Uplift – Teacher Notes

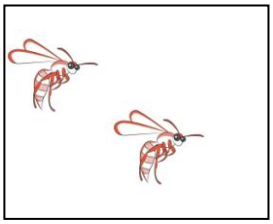
Tectonic movements uplift and down warp our crust. They raise mountains and create sedimentary basins. In Western Australia the Yilgarn and Pilbara cratons are slowly moving upwards and being eroded whilst the major sedimentary basins such as the Perth Basin, Canning Basin and Eucla Basins are slowly moving downward and being filled with sediment.

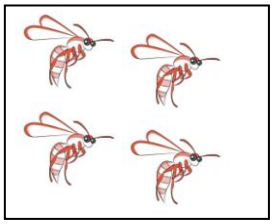
Uplift is the result of two forces working in concert, temperature and density

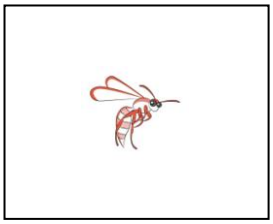
1. Temperature causes expansion or contraction creating density changes and the formation of convection currents within the asthenosphere (crust/mantle interface zone)
2. Density changes permit vertical and horizontal movement of rock masses

Density

Density is a measure of mass per unit volume.







If each of these pictures represented a 1 cubic centimetre ($1cm^3$) box, what is the wasp density in each box?

Two wasps per cubic centimetre ($2/cm^3$), four wasps per cubic centimetre ($4/cm^3$) and one wasp per cubic centimetre ($1/cm^3$).

If each wasp had a mass of 1 gram (1g) what would the density of each cube be?

$2g/cm^3$, $4g/gm^3$ and $1g/cm^3$.

Students who are still using concrete operational thinking may require practical experience of density and often find using the "density triangle" useful.

MASS

VOLUME X DENSITY

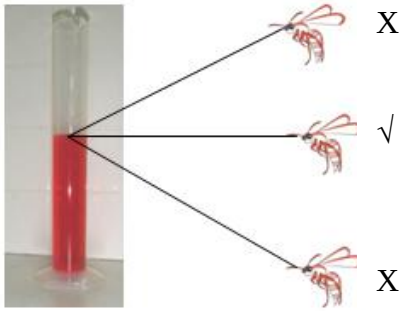
To find" Volume", students cover "VOLUME" with their finger and see that volume = mass divided by density. To find "Mass", students cover that and see mass = volume multiplied by density. (The word "mass" comes from Greek for a barley case or lump of dough). Similarly "Density" is mass divided by volume.

Uplift – Teacher Notes

To find what happens when substances of different densities are placed in the same container.

Materials per student or group

- 1 test tube
- Equal volumes of water and vegetable oil (20mL)
- Test tube rack or beaker to hold it upright
- A measuring cylinder



1. Measure out 20mL of oil and 20ml of water. HINT it is easier if you measure the water first. Remember to take your eye down to the level of the liquid and measure from the bottom of the meniscus.
2. Place your thumb over the mouth of the test tube to seal it and give the liquids a good shake.
3. Leave the test tube upright and note what happens to the oil and water.
4. Repeat three times.

Test	Observation
1	Oil is less dense than water and therefore "floats" on it
2	
3	

Why did you repeat the experiment? To ensure accuracy

*Estimation of relative densities of oil and water may best be performed by the teacher or by a single student as a large volume of oil is necessary to produce a visual and measurable response.

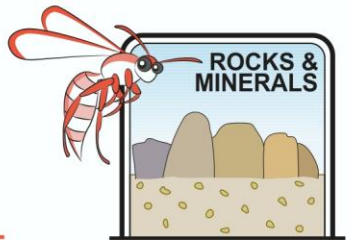
Materials

- Two 500mL beakers
- Two measuring cylinders
- A triple beam balance or equivalent mass measuring device
- Oil and water

Measure the mass of each beaker
Add 500mL of oil to one and 500mL of water to the other
Measure the mass of liquid + beaker and subtract the mass of the beaker.
Estimate the densities of oil and water
Density varies with temperature, but using this laboratory equipment water will have a density of 1g/cm^3 and most cooking oils about 0.9g/cm^3

Do we now have scientific data to explain why oil "floats" on water? Explain your answer.
Yes. We have data that is observable, measurable and repeatable. We can make a scientific report.

Uplift – Teacher Notes



Density of rocks

Igneous rocks are rich in iron which has a density of 7.87g/cm^3. Sedimentary rocks are rich in silicon which has a density of 2.33g/cm^3. Core rocks are much more dense than crustal rocks due to gravitational pull.

Which rocks are more common on our Earth's crust? Less dense sedimentary rocks.

Which rocks must have risen up from deeper in the Earth? Igneous rocks, they are denser.

The volume of non-geometrically shaped rocks can be estimated by water displacement. The rock is tied by string and lowered into a beaker which is full to the brim with water. The volume of water displaced is collected into a measuring cylinder. Where rocks are not available concrete and brick may be substituted. If students have made their own replica rocks their densities may me estimated also.

Materials per student or group

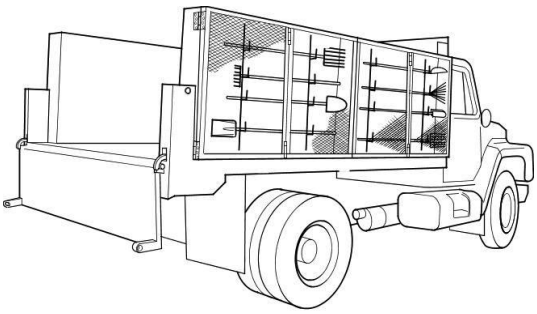
- String
- Different rocks
- A large beaker
- A measuring cylinder
- Triple beam balance
- Water

1. Using the triple beam balance measure the mass of the rock. Remember to move the heaviest weights first.
2. Fill the beaker with water and place it somewhere any overflow can be collected by the measuring cylinder, perhaps placing it on the edge of the sink draining board?
3. Tie the rock with string. Some students will need guidance to make "lasso" loops
4. Lower the rock into the water and collect the volume of water it displaces into the measuring cylinder.
5. Use the mass and volume data to estimate the density of each rock.

Rock	Mass (g)	Volume (cm^3)	Density (g/cm^3)

Uplift – Teacher Notes

Extra for experts



A contractor has to carry twenty 1 metre cubes of granite and twenty of sandstone to a new building site. His truck is only licensed to carry 10.5 tonnes (1,050,000g). Granite has a density of 2.64g/cm3 and this sandstone has a density of 2.32g/cm3. What is the most efficient way for him

Limiting factor = mass = 10.50tonnes
Mass = volume X density
Mass of one block of granite = (100 X 100 X 100) X 2.64 ÷ 1,000,000 = 2.64 tonnes
Mass of one block of sandstone = (100 X 100 X 100) X 2.32 ÷ 1,000,000 = 2.32 tonnes

Answer 6 loads of 3 granite and 2 sandstone blocks, 2 loads of 1 granite and 3 sandstone blocks and 1 load of 2 sandstone blocks

As sediments become covered by more and more sediments in a basin, they will compact decreasing pore space, losing water and increasing their density.

Density and mineral ores

Mineral ores have their origins in different rocks at different depths within the Earth .The greater the density the greater the depth. Tectonic forces bring them to the surface for our use.

Please use the data provided to range the minerals from deepest source to least deep.

Manganite (magnesium Mg)	4.32g/cm^3	Gold (Au)	19.32g/cm^3
Bauxite (aluminium Al)	2.45g/cm^3	Siderite (tin Sn)	3.85g/cm^3
Galena (lead Pb)	7.5g/cm^3	Magnetite (iron)	5.12g/cm^3

Gold>Galena>Magnetite>Manganite>Siderite>Bauxite
Gold>Lead>Iron>Manganese>Tin>Aluminium

MASS
VOLUME X DENSITY

CALCULATIONS
If a rock has a mass of 9g and a volume of 3cm^3 then its density will be 3g/cm^3.

Trial estimations

1. If the igneous rock gabbro has a mass of 12g and a density of 3.03g/cm^3, what is its volume? 3.96cm3
2. If the sedimentary rock sandstone has a volume of 36cm3 and a density of 2.50g/cm^3, what is its mass? 90g

3. What is the density of a gold nugget which has a mass of 3g and a volume of 0.16cm^3? 19.32g/cm^3

Extension

Archimedes "Eureka" moment happened when he solved the problem of whether a crown was made of solid gold after he had been having a bath! What did he do to prove the crown was not pure gold?

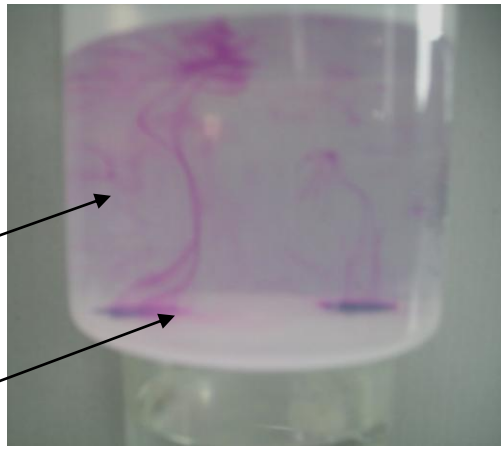
His body had displaced water from his bath. He used displacement of water to estimate the volume of the crown and weighed it. This density was compared with the density of a known specimen of gold.

Heat and density Convection currents

Away from tectonic boundaries (hot spots) temperature increases by 25^{o}C for every kilometre of depth. Miners often have to be provided with air conditioning to work in deep mines. As heat increases kinetic energy increases. Molecules become more mobile and bounce off each other pushing each other farther and farther apart. This decreases the density of rocks with depth. Less dense rocks can rise. Within the sticky partially melted zone of the asthenosphere which lies at the boundary of the crust and mantle, these rising masses of hot rocks create very slow moving convection currents. When the rocks rise, they cool, become denser and create downward currents. There are many convection currents currently at work moving rocks around. Australia is slowly moving northwards at the same rate as your fingernails grow powered such a convection current in the asthenosphere (crust-mantle interface).

Teacher demonstration Convection cell and mountain formation

Drop a large crystal of potassium permanganate (Condy's crystals) into one side of a large beaker full of very hot water.
The purple dye will outline convection cells in the hot water.

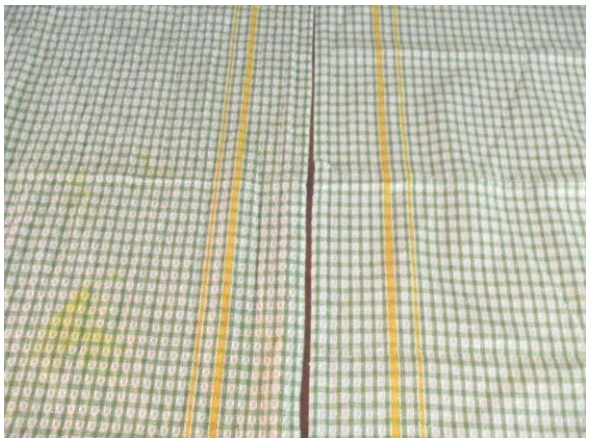


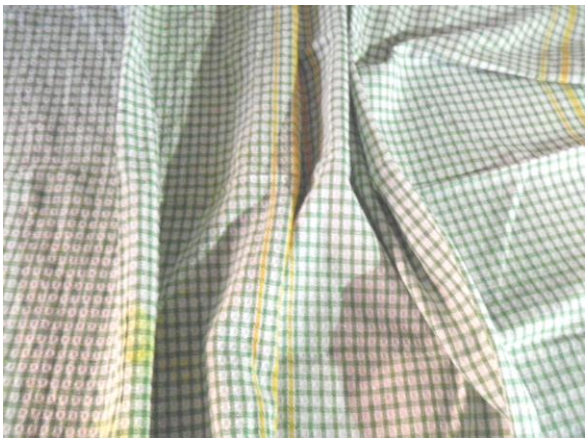
Cooling at the surface and dropping down

Heat causing decrease of density and rising

Uplift – Teacher Notes

Convection currents can move two tectonic plates together. If they have the same density their impact zone will crumple and form a mountain range like the Andes in South America or the Great Dividing Range in Australia . This can be demonstrated by pushing two laboratory towels together on a flat surface





If one plate is denser than the other it will slip below pushing the less dense land mass upward. This is what is happening in the Himalayas. The Indian plate is pushing under the Asian plate causing the continuing rise of the mountains. This can be demonstrated by pushing the spine of a towel or newspaper against a denser textbook.

Where currents move the crust apart, molten material from below the crust is able to rise and create a line of volcanic activity such as the mid-Atlantic ridge.