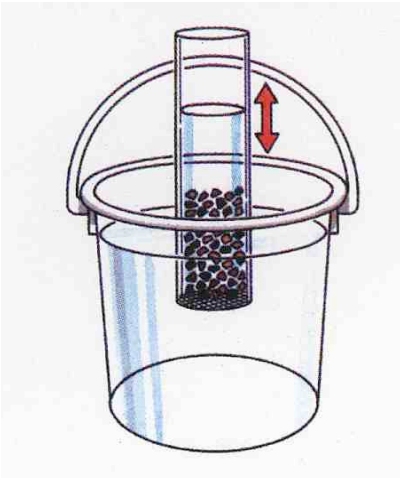
Jigging
Using density to separate different materials

Jigging separates materials of different density by shaking under water – and can easily be done in the classroom, lab or field. You can try jigging with several different sorts of mixtures, so long as there is a range of density of the constituents. The diagram shows a mixture of coal and shale, and the close-up photograph shows a mixture of the minerals galena, barite, fluorite and calcite (in that order from the base). We shall describe the latter.

Show the pupils a large sample taken from a mineral vein, containing several different minerals. Tell them that each mineral has economic value, if only it can be separated from the others. Ask them how they think the minerals could be separated.
Then, either demonstrate how minerals can be separated by 'jigging', or ask small groups of pupils to try it for themselves. Add the 'charge' of mixed crushed minerals to the top of a jig, made from a plastic tube, to the base of which a piece of gauze has been fixed (See 'Resources'). Shake the tube of minerals vigorously up and down in a bucket full of water (the deeper the water, the better) and continue until a good measure of separation has been achieved. The photograph shows that if minerals of widely differing density and colour are used, the effect can be dramatic. Ensure that the materials are retained for future use.
Point out that this method was used for several centuries by miners, who mainly wanted the lead ore, called galena. Ask pupils how they could get the galena out of the jig. Then show them the photograph of the full scale reconstruction, and point out that it was big enough for a boy to climb in and shovel out the minerals from their different layers.

A jig being used to separate galena, barite, fluorite and calcite from a crushed sample

A full-size reconstruction of a jig on the ore-dressing floor at the Kilhope Mining Museum, County Durham



The apparatus – a jig and a bucket full of water (redrawn from 'Power from the past: coal'. ESTA)

The back up

Title: Jigging

Subtitle: Using density to separate different minerals

Topic: A simple practical activity used to separate minerals of different density from each other. It is a small scale version of a method which was used for centuries.

Age range of pupils: 8 – 80 years

Time needed to complete activity: 5 minutes

Pupil learning outcomes: Pupils can:
- appreciate that materials have different densities;
- separate several minerals from each other, using their different densities;
- experiment with different shaking actions to see which is the most efficient way of jigging;
- explain that this method might have commercial application in mining areas, when scaled up.

Context: This activity is a useful introduction to the concept of density. It is helpful if pure hand specimens of the minerals of approximately equal size can be passed round. Pupils can then 'heft' them in their hands to feel the differences in density. In the example used above, the relative densities of the minerals (where water is 1.0) are:- galena 7.4: barite 4.4: fluorite 3.2: calcite 2.7. If coal is being used instead, its relative density is about 1.3, in contrast to shale at about 2.5.
When asked how they would separate the minerals in a large sample taken from a mineral vein, answers will range from dissolving it in acid (possible, but very expensive and environmentally unsound) to crushing it and picking out the different minerals by hand. (This was done, in some cases where the ore was particularly rich). Some pupils will suggest using water in some way, and some may have seen separation on a shaking table. Some will have tried gold panning.

Following up the activity: Try another method, known as buddling, for separation of minerals using the property of density. See www.earthlearningidea.com 'Riches in the river'. Carry out a web search for the techniques used by mineral extraction companies to separate the ore from the waste. This will include the modern process known as froth flotation.

Underlying principles:
- Density differences have long been used to separate valuable metal ores from the lower density waste material. 'Jigging' is a process whereby a container of ore and waste is jigged up and down in water, which pulses though the open mesh base of the container.
- 'Buddling' (see 'Riches in the river') was used in association with jigging, often with the minerals being passed repeatedly through the system to ensure maximum recovery of the commercial product, usually ores of metals such as lead, copper and tin.
- Modern separation of ores from waste is mostly done by froth flotation, which depends more on the chemical properties of the materials than their densities. In this case, crushing alone is not sufficient and the minerals are ground to a fine powder before treatment.

Thinking skill development:
Pupils observe the different densities of the minerals (construction).
They reason the order in which they expect the minerals to settle in the jig (metacognition) and apply their findings to the commercial world (bridging).

Resource list:
- a jig (or more than one for group work). A jig is made quite simply by cutting a length of about 25 cm of Perspex™ tube and fixing a piece of gauze to the base, by heating the gauze and pressing the tube onto it so that it melts enough to hold it. Rough edges are smoothed off with a file. Gauze such as that used for a Bunsen burner is suitable.
- A bucket nearly full of water
- mineral samples of different density, crushed to about 3mm diameter. This can be done between two hammers, followed by sieving to remove powder.
- a hand specimen containing several minerals, to match those supplied in crushed form (optional)
- alternatively, crushed samples of coal and shale or other 'waste' rock may be used.

Useful links:
http://www.nationalstemcentre.org.uk/elibrary/collection/215/earth-science-teachers-association-resources

Source: Based on *Power from the past: coal*, ESTA, 1990. See the website above for a scan of the original unit.