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. Spots 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.

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.

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

Is this what you found?

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

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

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

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.

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)

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

Acid test answers
There is only one carbonate mineral in this set. It is calcite – CaCO₃.
<table>
<thead>
<tr>
<th>Property</th>
<th>Calcite</th>
<th>Fluorite</th>
<th>Barite</th>
<th>Galena</th>
<th>Sphalerite</th>
</tr>
</thead>
<tbody>
<tr>
<td>Colour</td>
<td>white, pink, colourless</td>
<td>blue, yellow, green, colourless</td>
<td>white, pink</td>
<td>dark grey</td>
<td>black to brown</td>
</tr>
<tr>
<td>Habit</td>
<td>&quot;dog-tooth&quot;: more often rhomb-shaped cleaved fragments</td>
<td>cubic</td>
<td>&quot;layered&quot; or &quot;cockscomb&quot;</td>
<td>cubic</td>
<td>good shapes are rare</td>
</tr>
<tr>
<td>Lustre</td>
<td>glassy</td>
<td>glassy</td>
<td>glassy to dull</td>
<td>metallic</td>
<td>metallic to glassy</td>
</tr>
<tr>
<td>Cleavage</td>
<td>rhombohedral</td>
<td>octahedral</td>
<td>two planes at right angles</td>
<td>cubic</td>
<td>several planes</td>
</tr>
<tr>
<td>Streak</td>
<td>white</td>
<td>white</td>
<td>white</td>
<td>dark grey</td>
<td>pale brown or off-white</td>
</tr>
<tr>
<td>Relative Density</td>
<td>quite low 2.7</td>
<td>Moderate 3.2</td>
<td>surprisingly dense for a pale mineral 4.5</td>
<td>very dense 7.5 Moderate 4.0</td>
<td></td>
</tr>
<tr>
<td>Hardness</td>
<td>3</td>
<td>4</td>
<td>3.5</td>
<td>2.5</td>
<td>3.5</td>
</tr>
<tr>
<td>Acid test</td>
<td>fizzes violently</td>
<td>nil</td>
<td>nil</td>
<td>DO NOT TEST (gives off hydrogen sulphide)</td>
<td>nil</td>
</tr>
</tbody>
</table>

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

## Appendix

### Common Mineral Data Sheet for ELI activities

<table>
<thead>
<tr>
<th>Name</th>
<th>Cleavage/Fracture</th>
<th>Hardness</th>
<th>Relative Density</th>
<th>Streak</th>
<th>Lustre</th>
<th>Colour</th>
<th>Other diagnostic properties</th>
</tr>
</thead>
<tbody>
<tr>
<td>Quartz</td>
<td>*none/conchoidal</td>
<td>*6</td>
<td>2.65</td>
<td>scratches streak plate</td>
<td>vitreous</td>
<td>colourless, milky but variable</td>
<td>hexagonal prisms terminated by pyramids</td>
</tr>
<tr>
<td>Orthoclase</td>
<td>2 good, 90</td>
<td>*6</td>
<td>2.6</td>
<td>scratches streak plate</td>
<td>vitreous</td>
<td>pink, white</td>
<td></td>
</tr>
<tr>
<td>Plagioclase</td>
<td>2 good, 90</td>
<td>*6</td>
<td>2.7</td>
<td>scratches streak plate</td>
<td>vitreous</td>
<td>creamy-white, grey, colourless</td>
<td></td>
</tr>
<tr>
<td>Muscovite Mica</td>
<td>*1 perfeci (basal)</td>
<td>*2.5</td>
<td>2.7-3.1</td>
<td>white</td>
<td>pearly</td>
<td>colourless or pale yellow, green or brown</td>
<td>*flaky</td>
</tr>
<tr>
<td>Biotite Mica</td>
<td>*1 perfeci (basal)</td>
<td>*2.5-3</td>
<td>2.7-3.1</td>
<td>white</td>
<td>pearly</td>
<td>brown/black</td>
<td>*flaky</td>
</tr>
<tr>
<td>Homblende</td>
<td>2 good, 60/120</td>
<td>*5-6</td>
<td>3.0-3.5</td>
<td>scratches streak plate</td>
<td>vitreous</td>
<td>black, dark green</td>
<td>prismatic crystals</td>
</tr>
<tr>
<td>Augite</td>
<td>2 good, 90</td>
<td>*5-6</td>
<td>3.2-3.5</td>
<td>scratches streak plate</td>
<td>vitreous</td>
<td>greenish-black</td>
<td>prismatic crystals</td>
</tr>
<tr>
<td>Olivine</td>
<td>none/conchoidal</td>
<td>*6-7</td>
<td>3.2-4.3</td>
<td>scratches streak plate</td>
<td>vitreous</td>
<td>*olive green</td>
<td></td>
</tr>
<tr>
<td>Chalcedony/Andalusite</td>
<td>1/ uneven fracture</td>
<td>*6-6.7-7.5</td>
<td>3.5-4.3</td>
<td>scratches streak plate</td>
<td>vitreous</td>
<td>pearly grey/pink</td>
<td>needle crystals with square x-sections, black centre</td>
</tr>
<tr>
<td>Garnet</td>
<td>none</td>
<td>*3</td>
<td>2.71</td>
<td>white</td>
<td>vitreous</td>
<td>colourless, white, tints</td>
<td>*refractives with 0.5M HCL rhombic shape</td>
</tr>
<tr>
<td>Fluorite</td>
<td>4</td>
<td>3.0-3.2</td>
<td>white</td>
<td>vitreous</td>
<td>colourless</td>
<td>purple/green/yellow</td>
<td>fluoresces in uv light, cubic or octahedral crystals</td>
</tr>
<tr>
<td>Halite</td>
<td>3 good, 90 cubic</td>
<td>*2.5</td>
<td>2.2</td>
<td>white</td>
<td>vitreous</td>
<td>colourless, white, often stained</td>
<td>*salty taste cubic crystals, often stained</td>
</tr>
<tr>
<td>Gypsum</td>
<td>1 good (basal)</td>
<td>*1.5-2</td>
<td>2.3</td>
<td>white</td>
<td>silky, pearly</td>
<td>colourless, white, often stained</td>
<td>fibrous</td>
</tr>
<tr>
<td>Barite</td>
<td>2 good, 90</td>
<td>*3-3.5</td>
<td>*4.5</td>
<td>white</td>
<td>vitreous, pearly</td>
<td>white, pink</td>
<td>bladed crystals</td>
</tr>
<tr>
<td>Chalcopyrite</td>
<td>poor/conchoidal</td>
<td>4</td>
<td>4.2</td>
<td>*black</td>
<td>metallic</td>
<td>bronze yellow</td>
<td>*tarnished to peacock colours</td>
</tr>
<tr>
<td>Pyrite</td>
<td>none/conchoidal</td>
<td>*6</td>
<td>5.0</td>
<td>*greenish-black</td>
<td>metallic</td>
<td>brass yellow</td>
<td>crystals often striated cubes</td>
</tr>
<tr>
<td>Galena</td>
<td>*3 good, 90 cubic</td>
<td>*2.5</td>
<td>*75</td>
<td>*lead grey</td>
<td>metallic</td>
<td>lead grey</td>
<td>cubic crystals</td>
</tr>
<tr>
<td>Haematite</td>
<td>poor/subconchoidal</td>
<td>5.8-6.5</td>
<td>4.9-5.3</td>
<td>*cherry red</td>
<td>metallic-dull</td>
<td>red/black/steel grey</td>
<td>kidney shaped masses, fibrous</td>
</tr>
</tbody>
</table>

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

With grateful thanks to WJEC/EDUQAS

© Earthlearningidea team. The Earthlearningidea team seeks to produce a teaching idea regularly, at minimal cost, with minimal resources, for teacher educators and teachers of Earth science through school-level geography or science, with an online discussion around every idea in order to develop a global support network. ‘Earthlearningidea’ has little funding and is produced largely by voluntary effort. Copyright is waived for original material contained in this activity if it is required for use within the laboratory or classroom. Copyright material contained herein from other publishers rests with them. Any organisation wishing to use this material should contact the Earthlearningidea team. Every effort has been made to locate and contact copyright holders of materials included in this activity in order to obtain their permission. Please contact us if, however, you believe your copyright is being infringed: we welcome any information that will help us to update our records. If you have any difficulty with the readability of these documents, please contact the Earthlearningidea team for further help. Contact the Earthlearningidea team at: info@earthlearningidea.com