Fusion 1: C2.1 – Particles in Action

National Curriculum Link up
•1.1a,b. 2.1a, b, c. 2.2a, b. 2.3a. 3.2a.

Electronic resources: Learning objectives, Practical worksheets**,** Interactive activity – Odd one out

Learning Objectives
Pupils should learn:
What matter is.
How matter can be classified.

Teaching / Learning activities
Lesson structure
Starter - Odd one out
Show pupils four pictures: a coin, a log, a rock and a stream (water). Ask them to choose the odd one out, giving a reason. Allow open responses, but eventually guide them to considering the way the materials behave. [Water is the odd one out, as it is a liquid and the picture shows that it flows.] (5 mins)
Main
Ask pupils whether something obvious in the room, such as a table or a wall, is a solid a liquid or a gas. Ask them to try to explain why they think so, in order to see if they can explain their ideas.
Introduce the practical activity 'Sorting out matter', described in the pupil book. Say to pupils that they must decide whether the objects and substances they are given are solids, liquids or gases. In the 'Observation' column they should write down what they saw that helped them to decide.
Elicit pupils' opinions about the substances they have seen and establish the following broad descriptions:
Solids: do not pour and do not take the shape of their container.
Liquids: can be poured and take the shape of their container.
Gases: can be poured and fill up any container
Plenary - What's the matter?
Ask pupils to write a description of a solid, a liquid and a gas in their own words. (10 mins)

Teaching suggestions
• **Special needs.** May only be able to make simple observations during the practical and may need help in recording them correctly.
• **Extension.** Show pupils some tomato ketchup and ask them to think about why it could be considered to be a solid or a liquid.
• **Learning styles.**
Visual: Making observations of the behaviour of materials.
Auditory: Describing their observations of materials.
Kinaesthetic: Manipulating solids, liquids and gases.
Interpersonal: Sharing ideas with other pupils.
Intrapersonal: Understanding that not all substances are easy to classify as solids, liquids or gases.
• **Functional skills link-up – English**
Write clearly and coherently including an appropriate level of detail. (Level 1) (Description of observations.)

Learning Outcomes
All pupils should be able to classify matter.
Most pupils should be able to recall that everything is made of matter.
Some pupils should also be able to explain why a sample belongs to a particular grouping.
How Science Works
Describe and record observations and evidence systematically. (1.2d)

Additional teachers notes
Equipment and materials required
Per group: 100 cm^3 beaker with water in [liquid], 100 cm^3 beaker containing golden syrup or runny honey in liquid, a modelling balloon inflated and labelled to show it contains air in gas, a 'dry ice' smoke machine or a video clip of 'dry-ice' clouds at a disco or concert [gas], a small block of metal such as a 1 kg mass [solid], a block of wood [solid].
Safety
If using a real dry-ice smoke machine, check room is well ventilated. The fumes may affect asthmatics. Dry ice can cause burns.

Fusion 1: C2.2 – Solids

National Curriculum Link up
•2.1a, b, c. 3.2a.

Electronic resources: Learning objectives, Practical worksheets, Homework activity – Model solids, Plenary activity - Model

Learning Objectives
Pupils should learn:
The properties of a solid.
How the particles in a solid are arranged.

Teaching / Learning activities
Lesson structure
Starter - Solid as a rock
Pupils must list as many solid materials as they can see in the room. Longest list wins. (5 mins)
Main
Ask pupils to carry out, or demonstrate, the 'Investigating solids' activity described in the pupil book. After the practical, gather together the results. [Solids cannot be compressed, when heated solids expand and similar-sized blocks can have a different mass (different density).]
Introduce pupils to the idea that matter is made of tiny particles. Introduce the word 'atom' but it may be best, especially with lower attaining pupils, to stick to the word 'particles' rather than 'atoms' as, for most substances, the particles are molecules made of several atoms.
Show pupils a tray that has a layer of marbles covering about two-thirds of its surface. Tilt the tray to one corner slightly and explain that, in solids, the particles are all packed close together. Very gently shake the tray to represent the particles vibrating. Emphasise that the particles can vibrate but not move around and remain touching most of the time.
Ask pupils if they think they can use the model to explain some of the results of the practical. Solids keep their shape and cannot be compressed as the particles cannot move and are already touching. They cannot be pushed closer together. Raising the temperature causes the particles to vibrate more, meaning they get slightly further apart. This causes the material to expand.
Plenary - What's it like?
Ask pupils to write a description of a solid for the benefit of Year 6 pupils. Ask some of the class to read their work out. (10 mins)

Teaching suggestions
• **Special needs.** The idea of particles is highly conceptual and lower attaining pupils may well struggle with the idea. It is important that as many pupils as possible can represent solids using a particle diagram, even if they cannot fully explain it.
• **Extension.** Ask pupils to explain why talc, which is a solid, can be made to behave like a liquid or even a gas. [Although it's a solid it is ground into a powder. The individual pieces of that powder can move separately, allowing the substance to flow like a liquid and, if the container is banged on the desk, to spread out like a gas.]
• **Learning styles.**
Visual: Making observations of the behaviour of solids.
Auditory: Describing how solids behave.
Kinaesthetic: Carrying out practical work on solids.
Intrapersonal: Understanding the concept that matter is made of particles too small to see.
• **Functional skills link-up – English**
Use language, format and structure suitable for purpose and audience. (Level 1) See Plenary 'What's it like?'
• **Homework.** Pupils to make a model of the particles in a solid.

Learning Outcomes
All pupils should be able to recall the properties of a solid.
Most pupils should be able to draw the particle diagram for a solid.
Some pupils should also be able to explain the properties of a solid in terms of the particle diagram.
How Science Works
Use an existing model or analogy to explain a phenomenon. (1.1a1)
Recognise that scientific evidence can be used to support or disprove theories. (1.1a3)

Additional teachers notes
Equipment and materials required
Per group: syringe with a piece of wood in it (not sawdust), metal bar and gauge, Bunsen burner, 'ball and ring' expansion apparatus, three metal blocks of identical size, balance.
Safety
Care must be taken when heating the metal bar and ball. The metal remains hot for a considerable time afterwards.

Fusion 1: C2.3 – Liquids

National Curriculum Link up
•2.1a, b, c. 3.2a.

Electronic resources: Learning objectives, Practical worksheets, Extension activity – Glass, Extension activity – Crazy custard, Interactive activity - Liquids

Learning Objectives
Pupils should learn:
The properties of a liquid.
How the particles in a liquid are arranged.

Teaching / Learning activities
Lesson structure
Starter - True or false?
Give pupils a list of statements that may apply to the way liquids behave. They must decide which ones are true. (10 mins)
Main
Ask pupils to carry out, the activity 'Investigating liquids'. After the practical gather together the results. [Liquids cannot be visibly compressed, when heated liquids expand (the level rises up the straw) and that they can have a different density (oil fl oats on water).] Refer back to the particle model introduced to pupils when learning about solids. Show pupils a tray which has a layer of marbles covering about two-thirds of its surface. Tilt the tray to one corner slightly and explain that, in liquids, the particles are all packed close together but they can slide past each other. Gently shake the tray to represent the particles vibrating. You will have to shake slightly harder than when trying to represent a solid. Emphasise that the particles can vibrate and slide past each other but remain touching most of the time.
Ask pupils if they think they can use the model to explain some of the results of the practical. [Particles can slide past each other means that a liquid can change shape and flow. Particles mostly touching means that a liquid cannot be compressed enough to see it. High density liquids have closer packed particles.]
Plenary - Particle people
Ask the pupils to work in groups of about six to demonstrate how the particles in a liquid behave, using themselves as the particles. (5 mins)

Teaching suggestions
• **Special needs.** The idea of particles is highly conceptual. It is important that as many pupils as possible can represent liquids using the particle diagram, even if they cannot fully explain it.
• **Extension.** 'Crazy custard' is an example of shear-thickening. When a force is applied to a liquid the particles attempt to move away by sliding over each other. If they cannot do this fast enough the mixture appears thicker than it is normally. The mixture needs to be very thick, but not so thick that dry cornflour is visible. If the dish is tipped the mixture will flow like a liquid. A finger can be slowly pushed into the mixture but if it is poked quickly this will not be possible – the mixture becomes hard.
Equipment and materials required
Per group: small plastic tub (250 g margarine tub or similar), water, cornflour, 2 spatulas (one for stirring and one for spooning out cornflour).
• **Learning styles**
Visual: Making observations of the behaviour of liquids.
Auditory: Describing how liquids behave.
Kinaesthetic: Carrying out practical work on liquids.
Interpersonal: Working with others to develop a drama of particle behaviour.
Intrapersonal: Understanding the concept that matter is made of particles too small to see.
• **Homework.** Pupils could make a model of the particles in a liquid.

Learning Outcomes
All pupils should be able to recall the properties of a liquid.
Most pupils should be able to draw the particle diagram for a liquid.
Some pupils should also be able to explain the properties of a liquid in terms of the particle diagram.
How Science Works
Use an existing model or analogy to explain a phenomenon. (1.1a1)

Additional teachers notes
Equipment and materials required
Per group: syringe filled with water and the end sealed with resin or glue, conical flask filled almost to brim with coloured water (use food colouring), bung to fit conical fl ask with 20 cm long straight glass delivery tube inserted through it, glass straw, beaker larger than fl ask half-filled with hot water (hot tap water should be sufficient), test tube and bung, 2 dropping pipettes, 5 cm^3 of cold water, 5 cm^3 of cooking oil.
Safety
Care should be exercised when using hot water. Pupils should be well controlled.

Fusion 1: C2.4 – Gases

National Curriculum Link up
•2.1a, b, c. 3.2a.

Electronic resources: Learning objectives, Practical worksheets, Plenary activity – Gases

Learning Objectives
Pupils should learn:
The properties of a gas.
How the particles in a gas are arranged.

Teaching / Learning activities
Lesson structure
Starter - Life's a gas
Pupils must list as many gases as they can think of. Longest list wins. (5 mins)
Main
Remind pupils of the work they did about solids and liquids in the last two lessons. Ask them to describe how gases are different from solids and liquids. Ask pupils to carry out the activity 'Investigating gases'. After the practical gather together the results. [Gases can easily be compressed, gases can be seen to fill the whole container and gases have mass.]
Refer back to the particle model introduced to pupils when learning about solids. Show pupils a tray which has a layer of marbles covering about one-tenth of it's surface. Shake the tray quite hard to represent the particles vibrating. Explain that the particles move in straight lines and change direction when they strike another particle or the walls of the container, like the balls on a snooker table.
Ask pupils if they think they can use the model to explain some of the results of the practical [Particles not touching each other means that a gas can change shape and flow and that it can be compressed by pushing the particles closer together. Those particles can move freely means that a gas will fill the whole of a container.]
Plenary - What's it like?
Ask pupils to write a description of a gas for the benefit of Year 6 pupils. Ask some of the class to read their work out. (10 mins)

Teaching suggestions
• **Special needs.** It is important that as many pupils as possible can represent gases using the particle diagram, even if they cannot fully explain it.
• **Extension.** Allow pupils to make bottle rockets. Challenge pupils to explain what makes the bottle fly and to try to improve the length of the flight. Do this outside! Pour a small amount of water into the bottle and push the bung in hard. Attach the other end of the delivery tube to the foot pump. Place the bottle neck into the clamp with the neck pointing down. Do not grip the neck with the clamp. Pump the foot pump to pressurise the bottle. Keep pumping until the bottle flies off. **Safety.** Keep pupils away from the flight path.
Equipment and materials required
Per group: 2 litre cola bottle, bung with plastic delivery tube to fit bottle, car foot-pump, water, clamp to hold bottle.
• **Learning styles**
Visual: Making observations of the behaviour of gases.
Auditory: Describing how gases behave.
Kinaesthetic: Carrying out practical work on gases.
Intrapersonal: Understanding the concept that matter is made of particles too small to see.
• **Homework.** Pupils could make a model of the particles in a gas.
• **Functional skills link-up – English**
Use language, format and structure suitable for purpose and audience. (Level 1) See Plenary 'What's it like?'

Learning Outcomes
All pupils should be able to recall the properties of a gas.
Most pupils should be able to draw the particle diagram for a gas.
Some pupils should also be able to explain the properties of a gas in terms of the particle diagram.
How Science Works
Use an existing model or analogy to explain a phenomenon. (1.1a1)
Recognise that scientific evidence can be used to support or disprove theories. (1.1a3)

Additional teachers notes
Equipment and materials required
Per group: syringe filled with air and with end sealed with resin or glue, sealed gas jar of chlorine gas, sealed gas jar of bromine gas (place a few drops of bromine liquid into a gas jar), sensitive balance, large beaker and a gas jar containing carbon dioxide.
Safety
Wear eye protection. Chlorine is toxic: CLEAPSS Hazcard 22A; bromine is toxic and corrosive: CLEAPSS Hazcard 15A; they should both be kept in a fume cabinet. Wear chemical protective gloves.

Fusion 1: C2.5 – Gases in Action

National Curriculum Link up
•2.1a, b, c. 3.2a.

Electronic resources: Learning objectives, Practical worksheets, Animation – The collapsing can, Homework activities A and B – Diffusion, Webquest – Who was Newcomen and what was his invention?, SEN activity - Diffusion

Learning Objectives
Pupils should learn:
How gases spread out.
What causes an empty can to collapse.

Teaching / Learning activities
Lesson structure
Starter - Holding up
Show pupils an inflated balloon. Ask them to explain what holds the balloon stretched. (10 mins)
Main
Show pupils the 'Diffusion in Gases' experiment. Ask pupils to describe what they can see and to try to explain it using what they know about gas particles. [The gas particles are moving in straight lines, frequently bouncing off each other. Slowly, this random movement causes the particles to spread further and further apart. In the gas jar, the colour should spread across the two jars, but be paler than it was when the gas is contained in just one jar.]
Ask pupils to carry out the 'Air pressure'. [The can collapses because the steam (water gas) inside the can condenses into liquid very quickly when the can is put into cold water. This reduces the pressure inside as liquid takes up much less space than gas. As the open end of the can is sealed with water, the air pressure outside the can is much greater than that inside. The can is crushed by the force of the air particles colliding with it.]
Plenary - Particle people
Ask groups of pupils to prepare a demonstration of gas pressure and diffusion, using themselves as particles. (10 mins)

Teaching suggestions
• **Special needs.** It is important that as many pupils as possible explain the effects of diffusion even if they cannot fully explain it.
• **Extension.** Demonstrate the diffusion of hydrogen chloride gas and ammonia in a tube. **Safety.** Ensure the area is well ventilated. Wear eye protection. Concentrated hydrochloric acid is corrosive: CLEAPSS Hazcard 47A. Concentrated ammonia is corrosive: CLEAPSS Hazcard 6. Be aware if any asthmatics are present.
Equipment and materials required 1 m long glass tube, approximately 2–3 cm in diameter, 2 bungs to fit tube, 2–3 cm^3 of concentrated hydrochloric acid, 2–3 cm^3 of concentrated ammonia, mineral wool, 2 pairs tweezers, 2 watch glasses.
• **Learning styles**
Visual: Making observations.
Auditory: Describing how gases diffuse.
Kinaesthetic: Investigating pressure in gases.
Interpersonal: Working with others to develop a particle model.
Intrapersonal: Understanding the concept that matter is made of particles too small to see.
• **Homework.** Newcomen Webquest.

Learning Outcomes
All pupils should be able to recall what we mean by gas pressure and diffusion.
Most pupils should be able to explain diffusion using the particle model.
Some pupils should also be able to explain why a can has collapsed, using the particle model.
How Science Works
Use an existing model or analogy to explain a phenomenon. (1.1a1)

Additional teachers notes
Diffusion in gases demonstration
Equipment and materials required
1 gas jar with 2 cm^3 of bromine liquid in it and a lid placed on top, further gas jar, and same size neck as the first. **Safety**
Must be carried out in a fume cabinet. Bromine is toxic and corrosive: CLEAPSS Hazcard 15A. Wear chemical protective gloves.
Air pressure
Equipment and materials required
Per group: 1 empty 330 cm^3 fizzy drink can, retort stand, boss and clamp, shallow bowl or tray half-filled with water, Bunsen burner. **Safety**
Turn the can over using the arm of the clamp. The arm of the clamp near to the burner will get hot.

Fusion 1: C2.6 – Changing State

National Curriculum Link up
•2.1a, b, c. 3.2a.

Electronic resources: Learning objectives, Practical worksheets, Interactive activity – Changes of state, Interactive activity – Changes, Simulation – Heating and cooling

Learning Objectives
Pupils should learn:
What happens when we heat a solid or a liquid.
What happens when we cool a liquid or a gas.

Teaching / Learning activities
Lesson structure
Starter - How many substances
Give pupils a list of substances and ask them to tell you how many different ones there are. E.g. ice, water, steam [all water] or lava, rock [both rocks] or cooking oil and margarine [both oil]. (5 mins)
Main
Show pupils some ice cubes and ask them to say what will happen to them if they were left on the side. [They will melt.]
Ask the pupils to investigate what happens to salol if it is heated and then cooled. They can observe the salol melting in a test tube and then freezing again. It is important at this stage to establish the meanings of 'melting' [solid becomes liquid] and freezing [liquid becomes a solid].
Return to the beaker of melted ice. Ask pupils what will happen if you continue to heat it. Heat the water to boiling point and show that it can be condensed by holding a piece of cold glass over the steam.
Ask pupils whether they think that the liquid water could turn into a gas if just left. [Yes, the water would slowly evaporate. Although most of the particles do not have enough energy to become gaseous, some do. The water left behind has less energy and becomes cooler.]
Plenary - Changing state
Show pupils a flow chart, linking the words solid, liquid and gas. Ask them to add the words, melting, freezing, boiling, condensing, and perhaps even sublimation, to the flow chart. (5 mins)

Teaching suggestions
• **Special needs.** It is important that they can name the changes though. You may wish to avoid discussing the melting and boiling points of substances which are gases at room temperature.
• **Extension.** Get pupils to carry out the 'Stretch yourself' activity, looking at sublimation of iodine. Substances, like iodine, which change directly from solid to gas are said to 'sublime'. Pupils could research other substances which do this, such as graphite.
Equipment and materials required. Per group: boiling tube and well-fitted bung, 4–5 iodine crystals, access to hot water. **Safety.** Wear eye protection. Ensure the bung cannot fall out of the test tube. Iodine crystals are harmful, avoid skin contact: CLEAPSS Hazcard 54A.
• **Learning styles.**
Visual: Observing changes of state.
Auditory: Describing their observations of salol changing state.
Kinaesthetic: Carrying out practical work on changing state.
Intrapersonal: Understanding the concept that matter is made of particles too small to see.
• **Functional skills link-up – Mathematics**
Understand and use whole numbers and recognise negative numbers in practical situations. (Level 1)
• **Homework.** Pupils to find out the melting and boiling points of some common substances, such as iron, copper, hydrogen, sugar.

Learning Outcomes
All pupils should be able to define melting, boiling, condensing and freezing.
Most pupils should be able to explain the difference between boiling and evaporation.
Some pupils should also be able to define sublimation and give an example.
How Science Works
Use an existing model or analogy to explain a phenomenon. (1.1a1)

Additional teachers notes
Melting ice demonstration - Equipment and materials required
5–6 ice cubes in a glass beaker, Bunsen burner, heat mat, tripod and gauze, matches.
Safety. Equipment will get hot.
Salol - Equipment and materials required
Per group: test tube and grip, 1–2 spatulas full of salol, mineral wool plug, access to hot water (above 50ºC), 2 small beakers, access to cold water.
Safety. Eye protection must be worn. A mineral wool plug will keep fumes in test tube. Hot water can scald. Salol is an irritant: CLEAPSS Hazcard 52.

Fusion 1: C2.7 – Mixtures

National Curriculum Link up
•2.1a, b, c. 3.2a.

Electronic resources: Learning objectives, Practical worksheets, Interactive activity – Pure, Animation – Dissolving sugar, SEN activity - Dissolving

Learning Objectives
Pupils should learn:
What a mixture is.
How particles are arranged in a mixture.

Teaching / Learning activities
Lesson structure
Starter - What is pure?
Ask pupils to write a definition for the word 'pure'. Allow open responses. You may wish to tell them afterwards that the chemical meaning is 'to describe a single substance'. (5 mins)
Main
Explain that when you have more than one substance at a time, you have a mixture. Most materials are mixtures. You could show them a piece of granite at this point; pupils should easily be able to see the different minerals in it.
Explain that, although many mixtures are liquids, it is possible to find solid and gaseous mixtures too. Introduce the solution key words.
Ask pupils to carry out the 'Investigating mixtures'. Common errors when carrying out this investigation include failing to zero the balance before weighing each time, and stirring the mixture so vigorously they spill some liquid. It is a good opportunity to instil the need for attention to detail when carrying out practical work in order to take accurate measurements. Repeating measurements will improve the reliability of their results.
Establish that the mass of a solution is the total mass of the solute used and the solvent.
Ask pupils whether they think an unlimited amount of solute can be dissolved. [No, a saturation point is reached where no more solute will dissolve and any extra solute will settle out.] Add more and more salt to one of the pupils' solutions from the practical to establish that it can't.
Plenary - What does it mean?
Ask pupils to match up the solution key words to their meanings. (5 mins)

Teaching suggestions
• **Special needs.** The idea of particles is highly conceptual and lower attaining pupils may well struggle with the idea of a solute dissolving, believing instead that it simply disappears.
• **Extension.** Get pupils to investigate the properties of a mixture of ethanol and water. Measure out 50 cm^3 each of ethanol and distilled water in separate measuring cylinders. Mix the two in the larger measuring cylinder and observe the final volume. [It will be less than the sum of the volumes of the separate solutions.] **Equipment and materials required.** Per group: Two 50 cm^3 measuring cylinders, 100 cm^3 measuring cylinder, 50 cm^3 distilled water, 50 cm^3 ethanol. **Safety.** Ethanol is highly flammable and harmful: CLEAPSS Hazcard 40A. No naked flames.
• **Learning styles**
Visual: Making observations of mixture behaviour.
Auditory: Describing the behaviour of mixtures.
Kinaesthetic: Investigating mixtures.
Interpersonal: Working with others to develop a drama of particle behaviour.
Intrapersonal: Understanding the need to take accurate measurements during the investigation into mixtures.
• **Homework.** Pupils to find substances in the kitchen which are not mixtures. [Any pure substances, such as salt, bicarbonate of soda.]

Learning Outcomes
All pupils should be able to recall a definition of 'a mixture' in words.
Most pupils should be able to define a mixture with a particle diagram.
Some pupils should also be able to explain why a substance is a mixture and collect reliable data.
How Science Works
Use an existing model or analogy to explain a phenomenon. (1.1a1)

Additional teachers notes
Investigating mixtures
Equipment and materials required
Per group: 100 cm^3 measuring cylinder, 100 cm^3 distilled water, 1 g salt, spatula, 250 cm^3 beaker, glass rod, access to a 1 decimal place balance (2 d.p. balance is too precise and is more likely to show a change in mass).
Safety
Clear up spillages immediately.

Fusion 1: C2.8 – Separating Mixtures: Sieving and Filtering

National Curriculum Link up
•2.1a, b, c. 3.2a.

Electronic resources: Learning objectives, Practical worksheets, Homework activity – Filtering and sieving, SEN activity – Filtering and sieving

Learning Objectives
Pupils should learn:
How to separate different-sized solids.
How to separate solids from liquids.

Teaching / Learning activities
Lesson structure
Starter - What's the question?
Give pupils key terms about solutions, such as 'solute', 'solvent' and 'solution'. Tell them that these words are the answers, but that they must write the questions. (10 mins)
Main
Demonstrate how to separate a mixture of gravel and sand using a sieve, i.e. separating solids. Explain that the sand passes through as the grains are smaller than the holes but the stones of the gravel cannot.
Ask the pupils to carry out the 'Separating mixtures'. Pupils will probably need to be shown how to fold a filter paper properly. Although they are forming the insoluble solid to filter out using a chemical reaction, stress that this method is suitable for all separations of a solid from a liquid. It may be worth explaining to pupils that filtering is often slow, as the trapped solid blocks the path of the liquid through the filter. Prodding the filter paper will only result in ripping it.
After the practical, ask pupils why they think the method works. [Liquid particles can move individually and can pass through the tiny holes in the filter paper. In the lead iodide precipitate the particles are clumped together as it is a solid. The clumps are too big to pass through.]
Plenary - It's a 'thingymajig'
Draw diagrams of the equipment used in this lesson and met so far in Year 7. Ask the pupils to label the items. (10 mins)

Teaching suggestions
• **Special needs.** Lower attaining pupils may cope better with the 'It's a thingymajig' plenary if suitable labels for the equipment is provided.
• **Extension.** Ask pupils to repeat the 'Separating mixtures' practical, investigating whether or not different ways of folding the filter paper make a difference. [They should find that fluting provides the best combination of fast filtering and good separation.]
• **Learning styles**
Visual: Observing the effects of sieving and filtering.
Auditory: Describing the effects of sieving and filtering.
Kinaesthetic: Carrying out sieving and filtering.
Intrapersonal: Understanding that the particles in a solid are joined together so the solid can't pass through a filter.
• **Homework.** Pupils to find out how the automatic sorting machines work. [Many waste management companies use automatic machines to sort recyclable materials. There are even some in supermarket car parks in the UK now. Some work by weighing the items, but more sophisticated machines use X-rays.]
• **Functional skills link-up – ICT**
Access, navigate and search internet sources of information purposefully and effectively. (Level 1) (See Homework Suggestion.)

Learning Outcomes
All pupils should be able to separate a mixture of solids using a sieve.
Most pupils should be able to separate a solid from a liquid by filtering.
Some pupils should also be able to explain why sieving or filtering is suitable for separating some mixtures.
How Science Works
Explain how action has been taken to control obvious risk and how methods are adequate for the task. (1.2c)

Additional teachers notes
Separating solids - Equipment and materials required
About 500 cm^3 of a 50:50 mixture of sand and gravel, tray, sieve with a suitable mesh to let the sand pass through but not the gravel. **Safety.** Sand can make the floor slippery if spilt.
Separating mixtures - Equipment and materials required
Per group: 5 m^3 of 0.01 mol/dm^3 lead nitrate, 10 cm^3 of 0.1 mol/dm^3 sodium iodide, boiling tube and rack, filter paper, filter funnel, conical flask. **Safety.** Wear eye protection. Lead iodide is toxic: CLEAPSS Hazcard 57A. Hands must be washed after any contact with it. Take care with disposal.

Fusion 1: C2.9 – Separating Mixtures: Chromatography

National Curriculum Link up
•2.1a, b, c. 3.2a.

Electronic resources: Learning objectives, Practical worksheets, Starter activity – Mixtures – solutions, Homework activity – Chromatography

Learning Objectives
Pupils should learn:
How we can separate inks and dyes.
How we can use chromatography.

Teaching / Learning activities
Lesson structure
Starter - Odd one out
Show pupils four pictures: a bottle of cola, some orange juice, a cup of tea and a glass of water. Ask them to decide which is the odd one out and why. (5 mins)
Main
Discuss with pupils how, in an Art lesson, they can make colours they don't have by mixing others together. Explain that many paints, inks and dyes are actually a mixture of colours. Blacks in particular are rarely, if ever, pure.
Ask pupils to carry out the 'Making a chromatogram' investigation. After carrying out the experiment, ask pupils to think of any situations where separating colours like this might be useful.
Ask pupils to carry out the 'Using chromatography' investigation. After the practical establish which food colouring was the same as the unknown one.
Plenary - Who 'dunnit'?
Show pupils a chromatogram 'prepared by the police' showing the traces produced by two known pens and another one. Set the scene by telling the class that the chromatogram was prepared from samples taken at a murder scene. A note was left in the room and the police have identified two suspects, both of whom were arrested shortly after the incident and pens were found in their pockets. Ask the pupils whether either person could have written the note. (5 mins)

Teaching suggestions
• **Special needs.** The 'Using chromatography' experiment will not work unless the pencil marks and the dye spots are prepared carefully and accurately. Some pupils may need assistance with this.
• **Extension.** Ask pupils to find out how DNA electrophoresis is carried out. [It is a form of chromatography where an applied voltage drives the movement of the components of the mixture, rather than the solvent.]
• **Learning styles**
Visual: Interpreting chromatograms.
Auditory: Describing the process of chromatography.
Kinaesthetic: Carrying out chromatography experiments.
Interpersonal: Working with others during the practical.
Intrapersonal: Understanding that dyes are often made from more than one colour.
• **Homework.** Pupils could make their own chromatograms at home using inks and dyes and blotting paper.

Learning Outcomes
All pupils should be able to separate a mixture of dyes with a wick.
Most pupils should be able to separate dyes into a chromatogram.
Some pupils should also be able to explain how chromatography works.
How Science Works
Describe and record observations and evidence systematically. (1.2d)

Additional teachers notes
Making a chromatogram - Equipment and materials required
Per group: 100 cm^3 beaker, 50 cm^3 water, filter paper disc (approx. 8 cm in diameter), 3–4 drops of black ink or a black, water-based felt pen, dropping pipette if using ink, scissors. **Safety.** Normal laboratory rules.
Using chromatography - Equipment and materials required
Per group: 3–4 drops of green food colouring (which is pure green, not a mixture), 3–4 drops of manufactured green food colouring (made from yellow and blue), 3–4 drops of an 'unknown' food colouring – one of the first two colourings labelled as 'X', 3 dropping pipettes, 250 cm^3 beaker, paper clip, sheet of chromatography paper to fit as a cylinder inside beaker (approx. 10 cm by 15 cm). **Safety.** Normal laboratory rules.

Fusion 1: C2.10 – Separating Mixtures: Distillation and Evaporation

National Curriculum Link up
•2.1a, b, c. 3.2a.

Electronic resources: Learning objectives, Practical worksheets, Extension activity – Fractional distillation, Starter / Plenary activity – Shipwrecked, Interactive activity – Distillation, Animation – Desert island distillation

Learning Objectives
Pupils should learn:
How to separate a solid which is dissolved in a liquid.
How to separate a mixture of liquids.

Teaching / Learning activities
Lesson structure
Starter - Shipwreck
Ask pupils how they could obtain fresh drinking water from seawater (which also contains some sand, picked up as the water is scooped into a bucket). They have a fire and some basic equipment, such as cloth which can be used as a filter. [Filter the water to remove the sand. Boil the water and collect and condense the steam.] (10 mins)
Main
Set up the 'Evaporation' experiment described in the pupil book at least 24 hours in advance. Look at the results of the 'Evaporation' experiment. Invite pupils to try to explain what has happened. [The water has evaporated and left the salt behind.] Ask pupils to suggest how the process could be speeded up. [Heat the evaporating dish.]
Get pupils to carry out the 'Distillation' experiment described in the pupil book. After the practical, establish that only the water transfers from the test tube. Any impurities are left behind.
Plenary - Shipwreck 2
Invite pupils to re-plan their method of gaining fresh water from seawater which also has sand in it, based on what they have learned from the lesson. Again, they must not use laboratory equipment but can use things which they might find on a ship. (10 mins)

Teaching suggestions
• **Special needs.** The idea of particles is highly conceptual and lower attaining pupils may well struggle with the idea that a substance is still there when it is dissolved, even though it cannot always be seen.
• **Extension.** Ask pupils to find out how fractional distillation is carried out and why it is used.
• **Learning styles**
Visual: Observing the results of distillation and evaporation.
Auditory: Describing what happens during distillation and evaporation.
Kinaesthetic: Carrying out distillation and evaporation.
Interpersonal: Working with others during practicals.
Intrapersonal: Understanding that dissolved substances are still there even if the particles cannot be seen.
• **Functional skills link-up – English**
Present information in a logical sequence. (Level 1) See Starter and Plenary 'Shipwreck'.
• **Homework.** Pupils to find out how spirits, such as whisky are made.

Learning Outcomes
All pupils should be able to separate a solid from a liquid by evaporation.
Most pupils should be able to separate a mixture by distillation.
Some pupils should also be able to explain why distillation or evaporation is suitable for separating a mixture.
How Science Works
Use an existing model or analogy to explain a phenomenon. (1.1a1)

Additional teachers notes
Evaporation - Equipment and materials required
Per group: 20 cm^3 saturated brine solution, evaporating dish. **Safety.**
If heating, do not heat the dish directly. Wear eye protection. If salt starts to spit, stop heating.
Distillation - Equipment and materials required
Per group: 20 cm^3 water, coloured, in front of the class, with ink or food dye, two boiling tubes, glass delivery tube with 90º bend, holed bung to attach delivery tube to top of one boiling tube, Petri dish, ice, Bunsen burner and heat-proof mat, matches.
Safety. Wear eye protection.
Pupils must not drink the distilled water. Do not heat too strongly (see above).

Fusion 1: C2.11 – Grouping Chemicals

National Curriculum Link up
•2.1a, b, c. 3.2a.

Electronic resources: Learning objectives, Practical worksheets, Interactive Drag and drop – Separating mixtures, Homework activity – Classifying substances

Learning Objectives
Pupils should learn:
How to decide if something is a solid, a liquid or a gas.
How to devise a method to decide if something is pure or a mixture.

Teaching / Learning activities
Lesson structure
Starter - Word challenge
Ask pupils to come up with as many words as they can, using only letters from the word 'chromatography'. Longest list wins. (10 mins)
Main
Get pupils to carry out 'Grouping chemicals by their state'. Allow open responses here, as all the substances exhibit properties of more than one state. The important aspect here is the reasoning behind the answers. Establish that it is not always easy to decide whether something is a solid, liquid or gas.
Get the pupils to carry out the 'Grouping chemicals as pure or impure' activity. The main focus of this is on the planning of the experiment. Pupils will need advice on what to include in their method. Many pupils will fail to include enough detail. You may wish not to carry out the practical, depending on the time you have available. If you do, plans must be checked before practical work starts.
Plenary - I've got the key
Ask pupils to prepare a key to guide someone into deciding whether a substance is a solid, a liquid, a gas or a mixture. [The key could start with the question, 'Does it flow?' No – it's a solid; Yes – next question …] (10 mins)

Teaching suggestions
• **Special needs.** Provide pupils with a jumbled method for the 'Grouping chemicals as pure or impure' activity which they must sort into the correct order.
• **Extension.** Get pupils to extend the practical by giving them a mixture of ethanol and water. They will have to employ fractional distillation to prove that it is a mixture. **Safety.** Ethanol is highly flammable and harmful. Wear eye protection.
• **Learning styles**
Visual: Observing the behaviour of materials.
Auditory: Describing whether a substance is a solid, a liquid or a gas, with reasons.
Kinaesthetic: Carrying out practical work to decide if a substance is pure or not.
Intrapersonal: Understanding that the state of a substance is sometimes difficult to define.
• **Functional skills link-up – English**
Present information in a logical sequence. (Level 1)

Learning Outcomes
All pupils should be able to recognise a solid, a liquid and a gas.
Most pupils should be able to explain why something is a solid, a liquid or a gas.
Some pupils should also be able to distinguish between mixtures and pure substances by devising a method independently.
How Science Works
Describe an appropriate approach to answer a scientific question using a limited range of information and making relevant observations or measurements. (1.2a)

Additional teachers notes
Grouping chemicals by their state - Equipment and materials required
Per group: watch glass with some ketchup on it, watch glass with some hair gel on it, watch glass with some emulsion paint on it. **Safety.** Pupils must not eat the ketchup.
Grouping chemicals as pure or impure - Equipment and materials required
Per group: a range of the equipment used for the practicals in lessons C2.7 to C2.10, depending upon what methods the pupils plan, a bottle of ink, a bottle of water (distilled or tap, depending on whether you wish the pupils to find it pure or not), a jar of mixed salt and chalk, labelled 'White powder'; Extension: 20:80 ethanol: water mix, labelled 'Water sample 2'. **Safety.** Ethanol is highly flammable and harmful: CLEAPSS Hazcard 40A. Wear eye protection.