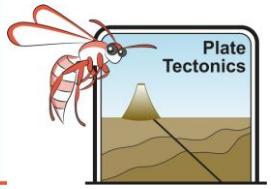
Convection Currents – Teacher Notes



Heat moves slowly through the solid parts of our Earth by conduction, the physical transfer of kinetic energy and more quickly by convection, the movement of molecules. There are two sources of heat, residual heat released during compression of cosmic dust at the time of formation of our planet and radioactive heat resulting from the spontaneous breakdown of radioactive minerals predominantly uranium, thorium and potassium.

A common misconception by students is that the Sun is the source of all energy on Earth.

A convection current is a current caused by the expansion of a liquid or gas as its temperature rises. Increased kinetic energy causes molecules to move faster and the material to expand decreasing its density. The material rises until it cools, becomes denser and descends.
At the core-mantle interface and at the mantle crust interface local zones of melting occur. Rocks melt, expand and rise through overlying layers. The Asthenosphere at the base of the crust is the source of the convection currents that are believed to power Plate Tectonics. Area where convection currents drive plates together are known as zones of convergence or destructive boundaries. Where currents bring melted material to the surface and new seafloor is formed are known as constructive zones.

Potassium permanganate is commonly known as Condy's crystals. It is a strongly oxidising and leaves permanent stains on fingers, clothes and desks. Use metal forceps or a wooden pop stick to transfer it. It might be safest for the teacher to distribute it if students perform the activity.

AIM To demonstrate a convection current

Materials per teacher or group

- Large beaker of cold water straight from the refrigerator (add ice cubes if the water is warm from the tap).
- Empty, clean, small container (baby food jar or probiotic yoghurt jar)
- Lead weights or 5c pieces to weigh down the jar
- Kettle of hot water
- Potassium permanganate
- Plastic wrap
- Small elastic band
- Two skewers

Method

1. Fill the large container with very cold water.
2. Lay two long skewers beside it.
3. If the small container is plastic add weights or 5c pieces to weigh it down

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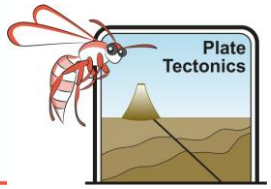

4. Drop a few pieces of potassium permanganate or food colouring into the small bottle. (Use forceps if you are using potassium permanganate as it stains skin and clothes).
5. ***Carefully*** pour hot water to completely fill the small bottle.
6. ***Carefully*** cap the bottle with plastic wrap hold in place with an elastic band.
7. Lower the bottle to the foot of the large container.
8. Using the skewers make two holes in the cap of the small container. It is easier if you hold the container in place with the blunt end of one skewer while piercing with the other.

OBSERVATION

Describe what happens when the little container's cap is holed. An annotated diagram may help.
The hot purple liquid rose to the top of the water, moved along the surface and then descended down through the water again.

DISCUSSION

Using your knowledge of Kinetic Theory, explain why this happened. (HINT "density")
The hot liquid had a higher kinetic energy than the cold water. Its molecules had more energy, took up more volume and its density decreased. Being less dense it rose. When it cooled at the surface it became denser and descended. This is a convection current.

What does the hot purple water represent in this experiment? The purple water represented molten rock rising from the asthenosphere.

What do you think would happen when the rising melted rock gets to the surface? It will cool and become solid. Being solid it can no longer flow.

What happened when the purple water reached the surface and cooled? It became denser. Being a liquid it could flow downwards.

THINK

What was the source of energy in this experiment? Sun to fossil fuels to electricity to heat

What name is given to energy that increases the rate of movement of molecules?
Kinetic energy

Why were two holes punched in the lid of the little bottle? It was to let water in and permanganate solution out.

Which material was the solvent? Water

Which material was the solute? Potassium permanganate

What is the chemical formula of potassium permanganate? $KMnO_4$

Where does the heat that powers convection currents within the Earth come from? Heat comes from two sources, residual heat from the formation of the planet and from radioactive decay.

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Alternative experiment
This experiment is similar but involves directly dropping crystals into hot water which permits some to dissolve while falling and the remainder to spread on rising with the convection current. The convection current is less obvious.

METHOD
Set up the equipment as before without the little bottle and boil the water.
Drop one large crystal into the water close to the edge of the beaker
Do not touch or disturb the beaker
Observe and report your observations

Students can also demonstrate their Bunsen burner skills by boiling the water themselves in their beakers.

<u>Teacher talk</u>

Potassium permanganate is a powerful oxidant and was used to control bacterial and fungal infections before antibiotics were developed. In the First World War, troops endured horrific conditions especially when fighting from trenches. They were frequently soaked to the skin and were not able to change their clothes. As a result soldiers often suffered from fungal infections in their groin (mostly Candida albicans or thrush). The exception was the Scottish troops whose kilts kept that area well aired. Women reported having their loved ones come back from the front with the relevant area stained purplish brown from potassium permanganate. Underwear had to be bleached severely before being hanged on the washing line!

Some Australian teachers still have to cope with students with impetigo or “school sores”. Two bacteria Streptococcus and Staphylococcus cause this disease. In the past teachers had to look out on a class whose heads were shaved and their stubbly skin painted purple. Aren’t antibiotics wonderful - if less colourful?