Be a mineral expert – 2

Identifying minerals using 'action' tests – streak, density, hardness, acid test

This activity is an extension of "Be a mineral expert – 1: Beginning to identify minerals – introducing colour, habit, lustre, cleavage".
In that activity, under the heading of:
1. Spotting mineral differences, pupils were asked to suggest as many ways as they could in which a set of 'unknown' minerals differed from one another, and to begin to identify them using only those properties that they could **see**. They were introduced to the properties of colour, habit, lustre and cleavage, by means of a 'circus' of separate mineral specimens.
The set of specimens is shown in the photograph opposite. This same set should also be supplied to small groups of pupils for this activity, "Be a mineral expert – 2"

Having carried out the visual tests as outlined above, introduce pupils to the following 'action' tests, which involve actively handling the mineral specimens.

2. The circus: using 'action tests' on some known minerals

Lay out the tests in a 'circus' as before and ask pupils to visit each of the four sites in turn, to find out how to use the mineral properties of streak, density, hardness and their reaction to acid as a means of identification. Each circus site has a description card (see below), and a set of mineral specimens, as suggested in the resource list. Answers are given on the back of each card.

3. Identifying minerals: using 'action tests' on the unknown minerals

When pupils have carried out the tests in the 'circus', they should return to their places and apply the tests to the 'unknown' minerals as shown in the photograph. They should then look up the properties of some minerals given on the chart below, to see if they can identify them from **all** their testing.

1. A pupil set of five 'unknown' minerals

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Cards for use with 'circus' of mineral tests

Streak

Streak -
The specimens are all **opaque**, i.e. you cannot see into them or through them, so it is difficult to tell their true colour. The streak test gives a powdered sample, which may show the colour better.
Make a short mark with the mineral on the *unglazed* side of the tile.
Note the colour of the streak and whether it is a thick or a thin line.

Answers on the back.

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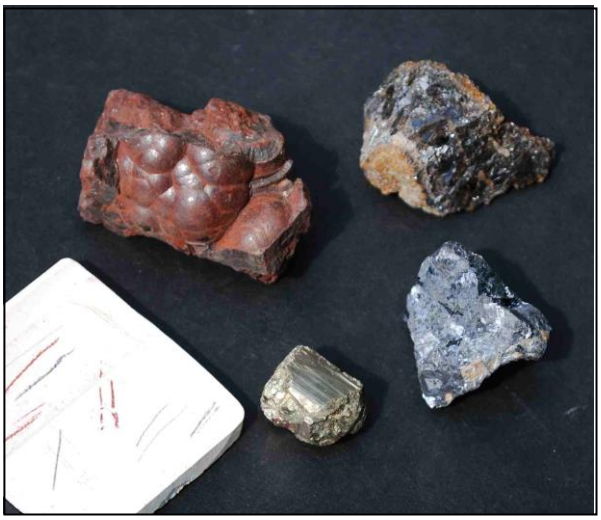
Streak answers

galena	thick grey
sphalerite	pale brown or off-white
haematite	browny-red
pyrite	thin greenish-grey

Is this what you found?



2. Streak: haematite, sphalerite, galena and pyrite, with a streak plate

Density - the weight of something in relation to its volume, e.g. a piece of lead weighs more than a piece of wood of the same size.
Pick up each specimen in turn
Put them back on the bench in order of increasing density.
The minerals are:

galena quartz
gypsum barite

Answers are on the back

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Density answers
The order of relative density, RD (water has a density of 1):
gypsum (RD = 2.3) – least dense
quartz (RD = 2.6)
barite (RD = 4.5)
galena (RD = 7.5) – most dense

3. Density: galena, quartz, gypsum, barite

Hardness
Use the steel nail, the coin and your fingernails to try to make a short scratch on the specimens. Check your answers against the ones on the back of the card.

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Hardness answers
gypsum 2
calcite 3
fluorite 4 (but you have to press hard to mark it with the steel nail)
quartz 7 (but all you can say is that it is harder than a steel nail = 5 and above)

4. Hardness: fluorite, calcite, gypsum, quartz, with a steel nail and a 'copper' coin

Mohs' Scale of mineral hardness
Each mineral in the Scale will scratch all the minerals *below* it in the list but cannot be scratched *by* them.
10 diamond
9 corundum
8 topaz
7 quartz
6 feldspar
5 apatite - steel needle scratches 5 & below
4 fluorite
3 calcite - "copper" coin scratches 3 & below
2 gypsum - fingernail scratches 2 & below
1 talc

Acid test
Use very weak hydrochloric acid, wear eye protection and wash off any spills.
Minerals which contain any **carbonates** will fizz when dilute acid is added.
Put **one drop only** of acid onto each specimen in turn, to find which one(s) contain a carbonate.
Dry off the acid with a paper towel.

Answers on the back

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Acid test answers
There is only one carbonate mineral in this set. It is calcite – $CaCO_3$.

5. Acid test: gypsum, fluorite, calcite, barite and a dropper bottle of dilute hydrochloric acid (All photos: *Peter Kennett*)

Table of properties of some common minerals

Property	Mineral				
	Calcite	**Fluorite**	**Barite**	**Galena**	**Sphalerite**
Colour	white, pink, colourless	blue, yellow, green, colourless	white, pink	dark grey	black to brown
Habit	"dog-tooth": more often rhomb-shaped cleaved fragments	cubic	"layered" or "cockscomb"	cubic	good shapes are rare
Lustre	glassy	glassy	glassy to dull	metallic	metallic to glassy
Cleavage	rhombohedral	octahedral	two planes at right angles	cubic	several planes
Streak	white	white	white	dark grey	pale brown or off-white
Relative Density	quite low 2.7	Moderate 3.2	surprisingly dense for a pale mineral 4.5	very dense 7.5	Moderate 4.0
Hardness	3	4	3.5	2.5	3.5
Acid test	fizzes violently	nil	nil	DO NOT TEST (gives off hydrogen sulphide)	nil

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The back up

Title: Be a mineral expert – 2

Subtitle: Identifying minerals using 'action' tests – streak, density, hardness, acid test

Topic: Using simple practical tests to enhance the identification of a set of 'unknown' minerals, which have previously only been observed visually.

Age range of pupils: 11 - 18 years

Time needed to complete activity: 30 minutes

Pupil learning outcomes: Pupils can:
- observe minerals carefully;
- carry out simple tests
- establish patterns in properties of minerals;
- apply the results of observations and tests on known specimens to the identification of unknown ones.

Context: This series of activities on minerals can be used in a variety of lessons, ranging from the nature of minerals as the 'building blocks' of rocks to the origins and recycling of useful elements in the Earth. The circus activity can be put together with the circus activity of the 'Be a mineral expert 1' Earthlearningidea to make a circus of eight activities.

Following up the activity: "Be a mineral expert 3 - The mineral foundations of everyday life" and "Be a mineral expert 4 -Recycle your mobile phone" will enlarge pupils' awareness of the sources of materials from minerals and will introduce them to the concept of recycling valuable components of a mobile phone, which originate from minerals.

Underlying principles:
- A mineral is a naturally occurring inorganic substance with a definite chemical composition, a definite atomic structure and physical properties which vary within known limits. Minerals are mostly compounds, although native elements such as copper and silver do occur as minerals. This geologist's definition excludes 'minerals' as used in the 'mineral wealth' of a country, e.g. coal or oil; the ions in mineral water; the 'minerals' found in foods such as cereals, etc.
- Common minerals may be readily identified with the use of the senses, or by applying simple tests.
- Most minerals are crystalline and may exhibit good crystal faces, and/or good cleavage faces.

Thinking skill development: Pupils build up a cognitive pattern as they work through their minerals. Some specimens may bring up a cognitive conflict. Applying their skills to other samples of unknown minerals is a bridging skill.

Resource list:
- enough pupil sets for the whole class of 'unknown' minerals, e.g. calcite, fluorite, barite, galena, sphalerite, as in Photograph 1, or any other common minerals which are available in good numbers

- one set of minerals for 'streak ', e.g. haematite, sphalerite, galena and pyrite, together with a streak plate (unglazed tile)
- one set of minerals for 'density', e.g. galena, quartz, gypsum, barite
- one set of minerals for 'hardness', e.g. fluorite, calcite, gypsum, quartz, together with a steel nail and a 'copper' coin
- one set of minerals for 'acid test': gypsum, fluorite, calcite, barite, together with a dropper bottle of dilute (0.5M) hydrochloric acid and a paper towel
- eye protection
- trays to hold the minerals
- description cards for each point in the 'circus', folded and glued, to bring 'answers' to the back of the card
- a copy of the Table of properties of minerals per small group.

- For those who wish to examine more examples, a data sheet of the properties of some common minerals is given in the Appendix, page 5.

Useful links: www.earthlearningidea.com "Found in the ground: sorted!" and **"**Be a mineral expert – 1: Beginning to identify minerals – introducing colour, habit, lustre, cleavage".
See the E-library of the National Science Learning Centre for a full version of "Groundwork" including these activities - http://www.nationalstemcentre.org.uk/elibrary/collection/236/science-of-the-earth-11-14

Source: Originally devised by Peter Kennett and published by the Earth Science Teachers' Association in a teaching pack titled "Groundwork – Introducing Earth Science", Geo Supplies Ltd. Sheffield, 1990.

The progression of thinking skills shown by the Earthlearningidea Mineral Expert activities

Earthlearningidea	Strategies and skills developed
Be a mineral expert – I: Beginning to identify minerals – introducing colour, habit, lustre, cleavage	Observational skills are used to begin to identify minerals.
Be a mineral expert – 2: Identifying minerals using 'action' tests – streak, density, hardness, acid test	Tests involving motor skills are added to purely visual ones, leading to an understanding of the need for more data to be sure of an identification.
Be a mineral expert – 3: The mineral foundations of everyday life	A much wider range of minerals is introduced, together with their chemical compositions, involving higher level thinking skills to match them to their uses in the real world.
Be a mineral expert 4 – Recycle your mobile phone: Why should I recycle my mobile (cell) phone?	An introduction to responsible citizenship, widening the scope from the purely scientific to a mature understanding of the need for recycling scarce materials.

Appendix

Common Mineral Data Sheet for ELI activities

Name	Cleavage/Fracture	Hardness	Relative Density	Streak	Lustre	Colour	Other diagnostic properties
Quartz RF	*none/conchoidal	7	2.65	scratches streak plate	vitreous	colourless, milky but variable	hexagonal prisms terminated by pyramids
Orthoclase Feldspar RF	*2 good, 90	*6	2.6	scratches streak plate	vitreous	pink, white	
Plagioclase Feldspar RF	*2 good, 90	*6	2.7	scratches streak plate	vitreous	creamy-white, grey, colourless	
Muscovite Mica RF	*1 perfect (basal)	*2.5	2.7-3.1	white	pearly	colourless or pale yellow, green or brown	*flaky
Biotite Mica RF	*1 perfect (basal)	*2.5-3	2.7-3.1	white	pearly	brown/black	*flaky
Hornblende RF	*2 good, 60/120	*5-6	3.0-3.5	scratches streak plate	vitreous	black, dark green	prismatic crystals
Augite RF	*2 good, 90	*5-6	3.2-3.5	scratches streak plate	vitreous	greenish-black	prismatic crystals
Olivine RF	none/conchoidal	*6-7	3.2-4.3	scratches streak plate	vitreous	*olive green	
Chiastolite/ Andalusite	poor 1/ uneven fracture	7.5	3.1-3.3	scratches streak plate	vitreous	pearly grey/pink	needle crystals with square x-sections, black centre
Garnet	none	*6.5-7.5	3.5-4.3	scratches streak plate	vitreous	red/brown	*12-sided crystals - each face rhomb shaped
Calcite RF	*3 good, not at 90, perfect rhombs	*3	2.71	white	vitreous	colourless, white, tints	*effervesces with 0.5M HCl, rhombic shape
Fluorite	*4 good, parallel to octahedron	*4	3.0-3.2	white	vitreous	colourless purple/green/yellow	fluoresces in uv light, cubic or octahedral crystals
Halite	3 good, 90 cubic	*2.5	2.2	white	vitreous	colourless, white, often stained	*salty taste cubic crystals, often stained
Gypsum	1 good (basal)	*1.5-2	2.3	white	silky, pearly	colourless, white, often stained	fibrous
Barite	2 good, 90	*3-3.5	*4.5	white	vitreous, pearly	white, pink	bladed crystals
Chalcopyrite	poor/conchoidal	4	4.2	*black	metallic	bronze yellow	*tarnished to peacock colours
Pyrite	none/conchoidal	*6	5.0	*greenish-black	metallic	brass yellow	crystals often striated cubes
Galena	*3 good, 90 cubic	*2.5	*7.5	*lead grey	metallic	lead grey	cubic crystals
Haematite	poor/subconchoidal	*5.5-6.5	4.9-5.3	*cherry red	metallic-dull	red/black/steel grey	kidney shaped masses, fibrous

* – Useful property for diagnosis RF – Common rock-forming mineral

With grateful thanks to WJEC/EDUQAS