8.1 Piezo igniters

Science understanding, Science as a human endeavour

Verbal/Linguistic

Piezoelectricity

Piezo is a Greek word meaning pressure. Piezoelectricity refers to making electricity by putting pressure on certain materials. Two French scientists, Pierre and Jacques Curie, discovered the effect in 1880. Their experiments showed that they could produce electric charges on the surface of some crystals simply by hitting or twisting them. The crystals they tried included quartz, cane sugar and topaz. These discoveries, and further experiments by other scientists, led to the development of many devices including:

- electronic alarms in mobile phones, cars and watches
- gas lighters (piezo igniters)
- microphones
- timers in clocks.

Piezoelectricity can easily be seen by striking two pieces of quartz together in a darkened room. 'Blue metal' on road surfaces often has pieces of quartz mixed in with it. In a dark room, one piece of quartz can be struck against the other like striking a match. Sparks or flashes of light can be seen if the room is dark enough.

Piezo igniters

A piezo igniter is a device that creates a spark without an outside source of electricity such as a battery or mains power. Most piezo igniters have a spring-loaded hammer that hits a piece of quartz. You can hear a definite loud 'click' as the hammer fires. A piezo igniter can only fire once each push because it is triggered by a spring. The spring can only reset when you release the button back up.

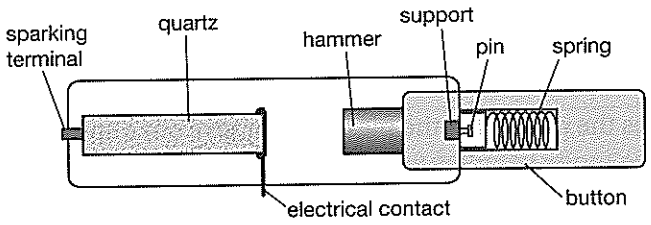


Figure 8.1.1

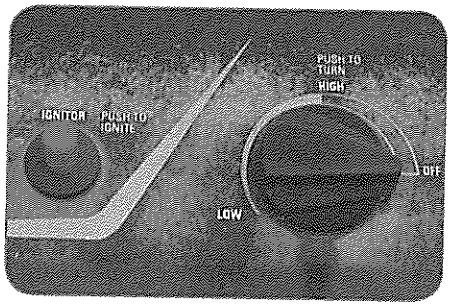
Side view of a piezo igniter button. Piezo igniters can give you a mild shock. Use them with caution because they can ignite gas.

Uses of piezo igniters at home

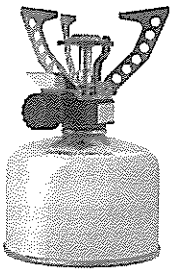
Piezo igniters may be found in homes in:

- gas heaters: On many types of gas heaters, the piezo igniter has a star shape or a 'lightning flash' symbol on the push button, which is often red or black. Other piezo igniters are connected to a knob that must be turned.
- gas barbecues: Most gas barbecues have a knob attached to the piezo igniter. When turned, there is a click and the gas is turned on at the same time. Other barbecues have knobs to turn on the gas, and the igniter is a separate push button.
- gas hot water systems: Some gas hot water systems such as storage systems have piezo igniters. The igniter lights a special flame in the system called a pilot light, which usually stays burning.

- portable gas cookers: Portable gas cookers use piezo lighters. Note that kitchen gas cooktops that are fixed use mains electricity instead to create sparks. You can tell because you cannot hear the click of the hammer firing, just a crackling sound of the sparks. The other indicator is that the sparks continue to appear with the one turn of the knob, unlike the single fire action of a piezo igniter.



Barbecue



Portable cooker

Figure 8.1.2
Some piezo igniter knobs

1 **Name** the scientists who discovered piezo electricity.

2 **Describe** what the scientists did in their experiments.

3 **Describe** how piezo electricity can be observed using two pieces of quartz.

4 **State** an advantage that a piezo igniter has over other methods of lighting gas.

5 **Name** the mineral inside most piezo igniters that creates the spark.

6 **Explain** what action makes the mineral in the piezo igniter give out a spark.

7 Refer to the diagram in Figure 8.1.1 on page 105 of the piezo igniter, and **explain** why only one click is heard when a piezo igniter fires.

8 **List** some devices at home that may contain a piezo igniter.

8.2 All four engines have failed!

Science as a human endeavour

Verbal/Linguistic

Refer to the Science as a Human Endeavour on page 284 of your student book to answer the following questions.

1 **State** where the British Airways 747 was when it lost power to all four engines.

_____

2 **Propose** a reason why the crew did not see the volcanic ash cloud.

_____

3 **Propose** a reason why the crew were confused about the cause of the engine failure.

_____

4 (a) **Describe** the contents of a volcanic ash cloud.

_____

(b) **Explain** how they interfere with the engines.

_____

_____

5 **Describe** the response of the international community to Flight BA009 nearly crashing.

_____

_____

6 **Describe** the information that is now gathered about ash clouds.

_____

_____

_____

7 **Discuss** how the crew of an aircraft knows that an ash cloud is on its route.

_____

_____

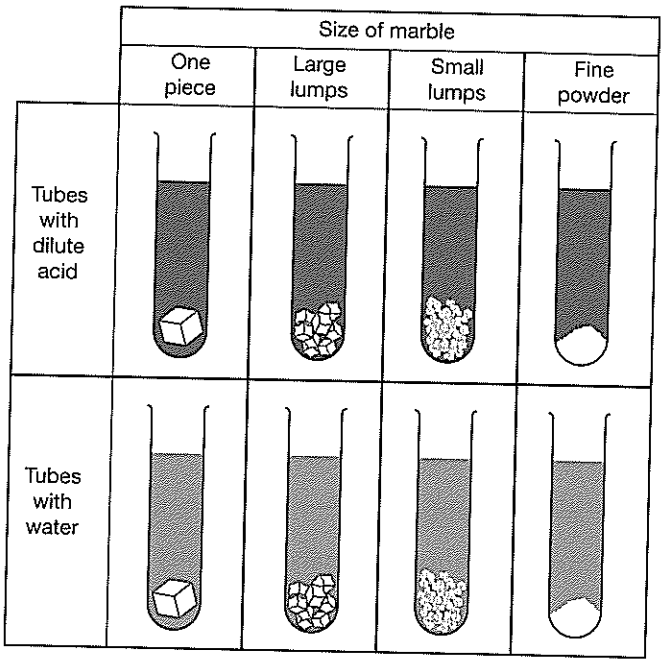
8.3 Weathering experiment

Science inquiry

Logical/Mathematical **Verbal/Linguistic**

Two students, Sita and Glenn, wanted to find out if physical and chemical weathering acted together in the weathering of marble. They knew from previous experiments that acid could attack marble and limestone. They wanted to see if this chemical weathering was affected by physical weathering of the marble.

They designed an experiment where they smashed up some marble pieces into different sizes to represent physical weathering and added dilute hydrochloric acid to them. You can see the set-up for their experiment below.



They made sure they used the same mass of marble, 5 grams, in each test-tube, and the same volume of hydrochloric acid, 25 mL, in each tube. In the first trial, Sita and Glenn used one piece of marble, in the second they used a number of large lumps, in the third trial they used numerous small lumps and in the final trial they used fine powder. To decide how fast the marble weathered, they decided to look at the mass of marble left after 10 minutes. After 10 minutes, they tipped each of the test-tube contents through separate filter papers. They then rinsed the solid captured in each filter paper with water until they were sure there was no acid left. Then they dried and weighed each filter paper to see how much of the marble solid was left.

Their results are shown in the table below. This shows the mass of marble left after 10 minutes in acid or water. Remember that each test-tube originally had 5 grams of marble in it at the start.

Liquid in test-tube	Mass of marble left (g) for different size of marble			
	One piece	Large lumps	Small lumps	Fine powder
Acid	4.5	1.1	0.5	0
Water	5.0	5.0	5.0	5.0

1 **Explain** why Sita and Glenn used the test-tubes with water in them.

2 **Explain** why Sita and Glenn made sure they started with the same mass of marble in each test-tube.

3 **Propose** why they rinsed (washed) the filter paper with water.

4 **Explain** why they dried the filter paper before weighing it.

5 **Describe** what effect changing the size of the marble pieces had on the amount of marble left at the end.

6 **Interpret** the results to produce a conclusion for this experiment.

7 **Propose** how Sita and Glenn could have improved on the design of this experiment.

8.4 Settling sediments

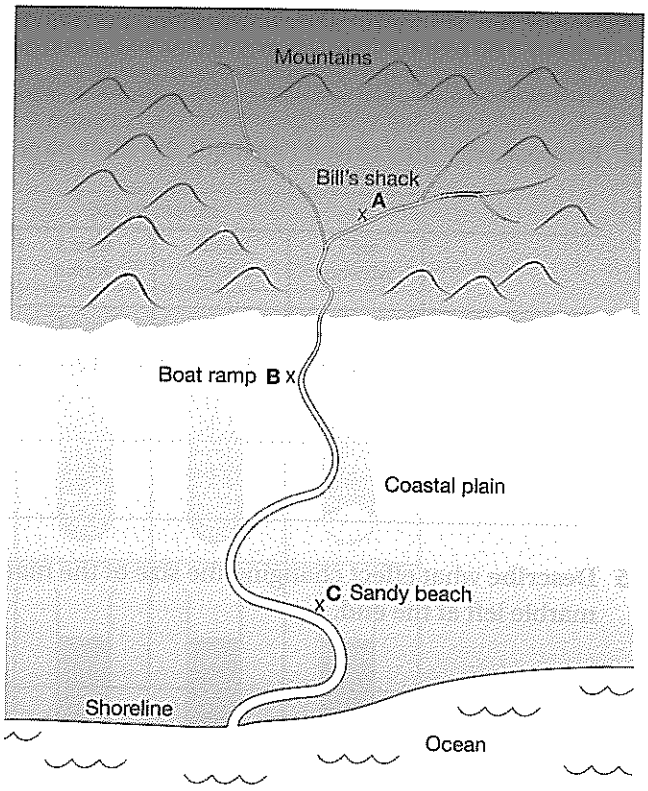
Science understanding, Science inquiry

Logical/Mathematical **Verbal/Linguistic**

Sediments are carried by rivers and eventually deposited. While the river is flowing fast, large sediments can be carried. If the river slows, only smaller sediments can be carried. If the river stops flowing, even the smallest sediments are deposited.

By studying the particles in sediment, you can learn a lot about the history of a place. The first step is to pass the sediments at a site through a stack of sieves. The sieves are of different sizes, from large at the top to small at the bottom. These sieves sort out the grains into size ranges. The next step is to measure the mass of each category of grain size.

Consider the sites shown in the river valley to the right.

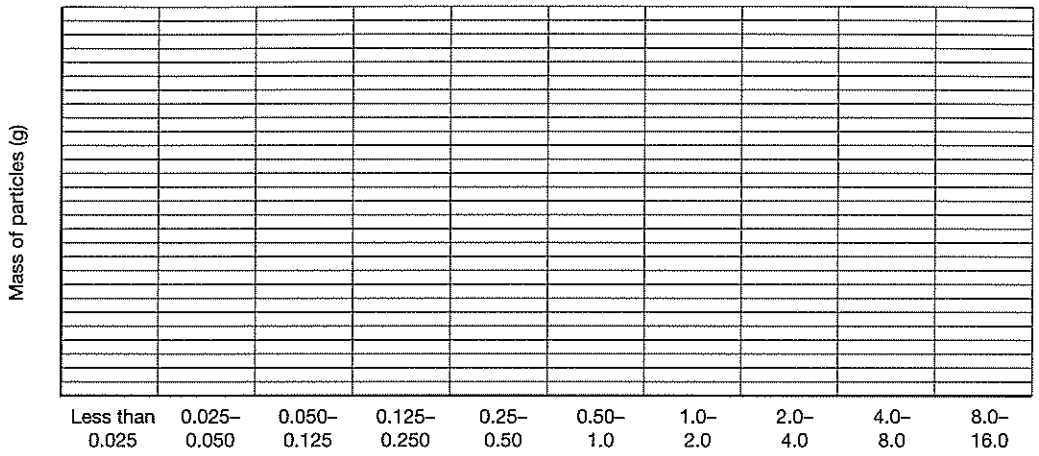


The river valley was studied by sampling the sediments at two of the sites, A (Bill's shack) and C (Sandy Beach). The results for sites A and C are shown in the table.

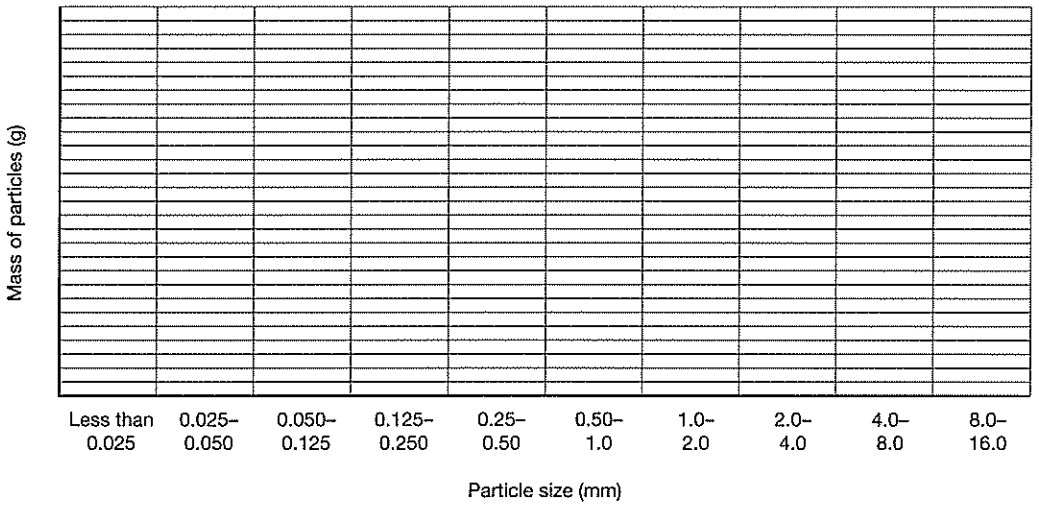
Particle size (mm)	Mass of particles (g) at site:	
	A: Bill's shack	C: Sandy beach
8.00–16.00	320	0
4.00–8.00	560	0
2.00–4.00	1200	0
1.00–2.00	1410	0
0.50–1.00	2410	0
0.25–0.50	700	600
0.125–0.250	400	1050
0.050–0.125	0	2000
0.025–0.050	0	2600
Less than 0.025	0	750

1 On the axes below **construct** column graphs of these results.

Site A



Site C



2 **Identify** the site where the sediment is mainly composed of smaller particles.

_____

3 **Discuss** some differences in the range of the particle sizes at the two sites.

_____

_____

4 **Propose** why there was a difference in the average size of the particles found at sites A and C (about 1 mm compared with about 0.05 mm).

_____

_____

5 **Predict** what the particle sizes may be like at site B, the boat ramp. **Justify** your answer.

_____

_____

8.5 The Grand Canyon

Science understanding, Science inquiry

Logical/Mathematical **Verbal/Linguistic**

The Grand Canyon is one of the deepest cuts in the Earth's crust where rock layers are exposed and visible. It is found in the United States in Colorado state, about 500 km from the sea. It was created by the Colorado River cutting its way down to a depth of 1.6 km into the rock beneath it. Geologists have concluded it took about 70 million years for the canyon to form. The canyon gave geologists an amazing opportunity to study the sequence in which the rocks were laid down. They concluded that the oldest rocks at the bottom of the canyon are 2000 million years (2 billion years) old.

The names and types of rock found in the different strata are shown below.

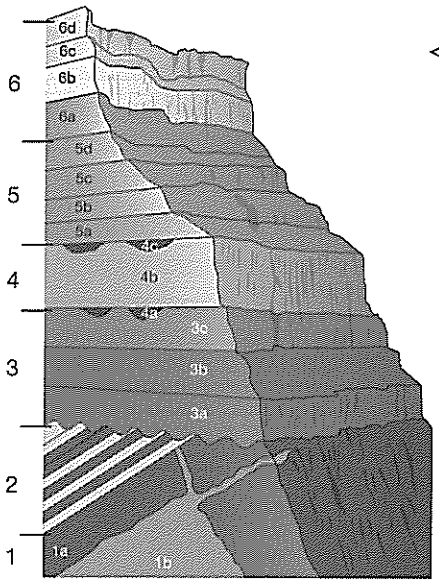


Figure 8.5.1

Key

6	**Hermit, Coconino, Toroweap and Kaibab**
6d	Kaibab limestone
6c	Toroweap formation
6b	Coconino sandstone
6a	Hermit shale
5	**Supai group**
5d	Esplanade formation
5c	Wescogame formation
5b	Manakacha formation
5a	Watahomigi formation
4	**Temple Butte, Redwall and Surprise Canyon**
4c	Surprise Canyon formation
4b	Redwall limestone
4a	Temple Butte limestone
3	**Tonto group**
3c	Muav limestone
3b	Bright Angel shale
3a	Tapeats sandstone
2	**Grand Canyon supergroup**
1	**Vishnu group**
1b	Zoroaster granite
1a	Vishnu schist

Layer 1, the Vishnu group, contains mainly igneous rocks. It is tilted at an angle due to Earth movements. There are no sedimentary rocks in this layer.

Layer 2, the Grand Canyon supergroup, consists of several different sedimentary rock layers and some igneous rock layers. The lowest sedimentary layer in the supergroup is called the Bass formation. This was tilted by Earth movements after it was laid down. The Bass formation contains fossilised structures known as stromatolites. These were formed by living organisms called blue-green bacteria that lived in shallow coastal seas. The existence of similar structures today in Western Australia and elsewhere indicates that the Grand Canyon must have been a shallow coastal sea at the time these rocks were formed. Other sedimentary layers occur on top of the Bass formation. Two of these layers are shale. One shows ripple marks in the shale that only form in shallow coastal seas. Above this layer is some basalt from volcanic activity, and above them again more sedimentary layers formed in shallow seas.

Layer 3, the Tonto group, is a horizontal series of three sedimentary layers. The first is Tapeats sandstone, which probably formed near an ocean shoreline. Fossils of sea creatures called trilobites (extinct relatives of horseshoe crabs) and brachiopods (shelled molluscs) have been found here. Above this there is a shale layer formed from mud that was just offshore, and contains brachiopod, trilobite and worm fossils. The next layer, called Muav limestone, is a chemical sedimentary rock formed at the bottom of a shallow sea that was probably deeper than layer 3b.

Layer 4a, the Temple Butte limestone, had fossils of animals with backbones. In the eastern part of the canyon, this layer contains bony plates from freshwater fish. In the western part this layer contains many marine (salt water) fish fossils. Layer 4b is the Redwall limestone, a very thick layer of limestone that indicates that the area was at the bottom of the sea for a long period of time. Many fossilised crinoids (sea star relatives), brachiopods, bryozoans (coral relatives), corals, nautiloids, sponges and trilobites have been found here.

Layer 5, the Supai group of strata, contains land plant fossils as well as amphibian footprints and reptile fossils. There were also some marine fossils in other parts of the canyon. This seems to show that the sea was retreating and land was forming at the time these layers were formed.

Layer 6a, the Hermit shale, had fossils of winged insects, cone-bearing plants and ferns, as well as tracks of amphibians and reptiles. This shows it was a swampy land environment. Layer 6b, the Coconino sandstone, formed from sand dunes on land. Layer 6c, the Toroweap formation, had some marine limestone in it, indicating that the sea had again submerged the area. Layer 6d, the Kaibab limestone, had many marine fossils such as shells so this must have been under the sea.

1 **Identify** the oldest sedimentary layer in the Grand Canyon.

_____

2 **Identify** the youngest sedimentary layer in the Grand Canyon.

_____

3 **Propose** why geologists would think that the Redwall limestone was laid down over a very long period of time.

_____

_____

4 Clastic sedimentary rocks are composed of weathered rock particles cemented together. **Identify** three layers that are definitely clastic sedimentary rocks.

_____

_____

5 The Grand Canyon is over 500 km from the sea. **Discuss** some evidence from these rock layers supporting the view that in the past this area was sometimes covered by the sea, but not at other times.

_____

_____

6 **Explain** how the Grand Canyon is evidence that the Earth's sedimentary rocks were laid down over a very long period of time.

_____

_____

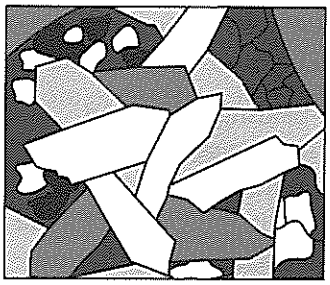
8.6 Identifying rocks

Science understanding, Science inquiry

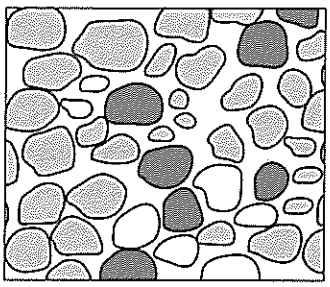
Logical/Mathematical Visual/Spatial

Consider the diagrams of the rocks.

a



b



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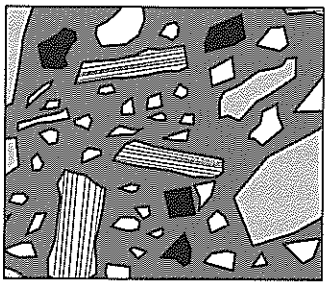

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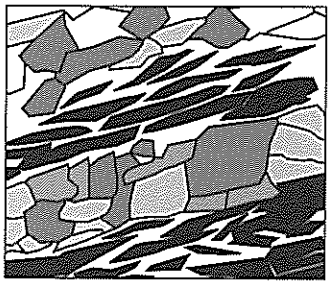

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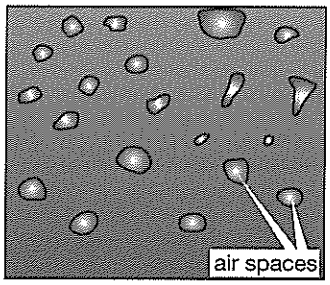

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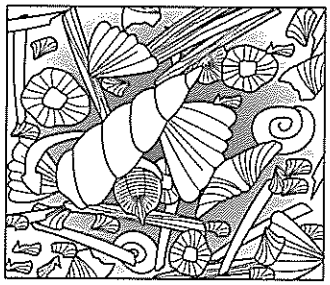

Classify each of the rocks into a type and justify your decision. Select the type of rock from the following list: extrusive igneous, intrusive igneous, clastic sedimentary (sandstone), organic sedimentary, clastic sedimentary (breccia) and banded metamorphic.

Rock	Type of rock	Justification for classification
a		
b		
c		
d		
e		
f		

8.7 You are a diamond!

Science as human endeavour

Verbal/Linguistic

When someone says 'You are a diamond', they mean you are a wonderful person. However, now it could be true—you could really become a diamond! Several companies throughout the world make dead bodies into diamonds. A Swiss company called LifeGem was the first company to do this. LifeGem will also turn dead pets into diamonds. Dozens of diamonds can be made from one individual.

One woman had her dead husband turned into a diamond necklace, so she feels close him to whenever she wears it. The ring shown in Figure 8.7.1 was made from the ashes of a dog. However, you don't have to be dead for some of you to end up in a diamond. Diamonds can be made from anything that is organic, meaning containing the element carbon, and once part of a living thing. Hair can therefore be turned into a diamond. In 2008, hair from the dead composer Ludwig van Beethoven was turned into a diamond and sold on eBay for US$200 000.

The diamonds from humans are made by creating similar conditions to when real diamonds are formed beneath the Earth's crust. These conditions are very high pressures and temperatures. The first step is to cremate the dead body. This means to burn it so that it turns into ash. This would happen at a normal cremation service at a cemetery. The family then gives the ashes to LifeGem.

Figure 8.7.1 This ring was made from the ashes of Digby the dog.

The ashes are heated to about 3000°C. This turns the ash into graphite, a form of carbon. The graphite is then added to a press—a metal device with sections called anvils that squeeze the graphite between them at pressures about 100 000 times greater than the pressure of the atmosphere. At the same time, the graphite is also heated to about 1500°C. The atoms in the graphite break apart from each other and rearrange into a different arrangement. The graphite is now diamond.

Human and pet remains contain many elements, such as boron. If some of the boron remains in the graphite, it results in diamonds that are blue. Early attempts produced all blue diamonds, but now other colours can be made by adding particular elements to the graphite before it is compressed.

Other uses of synthetic diamonds

Diamonds have many uses, but natural ones are rare and therefore expensive. Diamonds made in the laboratory are called synthetic diamonds. Synthetic diamonds are generally much cheaper than natural ones. Diamonds are valued mainly for their hardness, but also for their colour and purity. Synthetic diamonds can be harder than natural ones. This makes them especially useful as powder for polishing and sanding and for cutting tools. These are the largest uses of synthetic diamonds at present.

8.7

Synthetic diamonds can be cut into gems. The purity and lower price of artificial diamonds makes them popular for jewellery. Synthetic diamonds can be artificially coloured yellow, brown, blue, green or orange. Natural diamonds also occur in a range of colours. Australia's Argyle diamond mine is famous for its pink diamonds. Special devices called spectroscopes can be used to tell the difference between natural and artificial diamonds. Natural diamonds can also have a number burned into them by a laser to show they are authentic.

1 **Name** the element that must be in the ash before it can be made into a diamond.

_____

2 **State** the conditions below the Earth's crust that result in the formation of natural diamonds.

_____

3 **Explain** what must be done to the ash before it can be placed in the press.

_____

4 **Describe** the conditions necessary in the press to turn the graphite into diamonds.

_____

_____

5 **Describe** what happens to the carbon in the press.

_____

_____

6 **Explain** why diamonds made from human and pet ash may be blue.

_____

_____

7 **Explain** why synthetic diamonds rather than natural diamonds are often used in cutting blades or for polishing and sanding.

_____

_____

8.8 Literacy review

Science understanding

Verbal/Linguistic

1 **Use** the clues to **identify** the jumbled words.

Jumbled word	Clue	Answer
logyoge	The study of rocks, their history and the processes that form and change them	
iclokrenting	Crystals that grow into each other in a rock	
gamma	Molten rock that does not reach the Earth's surface	
newheatrig	The physical and chemical processes that break rocks down into smaller pieces	
meantedysir	Rocks made by sediments being cemented together	
nitfoolia	Process where minerals under pressure become squashed flat and the rock develops layers or bands	
phormaticme	Rocks formed when high temperature and pressure alter existing rocks	
cork cecly	Model that geologists use to explain the endless cycle of change that happens to rocks as they change from one form to the other	
medestination	The process of water or wind depositing eroded rock particles	
ogenius	Rocks formed from cooling magma	

2 **Use** the clues to **identify** the missing words.

Clue	Word
Igneous rock forming below the surface of the Earth	m _ g _ _
Molten rock reaching the Earth's surface	l _ v _
Whether a rock is rough, smooth or has lumps or holes in it	t _ x _ _ r _
Type of weathering caused by water and chemicals in the water and air reacting and breaking down rock	c _ _ m _ c _ l
How well soil particles stick together	c _ _si _ _ e _ _ y
How well the soil particles join up to form lumps	s _ r _ c _ u r _
Rocks that form by the accumulation of plant or animal debris, which is then cemented together	s _ _ _ m _ _ t _ _ y
Type of weathering caused by ice, temperature change, salts, wind and plant roots	p _ _ s _ c _ l
Combined with high temperature, this can cause metamorphism	_ r _ _ s _ r _