room to move around in, they can have their arms out horizontally to help them understand the spacing more. Staff can join in! Revise that in a solid, particles are closely packed.

Lesson 3

Mixing and Separating: Reversible Reactions

Before and After

Aims

To revise the properties of solids and liquids.

To learn and use scientific vocabulary.

To explore mixing and separating solids and liquids.

To investigate *reversible reactions*.

To SEE a mixture form and separate, to HEAR mixing and separating, to SMELL the materials, to TOUCH different textures.

Key vocabulary

Science, chemistry, materials, solid, liquid, gas, mix, mixture, separate, reversible, irreversible, sieve

Vocabulary

Sand, pasta, rice, water, colander, filter, jug, bowl, tissue

Materials

Class

- Three different sized solids e.g. uncooked pasta shapes, uncooked rice, dry sand. Approx. 1kg of each
- Scoop for each solid (plastic cup)
- Water
- Sieves and colanders. Enough for each pupil to have ready access. Raid your nursery sand and water play trays!
- Strong tissue paper (e.g. blue roll)

Per child

- Spoon
- 2 bowls
- Jug for water
- Symbol sheet for vocabulary

Cost for a class of 10

Pasta 60p, rice 40p, sand 50p

Total: £1.50

Activity

- Place bowls of solids in the centre of the table. Place sieves, colanders, bowls and spoons within easy reach of pupils.
- Name the items on the table. Ask if they are solid, liquid or gas. Use the photographs from previous sessions as a prompt. Ask the pupils if they can remember the properties of solids. What tests did they do before? Can they test these in the same way?
- Model to pupils taking a scoop of two different solids, placing them in a mixing bowl and using a spoon to mix them together to make a mixture.
- Use a sieve or colander to separate them out again. Ask pupils how it happened. Show how the holes in the sieve/colander made it possible to separate them. We call this a reversible reaction because we can get back to where we started.
- Invite pupils to make their own mixtures and separate them. Note down results. Encourage them to think about why the sieve/colander worked with respect to the size of the holes.
- Provide jugs of water (approx. 100ml) to each pupil. Ask if they are solid, liquid or gas. Use the photographs from previous sessions as a prompt. Ask the pupils if they can remember the properties of liquids. What tests did they do before? Can they test these in the same way?
- Invite pupils to mix liquid water with one solid and then separate. Sand and water will need tissue paper adding to a sieve to act as filter paper. Encourage pupils to think about why the paper worked. They might not have thought about it as having tiny holes in to let the water through but not the sand. We call this filtering. Use a magnifier to look at the holes in the paper.
- Use the symbol sheet to show that each reaction is reversible. This is like a circle where "before" and "after" can actually be the same if we add in the right filtering step. They can keep repeating it over and over mixture - separate - mixture - separate. Use this idea for any extension work.

If you can't find enough colanders, you can make them!

Simply heat an old screwdriver and use it to make holes in a cheap mixing bowl. This should be done in a well-ventilated area, taking care with the heat source.

Definitely not a job to do with pupils.

Repetition and Extension

- Encourage pupils to find other solids from the classroom to make their own mixtures - cars, blocks, beads, confetti.
- Make more complex mixtures with staged separation.
- If you have a large base tray or can work outside: Offer vegetable oil to mix with water. Ask pupils to mix them thoroughly then separate it with available kit. They will discover that the oil AND water can pass through the colander, sieve and tissue paper because the both have similar small particle sizes. Let it stand and the two liquids separate. Encourage them to try pouring the top layer off. This mixture can be separated! This may be familiar from sensory bottles.
- Take a bowl of hot water (approx. 100ml) and stir in salt until it can no longer dissolve. This is called a saturated solution. Now place a spoonful in a foil cake case or . Place it on the radiator or windowsill to warm through. Ask pupils what they can see happening as it heats up (white crust of salt). Where has the water gone? (evaporated into the air). Mixing salt and water is a reversible reaction.
- Make salt geodes. Make a saturated salt solution (plus food colouring for interest) and pour into egg shells which have had ALL layers of membrane cleaned from inside (in case of allergies, you can use foil trays). Stand them in egg boxes to keep them upright. Leave for a week. The water evaporates off, leaving a salt crust behind. Use a magnifier to see the cubic crystals typical of table salt. Mixing salt and water is a reversible reaction.

Assessment for lessons 1-3

P1 (i) Pupils encounter the activities and may be passive or resistant. They may startle at the sound of solids being banged on the table or react to hand being placed in liquid. Participation is fully prompted.

P1 (ii) Periods where pupil is alert and ready to focus on activity. Turning towards banging and crinkling sounds or touching materials.

P2 (i) Reacting to new activities (sound, textures, movement of staff and pupils). Beginning to show an interest in materials (e.g. a bag of liquid placed on the knee or hand). Accept and engage in coactive exploration to pour, stir, mix and separate.

P2 (ii) Showing consistent preferences or dislikes for materials used in lessons. Beginning to recognise familiar items. Become more confident in movements as repeated and remember learned responses (e.g. "brick is solid") over a short period of time. Cooperate in sharing materials and examining samples handed to them.

Assessment for lessons 1-3 (cont.)

P3 (i) Request staff to select different materials by touch/pointing/reaching/eye contact. Movements with increasing confidence, requiring less support. Sustaining interest and concentration for short periods. Exploring materials with senses and observing the consequences (including scrunching paper/foil, pressing hard and splashing liquids). Starting to move materials (intentional actions). Remembering learned responses over longer periods (which liquids they liked the smell or feel of when the lesson is repeated).

P3(ii) Pupils recognise activities and objects and might select favourite when repeating a lesson. Can remember learned responses and anticipate known events such as ice melting. May express a preference for items through touch, preferring the thin minty mouthwash to the sticky syrup. May explore for longer with greater concentration. Use the sieve/colander systematically.

P4 Pupils explore materials given to them (by any sensory means), mixing and observing reactions. They imitate staff actions for testing, mixing and separating, involving pushing and pulling. May initiate more complex exploration of materials - crushing pasta, splashing water, mixing, watching sieving. Check actions are intended not accidental.

P5 Focus on anticipation and enquiry. Matching solids and liquids based on single factor e.g. hard or runny. Expect a liquid to pour or bubbles to rise once they have seen it happen. Can see adding ingredients, mixture and separation as "before and after" or "back again". Try range of equipment as become familiar. "Show me how to separate these", "Are the holes big or small?", "Is the sand big or small?" "Show me what you do with this". Try out the equipment provided (spoons and sieves). Able to show, demonstrate and try out the materials in their own method (pupil may guide an adult to do this).

P6 Pupils can recognise the familiar objects used and where they come from. Beginning to make generalisations, connections and predictions based on regular experience (expecting the ice will melt, or that some items will go through the sieve holes). Can sort materials on a single factor if the contrast is obvious (wood, metal, glass). Close observation of experiments.

P7 Understand simple scientific vocabulary "before", "after", "solid", "hard". Can relate observations and ideas/predictions. Describe movement as "fast" when referring to a very runny liquid. Put symbols in sequence or label items using symbols. Beginning to make plans and suggestions e.g. selecting a contrasting liquid to add to their tray. This may require staff assistance to carry out.

P8 Pupils observe regular changes e.g. the melting process. They contribute to planning and evaluation and recording their findings. They can identify common materials and some of their properties. Observe and compare. Can group similar materials (eg plastic, wood). Can communicate these differences. Can sort solids into groups based on their own terms (shiny, smooth, rough). Can explain changes due to heating the ice: it melts, it is water, it is liquid. Can describe changes in flexible plastics after bending when questioned directly.

Notes:

Notes:

Lesson 4

Exploring Change: Irreversible Reactions

Fizzing Rocks

Aims

To revise the properties of solids, liquids and gases.

To learn and use scientific vocabulary.

To explore mixing solids and liquids and observe changes in materials.

To investigate *irreversible reactions*.

To SEE a reaction which makes bubbles of gas, to HEAR the fizzing of bubbles, to TOUCH bubbles of gas, to SMELL the vinegar.

Key vocabulary

Science, chemistry, solid, liquid, gas, mix, reaction, mixture, separate, irreversible, rise, lighter

Vocabulary

Bubble, fizz, water, vinegar, sodium bicarbonate, pipette, bowl

Materials

Class

- Sodium bicarbonate "rocks" made at least 48 hours in advance of session. The longer they dry, the harder they become, and the longer they last in the session! Add water slowly to a bowl of the powder, stir with a spoon until it starts to come together into a loose paste (see pictures P22). Press the mixture together in your hand to make rocks about 2-3cm in diameter. Hide a large piece of glitter confetti in the middle of each. Leave to dry. 500g makes approx. 25 rocks
- Distilled vinegar, each rock takes about 150ml to dissolve completely
- Symbol sheet for vocabulary

Per child

- 3-4 "rocks"
- Small bowl and cup
- Pipette, beaker or spoon to pour vinegar on in controlled manner

Cost for a class of 10

500g sodium bicarbonate (eBay, sold as bath bomb ingredient) £1, vinegar £3.60, glitter confetti 50p

Total: £5.10

*Disposable Pasteur pipettes (£3 for 50 on eBay) Asda vinegar comes in plastic bottles,

Activity

- Place a rock on a tray. Ask the pupils if it is solid, liquid or gas. Use photographs from previous session as prompt.
- Drip water over it and observe. There is no reaction (it just gets wet)
- Show pupils the liquid vinegar. Ask them to smell it - some might say it smells like chips. Show that it is runny and takes the shape of the container. Ask the pupils if it is solid, liquid or gas. Now use a pipette to put drops of vinegar on the rock. Watch and listen to what happens.
- The bubbles are made of the gas carbon dioxide (the same gas used in fizzy drinks). They are made when the runny liquid vinegar (acetic acid), reacts with the hard solid bicarbonate of soda (sodium hydrogen carbonate).
- Give pupils the equipment to do it for themselves. They may need assistance with pouring the vinegar or using a pipette but it's great motor skill practise. Can they discover what is hidden inside?
- As the pupils work, ask them what is happening to the rock. Where is it going? It seems to be disappearing as the reaction happens. Nothing has actually disappeared, it has changed.

  bicarbonate of soda + vinegar (acetic acid)

  → carbon dioxide + sodium acetate + water

  The sodium acetate and water are left in the bowl (they look just like water). The carbon dioxide has gone into the air. It is an irreversible reaction, because we cannot get it back like we did last week. This kind of reaction is a straight line instead of the circular reversible reaction.

  Explain that as the ingredients react they are changed into something different - that's why it looks like they are running out of rock or vinegar. How can they make the reaction happen again? What do they need more of?
- Encourage pupils to hold a fizzing rock so they can feel and hear the reaction as well as seeing and smelling what is happening.
- Encourage pupils to repeat the water test for themselves when they get their second rock. Does it work? It's not as smelly but the reaction does not happen. We need vinegar! Help them drain the water away and add vinegar to the same rock - this proves it's not a trick rock.
- Does breaking up the rock change how quickly the reaction happens? (work in a tray or have paper towels ready!) When we break it up, we increase the surface area so the reaction can happen in more places at the same time. This means it fizzes much more but the reaction will be over more quickly.
- Use the symbol sheet to show that the reaction is irreversible. It is like a straight line where "before" and "after" are different. Use this idea for any extension work.

Repetition and Extension

- You can improve the sensory qualities by adding different ingredients. Add glitter/confetti to the dry powder and stir BEFORE you add the water. Add food colour/flavour to the water BEFORE you stir it into the powder. This will help it to spread more easily through the mix.
- Encourage the pupils to work with staff to make the rocks for themselves. Ask them to make one for a named classmate. They can hide something inside and add glitter/colour/flavour/scent which they know the named pupil will like. In the following practical class pupils can watch as their surprises are revealed.
- Bag bombs. (see pictures P23)You'll need small resealable plastic bags in addition to previous materials (GL05 11x11cm resealable bags (£2 for 50) eBay). Work as a class team. Put a large tray on the floor or work outside. You can do a version using a small tray and large sandwich box placed on a resonance board.

  Remind the pupils of the reaction you have just done and how it made bubbles of gas. What will happen if you try to trap the gas in a bag?

  Put two tablespoons of bicarb onto a piece of toilet roll and wrap it to make a parcel. Place 100ml vinegar into the bag. Now put the parcel of bicarb into the bag, seal it quickly and give it a gentle shake. Cover it with a transparent storage box so pupils can observe in safety.

  You should be able to see the fizzing as the bubbles of carbon dioxide are made. The bag will puff up as the gas is released. This shows that the gas takes up more space than the solid plus liquid ingredients. Eventually the bag will burst with a loud pop.

  Try again and vary the quantities. Change just the amount of vinegar, just the amount of bicarb, or just the size of the bag. This will ensure a fair test. Which combination gives the best bang? Are some reactions too fast to get the bag sealed in time?
- Make bath bombs for the school fair (and test them out!). Place 300g bicarbonate of soda and 100g *finely* powdered citric acid into a bowl. Mix them together with a spoon, crush out any lumps. Add in colour: Powdered colouring is best, if you use liquid food colouring it needs to be stirred in quickly or it will start the fizzing reaction! Add in food flavourings, a dessert spoon of vanilla essence works well. Mix well. Now use a sprayer bottle to slowly add water. Keep mixing to prevent fizzing!

  When it starts to come together, press it into flexible silicone ice cube moulds. Push some glitter into the centre of each to make the bath sparkly. Allow to dry for 30 minutes then remove from the moulds and allow to dry completely. This will make 10 large ice cubes worth.

Assessment

P1 (i) Pupils encounter the activity and may be passive or resistant. May reflex react to sound of bag bomb.

P1 (ii) Pupils show emerging awareness of activity. May react to feeling of bubbles on hand, smell of vinegar, sound of fizzing, bag popping.

P2 (i) Pupils will react to the smelly vinegar and may push it away. Beginning to show interest in activity, may engage in coactive exploration of materials in hand-over-hand partnership with staff.

P2 (ii) Pupils begin to be proactive in their interactions. They may show consistent preference for dislike for vinegar. Performing experimental actions by trial and improvement (pipetting, pouring, crushing). Remembering (over short period) that adding vinegar will make the rock fizz. Cooperate in shared and supported exploration with staff.

P3 (i) Request staff to add vinegar by touch/pointing/eye contact. Complex exploration of materials - crushing rocks, mixing. Examining reaction, exploring through touch and other senses. Remember what happens when you add vinegar (remembering learned response).

P3 (ii) Pupils may imitate staff to add their own vinegar, may anticipate the reaction of vinegar and rock. May be able to choose vinegar rather than water for the reaction. Will actively explore the reaction and apply their own solution to adding the vinegar .

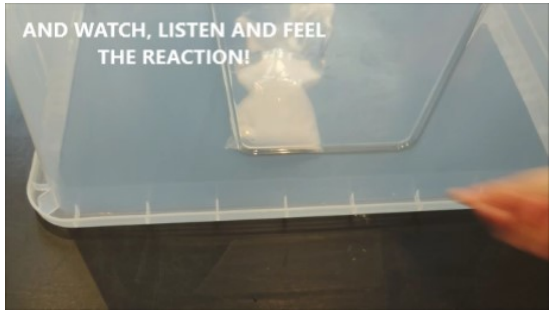
P4 Pupils will push and pull the equipment and explore it with their senses. They will investigate and observe. Staff should ensure these are intentional actions.

P5 Anticipation and investigation. Can see adding ingredients, fizzing and reaction as "before and after". Try different ways of adding vinegar as become familiar. "How do you make it fizz?". Staff may need to carry out actions.

P6 Pupils begin making connections, generalisations and predictions based upon their experience. Crush the rock a little and watch the increase in fizzing. "What will happen if we completely crush it?"

P7 Pupils Understand simple scientific vocabulary "before", "after", "mix", "fizz", "react". Can relate observations and ideas/predictions. Make a record with symbols.

P8 Pupils can recognise the vinegar-bicarb reaction as producing gas and may be able to predict what will happen in a sealed "bag bomb". They can identify vinegar as a liquid, the rock as a solid, and the bubbles as gas.



Making Rocks

500g bicarbonate of soda makes about 25 rocks.

Make them at least 48 hours in advance of your lesson.

Have plenty of vinegar and pipettes ready!

Mix bicarbonate of soda with water until you get a soft paste. If you add too much water it will be difficult to form and take longer to dry.

Each rock should be about 2 dessert spoons worth of mixture.

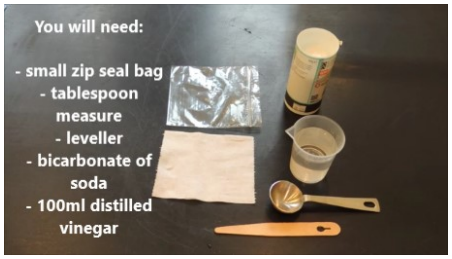
Add glitter to the rocks. Some pupils will enjoy revealing it if it is completely hidden.

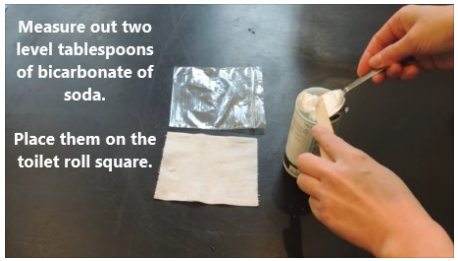
Leave to dry.

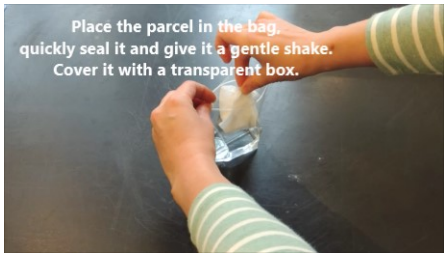
Give pupils a bowl, a rock, some vinegar and a pipette and let them explore! Encourage the use of all the senses including touch.

Bag Bombs

These were hugely popular in class!







Encourage pupils to feel the box, floor or table where you do the reaction. Can they feel the vibration? A wooden floor or resonance board might help.

You can increase pupil participation by sealing the two ingredients in separate corners with bag clips. You will need larger bags for this and they will use more ingredients.

Lesson 5

Exploring Change: Reversible and Irreversible Reactions

Lava Lamps

Aims

To revise the properties of solids, liquids and gases.

To learn and use scientific vocabulary.

To explore mixing solids and liquids and observe changes in materials.

To investigate and revise *irreversible* and *reversible reactions*.

To SEE liquids and gas separate by density, to HEAR the fizzing of the reaction, to TOUCH bubbles made by a fizzing reaction, to SMELL the fruity tablets.

Key vocabulary

Science, chemistry, materials, solid, liquid, gas, mix, reaction, mixture, separate, reversible, irreversible, rise

Vocabulary

Bubble, fizz, water, oil, tablet, funnel, bottle, lid, glitter

Materials

Per child

- Glitter confetti
- Large bowl
- At least 6 effervescent vitamin C tablets. For pupils with gluten or maltodextrin contact allergy, suitable tablets are available from Holland & Barrett.
- Food colouring
- Symbol sheet for vocabulary
- Cost for a class of 10

Super-sensory version

- Large ziplock bag
- 50ml vegetable oil
- 100ml water

Bottle version

- Empty 750ml-1litre transparent bottle with lid.
- 300ml vegetable oil
- 200ml water
- Funnel

Vegetable oil £1/litre, vitamin C tablets £1/20, food colouring £1/bottle, large ziplock bags £1/20

Sensory Total: £4.50 Bottle version Total: £6.00

Activity

- Use a funnel to add water to your bottle. Add a few drops of food colouring for added contrast and swish it. Gently add vegetable oil - help pupils to observe how the water and oil don't mix and the oil is floating on the water. Put the lid on. They separate because they have different densities. There are fewer particles in 1cm³ of oil than in 1cm³ of water. This makes the oil less dense than the water, so it floats just like a dry sponge on water. The oil is effectively lighter.

  Pupils may be familiar with this from sensory bottles. If so, ask pupils if they can think where they have seen this before (have a sensory bottle in clear view!). Ask them to help show how the oil and water mix and separate. This is a reversible reaction, we can think of it as a circle and keep repeating it.
- Assist pupils to make their own version. Try to limit excessive shaking or the bottles take a long time to settle out and the lava lamps don't work as well. Observe well, then remove bottles from the table and allow them to settle.
- Now show the pupils how an effervescent vitamin C tablet works. Give each pupil a large bowl of water and give them a tablet to put in it (monitor for consumption, include in your Risk Assessment). Ask them what they can see, feel, smell and hear. Encourage pupils to think about where they have seen this fizzing before. It's similar to the vinegar/bicarb reaction from last week because a gas is made. This time, the tablet is made from two dry ingredients which react when they get wet.

bicarbonate of soda + citric acid + water → water + carbon dioxide + sodium citrate

  Apart from the gas which is produced, everything else becomes dissolved in the water. The water changes colour because the tablet has colour added to it. The reaction is a straight line irreversible reaction. We can't get it back to the same as before because the gas has been released into the classroom.
- Break a vitamin C tablet in half. Add one piece to the bottle. DO NOT PUT THE LID ON - any trapped gas could cause an explosion! Watch together.
- Notice how the tablet dissolves in the water, just as it did in the bowl. The gas bubbles will rise to the surface because they are less dense than the water or oil. A gas is less dense than a solid or a liquid. As the bubbles rise they take small amounts of coloured water, which fall down again when the bubbles pop at the surface.
- Give each pupil a piece of vitamin C tablet so they can make their own lava lamp. Encourage them to explore reaction rates by adding more pieces or by crushing it to a powder. Monitor tablets to prevent consumption. Stand bottles in trays if necessary!
- Notice how the water changes colour as more tablets are added. The food dyes are water soluble and will not colour the oil.

Activity (cont)

- Super-sensory version Start by showing a vitamin C tablet in a bowl (see above) then encourage children to try for themselves. See above.

  Then place a smaller quantity of oil, water, food colouring and glitter into a ziplock bag. Encourage pupils to do this with a helper if required. Add 1/4 tablet to the bag and seal it with as little air in the bag as you can manage. Encourage pupils to observe and explore the reaction. Repeat with more tablet pieces. Keep an eye out for bags filling with gas. You can remind pupils of the bag bombs from Week 3 and ask what might happen next!
- Use the symbol sheet to show the two reactions. The oil-water mix is reversible. We can think of it as a circular reaction with "before" and "after" the same. Adding the vitamin C tablet is irreversible because the carbon dioxide gas escapes from the bottle and the contents of the bottle have changed. It is like a straight line where "before" and "after" are different. Use these ideas for any extension work.

Repetition and Extension

- Do not dye the water and secretly give the pupils different tablet flavours. Can they explain why the water becomes different colours?
- Add washing up liquid. The bubbles of carbon dioxide gas become trapped in the soapy water to create a bubble foam which pours out of the bottle (do this in a tray).
- Turn off the lights and shine a light through the bottle - just for fun!
- Use liquids of different densities to add more layers: honey, golden syrup, baby oil.
- Add in glitter confetti, sweetcorn or raisins to see if the gas bubbles can lift them. If enough bubbles form on an item, it effectively decreases it's density so that it floats. When it reaches the surface, the bubbles pop and it sinks down again.

Assessment

P1 (i) Pupils encounter the activity and may be passive or resistant. Any participation is fully prompted.

P1 (ii) Pupils may have periods of alertness and give intermittent reactions to the activity.

P2 (i) Pupils react to the activity, pushing away or moving their eyes to the movement of the bubbles and glitter. Accept and engage in coactive exploration

P2 (ii) Pupils show consistent preference for items, recognising familiar things (showing like/dislike of vitamin C tablet smell). They perform actions, like adding a tablet, by trial and improvement. They remember learned responses over a short time ("bubbles") Coactively work with staff to make a bottle. Become more confident in movements as repeated.

P3 (i) Request staff to add components by touch/pointing/eye contact. Complex exploration of materials - crushing tablets, mixing. Examining reaction, exploring through touch and other senses. Observe with interest what happens when you add a piece of tablet. Movements with increasing confidence.

P3 (ii) Pupils may initiate adding tablets tot the bottle and may anticipate what will happen when the do. They may respond to options and choices with actions or gestures (e.g. selection of glitter type). They may explore for an extended period of time.

P4 Exploring materials and equipment. Observing what happens when you combine the ingredients. Starting to move materials, equipment, add tablet pieces for themselves (intentional actions). Explore materials with senses.

P5 Anticipation and investigation. Can see adding ingredients, fizzing and reaction as "before and after". "How do you make the bubbles?" This may involve directing an adult in the task.

P6 Pupils closely observing processes and changes. Making generalisations, predictions and connections "If I add more tablet it will happen faster", "The reaction has slowed, I can add more tablet to speed it up"

P7 Understand and use simple scientific vocabulary "before", "after", "mix", "separate", "react", "bubble". Can relate observations and ideas/predictions. May need to direct an adult to carry out actions.

P8 Pupils notice patterns of adding more tablet or crushing vs reaction rate. The contribute to planning, evaluating and recording. Understand solid (hard), liquid (runny) and gas (like air) are different and select example of described material. Observe changes are result of what they did and describe when questioned directly.

Lesson 6

Exploring Change: Irreversible Reactions

Super Gloop

Aims

To revise the properties of solids and liquids.

To learn and use scientific vocabulary.

To explore mixing solids and liquids and observe changes in materials.

To investigate and revise *irreversible* and *reversible reactions*.

To SEE changes in materials, to TOUCH and explore changes in a non-Newtonian liquid under different conditions, to HEAR the sounds made by the Super Gloop, to SMELL the ingredients used.

Key vocabulary

Science, chemistry, solid, liquid, mix, reaction, mixture, separate, reversible, irreversible, flow, break

Vocabulary

Glue, starch, runny, lump, hard, squeeze, bounce, ball, stretch

Materials

Per child

- Small bowl with about 50ml (5 dessert spoons) PVA glue.
- A teaspoon (5ml) of contact lens solution which lists boric acid and sodium borate in the ingredients. The solution contains enough borax for the reaction but at non-toxic levels. "Saline solution" contains the ingredients at a lower concentration and you will need to use about 4x more to get the same results.
- A pinch of bicarbonate of soda
- Spoon or lolly stick for mixing
- Colouring paste (if desired)
- Plate or tray
- Ziplock bags for tactile defensive pupils
- Symbol sheet for vocabulary

Cost for a class of 10

PVA glue (use cheap high street version not super-washable school supplies version) £1.00/500ml, Contact lens solution (NOT SALINE) £10/250ml, Bicarbonate of soda 90p/180g, ziplock bags £1/20

Total: £4.00

Activity

- Super Gloop can represent a choking hazard. Monitor pupils closely and include this in your Risk Assessment. Wash hands and surfaces after handling Super Gloop. Wear aprons - Super Gloop can stain clothing, especially if you add food colouring.
- Show the pupils a bowl of glue (50ml) - they should be familiar with this, ask if it is a solid, liquid or gas. Revise the properties if necessary.
- Add two large pinches of bicarbonate of soda to the glue and stir it in. You can explain how you used this before for the rocks and bag bombs. Here it does a different job (see below). Now add a teaspoon of the contact lens solution and stir vigorously. You could use a pipette to measure 5ml instead. When it starts to come together, use your hands to squelch and form it into a ball. This is Super Gloop. The more you handle it, the better the texture.
- Give each pupil a bowl of glue, a pinch of bicarb and a spoon and ask them to stir. Help pupils to add 5ml of contact lens solution, either by pipette or teaspoon and ask them to mix it all. **If it is too runny, it needs more contact lens solution, if it is too hard, they need to add a little more glue.** Can they balance it to make some brilliant Super Gloop?
- Once they each have a ball of Super Gloop, get them to place it on a plate and clean down the work area. Throw waste into the bin. DO NOT POUR IT DOWN THE SINK or it will clog the pipes.
- If you have sensory defensive pupils, place the gloop into a ziplock bag for exploration. Alternatively have some gloves available.
- Encourage pupils to explore the Super Gloop. The more it is handled, the better it behaves!

- Can you make a ball?
- What happens if you pull it quickly?
- What happens if you thump it? Does it splash?
- What happens if you pull it slowly? How far can you make it reach?
- Can you make it so thin you can see light through it?
- What happens if you make a ball and then leave it? Does it change shape?
- Can you bounce it on the table?

- ACTIVITY CONTINUED OVER PAGE

Activity (cont.)

- Super Gloop is amazing. PVA (Poly Vinyl Alcohol) glue is made of long strands which slip past each other. When the water dries from it, the strands become locked into place and hence things stick together. The bicarb reacts with the lens solution and it forms weak bonds with the PVA. This lets the strands slide past slowly and behave like a liquid. When we put it under stress (by squeezing or hitting) the weak bonds break.
- Super Gloop is an example of a non-Newtonian fluid. Just like cornflour-water oobleck, it behaves differently under pressure compared to a normal liquid. It is an irreversible reaction (a straight line instead of a circle).
- Super Gloop can be stored in airtight bags/boxes overnight for re-use. After this time it might start to collect too much dirt. Do not allow pupils to take it home. Always dispose of it in the rubbish, not down the sink.
- Use the symbol sheet to show the reaction. Combining the bicarb, contact lens solution and glue is irreversible because a chemical change happens when the bonds are formed. It is like a straight line where "before" and "after" are different. Use these ideas for any extension work.

Repetition and Extension

- Pupils can measure the quantities for themselves and control the mixing and choices of colour and glitter.
- Make cornflour-water oobleck (also known as gloop). This is also a non-Newtonian fluid. Ask pupils to:
  - Let it flow through their fingers
  - Flow across the bowl
  - Press it into a ball
  - Snap a ball of oobleck in two
  - Hit it with a spoon. Does it splash? Does it become hard?
  - Do they notice it behaves like the Super Gloop?
- Crash protection: Fill a small plastic bag with oobleck or Super Gloop then gently push an uncooked egg into the centre of it. If you drop it to the ground, the stress of the impact should make the oobleck/Super Gloop become solid and absorb the impact force. The egg SHOULD remain intact!

  How high can you drop it from before the egg breaks? Use the same size bag and amount of oobleck/Super Gloop each time. By keeping these factors constant and only changing the height, you are performing a fair test. Measuring the height allows you to quantify your results. Can you make a graph or other pictoral representation of your results?

Assessment

P1 (i) Pupils encounter the Super Gloop making and may be passive or resistant. Any participation is fully prompted.

P1 (ii) Pupils may have periods of alertness to activity and give intermittent reaction to touching the Super Gloop.

P2 (i) Pupils react consistently to the Super Gloop and accept and engage in hand-over-hand exploration.

P2 (ii) Pupils communicate consistent like/dislike of smell/textures. Coactively work with staff to make Super Gloop. Become more confident in movements as repeated.

P3 (i) Request staff to add components by touch/pointing/ eye contact. Complex exploration of materials - squeezing, splashing, mixing. Examining reaction, exploring through touch and other senses. On second run-thorough, pupils may anticipate what happens when you mix the ingredients. Movements with increasing confidence.

P3 (ii) Pupils can anticipate what will happen if they drop the Super Gloop from height (it will fall). Will actively explore the Super Gloop for a longer period

P4 Pupils may select items by pulling and pushing, Using all their senses to explore the activity. Ensure actions are intentional.

P5 Anticipation and investigation. Can see adding ingredients and reaction occurring, can see different materials as "before and after". Pupils can respond to simple scientific questions about the activity.

P6 Pupils are closely observing processes and changes. Making generalisations, predictions and connections "If I squeeze this it becomes hard" "If I am gentle I can stretch it all the way across the table"

P7 Pupils understand simple scientific vocabulary "before", "after", "mix", "react", "stretch". Can demonstrate the properties of Super Gloop and relate observations and ideas/predictions. Can use symbols to record. May direct an adult to do this.

P8 Notice patterns of actions on Super Gloop. Plan, evaluate and record. Observe changes are result of what they did and describe when questioned directly.

Six easy-access, super-sensory "hands-on" chemistry lessons exploring states of matter and materials:

1. Hard Work: investigating solids
2. Sensory sensations: investigating liquids and gases
3. Before and After: mixing and separating; reversible reactions
4. Fizzing Rocks: an irreversible reaction
5. Lava Lamps: reversible and irreversible reactions
6. Super Gloop: making "slime" with an irreversible reaction

Each lesson plan includes:

- key vocabulary
- shopping list
- detailed description of the activity
- ideas for repetition and extension
- assessment

This booklet and additional support materials available for free download from the National STEM Centre www.stem.org.uk by searching for "Exploring Chemistry in SEND Schools"