



Fusion 2: C2.1 – Our Planet National Curriculum Link up •1.1a, b. 2.1a, b, c. 2.2a, b. 2.3a. 3.4a, c.		
Learning Objectives Pupils should learn: What a rock is. What rock is made from. How rock is useful to us.	Teaching / Learning activities Lesson structure Starter -Rock on! Ask pupils to list as many items made from rock that they can see in the room. Longest list wins. [Allow items made from metal if pupils know that metals are extracted from rock ores.] (5 mins) Main Open the lesson by talking about mountains and volcanoes and asking pupils whether they think the Earth has always looked like it does now. Perhaps allow a short, open discussion on this area. Ask pupils what mountains are made from – establish that they are made from rock. Suggest to pupils that there are many different sorts of rock and that they are going to observe some rocks to see if they can identify any differences. Ask pupils what sort of things might make different rocks appear different from each other. Ask pupils to carry out 'Studying rocks' as described in the pupil book. After pupils have carried out the activity, draw together any common themes they observed, e.g. the presence of crystals in some of the rocks or whether any rocks were particularly hard or soft. Plenary - Think you're hard? Ask pupils to sort rock samples into order of hardness. You could relate this to Moh's scale. (5 mins)	Teaching suggestions • Learning styles. <i>Visual:</i> Making observations of rocks. <i>Auditory:</i> Describing their observations of rocks. <i>Kinaesthetic:</i> Carrying out practical work. <i>Interpersonal:</i> Sharing ideas with other pupils. • Special needs. Emphasise the obvious features of rock and stick to examples which are easy to observe, such as granite and sandstone. • Extension. Ask pupils to find out about Moh's scale and how it was developed. ♦Homework. Pupils could find out what sort of stone a local historic building is made from, where the stone was quarried and how long ago.
Learning Outcomes <i>All pupils should be able to recognise a rock.</i> <i>Most pupils should be able to recall what a rock is made from.</i> <i>Some pupils should also be able to relate the structure of a rock to its uses.</i> How Science Works Describe an appropriate approach to answer a scientific question, making relevant observations (1.2a).	Additional teachers notes Equipment and materials required per group: 5–6 rock samples (such as granite, slate, limestone, basalt, sandstone), mounted needle or short nail, hand lens. Details Refer to pupil book. Pupils may need help to identify some of the features of rocks, such as what crystals actually are. Safety Large rock samples may present a hazard if dropped. Mounted needles are sharp. If breaking rocks, wear eye protection.	



Fusion 2: C2.2 – Igneous Rocks		
National Curriculum Link up •2.1a, b, c. 3.4a, c.		
Learning Objectives Pupils should learn: What igneous rock is. How igneous rock is formed. How to get reliable results.	Teaching / Learning activities Lesson structure Starter - Crunchie! Cut through a Cadbury's Crunchie bar and observe the bubbles. [The bubbles are largest in the centre where the cinder toffee cooled slowly, but you may choose not to reveal the reason at this stage of the lesson.] (5 mins) Main Explain that 'geologists' are people who study rocks and they divide rocks up into three categories: igneous, sedimentary and metamorphic. Give pupils some pieces of igneous rock to observe with a hand lens, such as basalt, granite, gabbro, rhyolite or pumice. After they have looked at them, establish that igneous rocks have crystals but that those crystals can vary in size. Explain to pupils how igneous rock forms. [It forms from magma from the Earth's mantle (the layer under the crust) which has cooled and solidified. Magma which escapes from a volcano becomes known as lava.] Ask pupils to carry out the 'Investigating crystal size' activity described in the pupil book. Establish that large crystals are formed when magma cools slowly. This typically happens when magma cools inside the Earth's crust where it is insulated. The crystals are much smaller when the magma cools quickly as it usually does when it cools on the surface. Plenary - Sort it out Give pupils some sentences describing how igneous rocks form but do not give them the statements in the right order. The challenge is to sort them out correctly. (10 mins)	Teaching suggestions <ul style="list-style-type: none"> • Special needs. Concentrate on getting lower attaining pupils to recognise the crystalline nature of igneous rock rather than crystal size. These pupils could also drop a droplet of liquid salol into a beaker of cold water during the 'Investigating crystal size' practical, to model igneous rocks forming under the sea in 'pillow' shapes. • Extension. Ask pupils to find out about pumice and why it has such a low density. [It is effectively a solid foam. Hot gas created bubbles in the lava and the lava then set quickly.] This can be followed up by research into the formation of obsidian. • Learning styles. <i>Visual:</i> Making observations of igneous rock. <i>Auditory:</i> Describing their observations. <i>Kinaesthetic:</i> Carrying out practical work on crystal sizes in igneous rock. <i>Interpersonal:</i> Working with others during practical. <i>Intrapersonal:</i> Linking crystal size to cooling rate. • Homework. Pupils could find out about some buildings which are made from granite.
Learning Outcomes <i>All pupils should be able to</i> recognise igneous rock and to give an example of it. <i>Most pupils should be able to</i> recall the general properties of igneous rock and explain the concept of reliability. <i>Some pupils should also be able to</i> relate the properties of igneous rock to how it was formed and explain the concept of reliability and accuracy. How Science Works Explain how the observation and recording methods are appropriate to the task (1.2d).	Additional teachers notes Observing igneous rocks equipment and materials required per group: hand lens, samples of igneous rocks, such as basalt, granite, gabbro, rhyolite or pumice. Safety. Large rock samples may cause damage if dropped. Investigating crystal size equipment and materials required per group: microscope, 5–6 drops of liquid salol (melting point 42°C; warm inside a boiling tube in a water bath at about 60°C to melt it), a microscope slide at room temperature, a microscope slide which has been kept in the freezer until just before use, a mounted needle, 2 microscope slide cover slips, dropping pipette. Safety. Normal laboratory rules, making sure pupils do not abuse the dropping pipette. Salol is an irritant: CLEAPSS Hazcard 52.	



<p>Fusion 2: C2.3 – Sedimentary Rocks</p> <p>National Curriculum Link up •2.1a, b, c. 3.4a, c.</p>		
<p>Learning Objectives Pupils should learn: What a sedimentary rock is. How sedimentary rock is formed. How to evaluate an investigation.</p>	<p>Teaching / Learning activities Lesson structure Starter - Fossilised Ask pupils to describe what a fossil is. [Fossils are the mineralised remains or impressions in rock of plants and animals.] (5 mins) Main Show pupils some samples of sedimentary rocks, such as sandstone, limestone and chalk. Explain that they are made of grains of other rocks which have been compressed and cemented together. Show pupils that some sedimentary rocks are quite soft, by scratching the rock with a nail. Ask pupils to carry out 'Investigating sedimentary rock' as described in the pupil book. The emphasis here should be on getting pupils to consider the validity of the tests and to evaluate the experiment. After they have completed the practical, hold a class discussion to evaluate the experiment. [There are several key areas of error; little consistency in the way the 'rock' is made; it is difficult to apply force onto the pillars]. Invite pupils to suggest how they could make the experiment more reliable. Plenary - Sort it out Give pupils statements which describe how sedimentary rock forms, but in the wrong order. Ask them to place the statements into the correct order. (5 mins)</p>	<p>Teaching suggestions</p> <ul style="list-style-type: none"> • Special needs. Concentrate on getting pupils to recall the names of some sedimentary rocks and on identifying their key features. Pupils may need prompts in order to be able to take part in evaluating the investigation. Ask them why it would be better if three samples of the same rock column were made at the same time. [It would allow the test to be repeated.] • Extension. Allow pupils to repeat the investigation, putting into place all their suggested improvements, to see if the outcome is improved. Invite pupils to work out how the age of a rock can be determined by the fossils found in it. [If we know when the fossilised animal was alive, we know when the rock must have begun to form.] • Learning styles. <i>Visual:</i> Observing the structure of sedimentary rock. <i>Auditory:</i> Taking part in the class evaluation of the experiment. <i>Kinaesthetic:</i> Making and testing the rock samples. <i>Interpersonal:</i> Working with others to make and test the rock samples. <i>Intrapersonal:</i> Reflecting on the idea that sedimentary rocks take millions of years to form. • Homework. Pupils could produce a poster about a particular geological period and the fossils we find from that time, e.g. Cretaceous.
<p>Learning Outcomes <i>All pupils should be able to recognise sedimentary rock and to give an example of it, as well as giving some examples of errors.</i> <i>Most pupils should be able to recall the general properties of sedimentary rock, as well as classifying errors in their investigation.</i> <i>Some pupils should also be able to explain how the properties of sedimentary rock relate to how it was formed, as well as giving a detailed evaluation of their investigation.</i> How Science Works Describe and suggest, with reasons, how planning and implementation could be improved (1.2e).</p>	<p>Additional teachers notes Demonstration: Investigating sedimentary rocks equipment and materials required: Samples of sedimentary rock (such as limestone, chalk and sandstone), hand lens, nail, small amount of water and a watch glass. Optional: visualiser or camera connected to a large display to allow class to see more easily. Investigating sedimentary rock equipment and materials required per group: syringe with nozzle end cut off, petroleum jelly to grease syringe, 100 g of sand, 100 g of clay, 50 g of plaster of Paris, 3–4 beakers (you may wish to use disposable cups), 3 spatulas (or plastic spoons), small sheet of blotting or filter paper, 2 heat-proof mats, set of slotted masses, eye protection. Safety. Care should be taken when testing the rock in case masses fall or the rock shatters. Eye protection should be worn.</p>	



Fusion 2: C2.4 – Metamorphic Rock		
National Curriculum Link up •2.1a, 3.4a, c.		
Learning Objectives Pupils should learn: What a metamorphic rock is. How a metamorphic rock forms. How we can model rock formation.	Teaching / Learning activities Lesson structure Starter - 'Morph' Show pupils a video clip of the 'Morph' animation. Ask them to explain what is special about Morph's character. [Morph can change his shape at will. Use this as a lever to explain that 'metamorphic' refers to the fact that the rock has been changed in some way.] (10 mins) Main Explain that inside the Earth it is very hot and that very slowly, the continents are moving around. Explain that the high temperatures and the forces involved in the slow movement of the crust can change the rocks by softening and putting them under immense pressure. Use the information in the pupil book to help describe how rocks are metamorphosed. [It is a common misconception that the rock fully melts during the process. It just softens as, despite the very high temperatures involved, the high pressure prevents full melting.] Show pupils some samples of metamorphic rocks, such as marble, slate, gneiss and schist. You may wish to give them time to examine the samples. Ask pupils to carry out the activity 'Modelling metamorphic rock' which is described in the pupil book. After they have done this, ask the class, in groups or together, to consider how they could improve the model. Plenary – Sort it out Give pupils statements which describe how metamorphic rock forms, but in the wrong order. Ask them to place the statements into the correct order. (5 mins)	Teaching suggestions <ul style="list-style-type: none"> • Special needs. Give pupils a set of instructions to help them form the model when undertaking 'Modelling metamorphic rock' rather than them having to develop the model by themselves. • Extension. Invite pupils to undertake the 'Stretch yourself' section described in the pupil book. [High-grade metamorphic rock, such as gneiss, is formed by high temperature and pressure.] • Learning styles. <i>Visual:</i> Observing metamorphic rocks and developing the formation model. <i>Kinaesthetic:</i> Developing the model showing how metamorphic rocks form. <i>Interpersonal:</i> Working with others to develop the model. <i>Intrapersonal:</i> Understanding the concept that the process of forming metamorphic rock is too slow to see. • Homework. Pupils could find out about the use of slate as a building material. [Slate is mainly found in North Wales and the Lake District in the UK. It can be split along the layers in the rock, allowing thin sheets to be obtained. These were often used as roof tiles until they were replaced by moulded tiles.]
Learning Outcomes <i>All pupils should be able to</i> recognise metamorphic rock and to give an example of it, as well as modelling how the rock was formed. <i>Most pupils should be able to</i> recall the general properties of metamorphic rock and explain the model of rock formation. <i>Some pupils should also be able to</i> relate the properties of metamorphic rock to how it was formed and evaluate the model of rock formation. How Science Works Describe how the use of a particular model or analogy supports an explanation (1.1a1).	Additional teachers notes Main lesson (optional): Studying metamorphic rocks equipment and materials required per group: samples of metaquartzite, marble, slate, gneiss, schist; hand lens. Modelling metamorphic rock equipment and materials required per group: 50–100 matchsticks, 2 laboratory spatulas. Safety. Normal laboratory rules. Use spent matches.	



Fusion 2: C2.5 – Which Rock?		
National Curriculum Link up •3.4a, c.		
Learning Objectives Pupils should learn: How to tell which type of rock they have. How to identify rocks.	Teaching / Learning activities Lesson structure Starter -What is it? Show pupils a picture of a piece of rock (any sort). Ask them to decide whether they think it is igneous, sedimentary or metamorphic, giving reasons. (5 mins) Main Remind pupils of the work they have done on the three categories of rock. Explain that it is important that geologists can easily tell the difference between them. Ask pupils to recall the key features of the rock types, e.g. igneous rocks have crystals. Explain to pupils what an identification key is. There is an example in the pupil book. You could, at this point get pupils to prepare a simple one of their own. For example, to identify sports equipment the first question might be: 'Is it round?' or 'Does it have strings?' Ask pupils to carry out 'Creating a key to identify rocks' as described in the pupil book. You will need to make named rock samples available. Ask pupils to check each other's keys once they have been prepared. Get them to suggest corrections for any errors and, perhaps, to score each others' work out of 10 for, say, usability. Plenary - Sort it out Give pupils a description of the three rock types and ask them to match the correct name to each: igneous, sedimentary or metamorphic. They should also try to give an example of each. (10 mins)	Teaching suggestions <ul style="list-style-type: none"> • Special needs. Allow pupils to build up to the task of preparing the rock key by giving them some rock samples which they should sort into three groups, each corresponding to the three rock types. Allow them to build from there. Instead of preparing a key which identifies particular rock samples, help lower attaining pupils create a key which just differentiates between igneous, sedimentary and metamorphic. • Extension. Insist that the key prepared by higher attaining pupils doesn't just differentiate by the appearance of the rocks. They should include detail that, for example, identifies igneous rock as intrusive or extrusive. [Intrusive: large crystals, cooled slowly; extrusive: small crystals, fast cooling.] • Learning styles. <i>Visual:</i> The key could be image-based, rather than textbased. <i>Interpersonal:</i> Checking the keys prepared by others and providing feedback. • Homework. Pupils could find out about the work of Alfred Wegener in relation to geology. [Wegener was the first man to propose the idea of drifting continents in 1915.] • Functional Skills – English Present information on complex subjects concisely and clearly (level 2).
Learning Outcomes <i>All pupils should be able to use a key to identify rocks.</i> <i>Most pupils should be able to develop a simple key to identify rocks.</i> <i>Some pupils should also be able to make a flow chart or couplet key to identify rocks.</i> How Science Works Describe an appropriate approach to answer a scientific question, making relevant observations [devising a key] (1.2a).	Additional teachers notes Equipment and materials required per group: selection of named rock samples from the last three lessons, hand lenses. Details Refer to pupil book. A good starter question for pupils who are struggling would be: 'Does it have crystals?' Safety Normal laboratory rules.	



Fusion 2: C2.6 – Weathering		
National Curriculum Link up •2.1a, 3.4a, c.		
Learning Objectives Pupils should learn: What weathering is. How plants and animals can change rocks. How to plan an investigation.	Teaching / Learning activities Lesson structure Starter - What's happening? Show pupils a photograph of tree roots disrupting a pavement. Ask them to explain what is happening. (5 mins) Main Remind pupils that sedimentary rock is made from grains of other rocks. Ask pupils to suggest how that may happen. Establish that, somehow, other rocks get broken down over time. Ask pupils to think about how this may happen, allowing very broad responses. Collate responses into groups on the board, placing them into one of three groups: biological (caused by plants and animals), physical (caused by weather and other physical processes) and chemical (caused by chemical reaction). Take care here over the difference between 'weathering' and 'erosion'. Weathering is the breakdown of rock <i>in situ</i> whereas erosion is the wearing away of rock by contact with abrasive material (usually transported pieces of weathered rock). Ask pupils to plan the 'Biological weathering' investigation. They will not be able to carry out the plan as it takes too long, but they need to consider how to make their investigation as fair as possible. Plenary - Txt spk Ask pupils to explain, as if they were writing a text message to their friend, what weathering of rocks is. You could make them stay within the limit of a normal text message of 160 characters, including spaces. (5 mins)	Teaching suggestions <ul style="list-style-type: none"> • Special needs. Give pupils a planning grid to help them plan the experiment. • Extension. Ask pupils to go out into the school site with a digital camera to record examples of biological weathering taking place. In each case they should try to explain what is happening. • Learning styles. <i>Visual:</i> Observing examples of biological weathering. <i>Auditory:</i> Describing how rocks might be weathered. <i>Intrapersonal:</i> Considering how to plan a fair investigation into weathering. • Homework. Pupils could look for examples of biological weathering caused by plants and animals around the town. • Functional Skills – ICT Obtain, insert, size, crop and position images that are fit for purposes (level 2) see question 3 in summary questions.
Learning Outcomes <i>All pupils should be able to</i> recognise when a rock has been weathered. <i>Most pupils should be able to</i> recall the three main types of weathering and identify key variables in an investigation. <i>Some pupils should also be able to</i> explain biological weathering and plan a detailed investigation into its effects. How Science Works Describe and identify key variables in an investigation and assign appropriate values to these (1.2b).	Additional teachers notes Equipment and materials required for teacher: acorn, photo of a fully grown oak tree, photo of a damaged road. Details. Refer to pupil book. Pupils need to use their imagination for this. They must consider how they could set the investigation up fairly. The independent variable will be the road material, while the dependent variable is the amount of damage. Pupils will need to think of a way to measure this, such as the height the road surface is raised by the root. They must also plan how to get reliable results by carefully considering the controlled variables, e.g. set each road surface up more than once, give each plant the same amount of water.	



Fusion 2: C2.7 – Chemical Weathering		
National Curriculum Link up •2.1a, c. 3.4a, c.		
Learning Objectives Pupils should learn: What chemical weathering is. How chemical weathering changes rocks.	Teaching / Learning activities Lesson structure Starter -Word up Ask pupils to make as many words as they can using the letters in 'chemical weathering'. Longest list wins. (5 mins) Main Remind pupils of the work they did in the last lesson into different sorts of weathering. Review what they can remember about biological weathering (caused by animals and plants). Explain to pupils that rocks can also be weathered by the action of other chemicals upon them. Explain that there are many acidic substances present in nature and that these can damage some rocks by reacting with minerals in the rock. Ask pupils to carry out the 'chemical weathering by acid' investigation as described in the pupil book. Suggest that oxygen in the air also causes substances to degrade by oxidising them. Ask pupils to set up the 'Chemical weathering – oxidation' investigation described in the pupil book. Plenary - Share – pair, square Ask pupils to work in pairs to list the five most important things they have learned in this lesson. Then get them to share their ideas with another pair to refine their five points. If you have time, you could continue to broaden the groups until the class agrees on a list of five points. (10 mins)	Teaching suggestions <ul style="list-style-type: none"> • Special needs. Focus on the acid experiment rather than the oxidation investigation. The former provides instant and concrete results. • Extension. Ask pupils to devise a method of collecting the gas from the 'Chemical weathering by acid' experiment. [Pupils could carry out the experiment in a boiling tube with a delivery tube attached, leading to another test tube.] Ask pupils to write word equations for the reaction between calcium carbonate and hydrochloric acid. • Learning styles. <i>Visual:</i> Observing the action of acid on rocks. <i>Auditory:</i> Sharing the key things they have learnt this lesson. <i>Kinaesthetic:</i> Investigating the action of acid and oxygen on rocks. <i>Interpersonal:</i> Sharing ideas in groups with other pupils. <i>Intrapersonal:</i> Understanding that chemical weathering of rock is often a very slow process. • Homework. Pupils could find some examples of weathered limestone and marble buildings, such as old cathedrals. • Functional Skills – ICT Bring together and organise components of images and text (level 2).
Learning Outcomes <i>All pupils should be able to</i> recognise chemical weathering. <i>Most pupils should be able to</i> explain what chemical weathering is. <i>Some pupils should also be able to</i> represent chemical weathering in word equations. How Science Works Explain how the observation and recording methods are appropriate to the task (1.2d).	Additional teachers notes Chemical weathering by acid equipment and materials required per group: 3 watch glasses, a small piece each of limestone, chalk and marble, 10 cm ³ of 1 mol/dm ³ hydrochloric acid, dropping pipette, magnifying glass, mounted needle. Safety. Clear up acid spillages immediately, hydrochloric CLEAPSS Hazcard 47A. Eye protection must be worn. Ensure pupils do not misuse pipettes. Chemical weathering – oxidation equipment and materials required per group: 250 cm ³ beaker, walnut-sized piece of granite, 50 cm ³ 1 mol/dm ³ hydrochloric acid, 50 cm ³ 20 vol. hydrogen peroxide, mounted needle, magnifying glass, watch glass or cling-film to cover beaker, digital camera with time-lapse facility. Safety. Wear eye protection. Clean up spills immediately. Hydrochloric acid: CLEAPSS Hazcard 47A. Hydrogen peroxide is an irritant: CLEAPSS Hazcard 50.	



Fusion 2: C2.8 – Acid Rain		
National Curriculum Link up •2.1a, 3.4a, c.		
Learning Objectives Pupils should learn: What acid rain is. What causes acid rain. What the effects of acid rain are. Ways we could reduce acid rain.	Teaching / Learning activities Lesson structure Starter - Acid from the sky Give pupils some 'samples' of rain water to test the pH. They should test the pH using universal indicator and decide how acidic each one is. (10 mins) Main - Ask pupils to set up a longer term investigation into the effects of acid rain. They could grow cress seeds watered with various forms of 'acid rain' to see what effects the rain has on plant growth. Please refer to 'Investigating the effects of acid rain'. After giving the class a short time to prepare, hold a class debate on what people could do to reduce the damage caused by acid rain. You could extend this to include the 'Great Debates' described in the pupil book. Variations on a straightforward debate are suggested in the differentiation section. [Ultimately, the solution is to reduce fossil fuel usage. However, oil companies are going to great lengths to remove sulfur from fuels and catalytic converters on vehicles break down nitrogen oxides so only nitrogen reaches the end of the exhaust. Talk about the pressure to balance the damage caused by acid rain against demand for energy.] Plenary - Acid burn Ask pupils to list 10 things which can be damaged by acid rain, based on what they can remember from the lesson. (5 mins)	Teaching suggestions <ul style="list-style-type: none"> • Special needs. During the debate, team lower attaining pupils up with higher attaining ones where you can, so that they may develop ideas together. If this is not possible, you could try using the 'opinion line'. Set up a rope or line across the room with the words 'Completely agree' at one end and 'Completely disagree' at the other. Read out and get pupils to stand next to the rope in a position which reflects their opinion. You can then ask them to explain why they stood there. • Extension. Higher attaining pupils could lead the class debate. • Learning styles. <i>Visual:</i> Observing the pH of rain water samples. <i>Auditory:</i> Taking part in the class debate. <i>Interpersonal:</i> Allowing others to have their say during the class debate. • Homework. Give pupils some pieces of universal indicator paper and ask them to collect and test the pH of rain water where they live. (Safety: Universal indicator is flammable.) • Functional Skills – English Present information and ideas clearly and persuasively to others (level 2).
Learning Outcomes <i>All pupils should be able to</i> describe what causes acid rain. <i>Most pupils should be able to</i> explain the difference between 'normal' and acid rain. <i>Some pupils should also be able to</i> explain methods of reducing the effect of acid rain on the environment. How Science Works Explain some issues, benefits and drawbacks of scientific developments with which they are familiar (1.1b).	Additional teachers notes Acid from the sky equipment and materials required per group: 5 cm ³ of 0.1 mol/dm ³ sulfuric acid, labelled 'sulfur dioxide in rain water'; 5 cm ³ of 0.1 mol/dm ³ nitric acid, labelled 'nitrogen oxide in rain water'; 5 cm ³ of sparkling water, labelled 'carbon dioxide in rain water'; 3 test tubes, test tube rack, universal indicator, solution or paper, eye protection. Safety. Nitric acid is an irritant: CLEAPSS Hazcard 67. Universal indicator is flammable. Wear eye protection. Investigating the effects of acid rain equipment and materials required per group: cress seeds, 4 Petri dishes, filter paper or cotton wool to line Petri dishes, 0.1 mol/dm ³ sulfuric acid, labelled 'sulfur dioxide in rain water'; 0.1 mol/dm ³ nitric acid, labelled 'nitrogen oxide in rain water'; sparkling water, labelled 'carbon dioxide in rain water'; distilled water, 4 measuring cylinders. Safety. Nitric acid is an irritant: CLEAPSS Hazcard 67.	



Fusion 2: C2.9 – Physical Weathering		
National Curriculum Link up •2.1a, c. 3.4a, c.		
Learning Objectives Pupils should learn: What physical weathering is. How physical weathering changes rocks.	Teaching / Learning activities Lesson structure Starter - Particles party Ask pupils to recall from Year 7 work, and to sketch, the arrangement of particles in a solid [regularly arranged and all touching], a liquid [mostly touching but not regularly arranged] and a gas [not touching, randomly arranged]. (10 mins) Main – Get the class to set up 'Investigating freeze–thaw weathering' described in the pupil book. You may wish to have a frozen cylinder which you prepared earlier. [The volume of ice is greater than the volume of liquid water which formed it, owing to the way the molecules align in the solid. You could link this to particle arrangements in matter. The expansion in volume forces rocks to split.] The instructions for 'Demonstrating onion-skin weathering' are given in the pupil book. Pupils must be very careful about broken glass during this experiment as the glass rod will break and may shatter. For this reason, you may wish to demonstrate rather than allow the pupils to carry it out. [The surface and the centre of the rod expand when the rod is heated and contract when it is cooled in the water. However, these processes happen much more quickly on the surface and the two parts do not move at the same rate.] Plenary - Sort it out? Give pupils statements which describe how freeze–thaw weathering takes place, but in the wrong order. Ask them to place the sentences into the correct order. (5 mins)	Teaching suggestions <ul style="list-style-type: none"> • Special needs. In 'Investigating freeze–thaw weathering' lower attaining pupils should concentrate on the qualitative results, rather than measuring the pieces. They could draw sketches of the pieces. • Extension. Ask pupils to research why broken rock in mountains is usually sharp-edged, unlike beach pebbles. [The rock in mountains has not rubbed against other rock to round it and is more likely to have been broken by freeze–thaw and fallen to its resting place.] • Learning styles. <i>Visual:</i> Observing the ways that rocks can be weathered. <i>Auditory:</i> Describing how weathering processes occur. <i>Kinaesthetic:</i> Investigating physical weathering. <i>Interpersonal:</i> Working with others during practicals. <i>Intrapersonal:</i> Understanding that the weathering processes are very slow. • Functional Skills - English Present information on complex subjects concisely and clearly (level 2).
Learning Outcomes <i>All pupils should be able to</i> recognise onion-skin and freeze-thaw weathering. <i>Most pupils should be able to</i> list the processes involved in onion-skin and freeze-thaw weathering. <i>Some pupils should be able to</i> explain onion-skin and freeze–thaw weathering in terms of particles. How Science Works Explain how the observation and recording methods are appropriate to the task (1.2d).	Additional teachers notes Investigating freeze–thaw weathering equipment and materials required per group: 100 cm ³ measuring cylinder, 100 cm ³ water, access to a freezer in which the cylinder can sit upright. Demonstrating onion-skin weathering equipment and materials required per group (or for teacher): glass stirring rod (which will get broken), Bunsen burner, heat mat, matches, 250 cm ³ beaker, 150 cm ³ cold water, eye protection. Safety. Pupils must be very careful not to burn themselves or each other and to look out for glass shards flying off glass rod when reheated. Wear eye protection.	



Fusion 2: C2.10 – Erosion		
National Curriculum Link up •2.1c. 3.4a, c.		
Learning Objectives Pupils should learn: What erosion is. What happens to weathered rock.	Teaching / Learning activities Lesson structure Starter - Tread carefully Show pupils a photograph of a badly eroded footpath and ask them to suggest how it has happened. (5 mins) Main - Ask pupils to carry out the 'Modelling a river' investigation described in the pupil book. They will need to set it up carefully and to observe closely what happens to the 'sediment' in the river. The water flow rate must not be too great or all the sediment will wash down at once. Ask pupils to work in small groups to come up with a description of what they saw happening. They should then share their ideas with another group, before the whole class comes together to decide how they think rocks are transported by rivers. [Small pieces are transported more easily. When the river slows the bigger pieces are 'dropped' first.] Ensure pupils are clear about the difference between 'weathering' and 'erosion'. [The former refers to breaking up of the original rock mass, where it was formed. The latter refers to the breaking down of fragments of rock as they are transported. Together, weathering and erosion lead to 'denudation' of the landscape.] Plenary - Waterfall Show pupils a picture of a waterfall. Ask them to explain why waterfalls move upstream over time. [The foot of the waterfall is continuously eroded and the cliff breaks off, moving the waterfall upstream.] (5 mins)	Teaching suggestions <ul style="list-style-type: none"> • Special needs. Lower attaining pupils may need assistance in setting up the investigation successfully. It is important that the flow rate is neither too slow (nothing moves) or too fast (all the rock moves). In either case it will be impossible to observe what happens in nature. Give pupils a series of small diagrams showing rocks of different sizes. Ask pupils to place the images in order of the ease with which they are moved by the water, from fastest to slowest. • Extension. Ask pupils to find out how lapidary is carried out using grits and stones of different sizes to work and polish rocks. • Learning styles. <i>Visual:</i> Observing the movement of rock fragments in the transportation investigation. <i>Auditory:</i> Sharing their observations with each other. <i>Kinaesthetic:</i> Investigating transportation. <i>Interpersonal:</i> Working with others during the practical. • Homework. Pupils could find out what National Park authorities are doing to limit footpath erosion on popular routes such as the Pennine Way. [Much of it is being laid with rock slabs which wear away much more slowly. However, some believe that this is damaging to the environment both because of the helicopters which are often used to transport the stone and because of the vastly altered appearance of the landscape.]
Learning Outcomes <i>All pupils should be able to recall a definition for erosion.</i> <i>Most pupils should be able to explain the size of particles in a river in terms of energy flow.</i> <i>Some pupils should also be able to predict where different sizes of particle will be found in a river and to explain why.</i> How Science Works Describe how the use of a particular model or analogy supports an explanation (1.1a1).	Additional teachers notes Equipment and materials required per group: 80–100 cm length of square guttering, water trough or sink, 20 cm ³ ink, length of rubber tubing, access to a tap, rock fragments of different sizes – stony soil would work well. Details Refer to pupil book. Pupils should run water down the guttering first, without any stones, dripping some ink in to observe the flow rate better at different points. After putting in the rock fragments they should gently wash them with water, observing the different flow rates depending upon the size of the pieces. You may wish to fit traps to the sinks to prevent soil and stones being washed down them. A fine sieve could be attached to the end of the guttering. Safety. Normal laboratory rules.	



Fusion 2: C2.11 – Rock Cycle		
National Curriculum Link up •2.1a, b, c. 3.4a, c.		
Learning Objectives Pupils should learn: How new rocks are made from old ones. What the rock cycle is.	Teaching / Learning activities Lesson structure Starter - Word Up Give pupils anagrams of the key words from this unit, such as igneous, metamorphic, sedimentary, weathering, transportation and erosion. They must unravel the words. (5 mins) Main - Remind pupils of the work they have done in this unit, from the different types of rock to the work done on weathering and erosion. Explain to the class that the minerals on Earth are recycled naturally over millions of years. The weathered fragments of igneous rock can be transported by rivers and eroded, eventually becoming sediments in the sea. These sediments can be compressed and cemented, forming sedimentary rock over time. Both igneous and sedimentary rock can be changed by heat and pressure inside the Earth into metamorphic rock. Pupils could make a model of the rock cycle using wax crayons or candles. They could use these to demonstrate each process within the rock cycle and label a flow diagram. Give pupils an outline diagram of the rock cycle and ask them to annotate and complete it. They should add the names of any missing rock types and processes such as weathering and transportation. They should also, if they can, add details to summarise how each step takes place, such as how sedimentary rocks are formed. To complete the activity you could ask individual pupils to explain a section of the cycle. Plenary - Have I been asleep? Ask pupils to imagine what Britain might look like after 100 million years of the rock cycle have taken place. (5 mins)	Teaching suggestions <ul style="list-style-type: none"> • Special needs. You may wish to give pupils pre-written labels to add to their rock cycle, rather than leaving them to write their own. They would need to decide where to put the labels, rather than write their own text. • Extension. Ask pupils to research a recent earthquake and to find out how severe it was. They may need to research the Richter scale first and they should also find out what causes earthquakes. [There are many earthquakes every day around the world, though most are very minor. Quakes occur along the boundaries of tectonic plates where, owing to the sliding of two plates, stresses occur in the rocks. These stresses can release suddenly, shaking the ground. Common earthquake zones include the western coast of the USA and South America, Japan and Southern Europe. Developed in 1935 by Charles Richter, the Richter scale describes, from 1 to 10, the severity of an earthquake. It is not, however, a linear scale.] • Learning styles. <i>Visual:</i> Completing the diagram of the rock cycle. <i>Auditory:</i> Describing sections of the rock cycle to the group. <i>Intrapersonal:</i> Understanding that the processes in the rock cycle take millions of years to occur. • Homework. Ask pupils to write a story about the life of a crystal in igneous rock. The story should give details of what happens to the rock after it has been weathered.
Learning Outcomes <i>All pupils should be able to describe that igneous, sedimentary and metamorphic rocks are connected by a series of processes.</i> <i>Most pupils should be able to recall the main parts of the rock cycle.</i> <i>Some pupils should also be able to explain how new rocks are formed from old.</i>	Additional teachers notes	



Fusion 2: C2.12 – Rocks in the Universe		
National Curriculum Link up •2.2a. 3.4a.		
Learning Objectives Pupils should learn: That igneous, sedimentary and metamorphic rocks are found elsewhere in the universe. That other planets have rock cycles.	Teaching / Learning activities Lesson structure Starter - Rock on! Ask pupils to recall the key elements of the rock cycle. (10 mins) Main - Remind pupils about the rock cycle. Suggest that it might be possible for other planets to have a rock cycle too. Gather suggestions as to what scientists might look for when trying to ascertain whether other planets have a rock cycle and how they might obtain this evidence. [Evidence might include: the presence of volcanoes (as on Mars), images of lava flows (which may be visible on Venus) or the existence of mountain ranges which are often brought about by the movement of tectonic plates. Evidence could be obtained by satellite pictures or from data sent back to Earth by probes.] If you have the resources available, give pupils some pieces of meteorite to study. Explain that meteorites are pieces of rock which were not formed on Earth, but in other parts of space. Ask pupils to decide whether the meteorite samples could be classified as one of the rock types found on Earth. Give pupils the opportunity to research the possibility of rock cycles on other planets. Good websites to begin research include: http://solarsystem.nasa.gov/planets and http://bbc.co.uk/science/space/solarsystem/earth Ask members of the class to report back their findings. Plenary - Sort it out Give pupils the key words from this topic and ask them to match them to definitions. (5 mins)	Teaching suggestions <ul style="list-style-type: none"> • Special needs. Lower attaining pupils will need extra support for the research task. It may be best to concentrate on just Mars and Venus where there is plenty of evidence of a rock cycle and to find a reliable webpage before the lesson. The content on the Internet changes too fast for it to be worth including an address here. • Extension. The key opportunity here is in the depth and quality of the research carried out. Pupils could be encouraged to look for common patterns in the geology of all the planets in the solar system, e.g. whether Earth's minerals are found elsewhere. Pupils could also consider the reliability of 'evidence' found on meteorites, for example could the bacteria which have been found on some actually have come from contamination on Earth? • Learning styles. <i>Auditory:</i> Describing their research into other planets. <i>Kinaesthetic:</i> Investigating meteorites. <i>Intrapersonal:</i> Understanding that other planets may have a rock cycle. • Functional Skills – Literacy Writing a report about rock cycles on other planets and the newspaper report. ICT Researching information about other planets.
Learning Outcomes <i>All pupils should be able to recall that rocks are found elsewhere in the universe.</i> <i>Most pupils should be able to explain that other planets have rock cycles.</i> <i>Some pupils should also be able to explain how evidence for what is happening in other parts of the universe is gathered.</i> How Science Works Describe what needs to be considered in the collection and manipulation of secondary evidence to evaluate the conclusion or interpretation made (1.2f). Recognise that the selection, ordering or rejection of secondary data could lead to different conclusions (1.2f)	Additional teachers notes Equipment and materials required per group: access to several pieces of different meteorites. Samples may be loaned from the Schools and Education section of the Science and Technology Facilities Council website (www.stfc.ac.uk), hand lens, mounted needle. Details. Study the meteorite samples and decide whether they can be classified as igneous, sedimentary, metamorphic or none of these. Safety. Mounted needles are sharp. Care must be taken when carrying or using them.	