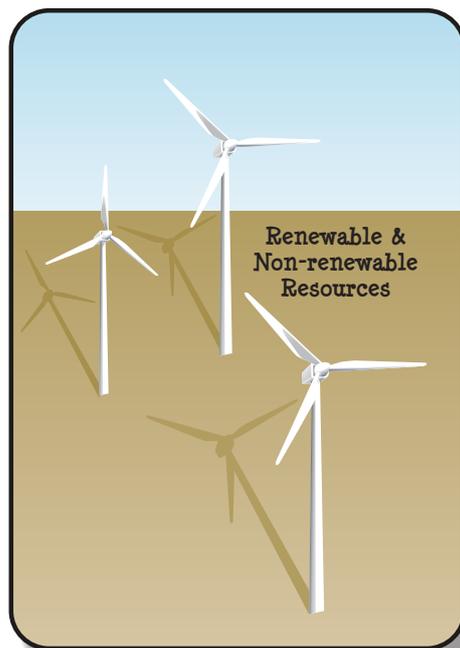
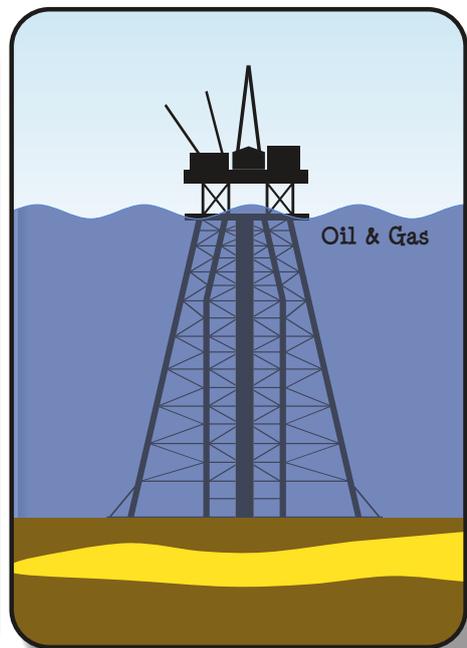
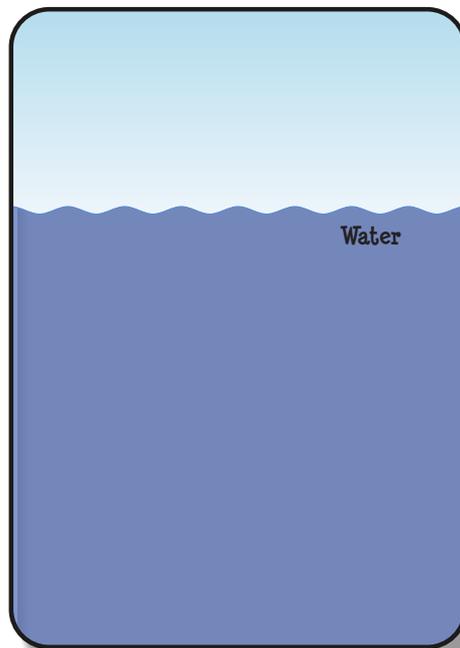


An initiative supported by Woodside and ESWA

# Oil & Water Package



**Year 7**  
**Australian Curriculum -**  
**Earth & Chemical**  
**Sciences**





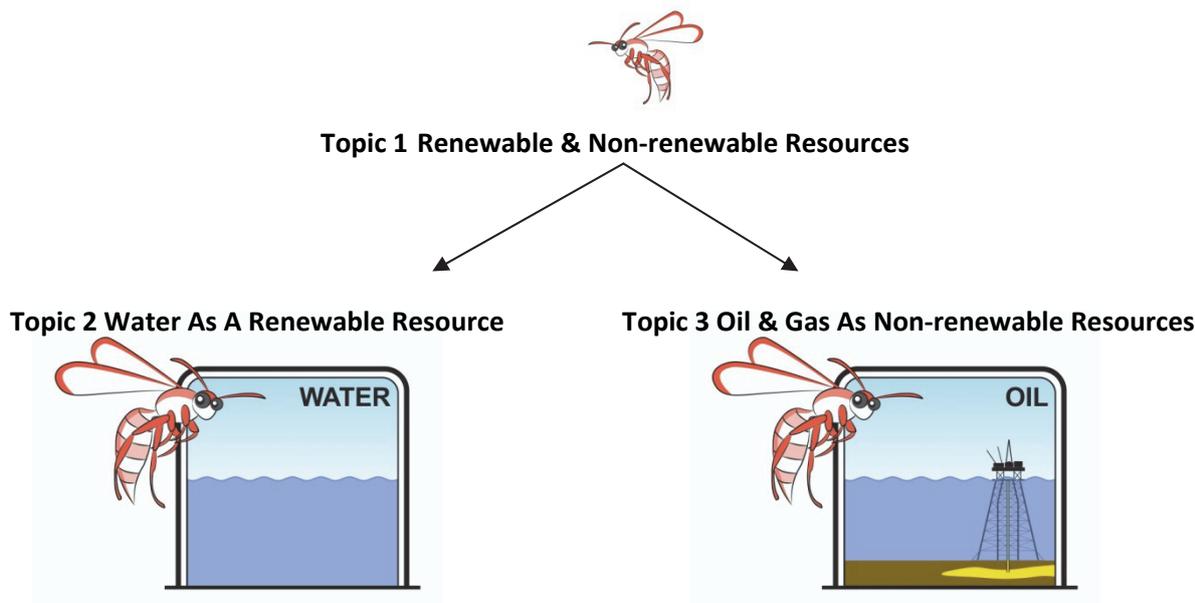
# Year 7 WASP – Teacher Introduction



The WASP (Woodside Australian Science Project) is an initiative supported by Woodside and Earth Science Western Australia (ESWA).

These activities are designed to provide support for the Earth Science part of the Earth & Space Science and Chemical Sciences topics required by the Year 7 Australian Curriculum.

Copies of this and other supporting material can be downloaded from the WASP website <http://www.wasp.edu.au> or by contacting Julia Ferguson, [julia@wasp.edu.au](mailto:julia@wasp.edu.au).



## Year 7 Australian Curriculum Science

### Earth & Space Science

Some of the Earth's resources are renewable but others are non-renewable

- considering what is meant by the term "renewable" in relation to Earth's resources
- considering timescales for regeneration of resources

Water is an important resource that moves through a cycle in the environment

- considering the water cycle in terms of changes of state of water
- investigating factors that influence the water cycle in nature

### Chemical Sciences

Mixtures, including solutions, contain a combination of pure substances that can be separated using a range of techniques

- recognising the differences between pure substances and mixtures and identifying examples of each
- identifying the solvent and solute in solutions
- investigating and using a range of physical separation techniques such as filtration, decantation, evaporation, crystallisation, chromatography and distillation
- exploring and comparing separation methods used in the home

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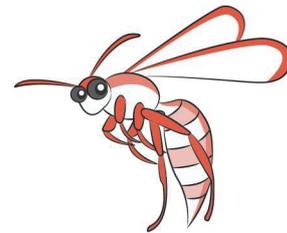
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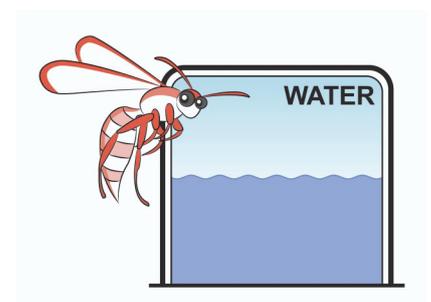
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## Year 7 WASP – Teacher Introduction

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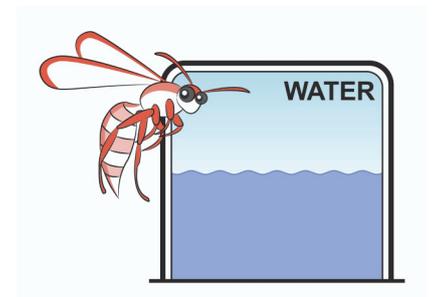
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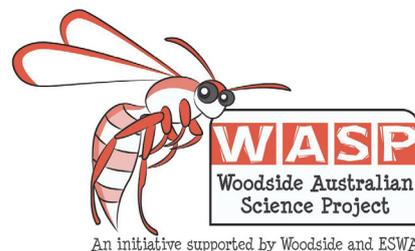
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# Year 7 WASP – Teacher Introduction



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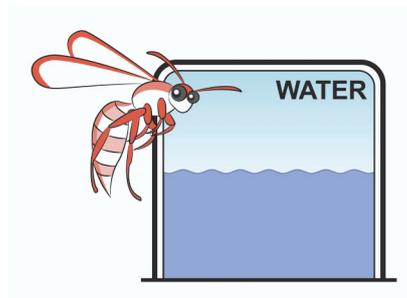
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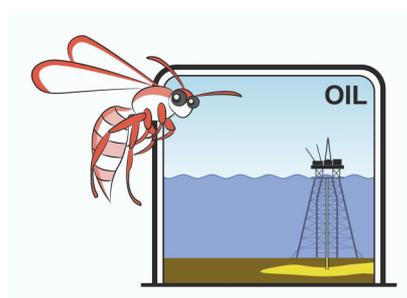
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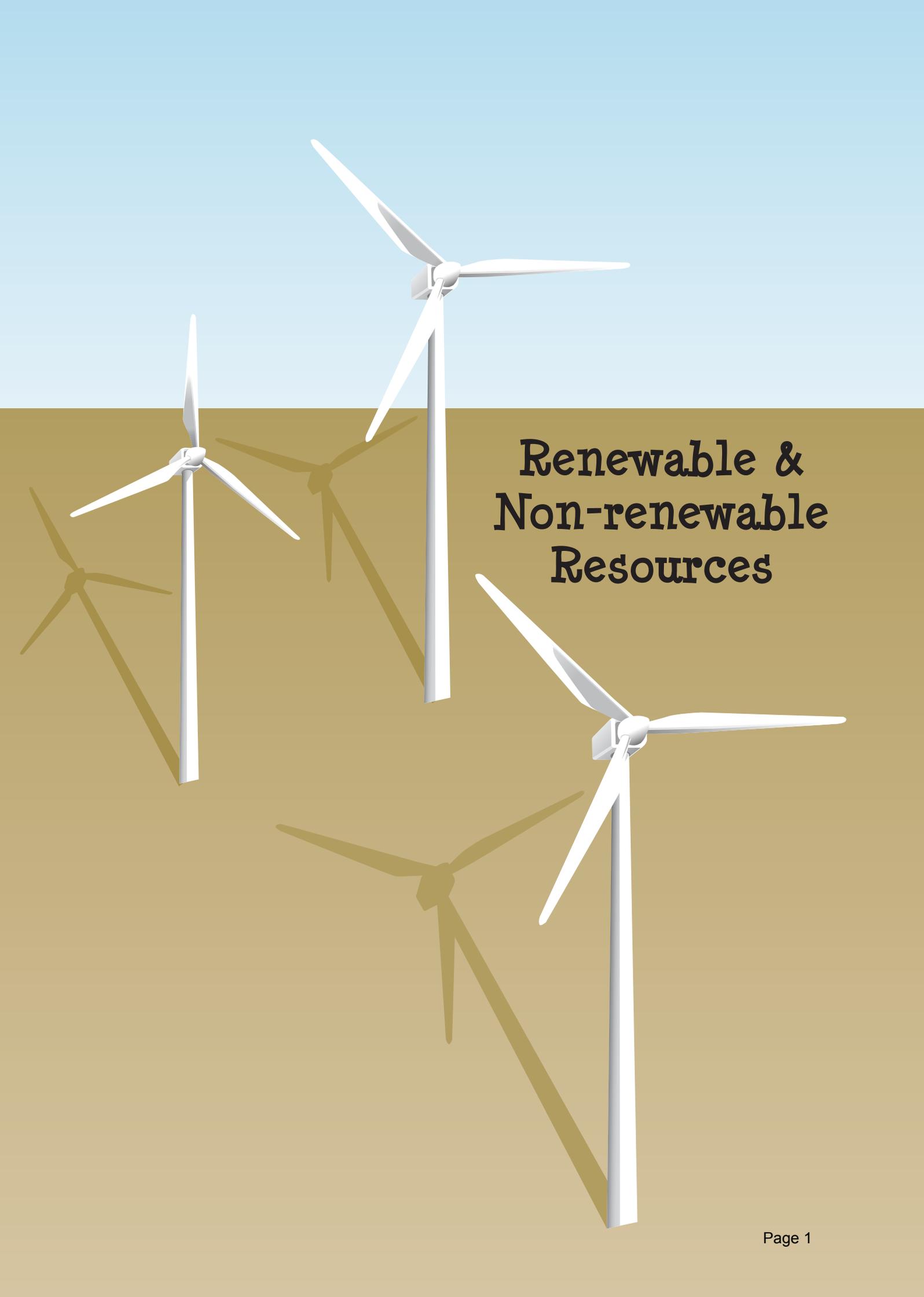
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# Renewable & Non-renewable Resources



## Renewable & Non-renewable Resources - Teacher Background

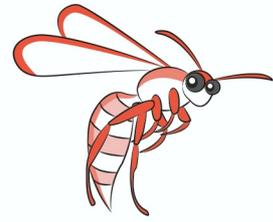


Our Earth processes cycle materials between reservoirs in the atmosphere (air), hydrosphere (water), biosphere (living things) and lithosphere (rocks). Matter is neither created nor destroyed but may be reassembled in different forms. The hydrogen which was once part of a water molecule may be used by a plant to make starch which is eaten by an animal to create its fat supplies and on the death of the animal be buried deep in sediment to become part of an oil molecule, only to be burned and become part of a water molecule again. We tend to use the term “renewable” if the resource is replenished on a human time scale. Modern humans have only been around for less than 200,000 years.

The Sun, which is the source of all energy used on earth, either directly as sunlight, wind and heat or trapped in fossil fuels, is consuming its own hydrogen and will eventually swell and engulf the Earth in about 5 billion years. However, since that is a long time in human terms, it is considered a renewable resource. Our planet’s ability to re-create complex materials and the speed of their replenishment varies. The environmental conditions necessary for deposition of our vast reserves of iron ore in Western Australia no longer exist since plants released oxygen into our atmosphere over a million years ago. Iron ore and most other minerals are considered a finite resource and non-renewable. Fossil fuels are being used at a rate that far exceeds their rate of replenishment (a rate of many millions of years) and are also considered non-renewable. Resources that are continuous such as sunshine, wind and waves are considered renewable. Resources such as biomass, soil, water and forests are considered sustainable as long as the rate of use does not exceed the rate of replenishment.

***The major resources on Earth are water, air, living things, rocks (including minerals and fossil fuels), soil and energy from the Sun.***

Australia is rich in both living and non-living resources.



## Renewable & Non-renewable Resources - Teacher Background

### Teacher Vocabulary

**Resource**      Something that is useful to living things.  
Renewable resources can be replenished within a human time scale.  
Non-renewable resources cannot be replaced once they have been used or require very long (geologic) periods of time to replenish.

**Reserve**      A known quantity of a resource.

### *Possible sequence of activities:*

#### 1. Resources For Schools

- Resources For School – Student Activity
- Human Resources For School – Student Activity

#### 2. Earth's Resources

- Earth's Resources – Student Activity

#### 3. Timescale For Renewal

- Timescale For Renewal – Student Research

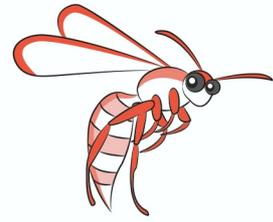
#### 4. Resource Use & Sustainability

- Paper Aeroplanes – Teacher Notes

#### 5. Revision

- Renewable & Non-renewable Resources – Student Review

## Resources For Schools – Teacher Notes



At the beginning of each school year students are reminded to bring the resources they need each day to their classroom. School sends out reminders and newspapers and televisions advertise “Start of School” sales.

Students are asked to reflect on the resources they need to bring to school to be able to work well.



1. In groups of three (or table/bench groups) they are given five minutes to write down a beginning of the year shopping list of student resources.
2. A scribe and a reporter are designated for each group.
3. Results are shared and written on the board to be copied into their student worksheet.
4. To this can be added resources provided by the school.
5. Poorly resourced students may report only on resources provided by the school.

Possible answers could include:

**Student resources** healthy (as possible) student, school uniform, sports gear, stationery, textbooks school bag/back pack, library bag, lunch box/money, laptops/iPads etc.

**School resources** rooms, light, heat/cooling, water, toilets, gymnasium, library, teachers, health professionals, administrators, cleaners, sports grounds, canteen, bike racks, textbooks, computers, desks, chairs etc.

Why do we have all these resources in school? **We have them to make learning easier/possible**

Explain your answer

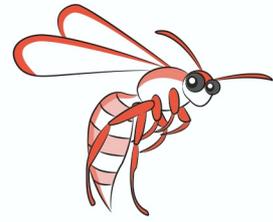
Why does Australia want everyone to attend school? **Human beings are resources too. People with skills are an important resource for the country's future development and economic competitiveness.**

Definition A resource is **something that is useful**

### **Extension or Homework**

Schools employ trained people without which the school cannot function. Students are encouraged to discover the time and training necessary to produce this resource. A worksheet is provided.

Western Australia is rich in both human and material resources. It is important that we can value add to our primary resources and educate our human resources.

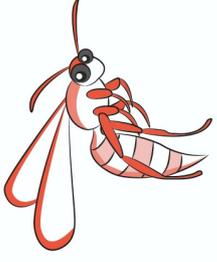


## Resources For Schools – Student Activity



These are things we **MUST** get to start the school year properly

**GROUP NAMES** \_\_\_\_\_



## Human Resources For Schools – Student Activity

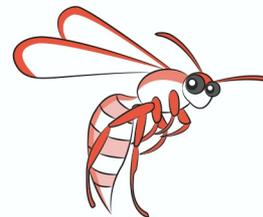
Schools also have human resources. Fill the table for the people below.

	Minimum entry qualifications to training	Job description	Extra useful background which helps
Year 7 student			
Year 7 teacher			
School Principal or Deputy			
Nurse or Health Care Professional			
Education Assistant or Aboriginal Islander Education Assistant			
School Gardener			
School Bus Driver			
Canteen staff			



## Human Resources For School – Teacher Notes

	Minimum entry qualifications to training	Job description	Extra useful background which helps
<b>Year 7 student</b>	6 years of school (+ K&P)	Follow directions and do ones best. Graduate to next school or next year.	Good family background so you arrive well fed, rested and with the correct equipment
<b>Year 7 teacher</b>	12 years of school, good WACE, 3 or 4 years at university, regular up-skilling. Working with Children. (WWC)	Care for and educationally guide year 7 pupils in (a list of) subjects.	Enjoy working with kids. St John's Ambulance. Bronze medallion
<b>School Principal or Deputy</b>	As above	Guide and support school community. Good communication and interpersonal skills.	As above, ability to lead and train staff. Innovation.
<b>Nurse or Health Care Professional</b>	Depends on your nurse WWC	Physical and emotional care for students and staff	Empathy and communication skills
<b>Education Assistant or Aboriginal Islander Education Assistant</b>	Ideally Cert 3 then further study through TAFE. On job training and further formal qualifications possible WWC	Help in preparation and delivery of teaching materials.	Maturity, experience of working with children and understanding their learning needs
<b>School Gardener</b>	WWC. Experience in gardening	Maintain school grounds. Often with handyman duties.	Enjoy working outdoors
<b>School Bus Driver</b>	WWC. "F" class driving licence	Pick up and drop off students safely, advanced bus driving for some excursions etc	Knowledge of the area, ability to encourage good behaviour.
<b>Canteen staff</b>	WWC . School Canteen Management Course.	Providing nutritious meals for schools	Patience, ability to work well with a changing staff.



## Earth's Resources – Teacher Notes

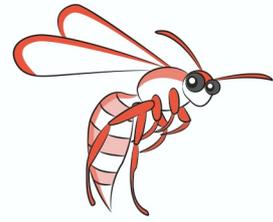
The major resources on Earth **are water, air, living things, rocks (including minerals and fossil fuels), soil and energy from the Sun**. Materials will move between different reservoirs in Earth at different rates for different periods of residence. Since the biosphere, atmosphere, lithosphere and hydrosphere are all inter-connected, each is of equal importance in maintaining sustainability.

List all the things that each resource can be used for, then number them in order of importance from 1 most important to 6 least important.

Resource	Uses	Importance
<b>Water</b>	Drinking. Washing. Bathing. Dissolving food for plants, cleaning, swimming, fish live in it, boats sail in it. Sink for carbon dioxide.  Carries away broken rocks. Holds dissolved oxygen for marine creatures. Rain. Recreation	
<b>Air</b>	Breathing for animals. Carbon Dioxide for plants. Necessary for burning. Reduces Sun's harmful radiation. Wind power for energy creation and windmills.	
<b>Living things</b>	Food for ourselves and others. Breaks down rocks to form soil, work it and holds it in place to stop erosion. Medicines. Humans helping humans. Animals helping humans. Recreation.	
<b>Rocks</b>	Construction of houses, castles, walls & bridges. Habitats for plants and animals. Broken to form soil. Weathered to form clays. Minerals such as gold, silver & iron ore. Fossil fuels - Petroleum, oil & gas.  Petro-chemicals and pharmaceuticals. Paints and plastics. Gems & jewels.	
<b>Soil</b>	Basis for food on land and in sea. Clays for bricks and china. Pigments. Rammed earth buildings.	
<b>Energy from the Sun</b>	Passive to heat and light.  Active solar power  Energy for photosynthesis leading to plant power and eventually fossil fuels	

Share your findings with others in your group and decide which resource (if any) is the most important. As a group, prepare a short statement on your findings and share that with the class.

We find that \_\_\_\_\_ **NONE** \_\_\_\_\_ is the most important because **all are necessary for the survival of living things on Earth. Everything is affected by everything else**



## Earth's Resources - Student Activity

The major resources on Earth **are water, air, living things, rocks (including minerals and fossil fuels), soil and energy from the Sun.**

List all the things that each resource can be used for, then number them in order of importance from 1 most important to 6 least important.

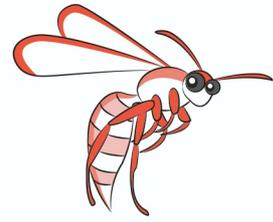
Resource	Uses	Importance
Water		
Air		
Living things		
Rocks		
Soil		
Energy from the Sun		

Share your findings with others in your group and decide which resource (if any) is the most important. As a group, prepare a short statement on your findings and share that with the class.

We find that \_\_\_\_\_ is the most important because \_\_\_\_\_

---

*"No man is an island entire of itself. Each is a piece of the continent. A part of the main.  
John Donne 1624*



## Timescale For Renewal – Teacher Notes

When resources take longer than a human timescale to replenish they are called non-renewable. Trees can be regrown, if replanted, in about 35 years for Pine and about 100 for Jarrah. The oldest living tree on Earth is a bristlecone pine estimated to be 4,767 years old. Wind, which depends on energy from the Sun is also termed renewable because the Sun's energy will last about another 4.5 billion years. Oil and gas take many millions of years to form and are non-renewable, as is iron ore. Iron ore rich rocks were deposited under oxygen poor conditions that no longer exist on Earth.

### Web search answers

The major resources on Earth are **water, air, living things, rocks (including minerals and fossil fuels), soil and energy from the Sun.**

**Living things** This includes things that are alive or have once lived.

#### 1. Cotton for clothes

How long does a cotton plant take to grow? **100 days**

How many cotton plants does it take to grow enough cotton for a tee shirt?

**2,000 plants produce 227kg cotton therefore 1 plant produces 0.1135kg cotton. One tee shirt requires 0.227kg cotton Answer 2 plants**

Extension it also takes 25 bathtubs of water to grow the cotton

[http://www.fas.usda.gov/remote/aus\\_sas/crop\\_information/crop\\_descriptions/as\\_crops.htm](http://www.fas.usda.gov/remote/aus_sas/crop_information/crop_descriptions/as_crops.htm)

Is this a renewable or non-renewable resource? **Renewable**

#### 2. Eggs for breakfast

What is the length of a battery hen's life? **2 years**

How many eggs does the hen lay in its life? **About 600 eggs for a battery hen**

Is this a renewable or non-renewable resource? **Renewable**

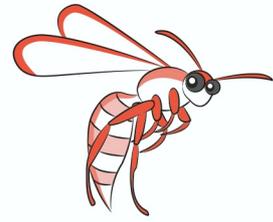
### Water

1. During September 2012 Perth had 30 mm of rain when the average rainfall would have been 290mm.

Is this a renewable or non-renewable resource? **The recharge rate is half rainfall. This resource is decreasing year by year. It is not renewable within a human lifespan at present rainfall rates. Of course rainfall varies year by year.**

2. To water my vegetable patch, I am using bore water from underground. This resource was created 1.2 million years ago when rainfall was higher.

Is this a renewable resource? **If the aquifer I am drawing water from is being recharged by present rains, then it is renewable. If not then it will be exhausted and be a non-renewable resource.**



## Timescale For Renewal – Teacher Notes

### Rocks

In Western Australia we depend on our minerals resource sector for most of our income.

1. Iron Ore Iron ore is found in the Pilbara in the “Banded Iron Formation”. These deposits were formed when oxygen levels in the atmosphere were very low (less than 2%)

How old are these deposits About 2,500 million years

How much oxygen is there in today’s atmosphere? About 21%

Is iron ore a renewable resource? Explain your answer. It is not renewable as the conditions for it to be formed no longer occur. Iron ore rich rocks were deposited when there was about 2% oxygen in Earth’s atmosphere. Later enrichment took place when the rocks were weathered to enrich the iron content.

2. Gold Gold has always been a major contributor to our economy. Workers in the “Super Pit” in Kalgoorlie dig out this resource.

How old is the gold mineralisation? About 2,670 million years

If there is no more mineralisation, is gold a renewable or non renewable resource? Non renewable

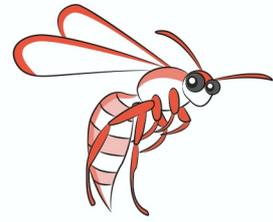
### Energy from the Sun

Our Sun is a giant thermo-nuclear reactor. Plants use its energy to produce food for both themselves and for us.

Is energy from the Sun renewable or non-renewable? \ renewable

Students may wish to visit

<http://www.epa.vic.gov.au/ecologicalfootprint/calculators/personal/results.asp> to estimate their own use of resources



## Timescale For Renewal – Student Research

The major resources on Earth are **water, air, living things, rocks (including minerals and fossil fuels), soil and energy from the Sun.**

**Living things** This includes things that are alive or have once lived.



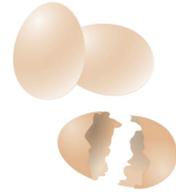
### 1. Cotton for clothes

How long does a cotton plant take to grow? \_\_\_\_\_

How many cotton plants does it take to grow enough cotton for a tee shirt? \_\_\_\_\_

Is this a renewable or non-renewable resource? \_\_\_\_\_

### 2. Eggs for breakfast



What is the length of a battery hen's life? \_\_\_\_\_

How many eggs does the hen lay in its life? \_\_\_\_\_

Is this a renewable or non-renewable resource? \_\_\_\_\_

## Non-living things

### 1. **Water**

During September 2012 Perth had 30 mm of rain when the average rainfall would have been 290mm.

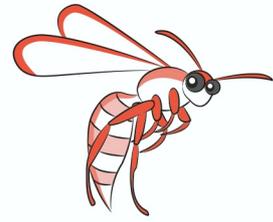
Is this a renewable or non-renewable resource? Explain your answer. \_\_\_\_\_

\_\_\_\_\_

To water my vegetable patch, I am using bore water from underground. This resource was created 1.2 million years ago when rainfall was higher.

Is this a renewable resource? \_\_\_\_\_





## Timescale For Renewal – Student Research



### 2. Rocks

In Western Australia we depend on our minerals resource sector for most of our income.

Iron Ore Iron ore is found in the Pilbara in the “Banded Iron Formation”. These deposits were formed when oxygen levels in the atmosphere were very low (less than 2%).

How old are these deposits? \_\_\_\_\_

How much oxygen is there in today’s atmosphere? \_\_\_\_\_

Is iron ore a renewable resource? Explain your answer. \_\_\_\_\_

\_\_\_\_\_

Gold Gold has always been a major contributor to our economy. Workers in the “Super Pit” in Kalgoorlie dig out this resource.

How old is the gold mineralisation? \_\_\_\_\_

If there is no more mineralisation, is gold a renewable or non renewable resource? \_\_\_\_\_

\_\_\_\_\_

### 3. Energy from the Sun

Our Sun is a giant thermo-nuclear reactor. Plants use its energy to produce food.

Is energy from the Sun renewable or non-renewable?

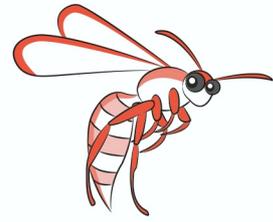
\_\_\_\_\_

#### Extension

Students may wish to visit

<http://www.epa.vic.gov.au/ecologicalfootprint/calculators/personal/results.asp> to estimate their own use of resources

## Paper Aeroplanes – Teacher Notes



We need to monitor our resource use so that it is sustainable and remains available for future use. There must be time for the source to be recharged.

Students will create paper aeroplanes or hats from old newspapers (limited resource). The aeroplanes will be flown across the yard to another student where it will be recycled for re-use.

This activity is best performed outside the classroom so the second student and third students have to walk/ run a reasonable distance between stages.



Materials per group of three:

- Location 1 10 sheets of newspaper and a desk or flat surface
- Location 2 a flat surface
- Timer/clock

Student roles

- Folder
- Runner
- Unfolder

1. The first student folds sheets of newspaper to create a paper aeroplane or hat as fast as they can. This is then carried by the runner to the second location or flown there.
2. The third student at the other end of the yard accepts the aeroplane, unfolds it and passes it back to the runner to carry back for re-use.
3. Find out how long it takes to make fifteen hats.
4. Pause and discuss what limits production and how it can be improved.

Amount of paper, age and condition of paper, speed of construction and breakdown, speed of runner, number of people at each stage.

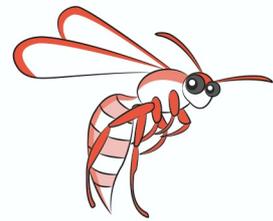
What must be changed to make this a sustainable production?

Recharge must meet demand

Hat folding instructions at: <http://www.uggabugga.com/Arts%20&%20Crafts/Origami/Origami%20-%20Hat%20Instructions.htm>

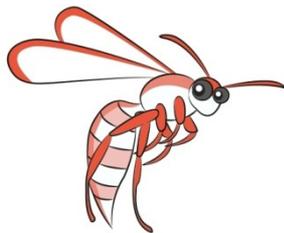
Maintaining resources so that they continue to be available to support life is termed SUSTAINABILITY.

Students may wish to reflect on the logistics involved in organising the removal of gold ore from the “Super Pit” in Kalgoorlie. Trucks have to travel at a specific speed to prevent traffic jams, facilities have to be available for drivers to go to the toilet in the vehicle to prevent hold ups and loaders must have a continuous supply of ore to be loaded. Food breaks and shift changes have to be carefully calculated to create least impact on production. These factors control the efficient rate of removal.

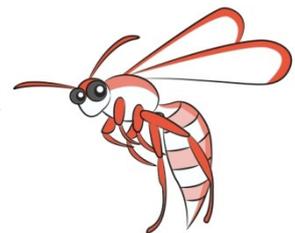


**Renewable & Non-renewable Resources – Student Review**

A resource is	example
A renewable resource is	Example
A non-renewable resource is	Example
The major resources of Earth are:	
W	A
L	R
S	E
We can help make resources more sustainable by:	
R	
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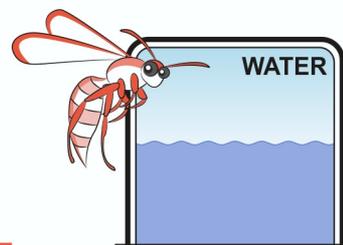


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- |              |              |                |        |
|--------------|--------------|----------------|--------|
| AIR          | ENERGY       | GEOLOGICALTIME | HUMAN  |
| LIVINGTHINGS | NONRENEWABLE | RECYCLE        | REDUCE |
| RENEWABLE    | REPLENISH    | RESOURCE       | REUSE  |
| ROCKS        | SOIL         | SUN            | WATER  |

**Water**



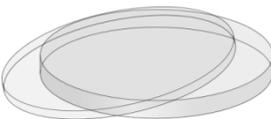
## Laboratory Rules - Teacher notes

When students are working on the following experiments they need to know the name of equipment they will be using and how to use it safely. The “Laboratory Rules” worksheet attached has suggestions in blue for teachers. Students may be encouraged to use this as evidence of developing laboratory proficiency (Lab. P plates).

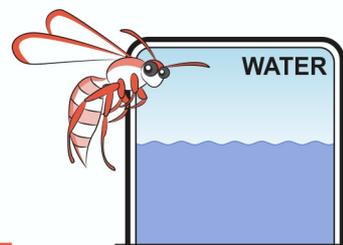
### Laboratory Rules

1. A teacher should always be present when entering the lab.
2. Leave all your belongings outside the lab.
3. No running in the lab. Always walk to avoid accidents.
4. No shouting or messing around with anything or anyone.
5. Long hair should be tied back.
6. Safety goggles may be worn to protect your eyes.
7. Eating and drinking in the laboratory is not allowed.
8. Follow all instructions carefully.
9. Ask questions if you are uncertain about the experiment.
10. When finished with your experiment waste materials should be put in the correct containers.
11. Put away all your equipment and clean your work bench.
12. Wash your hands.



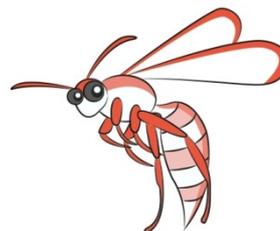
Equipment		Notes
Beaker		Beakers come in varying sizes and are used to contain liquids and solids. They have rough estimations of volume as graduations on their side. They should always be placed on cleared level surfaces. Wash after use.
Test Tube		Test tubes are used to contain liquids. Filled tubes should be held upright in racks or beakers. Always hold by upper rim. Wash after use.
Filter funnel		Filter funnels are used to separate liquids from solids. Always make sure a beaker or test tube is under before pouring in liquid. When not in use invert onto table to avoid the funnel rolling off. Wash after use
Filter paper		Filter paper is used to retain solids. Fold before placing in filter funnel and add a drop of water to help it retain the funnel shape. Do not prod as the filter paper will tear. Dispose of after use.
Petri dish		Petri dishes can be used to view materials and also to grow bacterial and fungal colonies. For the latter they must be sealed to prevent infection. Dispose of without opening or sterilise in an autoclave.
Pasteur pipette		The Pasteur or transfer pipette is used to hold known volumes of liquid. Clean thoroughly after use

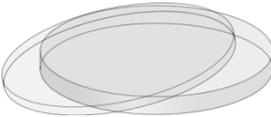
## Laboratory Rules - Student Activity



Please read and discuss the reason for the following rules

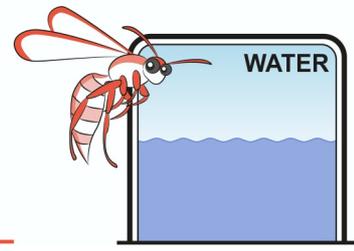
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8. Follow all instructions carefully.
9. Ask questions if you are uncertain about the experiment.
10. When finished with your experiment waste materials should be put in the correct containers.
11. Put away all your equipment and clean your work bench.
12. Wash your hands after activities.



Equipment		Notes
Beaker		
Test Tube		
Filter funnel		
Filter paper		
Petri dish		
Pasteur pipette		

I have read and will obey our laboratory rules \_\_\_\_\_

## Fair test - Teacher Notes



The concept of “Fair Test” is central to scientific practice. Scientists should only produce data that can be OMRR

- **Observed** Using their five senses. Though students should only ever use their sense of taste if directed by their teacher. E.g. to test for salt in clean salty water.
- **Measured** Using International standard units such as grams or kilometres. Subjective measurements such as “big” vary on the age and experience of the experimenter.
- **Repeated** If only a single measurement is taken it may be an outlier and not represent the most common, mean or average result.
- **Reported** Only when the above criteria are met.

To achieve a “Fair Test” everything should be kept the same except the one thing we will change to find out what results. We call this “reducing everything to one variable”.

The one variable we change is known as the **independent** variable.

The one variable we measure is called the **dependent** variable.

Students are not required to use this terminology until Year 8.



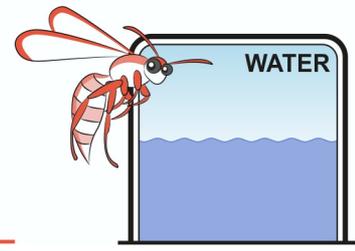
A fun activity to demonstrate the necessity for repetition uses a Pasteur or transfer pipette and a five cent piece. The pipette is named after the famous French microbiologist. These pipettes are inexpensive (less than \$17.00 for 500 in 2012).



If coins are sourced from the school canteen or local hot food shop they will be in different states of preservation, have different patterns having been minted in different years and some will be very greasy from food and human usage.

ASIDE Disease follows money. Medieval merchants used to keep their coins in vinegar in an attempt to ward off plague.

## Fair test - Teacher Notes



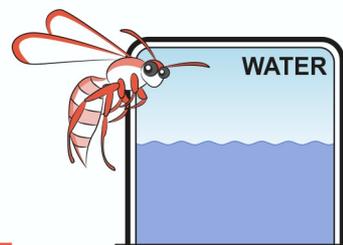
### Materials per student

- Newspaper or paper towel to work on
  - A 5c piece
  - A beaker or other container of water (can be shared)
  - A transfer pipette
1. Students place the towel or old newspaper onto the desk to mop up spillage.
  2. Demonstrate how to load the pipette by placing it into water, squeezing out air and letting it fill with water.
  3. Challenge students to see how many drops of water they can put onto their 5c piece before it overflows.
  4. Table their initial results on the board and there will be a broad range of results.
  5. Ask them which is the correct answer/answers? Because we had not controlled all of the variables none are.

### Variables to be controlled

- Head or tails
  - Same year/pattern on surface of coins
  - Clean/dirty coins
  - Damaged/undamaged rims
  - Distance of water drop
  - Pressure on pipette/size of water drop
  - Whether the tip of the pipette penetrates the growing water dome on the coin or not
6. Repeat with as many variables controlled as possible. Results will be closer but not all the same. Scientist report the mean or average reading AND the range of readings. E.g. average 38 drops, range 17 to 84 drops.

Absolute control is rarely obtained and a range of data is not uncommon. Scientists will repeat their measurements many hundreds of times before publishing their data.



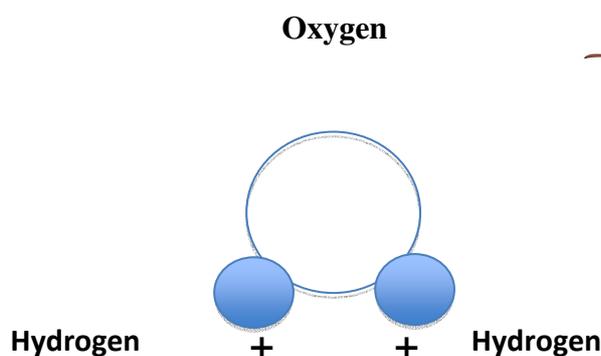
The chemistry of water controls its physical behaviour. Although knowledge of the behaviour of atoms and molecules is not usually covered until year 8, a general background will help explain why water clumps together (cohesion) or sticks to other substances (adhesion).

Water is a compound of hydrogen and oxygen (H<sub>2</sub>O), meaning two atoms of hydrogen bond with one atom of oxygen to form one molecule of water (di-hydrogen oxide).



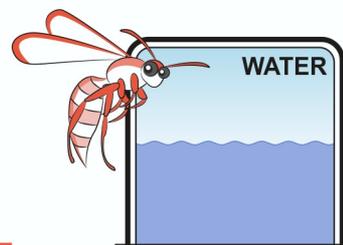
### ***Cohesion or Surface Tension***

The water molecule is polarised (acts like a small magnet) because oxygen pulls more negative electrons over to its side leaving the hydrogen atoms with a positive charge.



Like tiny magnets the individual water molecules are attracted to each other and form larger and larger droplets until they overcome the cohesive force. Surface tension is easily visible in the domed surface of a droplet of pure water on a clean flat surface. The bead of water is only broken when the droplet is large enough to be affected by the force of gravity or the presence of impurities decreases cohesive force.

- |           |   |
|-----------|---|
| Raindrops | Water vapour is present as clouds in the atmosphere. When water vapour cools, tiny droplets of water bond together to create larger and heavier rain drops. These fall to earth under the influence of gravity.   |
| Tides     | This cohesive power also allows seas to act as one body and rise and fall in response to gravitational attraction by the Moon, resulting in tides.  |
| Waves     | Wind pressure on the surface of the sea or lakes causes waves to form. The individual droplets of water only move in a local circular path because of their cohesion. The wind energy is passed on from molecule to molecule across the surface of the body of water.<br><a href="http://www.angelfire.com/crazy2/nur_filzah/new_page_2.htm">http://www.angelfire.com/crazy2/nur_filzah/new_page_2.htm</a> What causes waves? |



### ***Possible sequence of activities:***

#### **1. Surface Tension (Cohesion)**

- Surface Tension – Student Activities
  - Surface tension on a glass slide activity
  - Charged balloon with stream of water (demonstration)
  - Bubbles and surface tension (extension)

#### **2. Breaking Surface Tension (Cohesion)**

- Breaking Surface Tension – Student Activities
  - Plummeting pepper
  - Racing boat or fish
  - Floating needle or paperclip (extension)
  - Colour chaos (extension)

#### **3. Adhesion (Capillarity)**

- Adhesion (Capillarity) – Student Activities
  - Capillarity in glass tubes (demonstration, optional)
  - Capillarity in plant fibres
  - Twisted paper towel
  - Coloured flower (extension)
  - Stains (extension)
  - Minimise your footprint/handprint

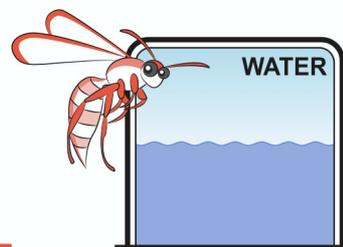
#### **4. Meniscus and Parallax**

- Meniscus & Parallax - Student Activities

#### **5. Revision**

- Cohesion & Adhesion – Student Review
- Cohesion & Adhesion - Wordsleuth

# Surface Tension - Teacher Notes



***Cohesion = Surface Tension***

## Introduction activity

Materials per student or group:

- 1 Glass slide or clean tray or plate or piece of waxed paper
- 1 Pasteur/transfer pipette
- Container of water

**HINT** If you don't have a pipette, place drinking straw in water and close top end with fingertip. Water can be carried in the straw and released when the finger is removed.

Students first use the pipette or straw to drop one bead of water onto a clean flat surface and observe the curved surface of the water bead. I heartily recommend that a fall of less than 1cm is encouraged. The water finds itself more attractive than the tray and forms round beads. This creates surface tension. If more water is added the bead will grow until the force of gravity exceeds the attractive force.



**Surface tension is the result of cohesive forces between water molecules.**

**ASIDE** An activity using pipettes and 5c pieces was included in the Laboratory Rules section. If students have not done this already, it might be included here.

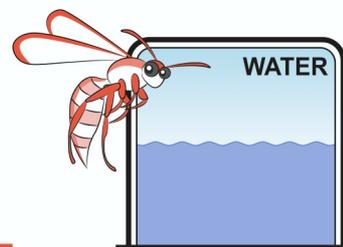
Pasteur pipettes are great fun and have lots of uses. They can be used to draw up mosquito larvae to examine with a hand lens, place vinegar in baking powder and add detergent to water. The end of the bulb can be cut off with scissors and the remains used as excellent large bubble blowers. Schools may wish to purchase a box of 500 for about \$20.00 (2012) and share them with others in their cluster.

## Teacher Demonstration

***Charged balloon with stream of water  
(Static electrical charge of water molecule)***



## Surface Tension - Teacher Notes



### Materials

- A well stretched balloon
- A thin stream of water
- A student with a good head of hair

Stretch then inflate a balloon and tie it off. Rub it against hair or man-made fibre. Friction will remove some of the outer negative electrons from the balloon's skin resulting in an overall positive charge. Hold the balloon near a thin stream of water (tap or carefully poured jug) and the stream will be deflected by the electrical charge.

Water molecules can easily align themselves when flowing and opposite poles attract "pulling" the water stream towards the balloon. The negatively charged ends of water molecules will be attracted to the positively charged balloon.

A thin plastic ruler or comb can also be charged by rubbing and will deflect the stream of water. This activity will demonstrate to students that water molecules are like tiny magnets, one end has a positive charge and the other a negative charge. Their cohesive attraction explains surface tension, the curved surface of water.

*Hint* This activity works best on a dry day. Recharge the balloon/ruler every time and keep it dry. Students may repeat the experiment to determine if the colour of the balloon or colour of hair affects the result.

### Extension Bubbles and surface tension

Bubbles can be blown to demonstrate surface tension using a pipette with the end cut off and bubble mix. Water forms a thin skin around air pockets. When the bubble hits another object the tension is broken and the bubble collapses.

#### Bubble mix recipe

7 parts water

3 parts detergent (dishwashing liquid)

1 part glycerine (chemist or supermarket)

Students may even try to blow bubbles within bubbles!

This requires inserting a loaded pipette into the centre of an already blown bubble and inflating it.

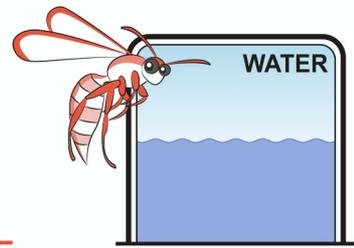
*Blowing bubbles inside bubbles*



#### **Cohesion explains why:**

- Water falls in raindrops and taps drip
- Puddles form after rain
- Some insects can walk on water
- Tides and waves rise and fall
- Drops form on the surface of raincoats until they become too heavy and run off
- Light rain stays on the surface of soil and can evaporate before it sinks in
- Bubbles keep their shape (for a while!)

## Surface Tension - Student Activities



Materials needed per student or group

- Glass slide or other flat surface
- Pasteur pipette or drinking water
- Container of clean water

Using a pipette or straw, drop water onto the flat surface to form a bead. Sketch a cross section of the bead below.



Describe the surface of the water bead.

---

Watch the teacher demonstration of the balloon and water

How does this explain the surface of your water bead?

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Design an experiment to see if the colour of the balloon changes the result.

What would you keep the same? \_\_\_\_\_

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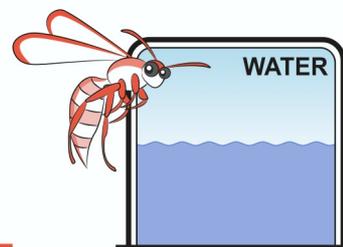
What would you change? \_\_\_\_\_

### Extension

Find the maximum angle at which surface tension is broken by gravity. Place a bead of water on a clean surface and raise one end until the bead streams down, its surface tension broken.

---

## Breaking Surface Tension - Teacher Notes



Water molecules are attracted to each other. This tension between them allows them to form drops with resistant curved surfaces. If you add detergent, it moves between the water molecules and decreases surface tension. These two fun activities demonstrate this.



Dispersed pepper on left

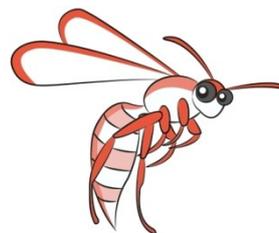


Racing fish

### **Plummeting Pepper**

Equipment required per student or per group:

- 1 Pasteur pipette/transfer pipette
- Small container of detergent
- Small beaker of water
- Finely ground black pepper



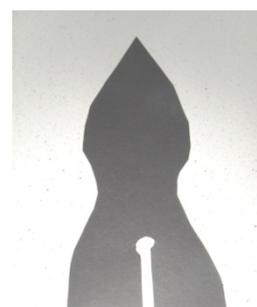
Sprinkle the pepper on the surface of the water. Pepper is held on the top by surface tension. Draw up a very little amount of detergent into the pipette (or use a straw) and drop it into the centre of the surface of the pepper covered water.

**Detergent will break surface tension in the immediate area and pepper there will fall to the bottom of the container.**

### **Racing boat or fish**

Equipment per student or group

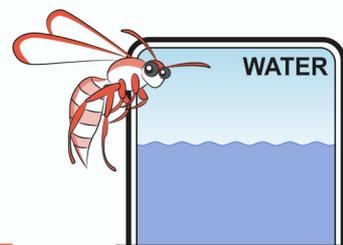
- Large flat tray of water. The tray under student desks is ideal.
- Thin cardboard and scissors
- 1 Pasteur/transfer pipette with a few drops of detergent



Cut the cardboard into the shape of a fish or boat. At one end slice to create a channel. Place the cardboard object at one end of the tray and carefully drop a little detergent into the central hole. **The boat will scoot across the tray.** Water released from surface tension will rapidly flow along the channel in the cardboard and push the boat along. Ask students to repeat the experiment. **Those who do not empty out the detergent contaminated water will find the boat no longer moves as the earlier detergent drop has spread throughout the water.** Discussion can follow as to how to design the best racing fish and how to reduce variables to make the competition a “fair test”

Why should you not touch the walls of a tent when it is wet? **Because it will break surface tension of water held in bubbles on the outside of the tent and water will flow inside the tent.**

## Breaking Surface Tension - Teacher Notes



### **Extension** Floating needle or paperclip

A very carefully placed needle may be held on the water surface by surface tension. However it needs to be placed on a square of toilet paper first. The toilet paper will sink leaving the needle floating.

Normally a paperclip would sink in water. There are many similar activities on “You Tube”.

### **Extension** Colour chaos

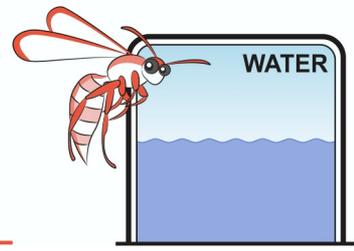
Take three different food dyes. Place a small drop of each widely apart in a shallow dish of milk. Dip a toothpick in detergent and gently stroke each drop of coloured dye. The colours will swirl as detergent breaks water surface tension releasing the dyes to diffuse.

### **Fascinating information**

Jaundice is not uncommon in neo-natal children. Doctors can sprinkle powdered sulphur on a specimen of the child’s urine. If the child is healthy, surface tension will hold the sulphur on the water. If the patient has jaundice the sulphur will sink. Their urine has less surface tension because of the presence of bile.

We sometimes use wetting agents to overcome this tendency of water to stick together and not move. Our WA soils are hydrophobic (hydro=water phobic=hater) and watering the garden with a sprinkler only results in blobs of water sitting on the surface and being evaporated away by the Sun’s heat. Like detergent, wetting agents break surface tension and make the water “runnier” to penetrate into pores between sand grains to get into soil. We don’t usually use detergents however as they also have negative effects on plant growth. Most wetting agents are not frog friendly.

## Breaking Surface Tension - Student Activities



### Pepper Plummet

Equipment required per student or per group:

- 1 Pasteur pipette/transfer pipette
- Small container of detergent
- Small beaker of water
- Finely ground black pepper



Half fill the beaker with water. Sprinkle the ground pepper over the surface of the water.

What happens to the pepper when it is sprinkled over the water? \_\_\_\_\_

\_\_\_\_\_

Why did this happen? \_\_\_\_\_

\_\_\_\_\_

Using the pipette drop a very little detergent onto the centre of the pepper

What happened to the pepper? \_\_\_\_\_

Why did this happen? \_\_\_\_\_

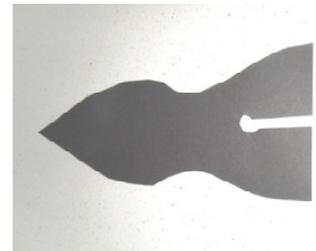
\_\_\_\_\_

***Fascinating fact***      ***Wasps and other insects can walk on the surface of water. Their weight is not sufficient to break surface tension***

### Racing fish

Equipment required per student or per group:

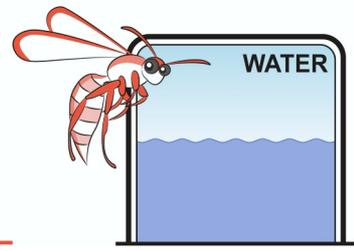
- Large flat tray of water.
- Thin cardboard and scissors
- 1 Pasteur/transfer pipette with a few drops of detergent



Cut cardboard into the shape of a fish or boat. At one end slice a channel. Place the "fish" at one end of the tray and carefully drop a little detergent into the channel hole.

What happened to the fish? \_\_\_\_\_

## Breaking Surface Tension - Student Activities



Why did this happen? \_\_\_\_\_

\_\_\_\_\_

Return the fish to the end of the tray and drop more detergent into the channel hole

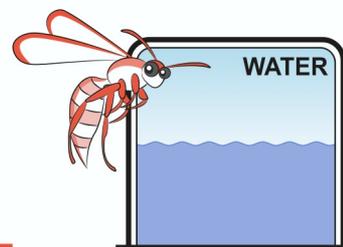
Explain what happened \_\_\_\_\_

\_\_\_\_\_

**Extension:** Why should you not touch the walls of a tent when it is raining? \_\_\_\_\_

\_\_\_\_\_

## Adhesion (Capillarity) – Teacher Notes



Water droplets are not only attracted to each other but also to the walls of their container. In narrow tubes such as plant fibres, water will rise, each molecule pulling up the next. The narrower the fibre the higher water will rise. This process explains how microfiber cleaning cloths mop up and hold dirty water and how sports clothes can “wick” away sweat. It also explains why the tops of underground water tables are not always flat and why water does not run out of a damp towel.

### **Capillarity in glass tubes (demonstration, optional)**

Three narrow glass tubes of different diameter can be placed in coloured water. The water will rise highest in the narrowest tube. Since the power of attraction decreases with distance from the glass the water surface dips in the centre forming a meniscus.

If you do not have narrow tubes you can try wrapping Glad Wrap round knitting needles to create thin tubes. Tape the edges. Place these in coloured water in beakers.

### **Capillarity in plant fibres**

Although paper was made from rags and papyrus in historic times, it is mostly made from wood and recycled paper nowadays. Trees use long thin tubes in their roots and trunk to pull water with dissolved mineral nutrients from the soil to their leaves. The phloem fibres transport sugars and other nutrients from the leaves for use and storage. Borers can kill trees by breaking the chains of cohesive water molecules and effectively starving it. Both these fibres are mashed to make paper. High quality paper is bleached then dressed with china clay to make it shine. Brown paper is often made with recycled paper.

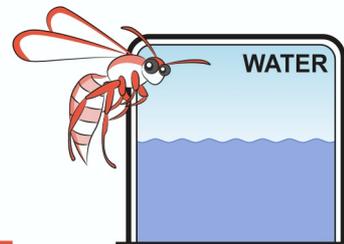
Comparing capillarity in different papers



Materials per student or group:

- Three different papers E.g. filter paper, kitchen towel, photocopy paper, newspaper, brown paper
- Scissors, pen and a ruler
- One beaker half full of water (food colouring optional)

Cut papers into equal sized strips 130mm by 40mm. I used a ruler as template. Mark the long sides with 10mm divisions. Hang the strips to the same depth in the beaker of water. Leave paper in beaker for 15 minutes. Remove and compare to find which paper has the greatest capillarity.



## Adhesion (Capillarity) – Teacher Notes

Students board data and decide whether both range and average should be included. This activity produces data that is observable, measurable, repeatable and reportable.

*Microfiber cloths hold and retain water because of capillarity in the thin micro-tubes they are made from. Water and the dirt held by it are strongly attracted to the walls of the micro tubes. Writing from normal pens will not leave marks on take-away containers as their surface is not made from fibres and the ink will smear away. Plastic “paint” pens must be used to leave lasting labels.*

### Twisted paper towel

Paper is made of plant fibres. Roll thin long strips of paper towel into a rope shape. Almost fill one beaker with water and leave the other empty. Place one end of the towel rope into one beaker and the other into the empty beaker. Mark the level of water on each beaker with a pen or piece of sticky tape. Although movement will start almost instantly it can take almost four hours for the water to move from beaker to beaker.



In hot climates rapid evaporation can remove water from the damp paper towel as fast as it rises. It is also interesting to note that the molecules of some food colouring are large and the colouring may appear to move at a different rate than water (See above).

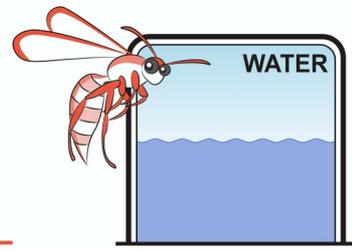
### Coloured Flower (Extension)

A white flower placed in coloured water may change to the colour of the water if left overnight. Care must be taken that the flower is freshly cut or air will enter into the veins and capillarity will not proceed. A scalpel or sharp knife cut through the flower's stem will demonstrate the cells transporting the dye.

### Stains (Extension)

On a piece of unbleached calico or a light coloured piece of cotton or linen, drop solutions of coffee, tea, fruit juice etc. Leave overnight to dry. Explain the pattern of colour that results. This can also be done on paper towel but the material is very easy to tear and must be left on a plate or board for support.

## Adhesion (Capillarity) – Teacher Notes



Minimise your footprint/handprint on resource usage



Students can also discover how to save money (and the environment) when using paper towels. On average people use four tri-fold paper towels or tear off three or four chunks of towel roll every time they dry their hands. If this usage can be reduced to one towel or chunk the savings to the school and home budget and to the environment will be great.

View <http://www.youtube.com/watch?v=2FMBSblpcrc> for a suggestion on how to organise a quick fun lesson

Students wash their hands as usual then either shake them twelve times or shake them as long as it takes to sing one verse of “Happy Birthday to you”. They can then dry their hands on only one sheet of towel folded in half.

Folding increases interstitial suspension, as any parent can tell. If there is a puddle on the floor, folding a cloth in two, dropping it on the puddle and then stepping on it and stepping back will increase the fluid uptake!

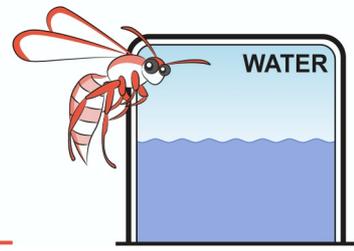
This is a useful activity for demonstrating “Science as a Human Endeavour” at school assembly.

### **ASIDE Terrible teacher’s jokes**

Capillarity sucks!

Cap-hillarity – the funny side of tubes

## Adhesion (Capillarity) - Student Activities



**Cohesion (surface tension)** = Attracted to the same thing water to water  
**Adhesion (capillarity)** = Attracted to another thing water to another

### Capillarity in plant fibres

Although paper was made from rags and papyrus in historic times, it is mostly made from wood nowadays. Trees use long thin tubes in their roots and trunk to pull water with dissolved mineral nutrients from the soil to their leaves. Water molecules are attracted to the sides of the tubes and move up them pulling other molecules up behind them. Borers can kill trees by breaking the chains of cohesive water molecules, effectively starving them.



Papyrus

### Comparing capillarity in different papers

Materials per student or group:

- Three different papers cut into strips
- Scissors, pen and a ruler
- One beaker half full of water (food colouring optional)

Cut different papers into equal sized strips 130mm by 40mm. I used a ruler as template. Mark the long sides with 10mm divisions. Hang the strips to the same depth in the beaker of water. Leave paper in beaker for 15minutes. Remove and compare water absorption to find which paper has the greatest capillarity.

Paper type	Initial reading	Final reading	Rise

Which paper would be best to mop up a milk spill? \_\_\_\_\_

Which paper would be best to use as a sandwich wrap? \_\_\_\_\_

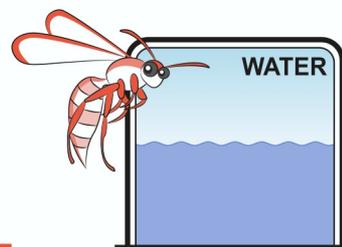
### USE YOUR KNOWLEDGE

Why are microfiber cloths such efficient cleaners? \_\_\_\_\_

\_\_\_\_\_

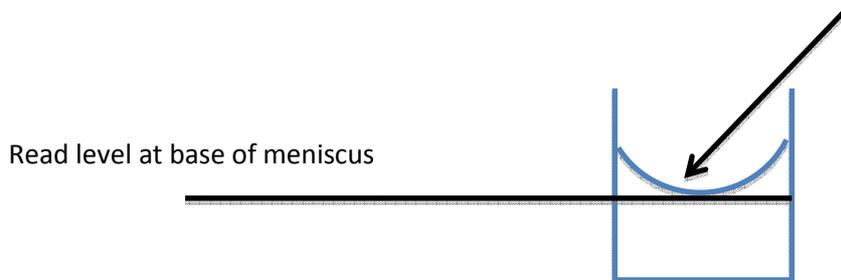
Why is it difficult to write on a plastic take-away container? \_\_\_\_\_

## Meniscus & Parallax - Teacher Notes



### Meniscus

Since water molecules are attracted to the sides of the measuring cylinder and this force decreases with distance from the sides, water has a downward curving surface or **MENISCUS**.

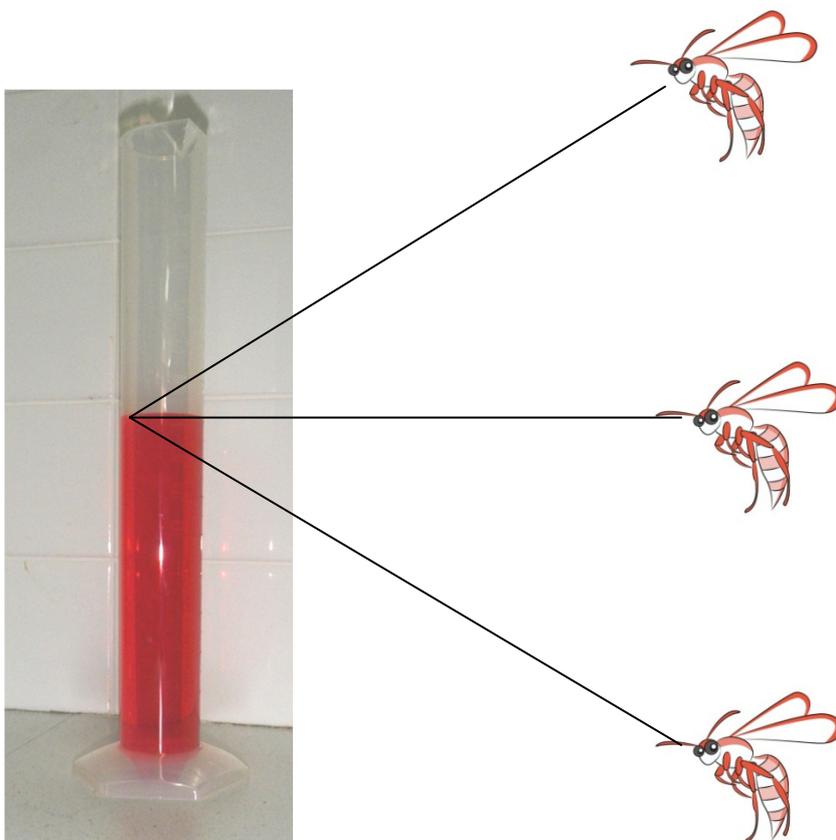


### Interesting Fact

Liquid mercury is not attracted to glass. As a result its meniscus domes upward.

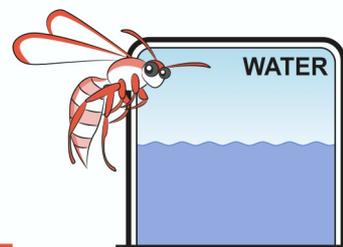
### Avoiding parallax error

Students need to take their eyes down to water level and read the level of the base of the curved surface.



The top wasp's reading on the side of the cylinder will be too high (53 mL). Similarly the lower wasp's reading will be too low (47mL).

## Meniscus & Parallax - Teacher Notes



### **ASIDE**      **A simple demonstration of parallax causing misreading**

Ask students to look around the room and find an object with an obvious vertical edge (door frame or window frame).

Close one eye and align their index finger with the edge.

Without moving their alignment finger exchange shut the open eye and open the closed eye.

The edge will appear to have moved sideways. This is caused by the difference in position of our two eyes. Even that small distance causes parallax error.

Students may practise getting correct measurements using beakers, measuring cylinders and pipettes. When decanting from one container to another, all the liquid must be transferred. This is easily demonstrated by transferring 50mL of water from one measuring cylinder to another. Some liquid usually remains adhering to the first container.

### **In general**

Beakers hold large amounts of liquid but only give measurements accurate to 10 or 50mL. Some even only give a maximum reading.

Measuring cylinders give more precise measurements but hold less liquid.

Transfer pipettes give the most accurate readings (if completely emptied) but only carry a small amount of liquid.

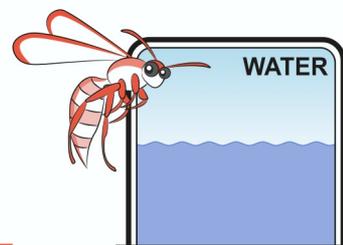
### **Inaccuracies rise from:**

- Parallax
- Not taking a reading from the bottom of the meniscus
- Liquid left behind in the container due to both cohesion and adhesion
- Not putting the volume units after the reading (E.g. 25 instead of 25mL)

### **NOTE**

Some students need practice to understand conservation of volume. They may misunderstand that in a tall measuring cylinder liquid has a greater volume than when it is poured into a large beaker. Moving the same liquid amongst several different containers will help.

## Meniscus & Parallax - Student Activity



Materials per group

- Beaker
- Measuring cylinder
- Transfer pipette
- Water

Half fill a measuring cylinder with water

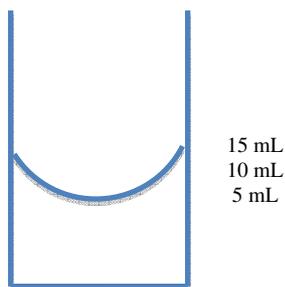
Why is the surface of water in a container curved? \_\_\_\_\_

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What do we call this curved surface? \_\_\_\_\_



The diagram above represents a measuring cylinder partly filled with water. Which part of the water's surface curve is used for measurement? \_\_\_\_\_

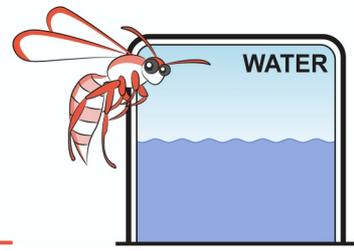
What is the volume of water in the measuring cylinder? \_\_\_\_\_

### Accuracy and precision

Which piece of laboratory equipment would you use to accurately measure these volumes of liquid?

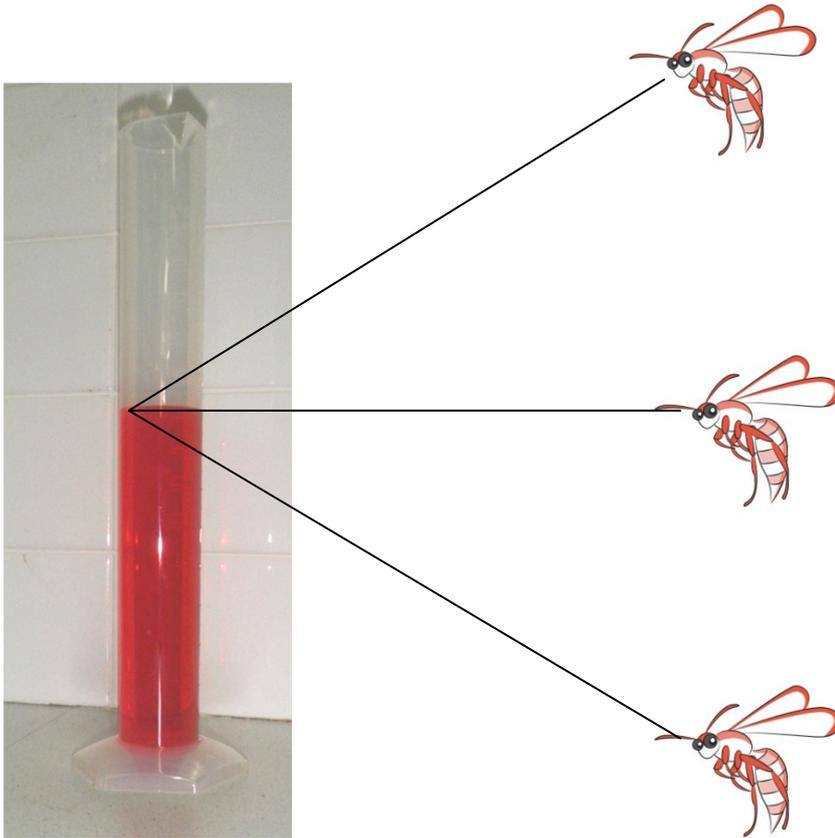
Volume (mL)	Pipette	Measuring cylinder	Beaker
5			
15			
50			
150			
500			

## Meniscus & Parallax - Student Activity



### Avoiding parallax (misreading) error

Which wasp will read the correct volume of water? \_\_\_\_\_



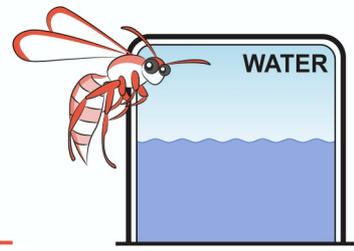
Using the equipment provided accurately measure these volumes of water:  
Get a friend to check your readings

Volume	Equipment selected	Equipment selected	Checked
5mL			
10ml			
25mL			
100mL			
500mL			

What can lead to inaccuracies in reading volumes of water? \_\_\_\_\_

\_\_\_\_\_

\_\_\_\_\_



## Cohesion & Adhesion – Student Review

*Using what you have learned, please explain your answers to the following puzzles.*



My little hairy dog Rory likes walking on the golf course even after it has been raining. Why is it that although the grass is always cut short and hardly reaches to the top of his paws, his hair is wet more than half way up his legs. Rory does not roll on grass as he is rather old.

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When I get Rory home I use an old cotton towel to dry my dog. A plastic bag just doesn't work for this. Why?

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My mother hated water on the bathroom floor so we were always very careful to mop up after baths. She was really angry to find an enormous puddle one morning? My sister explained that the towel on the edge of the bath was the culprit not her. Explain what she meant.

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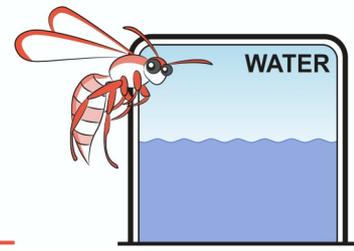
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Blue carnation flowers do not occur in nature however some florists sell them. How can this be?

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## Cohesion & Adhesion – Teacher Review Notes



*Using what you have learned, please explain your answers to the following puzzles.*



1. My little hairy dog Rory likes walking on the golf course, even after it has been raining. Why is it that although the grass is always cut short and hardly reaches to the top of his paws, his hair is wet half way up his legs. Rory does not roll on grass as he is rather old.

ANS. The water has risen up the hair fibres by capillarity. Rory's hair acts like a microfiber mop.

2. When I get Rory home I use an old cotton towel to dry my dog. A plastic bag just doesn't work for this. Why?

ANS. The towel is made of plant fibres that absorb the water onto their veins. The plastic bag is not made of fibres and will not absorb water.

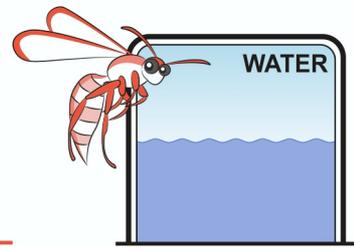
**Interesting fact** Modern towels were invented when a weaving loom developed a fault that caused threads to pucker into loops. Weavers noticed that this was better for mopping up spills than flat weave.

3. My mother hated water on the bathroom floor so we were always very careful to mop up after baths. She was really angry to find an enormous puddle one morning? My sister explained that the towel on the edge of the bath was the culprit not her. Explain what she meant.

ANS. The towel had fallen with one side into the bath and the other onto the floor. Water had migrated up through the cotton fibres of the towel and dropped onto the floor of the bathroom.

4. Blue carnation flowers do not occur in nature however some florists sell them. How can this be?

ANS. They place cut white carnations in blue coloured water. Capillarity causes the water to rise through the flower stem to the petals, which then turn blue.



## Cohesion & Adhesion - Wordsleuth

Surface tension occurs because \_\_\_\_\_

\_\_\_\_\_

An example of surface tension is \_\_\_\_\_

Capillarity occurs because \_\_\_\_\_

\_\_\_\_\_

N W L U S C A P M C D S R P L  
 D O A G D E I H H W E U E L B  
 A C I L A P R E O R T C K A B  
 H E T S E T M B E P E S A N R  
 V C W T E I T F I V R I E T O  
 Z E T Y S H S R Q F G N B D M  
 S E I T O N D P A I E E F J O  
 M S R N A D R A S C N M X F L  
 N Y D R S W A T E R T A T K E  
 H L T R E S O U R C E I D E C  
 S U R F A C E T E N S I O N U  
 N O I S E H O C F N U U F N L  
 S E L B B U B K T Q G T E D E  
 B S L G H L K L I V S X G T B  
 R L R D E Y P L L F E Z G I T

Adhesion  
Detergent  
Plant

Attraction  
Fibres  
Resource

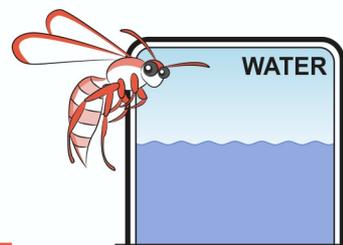
Beaker  
Liquid  
Surface Tension

Bubbles  
Meniscus  
Transfer

Chemistry  
Molecule  
Veins  
Pipette

Cohesion  
Water

## Physical Separation Techniques – Teacher Background



***Every 20 seconds a child dies from water related disease***

Water is essential for life on Earth. Early life forms absorbed all their nutrients dissolved in seawater. On land essential nutrients move into plant and animal bodies dissolved in water and toxic wastes are removed by water. Too much or too little water causes death.

Water can also carry diseases such as diarrhoea, typhoid and malaria. UNICEF states that only one person in nine has access to clean water. During war, waterborne diseases kill more soldiers than the enemy. To efficiently work with water as a resource from nature, we need to understand what water is and what causes it to behave the way it does. We can then comprehend why rain falls in discrete drops, why the sea has waves, why puddles disappear in sunny days, why we have to wait a long time after rain for the water table to rise and why a good cotton towel efficiently “mops up” water.



The weir at Mundaring Dam. Perth's water supply

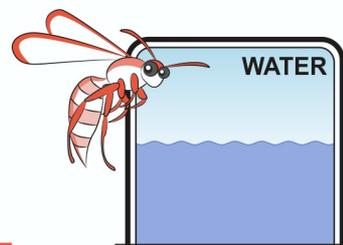
### **Some History**

About 4,000BC, Greek and Sanskrit (Indo Aryan) writings tell of boiling and of filtering water to make it smell and taste better. Hippocrates the father of modern medicine (370BC) invented the Hippocratic sleeve that filtered water through cloth bag because he believed it was healthier for the human body. This is probably the prototype of the “soldier's sock” where soldiers would use sand in a sock to filter larger impurities out of dirty water.

In 1854, British scientist John Snow (famous for using ether & chloroform for anaesthetics) noted that the map of cholera outbreak was centred on a specific well in Broad Street in London. Previously people thought the disease was caused by “miasma” or foul air. The water was being taken from sewage polluted underground sources. When the pump handle was removed deaths stopped.

Suggested background contexts for these activities could include child/community health, the Kokoda Trail conflict, early settlers and life in the Goldfields.

## Physical Separation Techniques – Teacher Background



### Physical Processes of separation of Mixtures

**Mixtures** are two or more substances physically combined. They are in the same place at the same time and can be separated using physical processes such as:

**Decantation** Pouring the liquid away from the solid. E.g. Separating water and marbles by pouring off the water and retaining the marbles.

**Filtration** Retaining the solid but pouring off the liquid. E.g. Separating peas from water using a sieve.

**Evaporation** Boiling off the solvent (liquid) to leave the solute (solid) E.g. Drying salty water to keep salt.

**Condensation** Cooling a gas to form a liquid. E.g. Cooling water vapour (steam) in air to collect water.

Examples would be:

- Peas and water. Water can be decanted from peas.
- Coffee grounds and water. Grounds can be filtered from the mix.
- Water and salt. Water can be boiled from the salt solution to leave solid salt
- Salt water can be boiled and the steam condensed to collect pure water

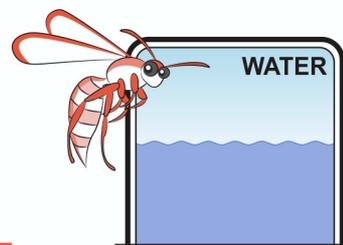
**Compounds** are two or more substances chemically combined and cannot be separated by physical means. E.g. sodium and chlorine form the compound sodium chloride or common salt.

### SOLUTION Vocabulary

**Solvent + solute = solution**

**Solvent** Solvents are the liquid in which solids can dissolve. E.g. water dissolves salt and alcohol dissolves grease.

**Solute** Solutes are solids which dissolve in solvents. E.g. cocoa powder dissolves in milk and instant coffee dissolves in water.



***Possible sequence of activities:***

**Physical Separation Techniques**

**1. Decanting**

- Decanting – Student Activity

**2. Filtering**

- Filtering With Filter Paper – Teacher Demonstration
- Filtering With Sand - Student Activity
- Filtering With A Sari - Student Activity
- Filtering With Rock - Student Activity
- Filtering - Vocabulary Worksheet

**3. Evaporating & Condensing**

- Evaporating & Condensing – Teacher Demonstration

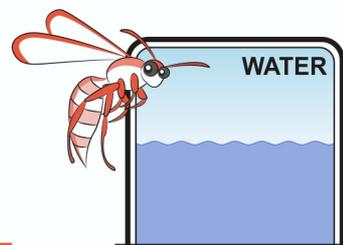
**4. Living Things In Water**

- Growing Bacterial & Fungal Colonies – Teacher Notes (for student activity)

**5. Revision**

- Physical Separation Techniques – Student Revision

## Decanting – Teacher Notes



Water collected from wells, dams, rivers and the water table underground often contains contaminating solids. **Mixtures such as this can be separated using physical methods.**

**Decanting involves pouring the liquid portion away from the insoluble solid portion.**

Common examples of decantation are:

- Water is decanted (poured off) from cooked potatoes, carrots and peas.
- Wine develops sediment if left for a few years. This is particularly true of fortified wines such as port. In the past it was poured from the cask into a glass decanter and left to permit gravity to separate the clear wine from the denser “lees”. The clear wine was decanted into the glass and the lees were given to the gods.
- Mint tea, a favoured refreshing drink in many Arab countries, is made by pouring boiling water over mint leaves and sugar in a pot or glass. The mixture is left for a little time to infuse before the tea is decanted into a glass, leaving behind wilted mint leaves. (Traditionally it is returned to the pot twice before its third and final decantation).



- In farm dams and tanks, muddy water is left to settle to the bottom before clear water is drawn from the upper levels. As a child I was taught to let the water from the well stand for a while before decanting the clearer upper portion into another bucket for washing whites and crockery. Decanted water will be clearer but not necessarily any cleaner as bacteria and any dissolved solids will remain.

**NB** If the dirty water source contains colloidal mud particles it is almost impossible to produce clear water in the short term. However if it is left to stand for some days before decanting, the water poured off will be clearer than the original sludge.

If however the water contains soluble substances such as salt or tea, these cannot be separated by decantation.

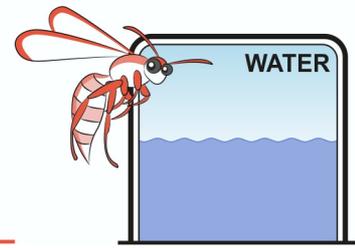
If you have measuring cylinders students may compare the volumes of original dirty water and decanted clear water. Students should be encouraged to lower their eyes to the level of the top of the water and read the base of the water’s meniscus (slightly downward curved top) to get accurate measurements.

### Extension

Competitions to find the best decanters are fun. Initially using dried peas or marbles will permit a fair competition with all competitors having the same volume of water and solids. More advanced competitors may use soup mixes where a higher percentage of “fines” require a steady hand.

If beakers are not available for the activity, use empty plastic cool drink bottles and mark the side to compare.

## Decanting - Student Activity

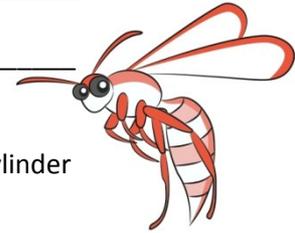


Clear water for stock, irrigation or household washing can be obtained by **DECANTING** dirty water that has been allowed to settle.

DECANTING involves \_\_\_\_\_

Materials needed per student or group

- Two 500mL beakers
- Stirring rod or spoon
- Water
- Measuring cylinder
- Dirt or sand
- Timer



Place two heaped tablespoons of dirt or sand into one beaker and half fill with water. Mix the sand and water. Leave the water to settle for 1 minute then attempt to pour off only clean water into the measuring cylinder. Stop when the water starts to become cloudy (translucent). Repeat the activity increasing the time left to settle the sediment.

**Vocabulary** (Memorise this during the experiment)

- Transparent** Light can pass through and objects clearly seen e.g. window
- Translucent** Semi-transparent (fuzzy image) e.g. milky glass
- Opaque** Light cannot pass through e.g. brick

### Results from decanting dirty water

Time to settle	Height or volume of clear water mL			Comment on clearness of water.		
	Test 1	Test 2	Test 3	Transparent	Translucent	Opaque
<b>1 minute</b>						
<b>2 minutes</b>						
<b>5 minutes</b>						
<b>10 minutes</b>						

Did waiting a longer time before decanting improve the clarity of the water? (Explain your answer)

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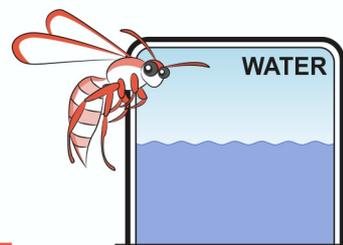


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Is this water potable (fit to drink)? \_\_\_\_\_

What could this water be used for? \_\_\_\_\_

## Decanting - Student Activity



### *Extra for experts*

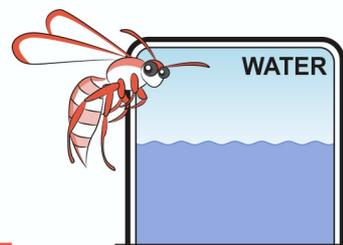
*Design a tool to measure the transparency of decanted water.*

Dissolved and solid materials in water are essential as they provide nourishment for plants and animals and deposit silt to become rich soil. The Great Yellow River of China, the Huang Ho and the Nile in Egypt might make your washing pretty yellow but their silt created the birthplace of ancient Chinese and Egyptian civilisations. Water must be sufficiently translucent to allow light to enter and water plants to photosynthesise.

A Secchi disk is used to measure transparency of water in dams, rivers and seas. A black and white chequered disc is lowered into water until the pattern can no longer be seen clearly. The length of rope is taken as the measurement of transparency.

[http://en.wikipedia.org/wiki/Secchi\\_disk](http://en.wikipedia.org/wiki/Secchi_disk)

Some farmers use a long graduated stick in the same way.



## Filtering – Teacher Notes

**Filtration involves passing a liquid and solid mixture through a solid permeable barrier that separates solids from liquids.**

Kitchen sieves separate rice from water, tea strainers separate tea leaves from liquid tea and lettuce spinners separate leaves from washing water. All are **filters**.

The liquid that passes through a filter is called **filtrate**.

Filter paper comes in varying qualities which are rated to control filter speed and size of solids retained. Schools without filter paper may use Chux towel or equivalent kitchen towels cut to size. They are however less efficient.

Students should not prod or probe damp filter paper as holes created will allow solids to escape.

If schools do not have filter funnels or beakers use scissors to cut washed clear cool drink bottles as shown in the picture alongside



Sand used for the rough filtering activity must be pre-washed to remove fines. Place it in a bucket, cover with water, give it a good swirl and quickly decant the coloured water. Repeat four times. Coarse sand is easier to clean than fine sand.

### Control of variables

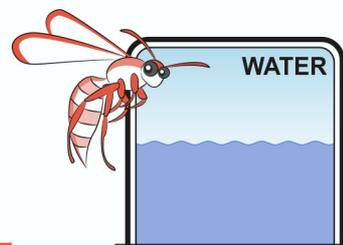
In a fair test, all variables must be controlled (kept the same) except the one we are testing. In this experiment the controlled variables are:

<b>Sand</b>	<b>equal measures</b>	<b>E.g. 3 tablespoonsful</b>
<b>Bottles</b>	<b>equal volumes</b>	<b>E.g. All same cool drink bottles of same size,</b>
<b>Dirty water</b>	<b>equal solids</b>	<b>E.g. Stir before collecting same volume of water</b>

### Sari experiment

A sari is the dress worn by many women in the Indian sub-continent. It can be from four to eight metres in length and made from woven materials ranging from silk to cotton. The World Health Organisation has tested using sari material as a filter to decrease water borne diseases during times of flood. They have found that four layers of sari are sufficient to filter out all but the smallest diseases. Even the poorest woman can give a fair protection to her family using her own clothes. An old sheet or pillowcase can be cut into squares larger than the diameter of the filter funnel for the sari experiment. Unbleached calico is useful and inexpensive.

## Filtering – Teacher Notes

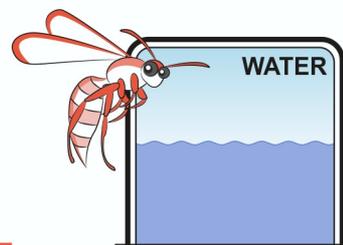


### **DANGER**

**Filtering water only removes solids. It does not remove germs and dissolved substances.** This can be demonstrated by paper filtering a clean solution of tap water and dissolved salt. Students are asked to vote on whether the filtrate will taste salty. Those who think it will not are encouraged to taste the filtrate. Similarly food colouring can be added to water before filtering

Filtrate can be tested for bacteria and fungi by growing drops in a nutrient gel (see 'Growing Bacterial & Fungal Colonies – Teacher Notes').

## Filtering With Filter Paper - Teacher Demonstration



It is often best to demonstrate the process of filtration before students attempt it.

### Materials

- A filter funnel and filter stand if you have one
  - A beaker to collect the filtrate
  - A filter stand (if possible)
  - Three sheets of filter paper
  - Dirty water
  - Water tinted with food colouring
1. Place the filter funnel in the top of the beaker or in the filter stand. Fold a circle of filter paper into four. Open the cone until it fits into the funnel. (Hint – If you moisten the inside of the funnel the paper will stick).
  2. Ensure the funnel is over the container to collect the filtrate
  3. Pour some dirty water into the filter paper in the funnel but do not fill. It is better to keep adding a little at a time rather than risk contaminating overflow down the sides of the filter paper.
  4. If dirty water appears in the beaker students have either overfilled the funnel or have poked at the paper with a pencil and torn paper.
  5. Wash equipment clean and place used filter paper in the bin.

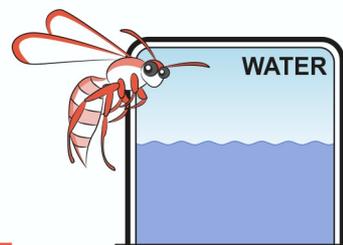
Ask the students to describe the difference between the water being poured into the filter paper and the remaining water.

Repeat with coloured water. The colour will pass through the filter as its molecules are too small to be caught.

Repeat with salty water. If you used clean tap water and salt you can ask a group of willing students to guess whether the filtrate will be salty.

**Interesting fact** *In Third world countries, poor people collect used coffee grounds from rich peoples' restaurants. They mix these with potters' clay, form them into tall pots and fire them. The grounds incinerate in the heat of the kiln and leave tiny holes in the baked clay pots. These can be*

## Filtering With Filter Paper - Teacher Demonstration



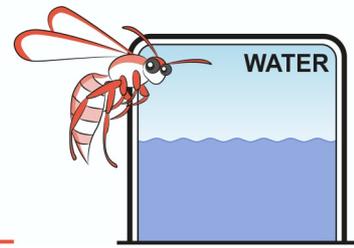
*used for filtering water. After they have been used for a while they easily break down and are recycled back into the fields.*

**More interesting facts** Although this paper we used cannot filter out germs, a Swiss company has made a filter that will almost manage that. It is called the “Life Straw” and was developed for use after catastrophes when water contamination occurs. It filters out 99.99999% of waterborne bacteria and 99.9% of parasites.

<http://www.lifestraw.com.au/>

One straw can provide clean water for a child for almost three years. These straws cost less than \$20.00 but are too expensive for the poor. Charity groups such as Lions are buying and distributing them. (Some diseases such as Giardia that causes diarrhoea can still filter through).

## Filtering With Sand - Student Activity

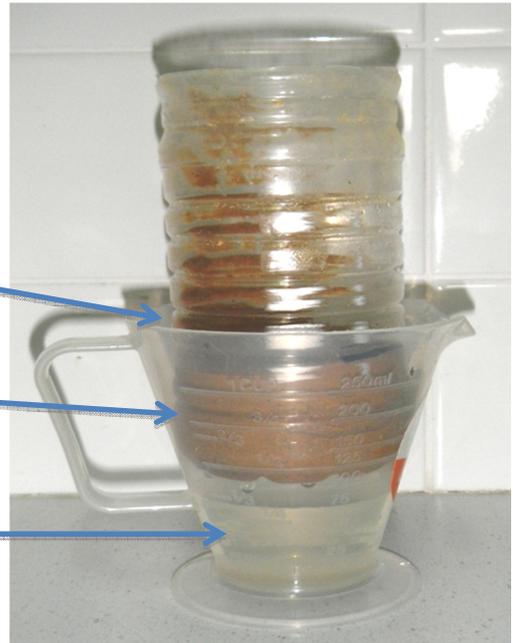


Water from reservoirs and dams is often passed through sand beds to filter out solids.

Solids held back

Sand filter

Sand filtered clear water



Liquid collected from filtering is called **filtrate**.

Soldiers used to filter nasty water through a sock half filled with sand. They said it was better than drinking water with the “lumps” in!

Unfortunately neither of these methods can filter germs efficiently.

**Do not drink the filtrate**

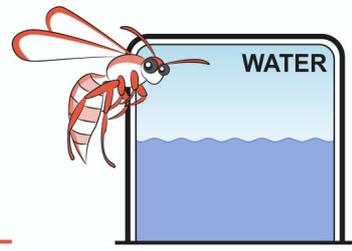
Materials needed per student or group:

- Clean sand (How will you control this variable?) \_\_\_\_\_
- One empty washed plastic cool drink bottle with the top removed by scissors (How will you control this variable?) \_\_\_\_\_
- Thumb tack, map pin or compasses to puncture the base of the bottle 10 times
- Dirty water (How will you control this variable?) \_\_\_\_\_
- Beaker or base of larger cool drink bottle to collect and measure filtrate
- Measuring cylinder or jug



Half fill the bottle with washed sand. With the bottle held over a beaker, part fill with dirty water and collect the filtered water in the beaker beneath. This water will appear fairly clean but still could contain germs.

## Filtering With A Sari - Student Activity



After annual cyclones and floods sewage often contaminates drinking water supplies. Poor people in third world countries to our north do not have the technology or economic infrastructure to access safe water. The elderly and babies are the first to die. They need to drink water to survive but the water they wade through and fills their houses is too dangerous to drink. In recent floods in eastern Australia many people suffered the same problem.

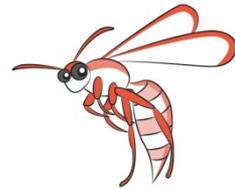
***Contaminated water kills one child every 20 seconds.***

A sari is a simple women's garment made from one long strip of cotton or silk. The World Health Organisation (WHO) advises that under these conditions filtering water through a sari folded four times is the best answer for people forced to use contaminated water. It is an acceptable simple technique that can continue to be used after the catastrophe. Just employing this technique has reduced the number of cholera bacteria (V cholera) victims by over 90%.

View <http://www.icddrb.org/media-centre/news/2141-simple-sari-cloth-filtration-of-water-protect-villagers-from-cholera-in-matlab-bangladesh>

Materials per student or group

- A filter funnel
- Two beakers
- 4 pieces of cheap cotton or unbleached calico.
- Dirty water



Fold the cotton to fit into the filter funnel. Pour the dirty water through the cotton taking care not to overflow.

Although the water may appear clean, students should not drink it as some microbes may be present.

How does this method compare with sand filtration? \_\_\_\_\_

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Where in our Pan-Asian region would people have had to use this method recently and why?

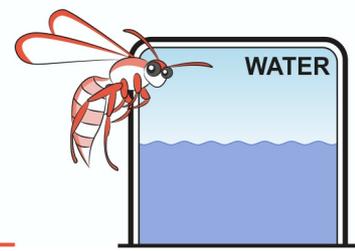
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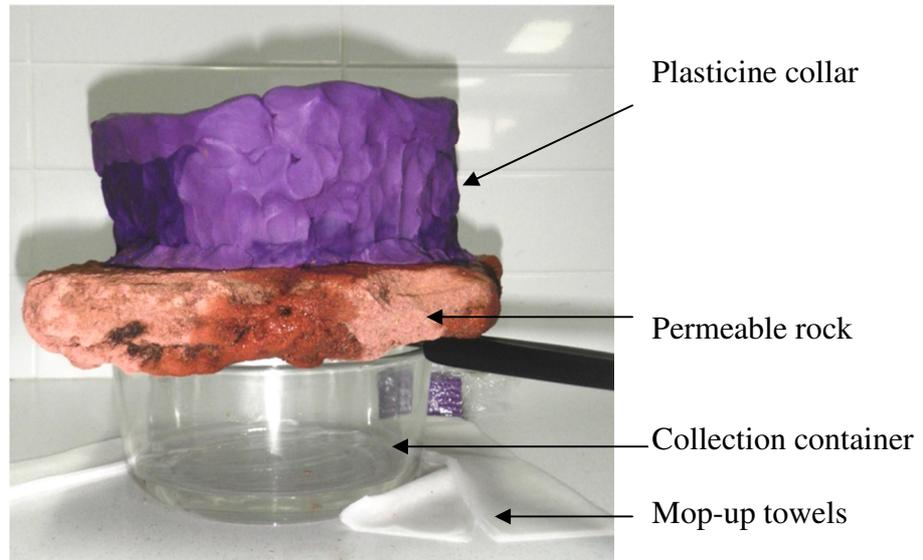
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## Filtering With Rock – Teacher Notes



Rocks that are both porous (having spaces between their grains) and permeable (the spaces are joined) can be used to filter water. Coarse sandstones are excellent. Igneous rocks such as granites and dolerite are not permeable. Garden centres often have tiles and slabs of sandstone. They may donate broken ones “for the children” if approached. Grinding a depression into rock is time consuming. A collar of plasticine or clay can retain water which gravity will encourage to penetrate and to fall into the container below.

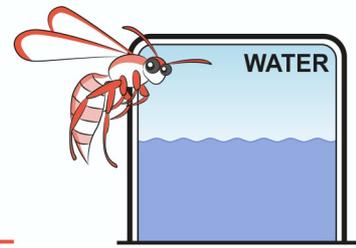


The equipment above would be improved if the impermeable plasticine collar had enclosed the edges of the stone stopping the water moving sideways through the stone and dripping outside the container below.

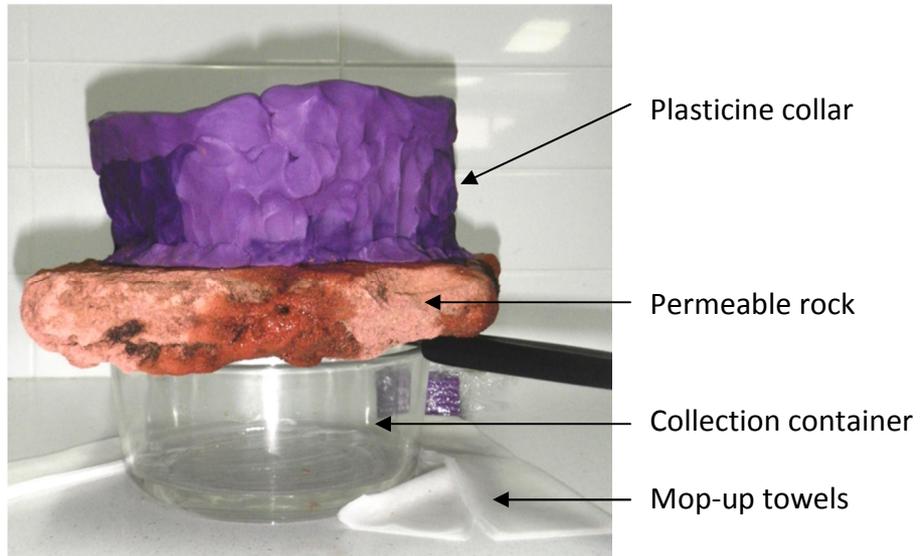
Materials needed per student or group

- A “wet” area inside or move outside to work on concrete where spills will not matter
  - A flat piece of permeable rock.
  - Plasticine works well but clay works best
  - A container for the dirty water and another container to collect the clear water.
  - Mop-up towels, rags or newspaper
1. Form an impermeable collar with clay or plasticine and press well to seal onto the rock. Sausage coil technique works well. Hold the collar up to the light to check for holes and seal them.
  2. Place this on top of the collection container.
  3. Slowly pour a little of the dirty water into the clay collar. Check for leaks and stop them with little bits of clay or plasticine.
  4. Be prepared to mop up any water that moves sideways through the porous rock and seeps outside the collection container.
  5. Students will be asked how long it would take to collect enough water to boil to make a cup of tea. In this case it took about 30minutes.

## Filtering With Rock - Student Activity



Early settlers in Australia would sometimes carve out a hollow in a permeable rock (a rock with spaces between their grains). Dirty water would be poured into the hollowed top and later clear water would be collected below. It would have to be boiled before drinking.



Materials needed per student or group

- A flat piece of permeable rock.
- Some plasticine or clay.
- A container of the dirty water and another container to collect the clear water.
- A measuring cylinder or cup (250mL)
- Mop-up towels, rags or newspaper
- A clock or timer

1. Form an impermeable collar with clay or plasticine and press well to seal onto the rock.
2. Place this on top of the collection container.
3. Slowly pour a little of the dirty water into the clay collar.
4. Check for leaks and stop them with little bits of clay or plasticine.
5. Be prepared to mop up any water that moves sideways through the porous rock and seeps outside the collection container.
6. Find how long it takes to collect 10mL of water

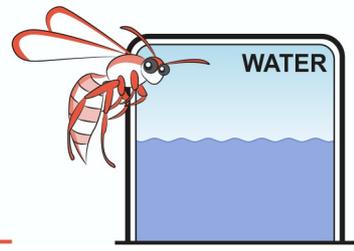


Why does the water have to be boiled before you drink it? \_\_\_\_\_

\_\_\_\_\_

How long would it take to collect enough water to make 1 cup (250mL) of tea?

\_\_\_\_\_



## Filtering - Vocabulary Worksheet

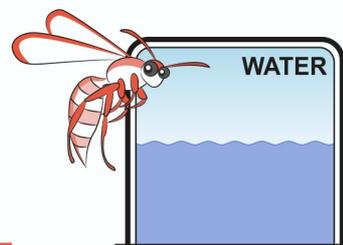
In the photograph, label and name the:

<p>Solvent (liquid)</p> <p>Solute (solid)</p> <p>Solution (solute + solvent)</p> <p>Filter</p> <p>Filtrate</p> <p>Organism</p>	 <p>It's not rocket science</p>
--	--

Draw a labelled sketch of other household examples of filtration below.

Title \_\_\_\_\_

## Evaporating & Condensing – Teacher Demonstration



In the Western Australian Goldfields there is little rain and rivers rarely flow. Aboriginal groups obtained precious water supplies from soaks and gnamma holes. (See 'An Aboriginal Perspective – Teacher Notes') Some callous European explorers fed Aboriginal people salt meat so they would be forced by thirst to show their precious water sources. The sudden influx of thousands of gold miners exhausted these supplies. Water from some salt lakes was boiled and the steam was collected and cooled to provide fresh water. The process was so expensive that fresh water was almost as expensive as gold weight for weight. Even water from bores and underground workings is hyper-saline (high levels of salts) being a third as salty as the sea. It kills most vegetation and animals and has to be kept in specially constructed dams with bunds (walls). Until the Kalgoorlie pipeline was completed on January 24<sup>th</sup> 1903, most water had to be carted from the coast

**Evaporation** Changing a liquid into a gas

**Condensation** Changing a gas into a liquid

In both cases this is a physical change as no new substance is created.

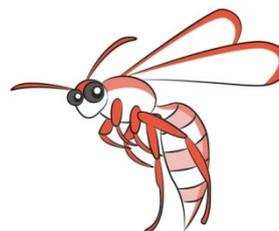
**Danger** Extra energy is required to turn a liquid (water) into a gas (steam). This means that a steam burn is particularly nasty. Any burns should be immediately placed under cold running water.

### Purifying water by evaporation and condensation

This activity is probably best demonstrated by the teacher.

#### Materials required

- Bunsen burner and match
- Tripod
- Gauze
- Beaker of dirty salty water
- Beaker with ice
- Beaker to collect condensation
- Safety glasses and gloves



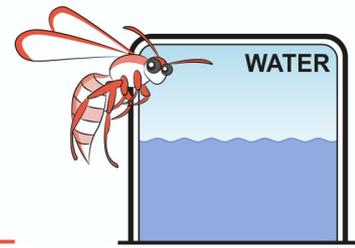
Boil dirty salty water and collect condensation by holding the cold beaker over the rising steam. The clean steam will cool, condense and water will drip down to be collected. Care must be taken to prevent steam burns.

Alternatively cool steam from a boiling kettle by condensing a cool glass full of ice or the surface of a cold plate.

#### Extension

Students could also collect condensed water from a tree. A weighted plastic bag is tied to enclose a leafy tree branch. Water is a by-product of photosynthesis and is lost as steam (water vapour) through pores on the underside of leaves. This transpired steam will condense in collect in the bag. When it cools it will condense and run to collect in the weighted section. Eucalyptus trees should be avoided as they also release strong smelling eucalyptus oil, which taints the condensate. It is safe to drink but definitely is an acquired taste.

## Growing Bacterial & Fungal Colonies – Teacher Notes



It is rare for pure water to exist in nature. Even water melting from a glacier may have fungal spores present. In the summer in Antarctica “watermelon stains” appear near crevasses in ice fields. They are caused by fungal colonies with red sporing bodies. There are also tiny arthropods found in lakes trapped under the ice caps.



Students may wish to examine the evidence of macroscopic living things in pond water using hand lenses, magnifying glasses or Proscopes.

Water from a frog pond, birdbath or bog teems with life. Collect samples from the bottom of the pool as well as the top as creatures such as mosquito larvae sink rapidly to the bottom as a form of defence when water is disturbed. Petri dishes and test tubes can be held towards the light or placed on a piece of white paper to highlight aquatic organisms.

When using the hand lens students may need to be reminded that the glass is held close to the eye and the object to be viewed is moved towards the glass and eye until in focus. Moving the glass between the eye and object can result in nausea.

### Growing bacterial and fungal colonies in nutrient gel in Petri dishes

Although filtration methods will remove most solids from the dirty water, dissolved materials and microbes will pass through the paper and could cause illness if swallowed. Bacteria and fungal spores are too small to be seen under a school microscope. If you provide them with nutrition they will multiply into visible colonies. Bacteria multiply at a rate of  $2^{n-1}$  where n is the time it takes for them to double. Students may wish to calculate how long it would take for one bacterium to become 64 bacteria if it only takes 15 seconds to reproduce asexually (one parent cell becomes two).

**15s-2, 30s-4, 45s-8, 60s-16, 1min 15s-32, 1min 30s-64**



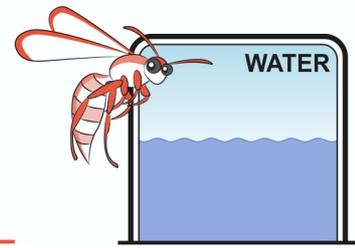
Petri dish

Petri dishes are named after Julius Rickard Petri the famous German bacteriologist (1853 – 1921). The dishes with gel should be prepared the day before the activity.

Materials required for 6 Petri dishes:

- Six Petri dishes
- Agar powder (about one and a half tablespoonsful)
- Stock cube or sugar
- Five cotton buds.
- Sticky tape

## Growing Bacterial & Fungal Colonies – Teacher Notes



A nutrient gel can be made by dissolving about a quarter of a stock cube in warm water. Add half a level tablespoon of agar to 100mL of warm water and pour into the smaller bottom dish. Close with the larger upper lid and seal with sticky tape. Dishes with nutrient gel should not be left uncovered as they will quickly be contaminated. Dishes can be prepared a day earlier if they are kept upside in the fridge. This minimises drying out. Commercial fruit jelly usually has too much food acid which delays, but does not prevent, microorganisms growing. (Soft fresh bread can be substituted but the results are not always successful)

One Petri dish with gel should be sealed immediately and returned to the refrigerator. This is the **CONTROL** dish. It is the dish against which any change will be measured. The other dishes are the **EXPERIMENTAL** models.

Moisten the cotton bud with filtered dirty water and smear it over the top of the gel with a few strokes. Replace the upper lid. Seal round the edges with sticky tape. Do not open again. Leave these in a warm (not hot) place and colonies should become visible over a couple of days. They are most easily seen by holding the sealed dish up to a light or window and letting the light shine through.

**DO NOT CONSIDER OPENING THE PETRI DISHES.** The few original microorganisms will have multiplied rapidly making them more virulent.

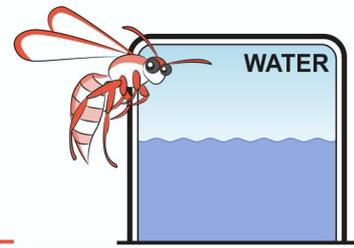
Bacterial colonies tend to be slimy whereas fungal colonies tend to be furry. I rather enjoy watching “real estate wars” when colonies compete for nutrient.

**Unless you have an autoclave, do not attempt to clean these dishes. Dispose of rapidly.**

Availability of food and warmth are major factors limiting in bacterial reproduction. Where sewage has mixed with drinking water in a warm climate, conditions for disease outbreak are present. Where the residents are poorly fed and have low medical aid, deaths of babies and the elderly follow floods and war.

Viruses need a living host to multiply.

## Physical Separation Techniques – Student Review



**Separation processes.** Please explain what they are and give an example.

1. Decanting means \_\_\_\_\_

2. Filtration means \_\_\_\_\_

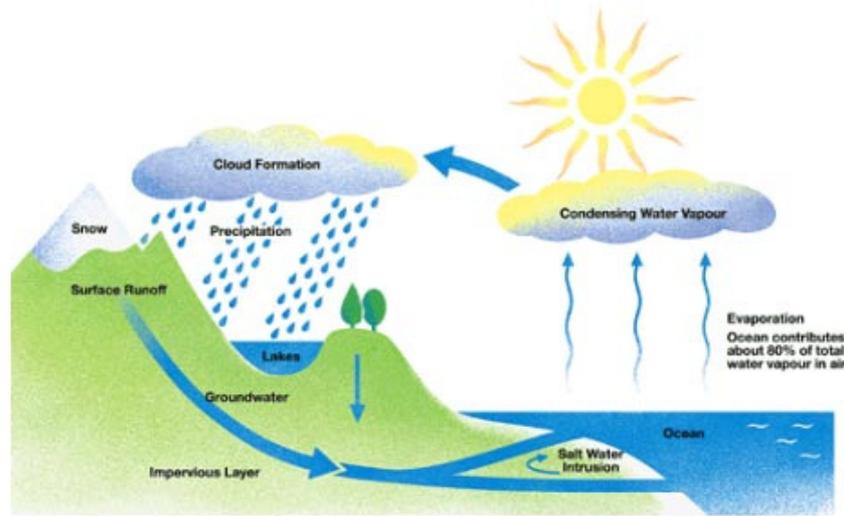
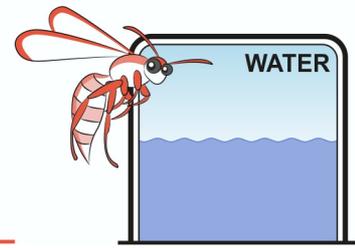
3. Evaporation means \_\_\_\_\_

E P B E H E R D O K N Z T F S  
 U R O C V E S B I H R N S I O  
 Q N C T P A S A F L E P E L L  
 A O R O A E P I E C O T T T V  
 P I R A R B L O U S U S R R E  
 O T E V R T L L R L I S I A N  
 R A E L R E S E O A A D A T T  
 E S I A B N H S M G T D F I M  
 P N T N A A R L I Q U I D O A  
 E E V R N O I T U L O S O N E  
 A D T D Q A T R P U D V J N T  
 T N S X D O R G A N I S M T S  
 W O E R U S A E M V R E T A W  
 Z C P P W O K X D M U K S O E  
 T R A N S P A R E N T P O F F

CONDENSATION	DISEASE	EVAPORATION	FAIR TEST	FILTRATE
FILTRATION	GAS	LIQUID	MEASURE	OBSERVE
OPAQUE	ORGANISM	POTABLE	REPEAT	REPORT
SOLID	SOLUTE	SOLUTION	SOLVENT	STEAM
TRANSLUCENT	TRANSPARENT	VARIABLE	WATER	

The resource we have been studying is \_\_\_\_\_

# Water Cycle - Teacher Background



Courtesy of wetfeet uk

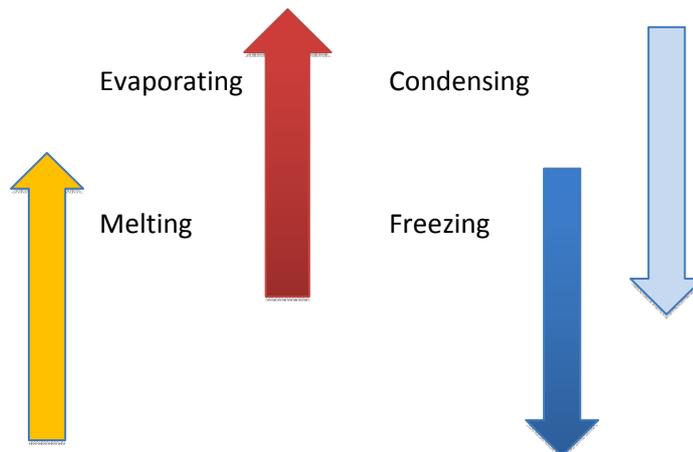
## Kinetic Theory Background

Students are not required to understand kinetic theory until Year 8. Kinetic theory explains how substances can change from being solid (constant volume, constant shape) to liquid (constant volume but varying shape) to gas (varying shape and varying volume). Molecules of water are in constant vibration. At low temperatures the force of attraction between the water molecules is greater than their capacity to move so the water remains as a solid, ice. With increasing heat the molecules have sufficient energy to slide over each other but still not enough to separate. They can change shape and become liquid water. With even more heat they can break the bond of attraction, fly apart and become a gas, water vapour.

**GAS** water vapour

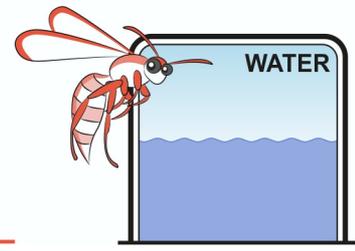
**LIQUID** water

**SOLID** ice



Melting can be demonstrated by moving ice cubes out of the fridge. Evaporation can be demonstrated by a pot or kettle of boiling water and watching the water vapour (steam) rise. Condensing can be demonstrated by holding a cold plate against steam rising from a kettle. Freezing can be demonstrated by making ice cubes. These changes are called physical changes or changes of state. No new material is formed.

## Water Cycle - Teacher Background



Water will change from solid to liquid to gas as it moves through the water cycle. The driving forces are heat (or lack of it) from the Sun and gravity.

Seawater evaporates to form cloud vapour. Vapour condenses to form rain that falls to Earth. Rain percolates through the soil to be held underground as groundwater. This eventually re-joins the sea and the cycle repeats.

Water cycles through many temporary reservoirs, leaving the sea to eventually return there. The path it takes is known as the hydrosphere.

### *Possible sequence of activities:*

#### **1. Water In The Atmosphere**

- Rate of Evaporation - Student Activity
- Rain - Student Activity
- Clouds – Teacher Demonstration

#### **2. Water On Land**

- Sources of Water - Student Research
- Permeability - Student Activity

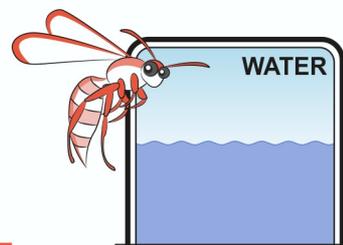
#### **3. Water For Humans**

- Student Quiz
- Water Cycle - Cloze Worksheet

#### **4. Water An Aboriginal and Indian Perspective**

- An Aboriginal Perspective – Student Activity
- An Indian Perspective – Student Activity

## Rate of Evaporation - Teacher notes



Heat from the Sun provides enough energy to evaporate liquid water from the sea, lakes and wet land surface and turn it into water vapour. Hot air rises carrying vapour upward. The water molecules travel on the wind until they become cooled and condense back into water again forming clouds. Cohesion binds the molecules into raindrops that become heavy enough to fall as rain, sleet or snow.

Between 0 and 4% of the atmosphere is water vapour.

The average period of residence of a water molecule in the atmosphere is 9 days.

Rate of evaporation can be measured by exposing a known volume of water e.g. 50mL for a set time. In cool conditions this activity should be left overnight or longer to be able to easily measure change.

Factors (variables) affecting the rate of evaporation are exposure to:

1. Temperature (higher is faster)
2. Humidity (higher is slower)
3. Wind (higher is faster)
4. Surface area exposed (larger is faster)



Students may relate to the time it takes to dry a wet towel or swimming costume to weather conditions

A towel will dry:

- Faster if the weather is hot
- Slower if the weather is humid
- Faster if there is a wind
- Faster if it is hung up flat rather than left crunched up in a ball or tightly folded

### Rate of evaporation activity

Materials required per student or group:

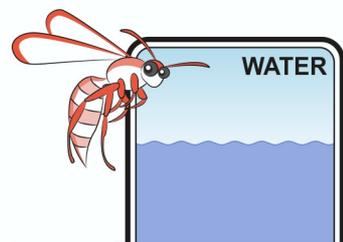
- Water (+ food colouring, optional)
- Measuring cylinder
- Beaker, bowl, cup saucer and plate or other, container for holding water
- Area of flat paving, concrete, asphalt or a hot window sill
- Timer

$$\frac{\text{Original volume of water} - \text{final volume of water}}{\text{Time in minutes}} = \text{rate of evaporation in mL per minute}$$

Using the measuring cylinder, pour the same volume of water into different containers. Expose the containers for a known time. Enter your results in the table provided. Calculate the rate of evaporation using the equation above.

Which variables do we have to keep the same to make this a **“Fair Test”**? Same volume of water, same time, same position/location, same exposure to wind, sunlight and sprinklers.

What variable did we change? The container (more specifically the surface area of water in each container)



## Rate of Evaporation - Teacher notes



### RESULTS Perth 33°C 19/11/2012 Exposure over 3 hours

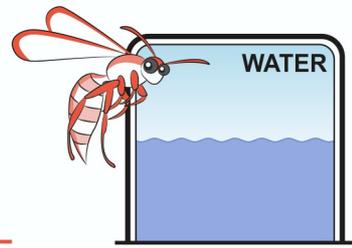
Container	Original volume of water (mL)	Final volume of water (mL)	Volume evaporated	Time	Rate of evaporation ( )
500mL beaker	100mL	80mL	20mL	3h 180m	6.6mL/h 0.11mL/m
250mL measuring jug	100mL	76mL	24mL	3h	8mL/h
Dinner plate	100mL	25mL	75mL	3h	25mL/h

What variable or factor caused the difference in rates of evaporation? **Surface area of water exposed to permit evaporation**

Two students needed to dry their towel before packing them to take them home. One laid theirs out flat on the grass. The other student folded theirs neatly into four and laid that on the grass. Which towel would dry first? **The towel laid flat on the grass.** Explain your answer. **The higher the surface area exposed the faster water evaporates.**

When reticulation systems sprinkle water onto plants and soil on a hot day, the high surface area per unit volume, due to tiny beads of water, results in a lot of water being lost by evaporation before it penetrates the soil. Drip and seep systems are more efficient. In Western Australia more water returns to the atmosphere through evaporation than penetrates the soil.

Water in our atmosphere is an important part in maintaining the "Greenhouse Effect". Without clouds, heat radiated from the sun would reflect back into space and Earth would be much cooler. Life would not be as plentiful as it is today. Unfortunately other gases such as methane, carbon dioxide and sulphur dioxide are intensifying this heating effect.



## Rate of Evaporation – Student Activity

In many areas of Australia rainfall evaporates back into the atmosphere before it gets a chance to sink into the soil. We can measure this rate of evaporation.

$$\frac{\text{Original volume of water} - \text{final volume of water}}{\text{Time in minutes}} = \text{rate of evaporation in mL per minute}$$

Materials required per student or group:

- Water
- Measuring cylinder
- Beaker, bowl, cup saucer and plate or other, container for holding water
- Area of flat paving, concrete, asphalt or a hot window sill
- Timer

Using the measuring cylinder, pour the same volume of water into different containers.

Expose the containers for a known time.

Enter your results in the table provided.

Calculate the rate of evaporation using the equation above.

Which variables do we have to keep the same to make this a **“Fair Test”**? \_\_\_\_\_

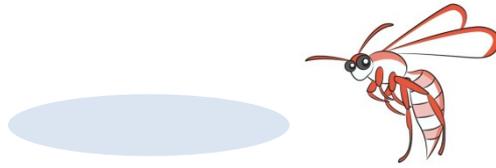
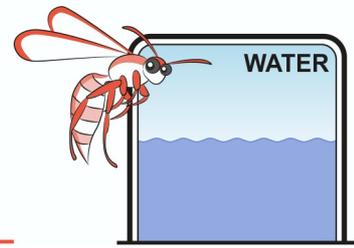
\_\_\_\_\_

Which variable did we change? \_\_\_\_\_

### RESULTS

Container	Original volume of water (mL)	Final volume of water (mL)	Volume evaporated	Time	Rate of evaporation ( )

## Rate of Evaporation – Student Activity



What variable or factor caused the difference in rate of evaporation? \_\_\_\_\_



After swimming, two students needed to dry their towel before packing it to take home. One laid theirs out flat on the grass. The other student folded theirs neatly into four and laid that on the grass. Which towel would dry first?

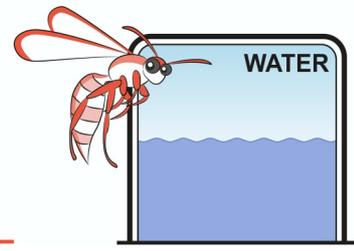
\_\_\_\_\_

Explain your answer. \_\_\_\_\_

\_\_\_\_\_

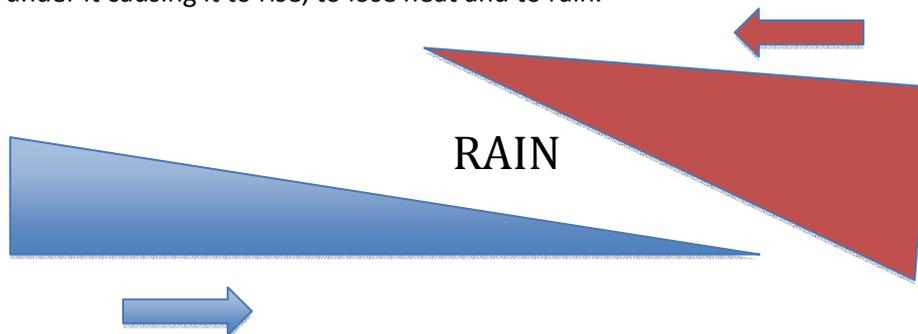
**Interesting Fact** Aboriginal people used to dig wells to reach groundwater. Before they moved on they would fill the well with clean sand. This would not only stop animals fouling the water but also reduced loss by evaporation. 90cm of sand reduces evaporation almost to zero. This is also why some Aboriginal people would bury themselves in sand to stop sweat loss in extreme heat.

## Rain - Teacher Notes



Rain falls if there is a drop in pressure or temperature. Winds blow clouds inland where they can rise over mountains, cool and drop rain. Places, such as the east coast of Tasmania where wind mostly comes from one direction can experience rain shadow. Clouds drop most of their rain on the western coast leaving little for the east. Hobart is the driest capital city of Australia.

Cold air is denser than warm moist air and travels faster. When a cold front approaches warmer air it slips under it causing it to rise, to lose heat and to rain.



### Making rain

This activity works best if water is very hot. Students need to behave responsibly or it may be used as a teacher demonstration.

Materials required per student or group:

- A large beaker (about 500mL or more)
- Plastic food wrap
- Hot water
- Two ice cubes

Carefully half fill a beaker with hot water.

Stretch the plastic food wrap across the top to seal.

Place the ice cubes on the centre of the wrap

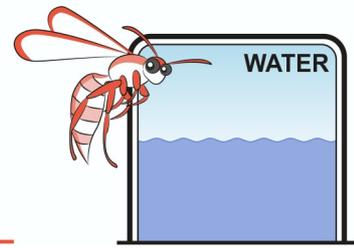
Water condenses below and falls like rain.

**Extra for experts** Why do my glasses steam over when I try to lift a pizza from a hot oven?

Hot moist air from the oven condenses on my cool glasses.

Water would be sea, rivers, lakes. Heat is from The Sun. Ice represents cool air at height in the atmosphere.

## Rain - Student Activity



In the shower, when steam from hot water cools it becomes liquid water and runs down the tiles and glass. We call this *CONDENSATION*

When clouds cool it rains. We call this *PRECIPITATION*

You will be using hot water. How does the sensible Science student behave when using hot water?

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What would you do if another student burned their hand with hot water?

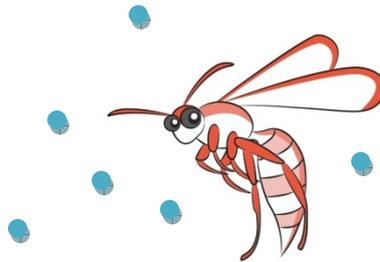
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### Making rain

Materials required per student or group:

- A large beaker (about 500mL or more)
  - Plastic food wrap or a large watch glass
  - Hot water
  - Two ice cubes
1. Carefully place hot water in the beaker
  2. Stretch the plastic wrap over the beaker of hot water to form a seal
  3. Place two ice cubes onto the centre of the wrap
  4. Write what happens below



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Explain why this happened \_\_\_\_\_

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We have been looking at the water cycle in nature.

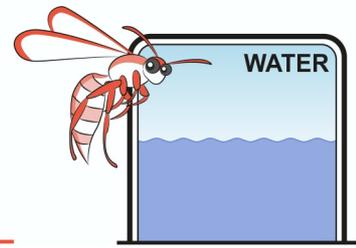
What has this experiment to do with the water cycle? (Nature doesn't have beakers or kitchen wrap).

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## Rain - Student Activity



In the box below draw and label the equipment you used. Place these words in the correct place on the diagram **Evaporation, Condensation, Precipitation**.

**Hint** Use pencil and a ruler. A large drawing is often neater than a small one.

In the water cycle what could the liquid be? \_\_\_\_\_

\_\_\_\_\_

In the water cycle where would the heat to evaporate the water come from?

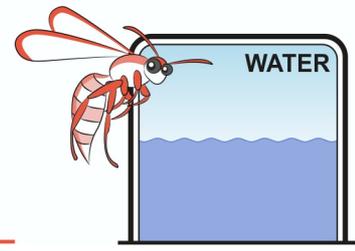
\_\_\_\_\_

In the water cycle what do the ice cubes represent? \_\_\_\_\_

\_\_\_\_\_

**Extra for experts**      **Why do my glasses steam over when I open the oven to pull out a pizza?**

## Clouds – Teacher Demonstration



Clouds are water vapour in the atmosphere. For clouds to form there must be three factors:

1. **Water vapour**
2. **Dust or salt** to provide an active surface for water vapour to condense into a liquid
3. **A chill or decrease in pressure.** The chill and decrease in pressure can be the result of air rising to go over mountains or a weather front.

Materials needed

- A two litre clear plastic cool drink bottle with lid
- A little methylated spirits or ethanol
- Hot water
- A match

**Method**

1. Swirl a little methylated spirits or any other alcohol round the inside of the bottle and empty out.
2. Pour about a glass of hot water into the bottle and screw the lid on.
3. Give it a good shake.
4. Squeeze and release the bottle. Nothing will happen.
5. Unscrew the lid, light the match, blow it out and drop the smoking match into the bottle.
6. Rapidly screw the lid tightly onto the bottle and squeeze. Nothing will happen but when you release the pressure a cloud will condense and appear.
7. If you squeeze again the cloud will disappear.

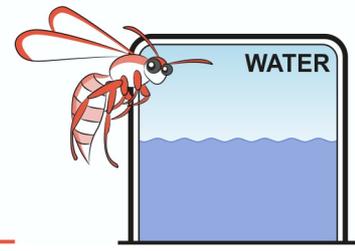
**Explanation**

The release of pressure will lower the heat (kinetic energy) of the molecules. Water vapour will become liquid water drops.

Smoke from the burnt match will provide active surfaces for water to condense on. Water vapour will condense into a cloud.

I had to practise this several times at home before demonstrating this in the classroom.

## Water On Land - Teacher Background



### Earth Processes      Evaporation and Percolation

Only one fifth of the surface of Earth is land. The other four are sea. Water is evaporated from the sea, condensed as rain to fall on the land and must percolate through the land to re-join the sea.

Moving water and the sediment it contains sculpts the surface of our planet. Erosion removes mountains and dumps sediments into the sea. Without wind or water our planet's surface would look like the Moon.

If rain falls on an impermeable surface such as granite, clay or concrete, the water may evaporate directly back into the atmosphere, run into rivers or may be directed to a dam or reservoir. This is called surface runoff. In Western Australia a lot of rain is lost through evaporation at the surface before it has a chance to penetrate into soil.

If, however, water falls on permeable ground it will percolate through soil and rock carrying dissolved substances down to the aquifer (water maker) underlying the water table. Most rural and remote areas rely on underground water from bores. Metropolitan areas increasingly rely on bore water (water from the aquifers) to provide domestic and industrial water. To replenish our underground reservoirs water must be able to seep through soils and rocks that are both porous and permeable. Underground water reservoirs are both permeable and porous but are sealed by non-permeable beds.

**Porous**      Having pores or spaces

**Permeable**      Having pores or spaces which are interconnected

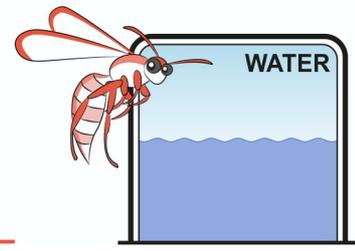
Many students have problems differentiating between porosity and permeability. Bubble wrap is porous (has holes) but is not permeable as the holes are not joined and do not allow water to pass through. A sponge is both porous and permeable as it has holes that are interconnected and will allow water to pass through.

Many native plants produce a waxy layer which coats sand grains and reduces permeability of soils. Water drops from a transfer pipette will remain as beads on the top of these soils. Surface water can be rapidly removed by evaporation. Soil wetting agents can aid penetration. Many native plants like acacia, have leaves and branches arranged to channel rainfall directly down their stems to their roots.

Water movement is delayed by cohesion between water molecules holding them together and adhesive forces between water and soil or rock. At depth, pressure of burial causes grains of rocks to be compressed reducing open pore space and squeezing water back up into the aquifer. Water can remain in an underground reservoir for days or for tens of thousands of years. The Yarragadee aquifer underlying Perth has water estimated to have resided there for 300,000 years.

Where the water table comes to the surface, spring water is released to become rivers and lakes. Eventually water will flow down to the sea.

## Sources Of Water - Teacher Notes



In earlier years students should have researched sources of water on land. They may need to be reminded of the use of key words, choosing reputable sources and how to cite them.

Scientists have to work swiftly in groups to collect information. Research must be well directed and the sources of data must be reputable. Scientists use peer review before publishing. In this case the names of students in the research group are not known to the review group to prevent influence. Research suggests that groups of three or less are most functional and intellectual parasitism (one person does all the work) is less likely to occur.

Plagiarism is intellectual theft. This is why students' rough notes are left attached to their final work.

Materials required

- Access to library and Internet or "a box of relevant books".
- Scrap paper for notes
- A3 paper for final flowchart

Students in groups are encouraged to draw a simple flow chart or cartoon explaining how we can directly source drinking water from one of the following:

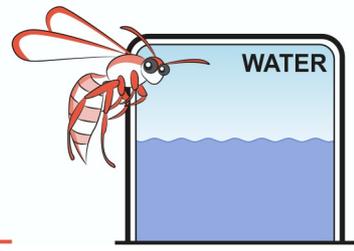
1. Rainfall
2. Rivers
3. Groundwater
4. Salt water
5. Domestic grey water

### Lesson Plan

<u>First five minutes</u>	Students brainstorm in their group to find out what they already know and agree on key words they will use for research. They then divide research targets amongst themselves.
<u>Next thirty minutes.</u>	Each student collects information from at least three sources. Students should make their own rough notes to avoid plagiarism. References should be included to give credence to work.
<u>Last 25 minutes.</u>	The group confers and then creates the flow chart on A3 paper. The chart must have a title and have on the back each student's rough notes and references attached. This work is handed in to their teacher.

The next day each group reviews another groups' work using the worksheet provided. Comments should include both positive and negative responses. It is important that negative responses should be accompanied by suggestions as to how work can be improved.

If time is available groups may improve their work using the suggestions provided in the feedback sheet.



## Sources Of Water – Student Research

### Peer review sheet

Names of peer review group

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Subject of research

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	Check	Comment
Flowchart completed		
Title clear		
Rough notes attached		
Each group member contributed		

We thought these things were good

1 \_\_\_\_\_

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2 \_\_\_\_\_

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3 \_\_\_\_\_

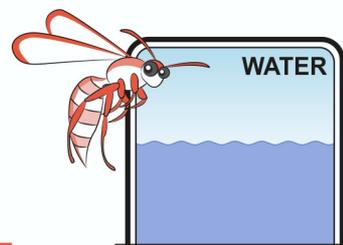
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These need to be improved	How (we suggest) they can be improved

Date

Signed

## Permeability - Teacher Notes



When fragments of weathered and eroded rock form soils and sedimentary rock small spaces or pores are left. If these spaces are joined water can move through them. They are permeable.

Sand will allow water through. Sand is **permeable**.

Clay will not allow water through. Clay is **impermeable**.

Permeability controls the movement of water through soil and rock. Soils with high permeability not only allow water to penetrate through to plant roots but all the way down to join the aquifer (aqua = water, fer = maker) below. Bores can tap into this water reservoir. Most water in metropolitan Perth now comes from bores. When bores are drilled into aquifers care must be taken not to drill through the impermeable layer below, as water would be lost.

Materials required per student or group:

- Filter papers
- Filter funnel
- Beaker
- Measuring cylinder
- Water
- Specimens of different soils
- A large spoon

Set up the equipment for filtration (See “Physical Separation Techniques” section for help)

Place two spoons of one soil in the filter paper.

Measure 20mL of water and carefully pour onto the soil. Do not disturb the soil.

Wait for 5 minutes then measure the volume of water that has permeated through the soil.

Enter your results in the table provided.

Wash the equipment and repeat for another two samples.

Compare your results with those of others.

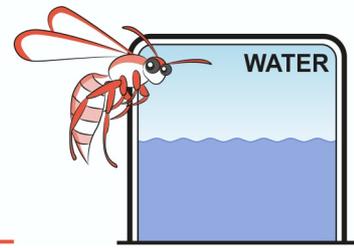
Sample	Description	Vol. water collected	Comment
1			
2			
3			

Why were you asked to compare your results with others? **To achieve a more accurate result. One reading might be atypical. To achieve a statistically relevant result. Fair test.**

Which soil would be best for farming? Explain your answer. **The most permeable soil is best because it allows water with dissolved nutrients to penetrate down to the plant roots. It also allows water to drain from the root zone to prevent waterlogging.**

Which soil would form the best aquifer? **The most permeable soil would hold the most water.**

## Permeability - Teacher Notes



Which soil would be the best one to use to build and line a farm dam? **The least permeable as it will reduce water loss through seepage. Farmers use clay.**

### Formation of salt lakes on clay pans

1. Clay (including salt) sediment is deposited on a low lying area by water flow
2. Rain falls on soil, dissolves any salt and the salt solution flows onto the low lying clay pan
3. Because clay is impermeable the liquid does not soak through but lies on the surface
4. Heat from the Sun evaporates water leaving salt.
5. This process repeats over thousands of years

In Western Australia this process is aided by salt being blown in from the sea on the prevailing western winds. Low rainfall means salt is rarely flushed back to the sea. High evaporation rates also pulls dissolved salt to the surface. Many salt lakes are formed over ancient river courses. These rivers flowed in the past when our climate was much wetter.

### **EXTENSION** Salt Pans and salt lakes

The rate of evaporation depends on temperature and wind. High temperature and wind means a high rate of evaporation. In cool rainy areas this activity may take a few weeks.

Materials needed per student or group:

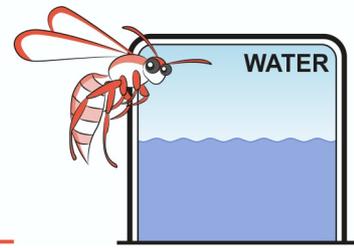
- A piece of clay to mould into a small saucer shape. Plasticine, a saucer or a small plastic plate will do as well
- A small beaker or cup to contain salt solution
- Salt and water to make a supersaturated salt solution
- Sunshine

### **Make your own saltpan or salt lake**

1. To make a super-saturated solution of salt in water, stir as much salt into warm water as you can until no more salt will dissolve
2. Create a saucer shape with your clay
3. Place the clay saucer outside in a hot windy area
4. Fill to the brim with salt solution and keep topping it up as it evaporates over one week
5. Leave and observe the saltpan form



## Permeability - Student Activity



When fragments of weathered and eroded rock form soils and sedimentary rock small spaces or pores are left. If these spaces are joined up water can move through them. They are permeable.

Sand will allow water through. Sand is *permeable*.

Clay will not allow water through. Clay is *impermeable*.

Permeable soils allow water to reach plant roots and percolate to replenish underground reservoirs.

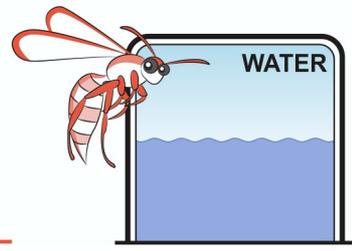
### Testing soils for permeability

Materials required per student or group:

- Filter papers
- Filter funnel
- Beaker
- Measuring cylinder
- Water
- Specimens of different soils
- A large spoon

1. Set up the equipment for filtration.
2. Place two spoons of one soil in the filter paper.
3. Measure 20mL of water and carefully pour onto the soil. Do not disturb the soil.
4. Wait for 5 minutes then measure the volume of water that has permeated through the soil.
5. Enter your results in the table provided.
6. Wash the equipment and repeat for another two samples.
7. Compare your results with those of others.

Sample	Description	Vol. water collected (mL)	Comment
1			
2			
3			

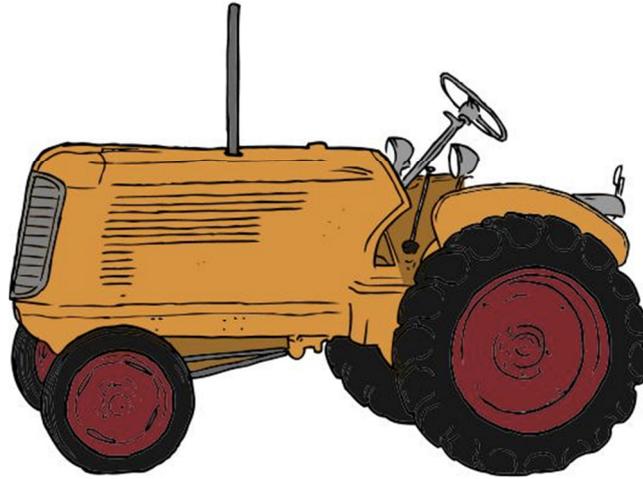


## Permeability - Student Activity

Why were you asked to compare your results with others? \_\_\_\_\_

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Which soil would be best for farming? Explain your answer. \_\_\_\_\_

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Which soil would form the best aquifer? \_\_\_\_\_

Which soil would be the best one to use to build and line a farm dam? \_\_\_\_\_

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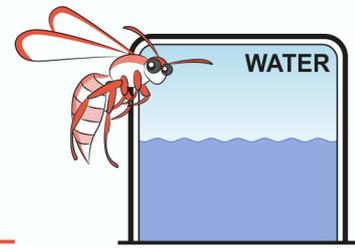
**Extra for experts** Explain why salt lakes form on clay pans (HINT there are at least three steps)

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## Water For Humans - Teacher Background



Water moves through the bodies of plants, animals and other living things. It brings in nutrients, moves them around the organisms and removes waste products. Water is essential to life on Earth. Western Australian households use over 44% of their water on their gardens. During a recent council audit I found that water wise people only use 120L per day. When I realised that 22% of household use was for showers it was time to introduce a water wise showerhead and a timer. It was also time to start collecting rainwater for the living things (plant and animal) in my garden. The average Western Australian uses 17 times more water than the average west coast Scot whilst their rainfall for groundwater replenishment is about one hundred times less than in Scotland. Whereas the Scot can depend on rain for the garden the Aussie cannot. Honestly it has nothing to do with personal cleanliness habits! We are now tapping into deep groundwater reservoirs that have taken tens of thousands of years to accrue and have been forced to start desalination of sea and salt lake waters in an attempt to feed our need for more fresh water.

You may wish to pre-empt the quiz by a demonstration of what happens to a living thing, a carrot, if it loses water.

### Materials required

- 2 fresh carrots
- 2 beakers of fresh water
- About 1 tablespoonful of salt

The day before the quiz, immerse each carrot in a beaker of water. To one beaker also add salt and stir to help dissolve the salt. Leave overnight. The following day you will find the carrot in fresh water is crisp and will break with a crack. The carrot in salty water will be quite plastic however.

Salt water has pulled fresh water from the carrot causing its cells to deflate and no longer provide support for the carrot. If you suspect someone is dehydrated, a rough test is to press firmly into a fleshy part. The pressed area will remain depressed.

The following quiz will help students understand how much water we need and how much we use. Information was gained from <http://www.mayoclinic.com/health/water/NU00283>

Ask students to silently circle what they think the correct answer might be on their sheet. Then either give the correct answers (below) or ask them to use the website above.

Since some students find it difficult to envisage volumes of water, it may be worthwhile to collect up some 1 and 2 litre empty bottles to use for demonstration.

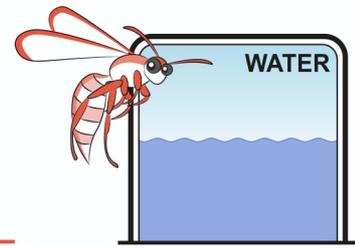
### Water and my body

What percentage of the human body is water?

- 20%
- 40%
- 60%
- 80%

Water is used in every system of the body. Water brings in nourishment and flushes out toxins. Water helps you balance (ear), clears dust from your throat and about 83% of blood is water

## Water For Humans - Teacher Background



How much water should you drink every day?

- a) About 0.5 litres
- b) About 1.5 litres
- c) About 2.0 litres
- d) About 3.5 litres

An adult male needs about 3 litres and an adult female about 2.2 litres. The amount needed varies with climate and exercise.

If you don't drink water you will suffer from:

- a) Dehydration
- b) Diarrhoea
- c) Dysentery
- d) Distemper

If you suffer from diarrhoea, dysentery or fever you need to drink water to replace fluid loss. (Dogs suffer from distemper)

If you enjoy a short period of intense exercise, how much water should you drink to replace water loss from sweating?

- a) 1 cup
- b) 2 cups
- c) 3 cups
- d) 4 cups

Water should be sipped and not gulped. Gulping can lead to vomiting and further water loss for a dehydrated person

If you have enjoyed sport and are feeling thirsty, what is best to drink to replace lost sweat?

- a) Water
- b) Milk
- c) Sports drink
- d) Cordial

Sports drinks contain salt to replace salt lost as sweat

How much of our body's water needs come from eating food?

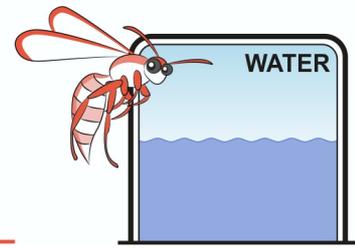
- a) None
- b) 20%
- c) 40%
- d) 60%

A lettuce is almost all water. A tomato or watermelon is almost 90% water. (Some people think that lettuces are soporific – make you sleepy)

How many calories can you gain from 1 glass of water?

- a) 100
- b) 75
- c) 50
- d) None

## Water For Humans - Teacher Background



### Water and my home

On average how much household water is used in the garden?

- a) 14%
- b) 44%
- c) 64%
- d) 84%

We are being encouraged to recycle and reuse grey water in our gardens and to install rainwater tanks

How much water is used in the house for showering?

- a) 88%
- b) 55%
- c) 44%
- d) 22%

A timer will limit shower use to 5 minutes. A “water wise” showerhead will also restrict flow.

How long should you plan to spend getting clean in a “water wise” shower?

- a) 4 minutes
- b) 10 minutes
- c) 14 minutes
- d) 20 minutes

A conventional shower uses 12 litres per minute whilst a “water wise” shower uses 9 litres per minute.

How much water will be lost if you let the tap run while cleaning your teeth?

- a) 3 litres per minute
- b) 6 litres per minute
- c) 9 litres per minute
- d) 12 litres per minute

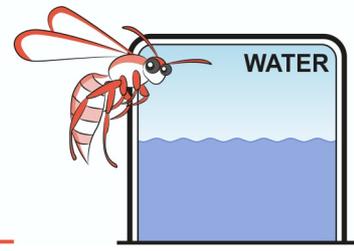
If you set a tap to drip and collect the water in a measuring cylinder or jug, you can estimate this in school.

How much water does the average washing machine use for each full load

- a) 90 litres
- b) 100 litres
- c) 110 litres
- d) 120 litres

What else do we use water for in the home? [Cooking, cleaning, swimming, aquarium frog pond etc.](#)

## Water For Humans – Student Quiz



Please circle the answer you think might be correct.

### Water and my body

What percentage of the human body is water?

- a. 20%
- b. 40%
- c. 60%
- d. 80%

How much water should you drink every day?

- a) About 0.5 litres
- b) About 1.5 litres
- c) About 2.0 litres
- d) About 3.5 litres

If you don't drink water you will suffer from:

- a) Dehydration
- b) Diarrhoea
- c) Dysentery
- d) Distemper



If you enjoy a short period of intense exercise, how much water should you drink to replace water loss from sweating?

- a) 1 cup
- b) 2 cups
- c) 3 cups
- d) 4 cups

If you have enjoyed sport and are feeling thirsty, what is best to drink to replace lost sweat?

- a) Water
- b) Milk
- c) Sports drink
- d) Cordial

How much of our bodies water needs come from eating food?

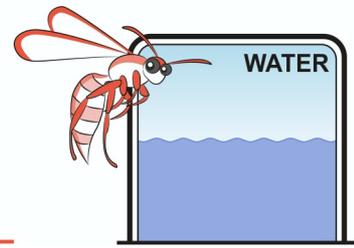
- a) None
- b) 20%
- c) 40%
- d) 60%

How many calories can you gain from 1 glass of water?

- a) 100
- b) 75
- c) 50
- d) None



## Water For Humans – Student Quiz



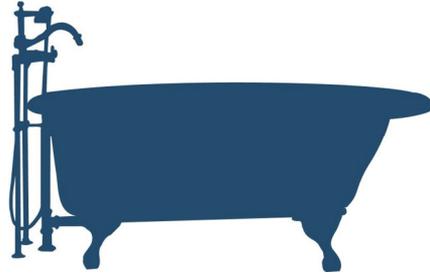
### Water and my home

On average how much household water is used in the garden?

- a) 14%
- b) 44%
- c) 64%
- d) 84%

How much water is used in the house for showering?

- a) 88%
- b) 55%
- c) 44%
- d) 22%



How long should you plan to spend getting clean in a “water wise” shower?

- a) 4 minutes
- b) 10 minutes
- c) 14 minutes
- d) 20 minutes

How much water will be lost if you let the tap run while cleaning your teeth?

- a) 3 litres per minute
- b) 6 litres per minute
- c) 9 litres per minute
- d) 12 litres per minute

How much water does the average washing machine use for each full load

- a) 90 litres
- b) 100 litres
- c) 110 litres
- d) 120 litres

What else do we use water for in the home? \_\_\_\_\_

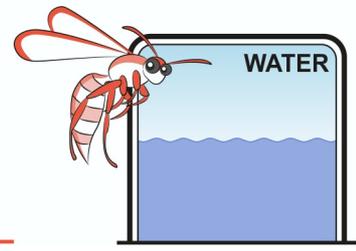
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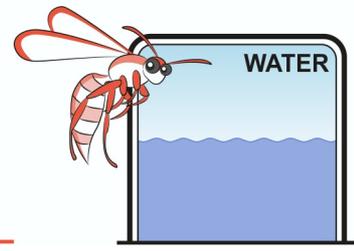
## Water Cycle – Cloze Answers



### Water cycle cloze

Heat from the **Sun** causes water in the sea to **evaporate**. Liquid water changes into **water vapour** and this rises into the air. Winds blow it inland where it cools and **condenses** to become **clouds** in the sky. When the droplets become big enough they fall as **rain** or **precipitation**. When this hits the ground some of it will **evaporate** back into the atmosphere. Surface runoff is collected in **dams**. If the soil is **permeable** some water will sink into the ground to become groundwater. Bores drill into the **aquifer** to produce water for **agriculture, industry** and for **household** use. Where the land's surface reaches into the aquifer, **rivers** and **lakes** occur. These eventually run to the sea and the cycle begins again. All living things need water to **survive**.

## Water Cycle – Cloze Worksheet



Insert the following words into the correct spaces to describe the water cycle.

Each word should only be used **once**.

agriculture	aquifer	clouds	condenses	dams	evaporate
groundwater	household	industry	lakes	permeable	
precipitation	rain	rivers	Sun	survive	water vapour

Heat from the \_\_\_\_\_ causes water in the sea to \_\_\_\_\_.

Liquid water changes into \_\_\_\_\_

and this rises into the air. Winds blow it inland where it cools and

\_\_\_\_\_ to become \_\_\_\_\_ in the sky. When the droplets

become big enough they fall as \_\_\_\_\_ or \_\_\_\_\_.

When this hits the ground some of it will \_\_\_\_\_ back into the

atmosphere. Surface runoff is collected in \_\_\_\_\_. If the soil is

\_\_\_\_\_ some water will sink into the ground to become

groundwater. Bores drill into the \_\_\_\_\_ to produce water for

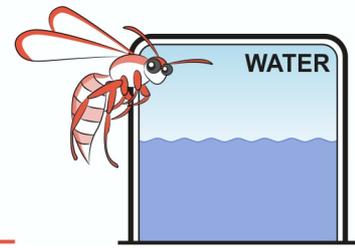
\_\_\_\_\_, \_\_\_\_\_ and for \_\_\_\_\_ use. Where

the lands' surface reaches into the aquifer \_\_\_\_\_ and \_\_\_\_\_

occur. These eventually run to the sea and the cycle begins again. All

living things need water to \_\_\_\_\_.

## An Aboriginal Perspective - Teacher Notes



Aboriginal people first arrived in Australia about 40,000 years ago during the last Ice Age when sea levels were lower than they are today. They travelled from north to south following the coast and rivers, even crossing over to Tasmania. Rising seas have covered signs of this early habitation. However midden heaps of abalone shells from seafood feasts lie offshore along our coasts.

As they lived their “hunter gatherer” life their movements were restricted by access to water and often followed seasonal rainfall patterns. Rainfall not only controlled available surface water but also encouraged food supply for the animals they hunted. Most of the Aboriginal population of Australia lived, traded and hunted along rivers.



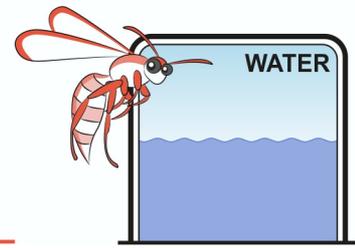
Groups protected and maintained their water sources and vigorously defended them against animal damage and incursion by other groups. Inland, dependable water sources such as rivers, billabongs, wells, soaks and gnamma holes were respected and were often signposted by rock art with concentric circles. (Gnamma are Dreamtime creatures that gnawed the holes into rock).



Gnamma hole Barlangi near Sandstone (infilled – cap stone missing) Photograph by G O Churchard

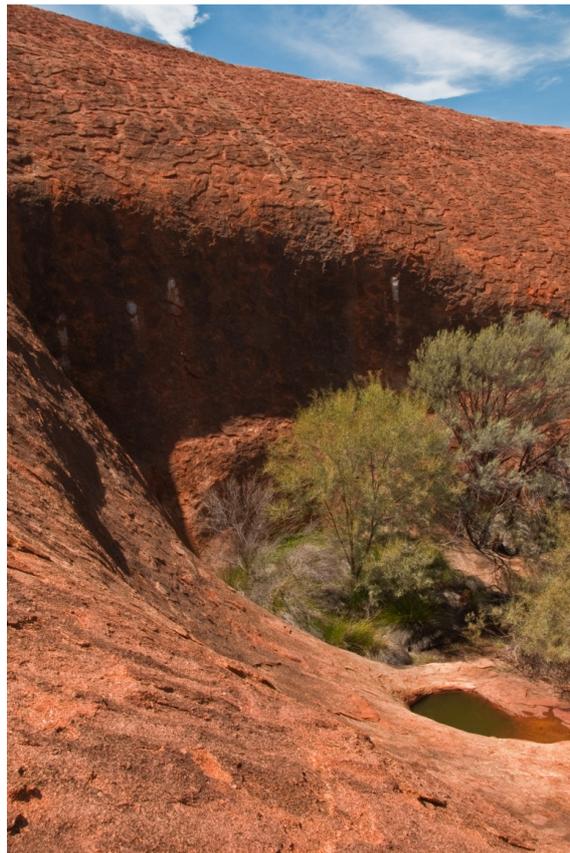
Their locations were passed on as an essential part of folklore. People also carried water in bailer shells and kangaroo skin bags for short-term use. Water sources would be treated with great respect. Shallow wells in sandy country would be filled with clean sand to stop animals fouling water. Gnamma holes were capped by stones and branches to minimise water loss from evaporation

## An Aboriginal Perspective - Teacher Notes



and from thirsty animals drinking. Because many groups might meet at good water sources, there were often rules of behaviour to minimise conflict.

On the Swan River men would travel down one bank with women and children travelling down the other. They re-joined by crossing the limestone bar that ran across the mouth of the Swan river. This limestone ridge was exploded by CY O'Connor to open the mouth of the river to ships.



Runoff soak at Walga Rock

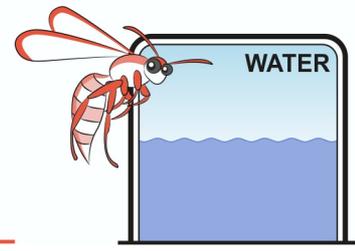
Photograph by G O Churchard

Many rivers courses in Western Australia are attributed to the movements of the Wagyl (rainbow serpent) carving out the watercourse on its journey across the land. Aboriginal people did not separate water from the land and the sky in their connection to Country. The importance of water is also represented by the many names for billabongs, springs, soaks, rain, mist and cloud types found in most Aboriginal languages. Strangers were sometimes “watered” when entering Country.

It is thought that the bunyip legend may be the result of inland people watching a coastal dance about a seal.

Remote Aboriginal communities in Western Australia do not always have guaranteed access to continuous clean potable water. Hospitalisation of Aboriginal children under five years old is primarily due to dehydration resulting from diarrhoea. Water borne disease and high levels of dissolved minerals target the very young and very old. In the past when people only stayed a short time at any one place, disease did not have time to build up to infectious levels and high levels of dissolved mineral salts water could be tolerated for a short time.

## An Aboriginal Perspective – Student Activity



### Aboriginal (Ab = from, original = original residents)

Aboriginal people arrived at the north of Australia and over the last 40,000 years have moved steadily south to inhabit the whole country. Access to fresh water controlled their movements. They did not read or write but depended on Dreamtime stories with paintings and engravings on rock to help them find their way and preserve their precious resource of water.



1. Find the nearest natural source of water to your school and draw a simple route map for someone to use to find drinkable water.

2. How long would it take to walk this distance? \_\_\_\_\_

3. Is this water seasonal or permanent? \_\_\_\_\_

4. What sign would you make on a rock to indicate that ***“water is found here”***?

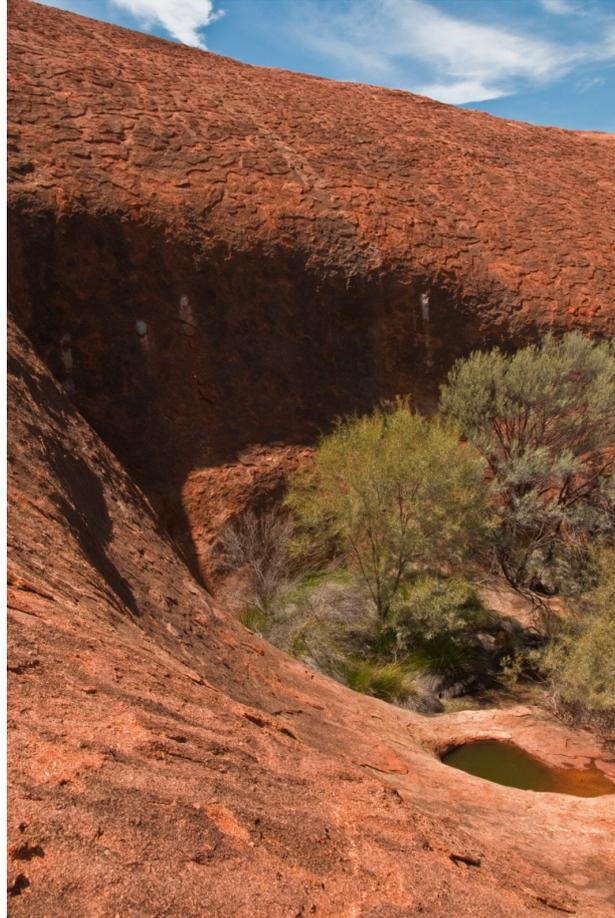
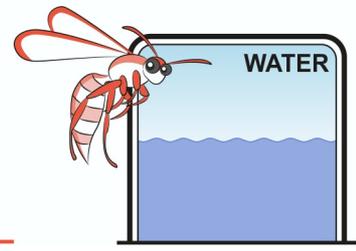
5. What story would you tell your children to convince them to treat water with respect?

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## An Aboriginal Perspective – Student Activity



6. This is a wonderful soak (water seep) at the foot of Walga Rock near Cue. Why would Aboriginal people often go to large rock outcrops like this to find water?

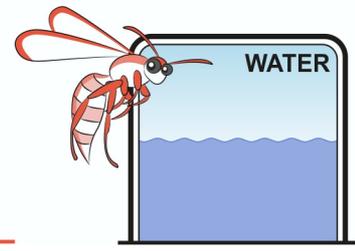
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## An Indian Perspective – Teacher Notes



“The centre of all life is water” Anupam Mishra

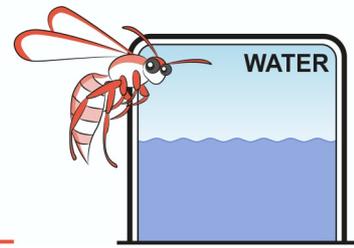
In the Golden Desert of India traditional “rain harvesting” methods have survived over 600 years. When modern canals filled with sand or water hyacinths they became unusable in less than twenty years and Indian people looked to past ways to support their needs. Hillsides are sealed with clay to provide run off and the water is channelled about 12 metres underground to storage tanks to prevent water loss by evaporation. These are for communal use. They have been perfectly maintained by local people for centuries because of their strong respect for water. Some cisterns have statues embedded in the walls to indicate depth of water and the length of time the resource will remain. Each house has a similar sloping floor on the flat roof which channels water into tanks along the side of the house or bounding their courtyard. In the Golden Desert where rainfall can be 6cm per year, every roof collects water and there are 40 different names for clouds. In this country there is insufficient fuel to support sourcing water through evaporation of salty water in rural areas. Teachers and their classes may wish to visit:

[http://www.ted.com/talks/anupam\\_mishra\\_the\\_ancient\\_ingenuity\\_of\\_water\\_harvesting.html](http://www.ted.com/talks/anupam_mishra_the_ancient_ingenuity_of_water_harvesting.html)

1. How deep is it to reach groundwater? 100m
2. Can you drink this water? No, it is too salty
3. Why can't they use solar power? It is a rural area. There is no power grid
4. How many names do they have for clouds? 40 This is because clouds and rain are important
5. What is the first device they have for harvesting rain? A false catchment on a raised platform. Rainwater falls, runs down a sealed slope and is collected in deep tanks underneath
6. What is the second device? Houses have tanks to collect rainwater runoff from roofs and courtyards.
7. What 600 year old device was described? A canal to convey water from mountains to be stored in tanks.
8. Thirty years ago the government built a canal to bring water down from the Himalayas. What happened to it? It was choked with water hyacinth plants and wind blown sand
9. Give an example how local people have combined good engineering with art. They built beautiful and functional stairs. They used sculpture to indicate how long the water could be depended on.
10. What five things did the 2,000 year old tattoo represent?
  - The centre of life is water
  - Waves
  - Stairs
  - Trees
  - Flowers

TED (Ideas worth spreading) is a not for profit group.

## An Indian Perspective – Student Activity



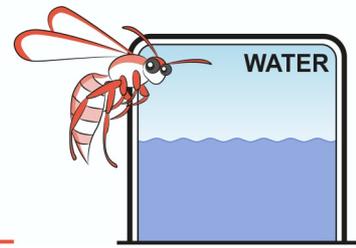
“The centre of all life is water” Anupam Mishra



In the Golden Desert of India traditional “rain harvesting” methods have survived over 600 years.  
[http://www.ted.com/talks/anupam\\_mishra\\_the\\_ancient\\_ingenuity\\_of\\_water\\_harvesting.html](http://www.ted.com/talks/anupam_mishra_the_ancient_ingenuity_of_water_harvesting.html)

1. How deep to reach groundwater? \_\_\_\_\_
2. Can you drink this water? \_\_\_\_\_
3. Why can't they use solar power? \_\_\_\_\_
4. How many names do they have for clouds? \_\_\_\_\_
5. What is the first device they have for harvesting rain? \_\_\_\_\_  
\_\_\_\_\_
6. What is the second household device? \_\_\_\_\_
7. What 600 year old device was described? \_\_\_\_\_  
\_\_\_\_\_
8. Thirty years ago the government built a canal to bring water down from the Himalayas.  
What happened to it?  
\_\_\_\_\_

## An Indian Perspective – Student Activity



9. Give an example how local people have combined good engineering with art.

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10. What five things were represented in the 2,000 year old tattoo?

1. \_\_\_\_\_

2. \_\_\_\_\_

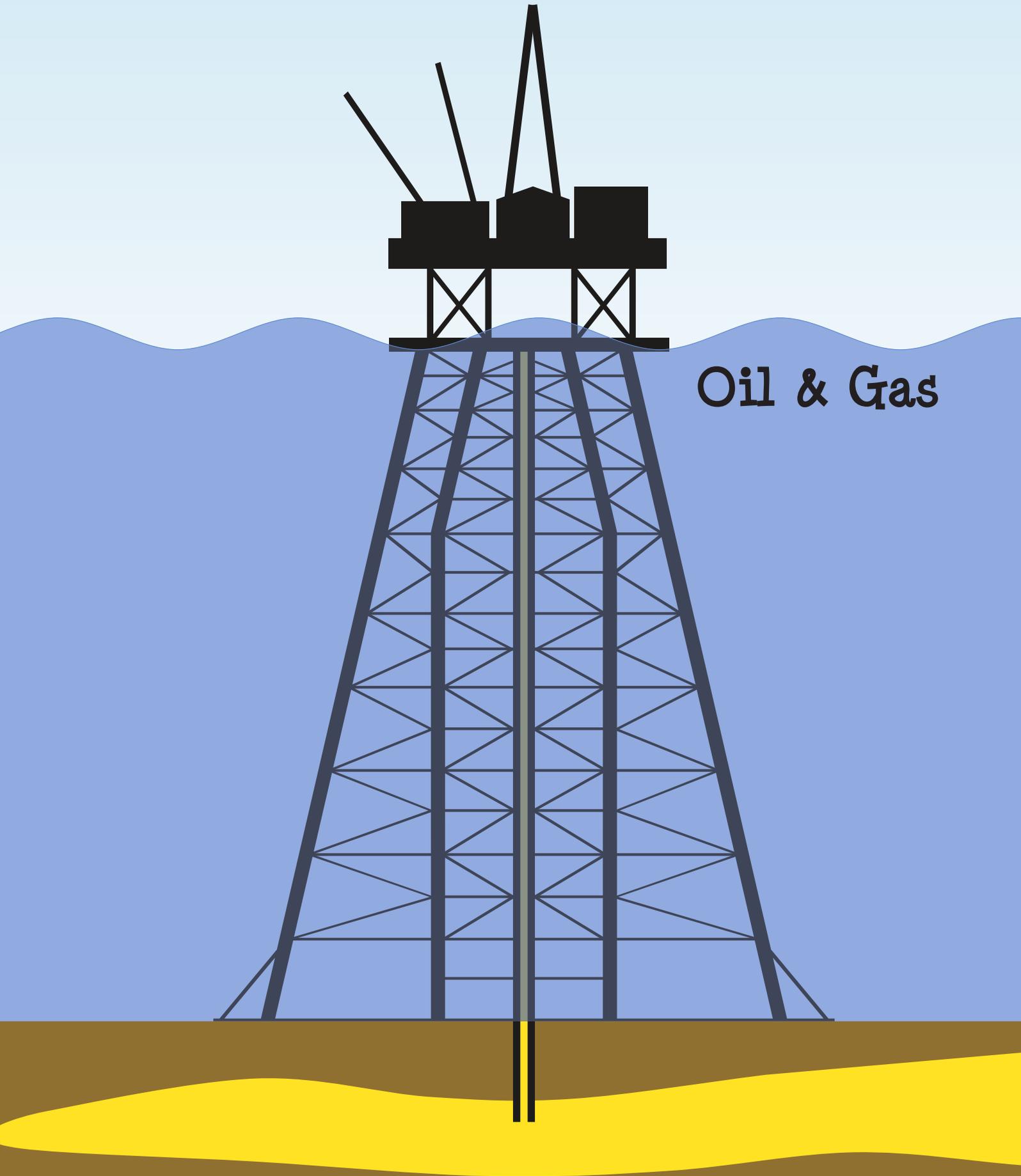
3. \_\_\_\_\_

4. \_\_\_\_\_

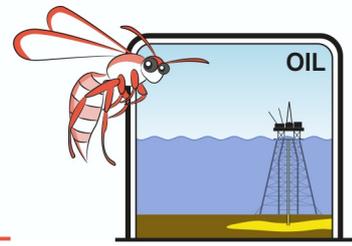
5. \_\_\_\_\_

Golden Desert





Oil & Gas



## Oil & Gas - Teacher Background

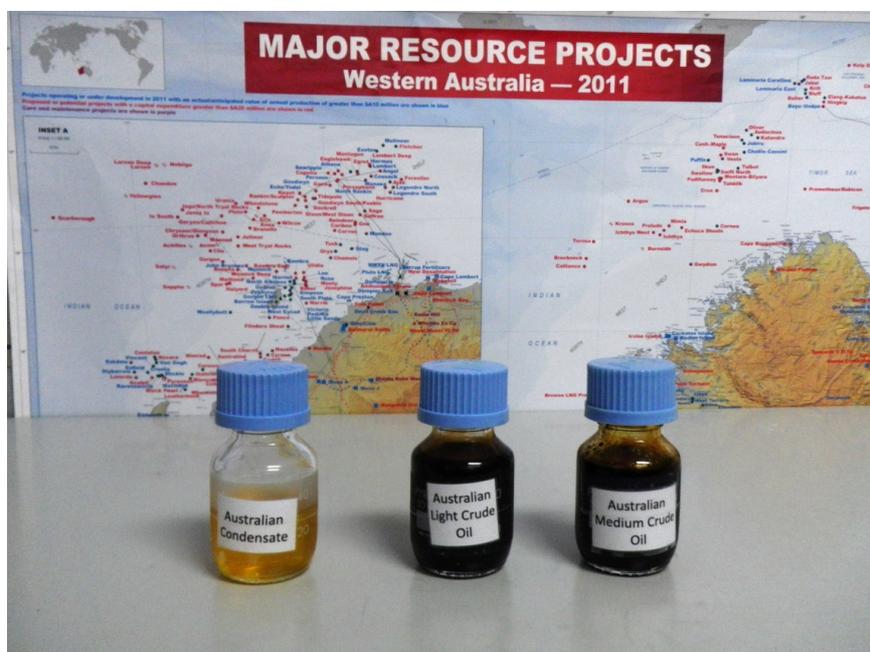
We are using “the dwindling deposits of the last hours of ancient sunlight”.  
Robert Newman, The History Of Oil.  
The Stone Age didn’t end because we ran out of stone – we just got clever!  
Engineers’ dictum

Oil and gas are **hydrocarbons**, molecules of combined hydrogen and carbon produced from the breakdown of organic (living) materials. Indirectly they are fossilised energy supplies from ancient sunlight, converted by photosynthesis to plant and then sometimes animal materials and then finally are buried and chemically changed by the Earth. Millions of years of Sun energy and great masses of organic material are turned into smaller but more concentrated energy sources. They start out as tiny isolated specks but migrate to areas where they are trapped and become more concentrated. These are the oil and gas fields we drill for our energy needs.

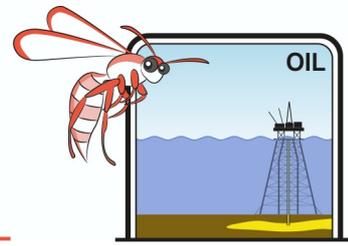
Surface hydrocarbon seeps have been utilised since Palaeolithic times. Bitumen was found on Neanderthal tools, was used to seal baskets in early cities of the Middle East and was employed in the construction of towers in Babylon where asphalt was used later to seal streets. Chinese people first drilled for oil as a fuel about 347AD using over 180m of bamboo poles. The oil was used to heat brine to make salt for preserving food.

Our modern life depends on using hydrocarbons as fuel for heat, for transport, for light and for a source of chemicals to produce plastics, paints and pharmaceuticals, among other things. Although new supplies of oil and gas are continuously produced the conditions that permit them to be concentrated into economic reserves are indeed rare.

As a resource, the timescale for their replenishment is vastly greater than their present depletion rate. As such, they may be regarded as non-renewable.



In the financial year 2011 – 2012, condensate, crude oil, LNG, LPG, and domestic natural gas to the value of \$23.8 billion dollars or \$754 per second were produced in Western Australia. The petroleum industry contributed to 18% of royalty receipts. Our petroleum products were exported to Japan (44%), China (16%), South Korea (8%), Singapore (8%) and others. We produce 77% of Australia’s crude oil and condensate and 63% of our Natural gas production. Source “Western Australian Petroleum statistics 2001-2012” [www.dmp.wa.gov.au](http://www.dmp.wa.gov.au)



## Oil & Gas - Teacher Background

**Fascinating fact**      *The Gorgon gas field in the seas north west of our Pilbara coast contains 25% of Australia's known gas reserves.*

### Tight gas & light oil

In a bid to balance the increasing demand for oil and gas with decreasing supply, exploration companies are now looking for methyl hydrates, commonly called "unconventional gas", in offshore sediments in river basins, around the continental coasts in river delta systems and under the Arctic permafrost. Referred to also as "bridge oil", this is mostly methane, has a lower energy rating but produces half the amount of carbon dioxide as coal. "Light" oil or condensate is also released as a by-product. The terms unconventional gas and tight gas broadly refer to resources that need special techniques and technology to enable oil and gas flow from shales and other tightly packed host rocks. "Fracking" or the hydraulic fracturing of rock is one of these techniques. Until recently the USA was traditionally a net importer of gas. As a result of an unexpected surge in shale gas production it will soon be competing with Australia, Malaysia, Algeria and Nigeria in the export of LNG (Liquefied Natural Gas).

**Interesting Fact**      *The US Energy Agency estimates Western Australia to have the world's fifth largest resource of shale gas (unconventional gas).*

The four on-shore areas currently under exploration for tight gas in shales in Western Australia are the Canning Basin, Carnarvon Basin and Perth Basin (both Mid West and South West).

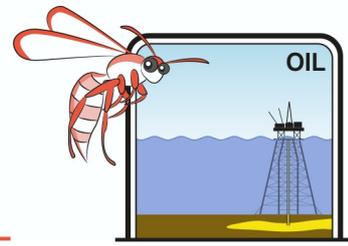
**NOTE** Fracking is also used to release coal seam gas from shallow formations in Queensland, Victoria and Queensland. When these shallow coal formations are fractured extreme care must be taken as poor well completion practise in the past has released highly toxic materials into the environment. In particular, care must be taken to case or seal the sides of the holes when they penetrate aquifers. In 2012 the Department of Mines & Petroleum Western Australia released more stringent guidelines for fracking shales. (More information at [www.dmp.wa.gov.au/onshoregas](http://www.dmp.wa.gov.au/onshoregas) )

Many oil-producing countries such as the USA had started to exhaust their reserves and were judged past "Peak oil" production. Since the 1980s the USA and UK became net importers depending on external suppliers to fill the gap between supply and demand. However the use of tight gas to fuel industry traditionally powered by oil has freed up more oil for petrochemical production.

Control over energy sources and energy access has changed geopolitical thinking in our world. Data below is from <http://truecostblog.com/2012/01/21/countries-by-peak-oil-date-2011-data-update/>

Country	Year peak oil achieved	Peak not yet achieved.
Iran, Libya, Venezuela	1970	
Kuwait	1972	
Indonesia	1977	
Iraq	1979	
UK and Europe	1983	
Uzbekistan	2002	
<b>Australia</b>	<b>2000</b>	
Canada		X
Brazil		X
Azerbaijan		X
Kazakhstan		X
Qatar		X

## Oil & Gas - Teacher Background



Although the data may be debatable in specifics, it is clear that production in most major traditional oil producing countries is declining. At the 2012 GSWA Oil and Gas conference, it was estimated that oil production in the World would be down to 30%. Energy security has become important across the globe. Politicians need to ensure reliable, safe and secure energy to maintain living standards.

In 2012, the Western Australian Minister for Mines Norman Moore stated, "Development of unconventional gas in the Perth Basin will double present available gas reserves". In the same year Western Australia produced 70% of the World's LNG (Liquefied Natural Gas). This future dependency on unconventional gas prompted the International Energy Agency to produce "The Golden Rules for the golden age of gas" at the G8 conference in 2012.

[http://www.iea.org/media/WEO\\_GoldenRules\\_ForA\\_GoldenAgeOfGas\\_Flyer.pdf](http://www.iea.org/media/WEO_GoldenRules_ForA_GoldenAgeOfGas_Flyer.pdf)

Natural gas emits half as much greenhouse gas as coal when burnt and therefore contributes only half as much towards global warming. There is concern that a sustained gas glut might undermine new investment in other energy production systems such as wind, solar and tidal systems, which produce, almost, zero emissions and maintain our addiction to burning fossil fuels.

To date (2012) Australia has not published a resource management plan to control development and to conserve future supplies of hydrocarbons for national use.

Teachers may find Newman's "History of Oil" witty, quirky, and confronting and that the opinions stated are clearly polarised. [www.youtube.com/watch?v=Qu47flklsY8&feature=related](http://www.youtube.com/watch?v=Qu47flklsY8&feature=related)

PowerPoint on oil and gas. <http://vimeo.com/8567803> Gives a good overall view of this subject for Natural Gas.

**Interesting fact**      **60-70% of domestic gas in Perth comes from the Karratha gas plant. It takes seven days to travel to Perth along the pipelines.**

*Oil and gas are the result of a fortuitous set of circumstances involving the deposition and maturing of a rich resource rock, the timely migration of oil and gas into porous reservoir rock and their containment in these reservoir structures beneath impermeable seals*

UK Offshore Operators Assoc. And Natural History Museum Britain's offshore oil and gas

To create an economic deposit of hydrocarbons, three factors are necessary:

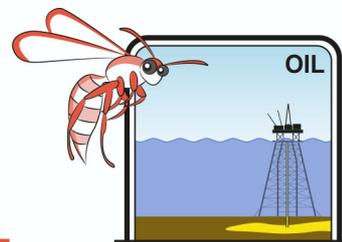
1. A source rock which contains hydrocarbons (e.g. oil shale or coal)
2. Migration of hydrocarbons from source through pores into a reservoir rock
3. The reservoir rock must be capped or sealed by an impermeable layer or structure to stop the oil escaping

**Trapping in reservoir (economic)**

**Migration through permeable rock**

**Formation of a source**

## Oil & Gas - Teacher Background

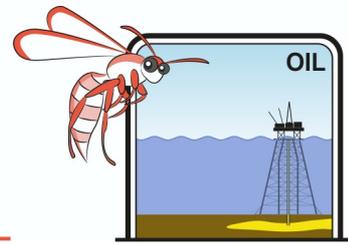


**Important Note** It can be dangerous to use petroleum and methane in school laboratories with students of any age. In the following activities water has been used as a safe substitute.

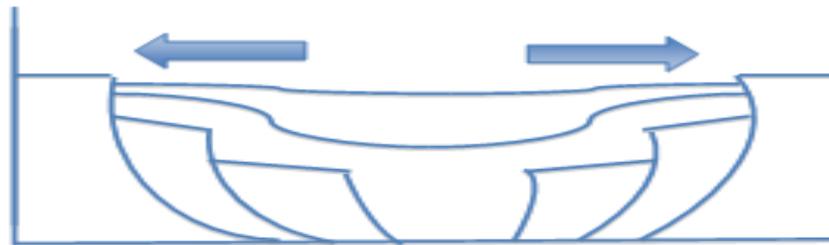
### *Possible sequence of activities:*

- 1. Formation Of A Source Rock**
  - De-watering Of Sediments – Student Activity
  - It's A Gas! – Student Activity
- 2. Migration To A Reservoir**
  - Pressure & Depth of Burial – Student Activity
  - Porosity & Permeability – Student Activity
  - Permeability – Student Activity (Optional)
  - Migration Rate – Student Activity
- 3. Formation Of A Reservoir**
  - Structural Seal – Teacher Demonstration
- 4. Recovery Of Oil & Gas**
  - Pressure Lift – Student Activity
  - Viscosity & Raising Raisins – Student Activity
  - LNG Gas & Oil Treatment - Flow Plan
- 5. Safety In The Oil & Gas Industry**
  - Safety In The Oil & Gas Industry – Student Activity

## Formation Of A Source Rock - Teacher Background



During ancient geological times Australia, India, Africa, New Zealand and Antarctica were welded together to form the super-continent of Gondwanaland. About 184 million years ago the super-continent began to break up and the present continental plates started to move apart. Continental crust between the separating plates was stretched thin and split by a series of faults. The stretched crust then sagged to create a marine sedimentary basin.

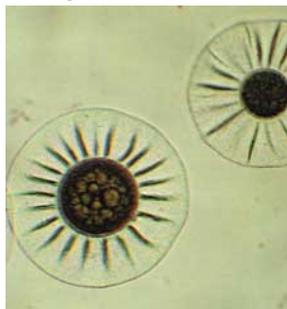


### **Interesting Fact**

***Five of the seven sedimentary basins in Western Australia have known hydrocarbon accumulations.***

Weathering and erosion on the continent produced sand and mud that poured into oceans filling a progressively deepening basin. A very small amount of dead land organisms (plants and animals) would be incorporated in these sediments because most would have decomposed naturally on exposure to weather, scavengers and bacteria. Shallow coastal and near coastal burial of mostly vegetable matter resulted in the formation of coal and methane gas deposits under anaerobic (oxygen poor) conditions. Coal measures in Collie, Coalseam Reserve and offshore of our northern coast were created under such lagoonal, swampy conditions.

In the ocean however, a continuous “rain” of dead plankton (microscopic marine plants and animals) falls into the depths where the lack of oxygen inhibits both scavengers and decomposition. These are rapidly buried under fine sediments brought from the land.



Picture of plankton <http://resources.schoolscience.co.uk/spe/knowl/4/2index.htm?origin.html>

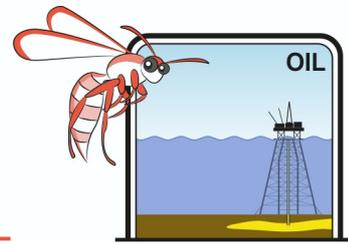
As the basins deepened younger sediments piled on those below and they sank deeper into the Earth becoming hotter and hotter. Rather like being in a great pressure cooker they became squashed and cooked.

### **Interesting fact**

***The Carnarvon Basin accounted for over 90% of Western Australian and over half of the total Australian hydrocarbon production in 2011.***

Sediments also de-watered as they became compressed to form “source rocks”. Source rock types in Western Australia are organic shale, coals and limestone.

## De-watering Of Sediments – Teacher Notes

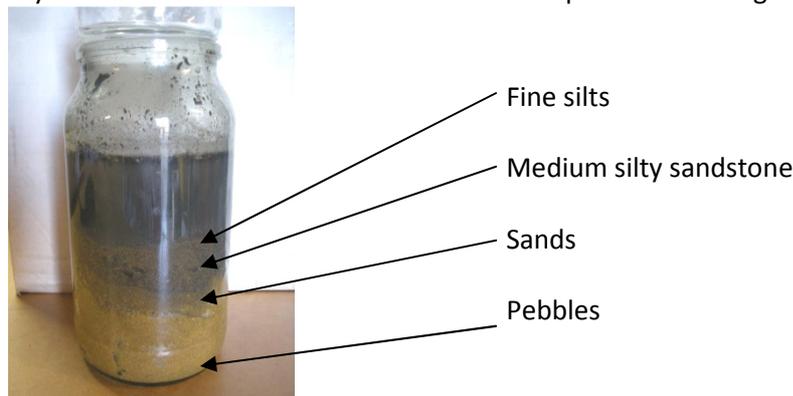


**A host rock must contain hydrocarbons (organic material).** The organics are rarely in high concentration. Source rocks form as sedimentary layers within basins. When marine sediments are compacted they de-water, become cemented and form sedimentary rocks such as sandstone, limestone, and shale. The organic material is changed chemically at the same time.

### Layered deposition of sediments - Teacher demonstration

When mixed sized sediments and water are shaken, it will differentiate into layers. This is how bedding (sedimentary layers) is formed during deposition.

Place a mixture of pebbles, sand, clay or potting mix and water in a large screw topped jar. Close the lid and ask your most energetic student to give it a vigorous shake for two minutes. Leave the jar for five minutes and you will be able to see that the sediments separate according to size and density.



What is the difference between sediment and sedimentary rock? **Sediments are materials which have been laid down by wind or water. Sedimentary rock is sediment that has been buried, compacted and cemented. During this process the rock becomes dewatered.**

### Student activity De-watering sediment



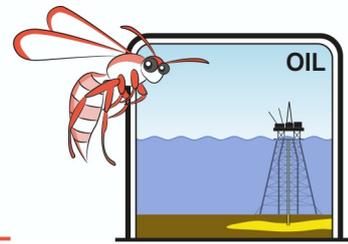
Height of sand 2.5cm



Height of sand + water 2.5cm or less

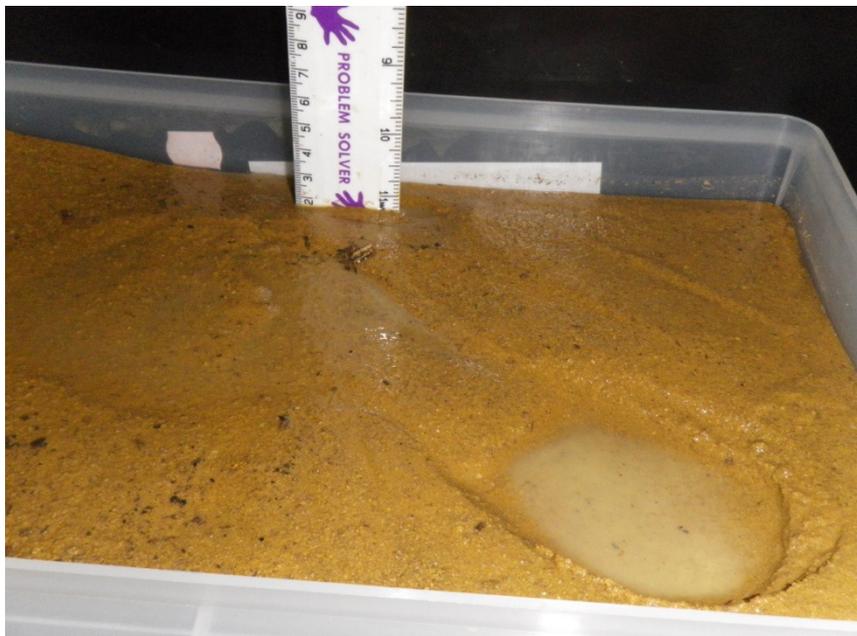
### Materials required per person or group:

- 1 plastic container or tray larger than a student's foot. Laboratory or student desk trays are excellent
- Sufficient dry sand to fill tray to a depth of between 2 and 3cm.
- 1 jug of water
- 1 plastic ruler
- 1 well shod student



## De-watering Of Sediments – Teacher Notes

1. Place a layer of dry sand in the bottom of a plastic container.
2. Place the ruler into the sand and measure the height of the sand. **2.5cm**
3. Add water to the sand until it is very damp (about 1 litre).
4. Measure the height of the damp sand. **2.5cm**
5. Explain any changes or lack of changes in the height of sand after water has been added.  
**Water has seeped into the empty pore spaces between the grains so the level of sand has not risen. NOTE If the tray is moved, the level of the top of the sand may even drop as liquid may allow sand grains to slip about and fit together better.**
6. Firmly step onto the sand with one foot. Keep your weight on the wet sand for 1 minute before stepping off.
7. Wait for 1 minute and record what has happened to the level of the wet sand.  
**The area under the foot has become compacted under pressure forcing water out from between the sand particles. When the foot was removed, water flowed into the depression.**

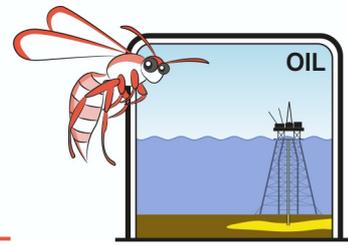


Water above compacted sand in footprint

When sediments are overlain by younger deposits water is squeezed upwards towards an area of lower pressure. Students may have noticed this when walking at the edge of the sea or across clay pans. Students can also stand on wet kitchen sponges and see how pressure dewateres the sponge. In both cases water was held in the holes or pores.

8. What happens to any fragments of dead living things in the sediment during this compression? **They become compressed and converted into kerogen. Kerogen is the precursor to oil and gas**
9. Draw what will happen to this sediment when it is overlain by more sediment.

Before compaction	After compaction



## De-watering Of Sediments - Student Activity

What is the difference between sediment and sedimentary rock?

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### Materials required per person or group:

- 1 plastic container or tray
- Sufficient dry sand to fill tray to a depth of between 2 and 3cm.
- 1 jug of water
- 1 plastic ruler
- 1 well shod student



Place a layer of dry sand in the bottom of a plastic container. Place the ruler into the sand and measure the height of the sand. (HINT Remember to write the unit e.g. cm or mm)

The height of the sand is \_\_\_\_\_

Add water to the sand until it is very damp (about 1 litre).

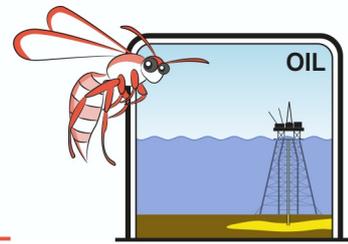
Measure the height of the damp sand. \_\_\_\_\_

Explain any changes or lack of changes in the height of sand after water has been added.

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## De-watering Of Sediments - Student Activity



Firmly step onto the sand with one foot. Keep your weight on the wet sand for 1 minute before stepping off.

Wait for 1 minute and record what has happened to the level of wet sand.

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What happens to any fragments of dead living things in the sediment during compression?

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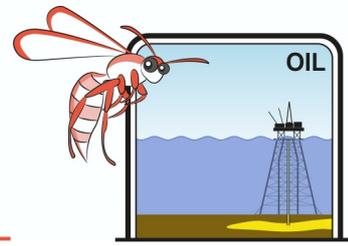
Draw what will happen to this sediment when it is overlain by more sediment.

Before compaction	After compaction

**Interesting Fact**

***By one kilometre depth 90% of water has been squeezed out of the sediments. Almost all is gone by the next 6 or seven kilometres.***

## It's A Gas! – Teacher Notes



Fragments of plankton and bacteria trapped within sediments are “pressure cooked” by increasing temperature and pressure at depth to become specks of **kerogen**, a waxy dense complex hydrocarbon. Further burial with higher temperatures and pressure will result in conversion of kerogen first to oil then to gas. This process is very slow taking perhaps about 150 million years to complete.

In general:

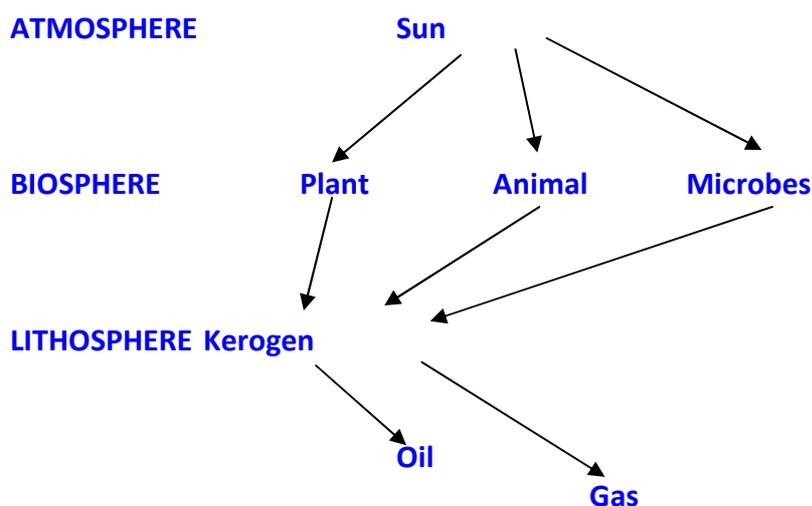
- **Oil and gas is almost exclusively derived from decayed plants, animals and bacteria.**
- **Both oil and gas can be found together.**
- **Oil forms between 3 and 4.5 km depth.**
- **Gas forms about 4 to 6 km depth.**
- **Below 6km kerogen becomes carbonised and will no longer produce oil or gas.**

Lighter oils are less viscous (sticky or less free flowing) than thicker heavier crude oils. The hydrocarbons are released over time. Being less dense they rise upward through pores and fractures in the overlying rock. Most seeping oil is digested at the surface by soil bacteria.

This fun experiment models the formation of hydrocarbons from plants and animals. Placing the materials in the bottle can be very messy. Old newspaper on desks or benches is a good idea. The gas produced is mostly methane. It can run for a few weeks but gas formation is obvious in the first few days. Production appears to slow down as the balloon takes longer to inflate due to back pressure. **The equipment must be well sealed and not opened before disposal.**

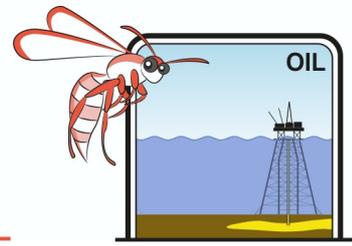
SUN ENERGY is converted to **PLANT** and **ANIMAL** energy. The dead matter is converted into **KEROGEN**. If this is buried over three kilometres deep the kerogen is converted into **OIL**. Deeper burial causes kerogen to become **GAS**. Both oil and gas are sources of **ENERGY**.

A simple chart showing the flow of energy between the Atmosphere, Biosphere and Lithosphere would be:



### Interesting fact

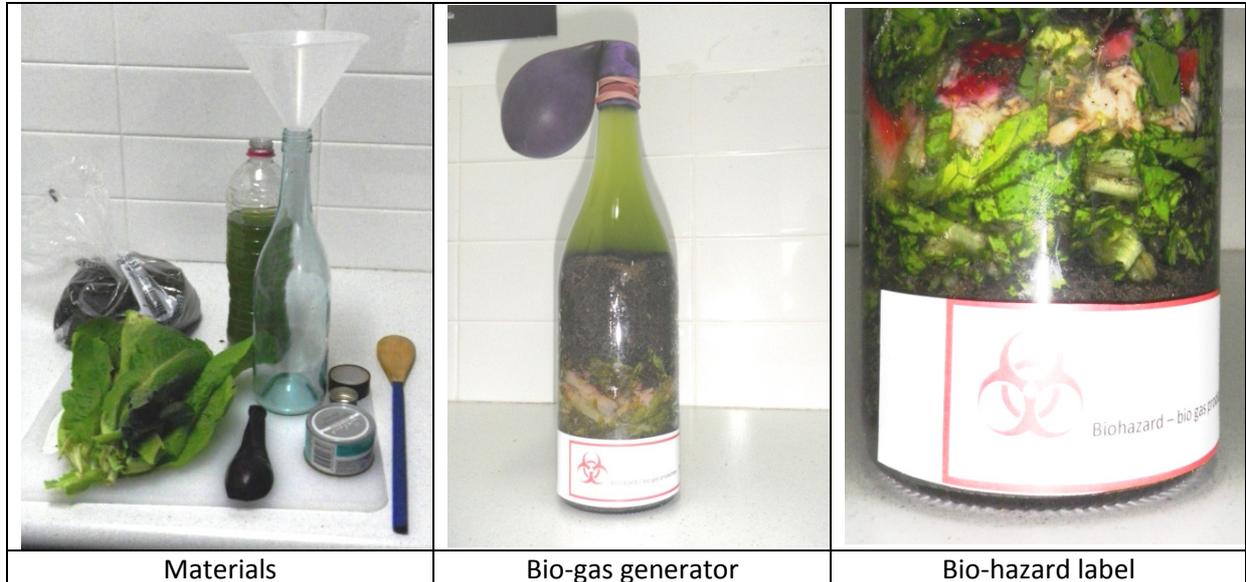
**The type of sediment deposited determines the final rock created. If 20-25% of sediment is mineral matter (quartz or silts) the rock formed will be shale. If 25% of the sediment is organic matter, the rock formed will be coal.**



## It's A Gas! – Teacher Notes

### Activity

### It's a gas!



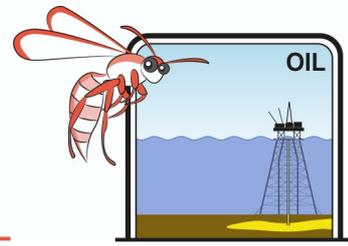
### Materials required per person or group:

- 2L plastic cool drink bottle. (I used a well washed wine bottle so I could observe decomposition better)
- 1 large balloon (pre-stretched) or thin soft rubber glove.
- Strong sealing tape (gaffer or insulating) or rubber bands.
- 5 shredded lettuce leaves (or any soft green plant).
- 1 tablespoon of tinned or fresh fish (or any soft animal flesh). ( I used tinned tuna in brine but washed most of the salt out first)
- Sand or soil and a funnel
- 1.5L pond water or water from drainage tray under plant pots.

Using the funnel, place some sand in the bottom of the bottle. Add layers of shredded lettuce, fish and sand above ending with sand at the top. Pour in pond water to cover. Run the water down a glass rod or along the side of the bottle to stop it breaking up the sand “sandwich” and leave the glass clean. Fit a well-stretched balloon over the neck of the bottle and seal well with tape. Gently lift bottle, locate it in warm place and watch the balloon slowly inflate with bio-gas over time.



## It's A Gas! – Teacher Notes



### SAFETY NOTES

**Label bottle “DO NOT OPEN” with a biohazard symbol.  
Do not expose the equipment to open flame.  
Dispose of carefully after use.**

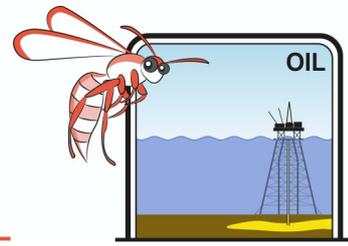
Since oil and gas are the result of much higher temperatures and pressure they are **Thermogenic** (thermo = heat, genic = made).

**Source rocks** are where oil and gas are generated from the thermogenic breakdown of kerogen. Small amounts of oil and gas may be held between widely spaced pores in this source rock. These low concentrations of hydrocarbons are rarely drilled because the quantities of resource are so small and so widely distributed. The oil and gas must be mobilised to be trapped in higher concentrations elsewhere. The Perth Basin gas fields have Permian coals as their source rocks. In the NW shelf the hydrocarbon gas source are from rocks which are older (Triassic to Middle Jurassic 250my to 170my) and underlie the more oil rich ones (Upper Jurassic 160my)

### **Interesting fact**

***If the source rock is raised closer to the surface because of tectonic movements, the oil and gas will denature to a thick tarry bituminous mass due to the action of microbes. These are the tar pits, asphalt soaks and bitumen sources used by our ancestors.***

## It's A Gas! - Student Activity



Ancient sunlight shone down on ancient seas. Plants used sun energy to make food and they themselves became food for animals living in the sea. Microbes fed on the living and dead plants and animals and they too joined the “rain” of dead material falling to the bottom of the ocean.

Under the immense pressure of overlying sediments and heat from the Earth, this material becomes tiny fragments of hydrocarbon called **kerogen**. If this is buried between three and four and a half kilometres it becomes oil. If it is buried deeper, between four and six kilometres it becomes gas.

Please fill in the blanks in the following cloze.

SUN ENERGY is converted to P\_\_\_\_\_ and A\_\_\_\_\_ energy. The dead matter is

converted into K\_\_\_\_\_ . If this is buried over three kilometres deep the

kerogen is converted into O\_\_\_\_\_ Deeper burial causes kerogen to become G\_\_\_\_\_ .

Both oil and gas are sources of E\_\_\_\_\_ .

Draw a simple flowchart of the information given above

### Student Activity      It's a gas!

#### Materials required per person or group:

- Newspaper to cover bench.
- 2L plastic cool drink bottle with biohazard label.
- 1 large balloon – very well stretched.
- Strong sealing tape.
- 5 shredded lettuce leaves (or any soft green plant).
- 1 tablespoon of tinned or fresh fish.
- Sand or soil and a funnel
- 1.5L pond water or water from drainage tray under plant pots.

#### SAFETY NOTES

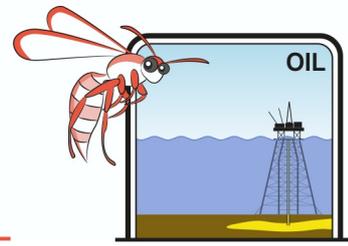
**Label bottle “DO NOT OPEN” with a biohazard symbol.**

**Do not expose the equipment to open flame.**

**Dispose of carefully after use.**



## It's A Gas! - Student Activity



1. Spread newspaper to cover work area.
2. Using a funnel spread alternating layers of soil and shredded plant and animal material into the bottle. Finish with a layer of soil.
3. Gently pour the pond water into the bottle without disturbing the sand layers.
4. Inflate a balloon several times to ensure it is stretched. Seal the balloon over the bottle with tape.
5. Create a label stating this and include the biohazard symbol.
6. Place the bottle in a warm place where it will not be disturbed. Observe what happens to the balloon over time.

What caused the balloon to inflate? \_\_\_\_\_

What was the source of this? \_\_\_\_\_

How can the results of this experiment be used to suggest alternative uses of garbage dumps?

\_\_\_\_\_

Use the library or internet to find where garbage is being used in this way

a) Give the URL of your information source \_\_\_\_\_

b) Give the location of the recycling plant \_\_\_\_\_

c) What is the gas used for? \_\_\_\_\_

Why did we not create oil in the laboratory? \_\_\_\_\_

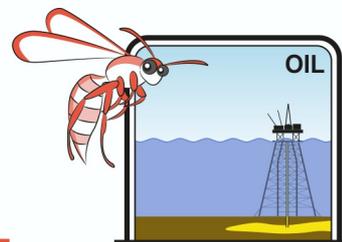
Are oil and gas resources? \_\_\_\_\_

Explain your answer \_\_\_\_\_

Explain the change that happens to the balloon \_\_\_\_\_

\_\_\_\_\_

## Migration To A Reservoir - Teacher Background



**Migration is triggered by:**

- A. Compaction of source rock**
- B. Processes of oil and gas formation**

Both oil and gas move in response to overlying pressure and to fluid movement. Most sediment deposited in ocean basins is made of a mixture of fragments of rock and water. As pressure from above hardens it to become rock, some water is squeezed out. If the rocks also contain oil and gas this is also expelled oozing through pore spaces to migrate upwards to area of lower pressure. Movement may only be a few centimetres per year. Even so, cumulatively, over millions of years, large reservoirs build up when the migration is halted and the hydrocarbons trapped.

**Porous rocks** e.g. sandstone and pumice have holes or voids between their grains. If the holes are not interconnected water or gas cannot migrate through them e.g. volcanic pumice is full of holes but they are not interconnected so oil and gas cannot travel through. Pumice floats in the bath precisely because gas remained trapped inside it when it erupted and solidified. This makes it less dense than water.

**NOTE** most commercial pumice “stone” is reconstituted compressed pumice dust stuck together by cement. There are no sealed pores full of gas. This sinks!

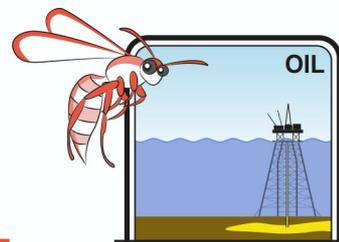
**Permeable rocks** have holes or spaces that are interconnected. These allow liquids and gases to enter and migrate through them.

Reservoir rocks must also be highly porous and permeable.



It can be difficult to use petroleum or methane gas in experiments in school laboratories due to fire and health issues. We substitute water and air to demonstrate how oil or gas would behave in these WASP7 activities.

## Pressure, Porosity, & Permeability – Teacher Notes



### 1. **Pressure** (Force per unit area)

Hydrocarbon migration occurs as a response to pressure from overlying rocks, sediment and water.

This demonstration or activity uses a water-filled plastic bottle into which holes have been pierced. When the bottle is held upright, water coming from the lower hole is under greater pressure and spouts further. It is easier if you fill the bottle with water, screw on the lid and lay it on its side to be punctured with a pin or nail before you lift it upright. (This activity or demonstration can precipitate a “run” on students asking to visit the toilet!) Oil is created from the hydrocarbon kerogen (fragments of buried organic material) at depths of about 2 to 4 km. Gas is formed between 4 and 6km. Pressure at these depths of sediment is extreme. Oil and gas will move upwards and laterally through porous rocks and fractures in rock.



**Porous rocks** have pores or voids between their grains, clasts (broken bits of rock) or crystals.

**Permeable rocks** have connections between the pores permitting gasses or liquids to pass through. Many students have problems differentiating between porosity and permeability.

### 2. **Porosity and permeability**

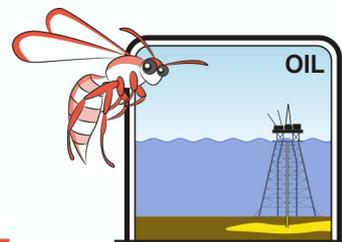


**Materials required per person or group:**

#### Part A

- 1 Filter stand or balance the funnels inside the beakers
- 2 filter funnels (or one used twice)
- 3 beakers
- Small polystyrene balls or marbles, (dry rice or pasta can be used if the funnels are lined with filter paper first)
- Bubble wrap cut large enough to line filter funnels (HINT Use squares one and a half times the diameter of the funnels)
- Water (with food colouring if you prefer)
- A hand lens or magnifying glass

## Pressure, Porosity, & Permeability – Teacher Notes



**Equipment note** Resource challenged schools may cut the tops off 500ml washed cool drink bottles. The base can be used as a beaker and the top inverted to form a funnel. Kitchen paper or Chux can be substituted for filter paper. The filtration section in 'Physical Separation Techniques of Water' may be of use.

1. Mix water with food colouring in one beaker
2. Set the filter funnels on the stand and place the empty beakers below. Students often forget this critical step and wet benches result!
3. Line one filter funnel with bubble wrap and fill the other with polystyrene balls
4. Pour some water slowly into the filter funnels.
5. Clean the equipment and store for further use

Describe what happens and give an explanation

Although both filtering materials had spaces/holes, only the balls had these joined up to allow the water to permeate through.

Materials which have holes or voids are called porous. Which filtering material is porous? Both are porous

Materials where the holes or voids are joined up are called permeable. Which filtering material is permeable? The polystyrene balls/rice/

**Porous rocks** have pores or voids between their grains, clasts (broken bits of rock) or crystals.

**Permeable rocks** have connections between the pores permitting gasses or liquids to pass through.

Which kind of rock would you need to allow oil or gas to migrate through it? Permeable

Igneous rocks are crystalline and unless broken through earth movements are rarely permeable. Sandstones and limestone are permeable but clay and siltstone are not.

### Part B

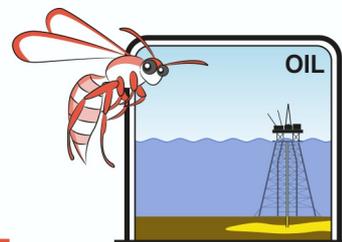
- Specimens of different rocks (E.g. granite, limestone, basalt, limestone, chalk, dolerite - commonly called road metal and slate)
- Pasteur pipette and water

**Equipment Notes** If you don't have pipettes, use a drinking straw. Measure 5cm from bottom of straw and make a mark with a waterproof pen. Place straw in water to the mark and hold finger over the other end. The straw can be lifted out of the water and water will be released when the finger is removed

**Rock specimens** Many garden centres and kitchen/bathroom outfitters sell prepared slabs of slate, sandstone, marble etc. They are often willing to hand over broken pieces for classroom use. Monumental masons (gravestone makers) have impermeable rock but do not often have samples of permeable rock as it weathers more easily. Some blackboard chalk is reconstituted and is impermeable because of the fixative used. Brick is cooked/metamorphosed clay.

**Oil/water** Because of safety considerations water is used to represent oil and gas in their migration from source rock to reservoir. Vegetable oil could also be used. However it is expensive and difficult to clean up afterwards.

## Pressure, Porosity, & Permeability – Teacher Notes



1. Using the hand lens or magnifying glass closely observe each rock to see if it is porous
2. Using a pipette or straw, drop 2 ml water onto the rock specimens.
3. Closely observe water movement using the hand lens to see if the rock is permeable.
4. Write up your observations in the table below.

	Porous	Permeable	Would oil or gas move through this
Granite	No	No	No
Chalk	Yes	Yes/No (see note)	Yes/No
Limestone	Yes	Yes	Yes
Dolerite	No	No	No
Sandstone	Yes	Yes	Yes
Pumice	Yes	No	No
Brick (cooked clay)	Yes	No	No

### **OPTION** Permeability pictures

Ask students to make observations based on the photographs on the following page. 2ml water was dropped on specimens of sandstone, granite and slate at the same time. A 5c coin was placed next to the water drop to act as a control for measurement. Photographs were taken at intervals of five minutes.

What was the **DEPENDENT VARIABLE**? Permeability

What was the **INDEPENDANT VARIABLE**? Rock type

What was the purpose of the 5c pieces? To indicate scale

Which rock or rocks would allow oil or gas to migrate through? Sandstone

Tick the correct boxes

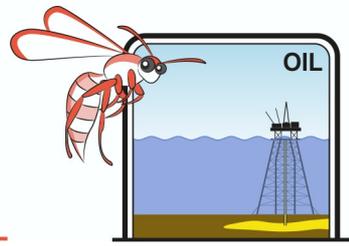
Rock	Permeable	Impermeable
Granite		X
Sandstone	X	
Slate		X

The rock above is pumice. It is a volcanic rock. 2ml of water has been dropped on its surface. Observe what has happened.

Is pumice porous? Yes, it has holes

Is pumice permeable? No, the holes were not joined up so the water ran off of the outside

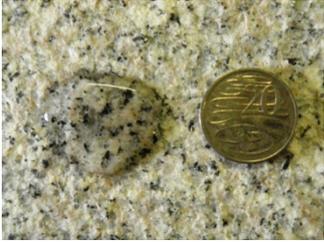
Which rock would be the best to allow oil and gas (hydrocarbons) to migrate through it and why? Sandstone. The hydrocarbons could migrate through the joined up holes or voids.



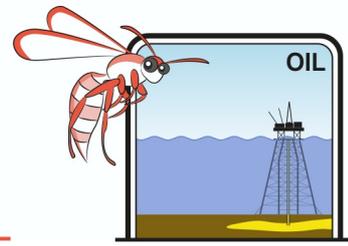
## Pressure, Porosity, & Permeability – Teacher Notes

### Permeability Experiment pictures

Five ml of water was dropped onto three different rock types. Photographs of what happened to the water were taken at 5 minutes, at 10 minutes and after 1 day.

Time	Granite	Sandstone	Slate
0min.			
5min.			
10min			
1 day			

## Pressure & Depth Of Burial - Student Activity



Hydrocarbon (oil and gas) migration occurs as a response to pressure from overlying rocks, sediment and water.

We shall see how pressure increases with depth.

Materials per student or group

- 1 clear clean plastic bottle with cap
- 1 thumb tack or nail
- Water
- Sink or outside area where splashing can occur

1. Fill the bottle with water and screw the cap on tight
2. Lay the filled bottle on its side and make three punctures evenly spaced down one side of the bottle
3. Mark these positions on the bottle diagram on the right
4. Making sure the holes are pointing away from you lift the bottle by the cap
5. Draw the trajectory of the three streams of water on the diagram on the right



Explain why the three streams of water were shaped differently

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Would oil and gas at depth under the earth be affected the same way as water?

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Why do some oil wells “blow” when they are first drilled?

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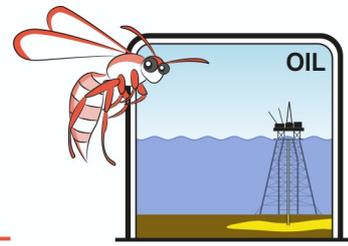
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### **Interesting facts**

***Mine walls and roofs have to be reinforced because of pressure from overlying rock.***

***Temperature also rises with depth. The World’s deepest mine, Tona Tona in S. Africa reached 3.9km in 2011. In the deeps, the rock face can reach 60°C and miners would die without air conditioning.***

## Porosity & Permeability - Student Activity



### Materials required per person or group:

- 1 Filter stand or balance the funnels inside the beakers
  - 2 filter funnels (or one used twice)
  - 3 beakers
  - Small polystyrene balls or marbles, (dry rice or pasta can be used if the funnels are lined with filter paper first)
  - Bubble wrap cut large enough to line filter funnels (HINT Use squares one and a half times the diameter of the funnels)
  - Water (with food colouring if you prefer)
  - A hand lens or magnifying glass
1. Mix water with food colouring in one beaker
  2. Set the filter funnels on the stand and place the empty beakers below.
  3. Line one filter funnel with bubble wrap and fill the other with polystyrene balls
  4. Pour some water slowly into the filter funnels.
  5. Clean the equipment and store for further use

Describe what happens and give an explanation. \_\_\_\_\_

\_\_\_\_\_

Materials which have holes or voids are called porous. Which filtering material is porous?

\_\_\_\_\_

Materials where the holes or voids are joined up are called permeable. Which filtering material is permeable?

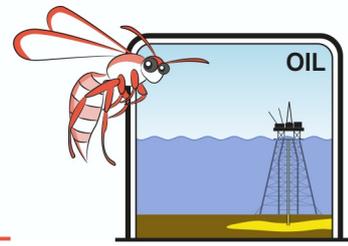
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Would oil and gas travel through rocks and sediments like water?

\_\_\_\_\_

# Porosity & Permeability - Student Activity



***Porous rocks have spaces between their grains***

***Permeable rocks have the spaces between their grains joined up***

Which kind of rock would you need to allow oil or gas to migrate through it? \_\_\_\_\_

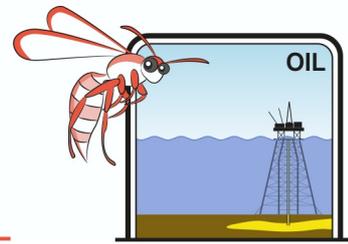
**Part B**

**Materials required per person or group**

- Specimens of different rocks (e.g. granite, limestone, basalt, limestone, chalk, dolerite - commonly called road metal and slate)
- Pasteur pipette and water
- Hand lens or magnifying glass

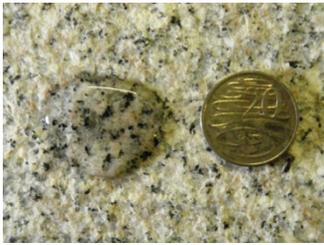
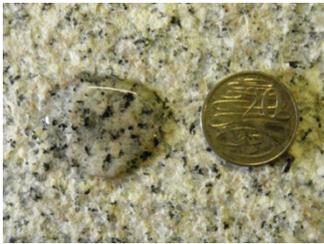
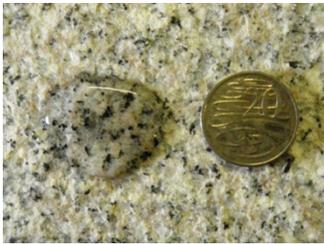
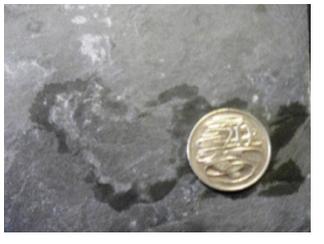
1. Using the hand lens or magnifying glass closely observe each rock to see if it is porous
2. Write observations on the table below
3. Using a pipette or straw, drop 2 ml water onto the rock specimens.
4. Closely observe water movement using the hand lens to see if the rock is permeable.
5. Write up your observations in the table below.

	Porous	Permeable	Would oil or gas move through this? 
Granite			
Chalk			
Limestone			
Dolerite			
Sandstone			
Pumice			
Brick (cooked clay)			



## Permeability Pictures – Student Activity

Five ml of water was dropped onto three different rock types. Photographs of what happened to the water were taken at 5 minutes, at 10 minutes and after 1 day.

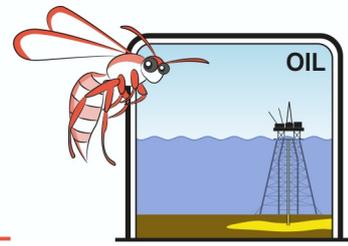
Time	Granite	Sandstone	Slate
0min.			
5min.			
10min			
1 day			

In this experiment:

Which was the **DEPENDENT VARIABLE**? \_\_\_\_\_

Which was the **INDEPENDANT VARIABLE** \_\_\_\_\_

What was the purpose of the 5c pieces? \_\_\_\_\_



## Permeability Pictures – Student Activity

Which rock or rocks would allow oil or gas to migrate through? \_\_\_\_\_

Tick the correct boxes

Rock	Permeable	Impermeable
Granite		
Sandstone		
Slate		



The rock above is pumice. It is a volcanic rock. 2ml of water has been dropped on its surface. Observe what has happened.

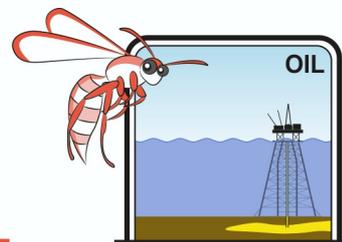
Is pumice porous? \_\_\_\_\_

Is pumice permeable? \_\_\_\_\_

Which rock (granite, sandstone, slate or pumice) would allow oil and gas (hydrocarbons) to migrate through it and why?

\_\_\_\_\_

## Migration Rate - Teacher's notes



Migration of hydrocarbons through rocks and sediments often takes extremely long times, often many millions of years. An impression of different rates through different soil mediums can be gained by this simple experiment below that measures their relative permeability. Easy to compare specimens are: pea gravel, road metal, river sands, beach sands, potting mix, garden soil etc.

### Materials required per student or per group:

- 1 large measuring cylinder
  - 1 beaker
  - Water
  - Specimens of different sediments (sand, silt, potting mix, clay, gravel)
  - Access to a sink or bucket to wash equipment between tests
1. Use the measuring cylinder to measure 200mL of the first soil sample
  2. Place soil in the beaker and gently shake until it is level
  3. Wash any soil remaining in the measuring cylinder and fill with 300mL of water
  4. Gently add water to the sediment in the beaker until the water is level with the top of the soil
  5. Estimate how much water was used
  6. Enter this into the table
  7. Clean equipment and repeat with other specimens

Permeability of the specimen is: 
$$\frac{\text{volume of water required} \times 100}{\text{volume of specimen}}$$

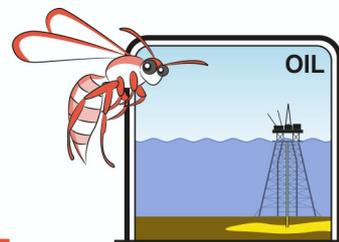
E.g. The permeability of 200mL of sand from my back garden, which absorbed 178mL of water is:

$$\frac{178 \times 100}{200} = 89\%$$

Specimen	Volume of water absorbed	Permeability

***The unit used by petroleum geologists and engineers to measure permeability is the darcy, named after Henri Philibert Gaspard Darcy a 19<sup>th</sup> century French hydraulic scientist. During his work on building bridges he studied the flow of water through various porous materials. The work has been critical to estimating hydrocarbon migration rates. The units are comparable only and not SI units.***

## Migration Rate - Student Activity



Migration of hydrocarbons through rocks and sediments often takes extremely long times often many millions of years. An impression of different rates through different soil mediums can be gained by this simple experiment below that measures their relative permeability.

### Materials required per student or per group:

- 1 large measuring cylinder
  - 1 beaker
  - Water
  - Specimens of different sediments
  - Access to a sink or bucket to wash equipment between tests
1. Use the measuring cylinder to measure 200mL of the first soil sample
  2. Place soil in the beaker and gently shake until it is level
  3. Wash any soil remaining in the measuring cylinder and fill with 300mL of water
  4. Gently add water to the sediment in the beaker until the water is level with the top of the soil
  5. Estimate how much water was used
  6. Enter this into the table
  7. Clean equipment and repeat with other specimens

Permeability of the specimen is: 
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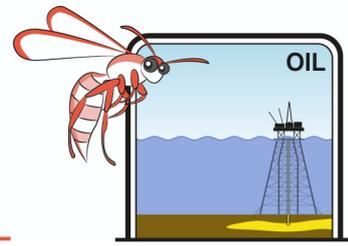
$$\frac{178 \times 100}{200} = 89\%$$

Specimen	Volume of water absorbed	Permeability

Migration would be fastest through \_\_\_\_\_

**Interesting fact**     *The unit used by petroleum geologists and engineers to measure permeability is the darcy, named after Henri Philipert Gaspard Darcy, a 19<sup>th</sup> century French scientist.*

## Structural Seal – Teacher Notes



The timely migration of oil and gas into porous reservoir rocks where it may be trapped and stored is the final requirement for an oil reservoir. Traps must be established before the oil and gas start to migrate. Some traps in the North Sea Oilfields were established 100 million years before the beginning of the generation of oil.

**Seal**      *an impermeable layer*

**Trap**      *a seal formed into a geometric shape (containing shape)*

Where earth movement has bent rocks into domes (anticlines) or has uplifted rocks forcing them to fault against each other structural seals can occur.

Many reservoirs are created in sands deposited by ancient river systems that emptied into sedimentary basins and in porous limestone that formed offshore. These are stratigraphic seals.

Usually hydrocarbons created elsewhere migrate into younger rocks in geographically different parts of the basin where they became trapped and in time built up to become a reservoir.

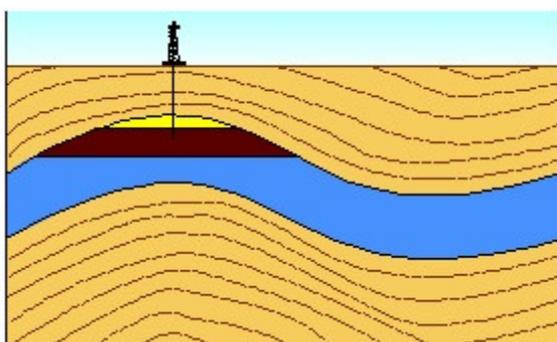
**Interesting fact** *Over 90% of all hydrocarbons created escape to be digested by soil and marine bacteria.*

Where hydrocarbon seeps approach the surface, bacteria prefer the lighter portions leaving thick tarry deposits such as the Athabasca tar sands and the oil seeps in the Middle East.

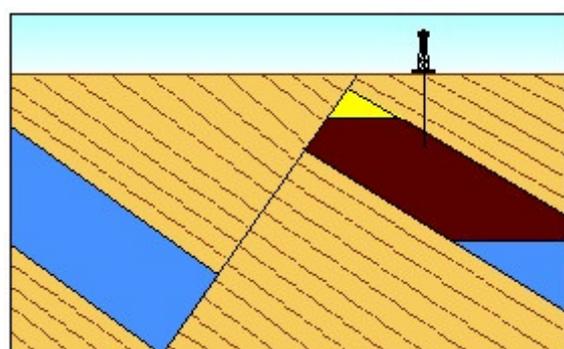
The seal for the reservoir may be:

### A. A structural seal

Structural seals are the result of tectonics (Earth movements) that fold rocks into suitable shapes and bring different rock types together. The Barrow island anticline in our North West was one of Western Australia's earliest recognised oilfield reservoirs. More recent discoveries have been traps sealed by closed faults

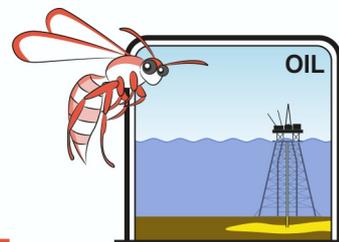


anticline



fault

## Structural Seal – Teacher Notes



**Teacher demonstration of a structural seal** - Using a test tube to model an anticline or dome trap.

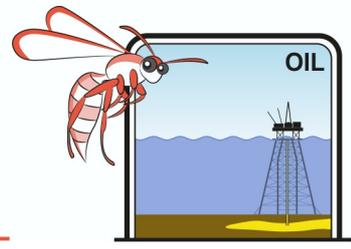
- Test tube
  - Shallow bowl or tray
  - Sand
  - Water
  - Pasteur pipette/transfer pipette.
  - A little cooking oil
1. Place sand into tray and cover with about 3cm water.
  2. Fill test tube with water, seal with thumb.
  3. Invert and place under water on the sand surface.
  4. Hold in place with hand or test tube then remove thumb. If there was no air in the test tube water will remain in place.
  5. Fill the pipette with 5ml of oil.
  6. Place nozzle into sand below the test tube and squeeze.
  7. Remove pipette and allow it to fill with air. Replace pipette under test tube and squeeze again.

The oil and gas will rise upwards because of their low density. Gas will rise above the oil as it does in hydrocarbon traps.

**Option** Gas rises faster than oil. This can be tested with a measuring cylinder, filled by the water above the tray then turned through 90°. Two pipettes, one with oil and the other with air are placed below and both squeezed at the same time.

### **B. A stratigraphic seal**

This could be an overlying bed of impermeable rock such as clay stopping the upward migration of hydrocarbons. When a river's flow slows down, the heavier sands are dropped out leaving a capping of fine impermeable clays at the top of the bed. This is called graded bedding. When a deposition basin finally fills, lower lying sediments may be capped by fine silt and mudstone that provide an impermeable barrier to the migration of water, of oil and of gas.



## Pressure Lift -Teacher Notes

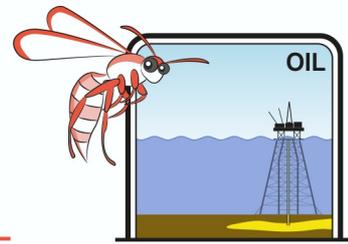
When the reservoir is drilled, oil and gas is released to the surface. In time pressure within the confining rock decreases and hydrocarbon flow slows. Pumping water and gas into the reservoir rock can increase reservoir pressure and cause the hydrocarbon flow to return to economic levels.

### Materials per student or group

- An empty clear soft drink bottle with the paper label removed
  - A sachet of salad cream, tomato sauce, soy sauce or other condiment. (Some school canteens or take-away establishments will give them to you “for the children!”)
  - Water
1. Fill the bottle almost to the top with water.
  2. Add the condiment sachet
  3. Firmly screw the lid on
  4. Draw the equipment
  5. Squeeze the bottle with one hand and observe
  6. Draw what you observed
  7. Try squeezing harder and observe

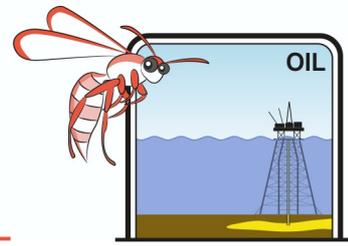


## Pressure Lift -Teacher Notes



Liquids do not compress with pressure. (Which explains how hydraulic brakes work. Pressure from your foot on the brake pedal is transferred to the brake cylinders). Gases however will compress. Gas trapped in the condiment sachet compresses and the packet become denser than water and sinks. When the pressure is released the gas molecules expand, the sachet becomes less dense and it rises to the top of the liquid. Very observant students will notice the sachet becomes thinner when compressed.

Permeability of the reservoir rock and viscosity of the oil controls the rate of recharge of the void left by the released hydrocarbons. Some oil wells recharge rapidly but others take geological time.



## Pressure Lift - Student Activity

When the reservoir is drilled, oil and gas is released to the surface. In time pressure within the confining rock decreases and hydrocarbon flow slows. Pumping water and gas into the reservoir rock can increase reservoir pressure and cause the hydrocarbon flow to return to economic levels.

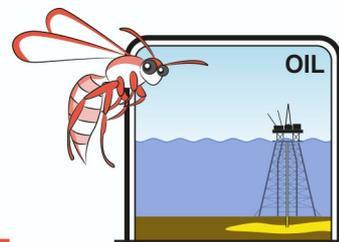
### Materials per student or group

- An empty clear soft drink bottle with the paper label removed
- A sachet of salad cream, tomato sauce, soy sauce or other condiment.
- Water

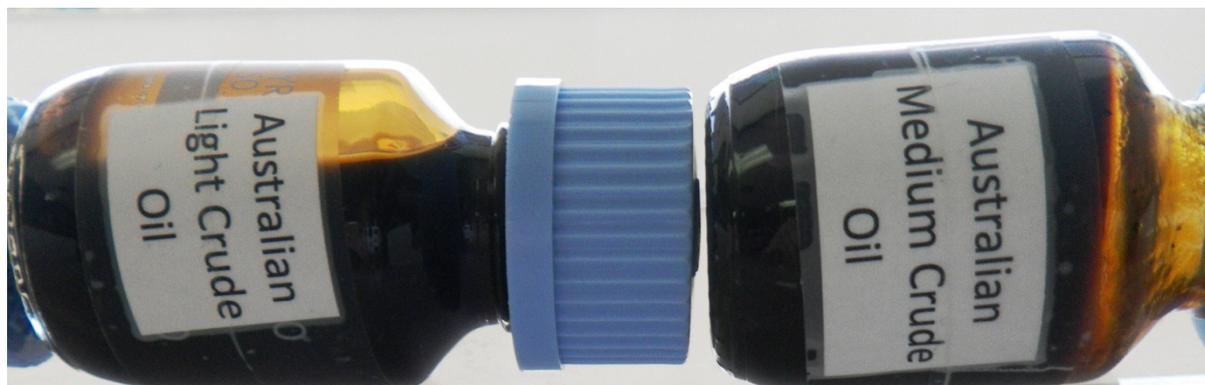
1. Fill the bottle almost to the top with water.
2. Add the condiment sachet
3. Firmly screw on the lid
4. Squeeze the bottle with one hand and observe
5. Draw what you observed
6. Try squeezing harder and observe

<b>Equipment assembled</b>	<b>Equipment squeezed</b>
	

## Viscosity & Raising Raisins - Teacher Notes



Viscosity is a measure of reluctance to flow. Treacle is more viscous than water. When a well is drilled, light oils will be recovered faster than heavier more viscous ones. Viscous oils also take longer to permeate through the reservoir rock. In time the well flow slows because of the increased percentage of heavier, more viscous, oils.



These oils above were sourced from local oil fields. Medium crude oil is more viscous and more reluctant to flow than light oil. It therefore requires more reservoir pressure or gas re-injection to allow it to be recovered. The bottles of oil above were moved from upright to horizontal position and left for 10 minutes. Light oil achieved a level surface almost instantly. The more viscous crude oil had only just started to level out after 10 minutes and took about 30 minutes to achieve a fully level surface.

Teachers may wish to introduce the concept of viscosity (a liquid's internal resistance to flow) by measuring the difference in rate of flow of various liquids down an inclined slope.

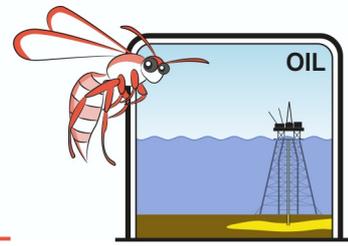
### Materials per group or teacher

- A laboratory or student tray raised at one end by a pile of books (any washable flat surface)
- Masking tape and ruler to create a 30 cm "race track" on the tray
- Transfer pipettes or teaspoons.
- A variety of liquids with different viscosities (e.g. honey, butter/margarine, tomato sauce, mayonnaise, water, oil, vinegar, syrup, treacle)
- Stopwatches (or stopwatch in their mobiles)

To make this a **fair test**, the same volume of liquid must be used on a surface inclined at the same angle in each trial. (**HINTS** do not make the angle of incline too steep and the difference between the fluids will be more apparent and honey from the fridge is **VERY** slow to move). A teaspoon usually holds 5mLs of fluid. Students measure the rate of movement of the fluids over the same distance using stopwatches. If data is scientifically acceptable, it must be **Observable, Measureable, and Repeatable before it is Reportable**. The table supplied is for three repetitions. The surface should be cleaned and dried between repetitions to reduce the effects of contamination by earlier competitors.

Substance	Time taken to cover 30cm				Comment

## Viscosity & Raising Raisins - Teacher Notes



Another simple demonstration of viscosity involves comparing the viscosity of two liquids, in this case blue water on the left and tomato sauce on the right.

Ask students to hypothesise (provide a scientific guess or estimate) which substance will be the most viscous. Expel air from both transfer pipettes and measure water level on the graduated column.

This experiment provides measurable data (comparison of volumes in the barrels of the transfer pipettes) however the amount of air expelled resulting in negative pressure cannot be controlled.

Similarly two transparent drinking straws can be used. Two students suck for two seconds. This experiment is even less controlled but can provide a rough indication of relative viscosity.

Viscosity also affects the rate of recharge in a reservoir. Most depleted oil reservoirs will recharge but it will take geological time.

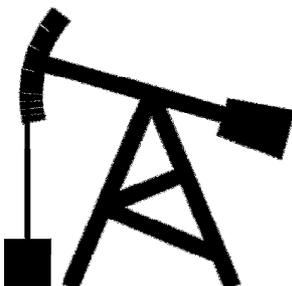
When either reservoir pressure decreases or oil becomes too viscous flow from the well can slow or stop. Gas can be pumped into the well to decrease the density and viscosity of the oil and raise it more easily to the surface. Carbon dioxide is a by-product from oil and gas refining and may be pumped back down the hole. This technique is called **"GAS LIFT"**.

Materials per student or group

- 500ml beaker or clean glass jar
- 6 raisins
- Lemonade, soda or clear fizzy drink

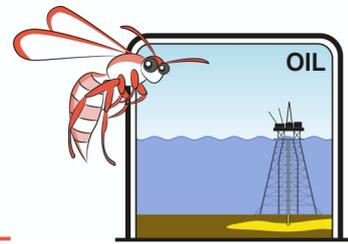
1. Place some raisins at the bottom of a large glass jar or beaker. The container must be clean and free from detergent.
2. Cover well with lemonade or soda water (anything with fizz).
3. Observe for at least 5 minutes

Raisins will slowly rise to the surface and then drop back down again. They will do this several times. Bubbles from the fizzy drink attach themselves to the surface of the raisin until their joint density is less than the drink and they rise up to the surface of the drink. At the surface gas is lost into the atmosphere increasing apparent raisin density and they sink, only to rise again as they pick up more gas bubbles. Movement will cease when there is insufficient gas left in the drink.



In onshore areas producing little oil, a donkey pump or pump-jack can be to pump shallow oil to the surface when reservoir pressure falls.

## Viscosity & Raising Raisins - Student Activity



Some oils are more viscous than others.

Definition of VISCOSITY \_\_\_\_\_

### To test the viscosity of various liquids

#### Materials per group or teacher

- A washable inclined surface
- Masking tape and ruler
- Transfer pipettes or teaspoons.
- A variety of liquids with different viscosities
- Stopwatch



Use masking tape and ruler to create a start and finish line 30 cm apart on the inclined surface

Measure the 5mL or 1 teaspoonful of each substance to be tested

Measure the length of time it takes to move 30cm

Repeat 3 times for each substance and estimate the average reading

The surface should be cleaned and dried to reduce the effects of contamination.

Substance	Time taken to cover 30cm				Comment
	1	2	3	Ave	

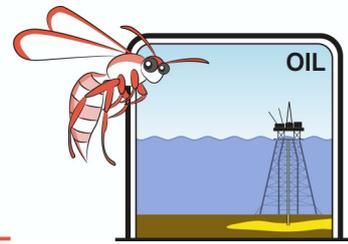
Was the data you collected:

Observable? \_\_\_\_\_

Measurable? \_\_\_\_\_

Repeatable? \_\_\_\_\_

Was this a "FAIR TEST?" \_\_\_\_\_



## Viscosity & Raising Raisins - Student Activity

### Estimate viscosity



#### Materials per student or group

- Two transfer pipettes
- Samples of liquids with different viscosities

1. Squeeze out air from pipette
2. Place in sample material
3. Release pressure on pipette bulb
4. Measure height of sample

Were all the variables kept the same? \_\_\_\_\_

Was the data measurable? \_\_\_\_\_

Was the data repeatable? \_\_\_\_\_

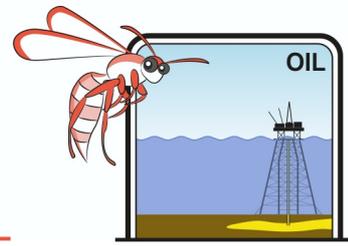
Was this a fair test? \_\_\_\_\_

These two oils were sourced from local oil wells. They were laid on their side and left for 10 minutes. Which oil was the most viscous? Explain your answer below.



Viscosity also affects the rate of recharge in a reservoir. Most depleted oil reservoirs will recharge but it will take geological time.

## Viscosity & Raising Raisins - Student Activity

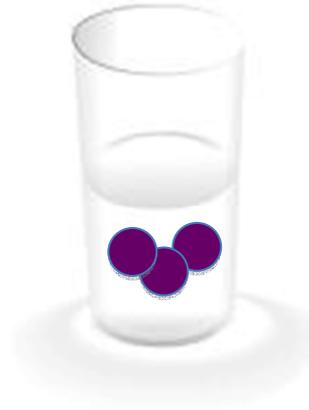


When either reservoir pressure decreases or oil becomes too viscous, flow from the well can slow or stop. Gas can be pumped into the well to decrease the density and viscosity of the oil and raise it more easily to the surface. Carbon dioxide is a by-product from oil and gas refining and may be pumped back down the hole. This technique is called "**GAS LIFT**".

### Raising Raisins (Gas lift)

#### Materials per student or group

- 500ml beaker or clean glass jar
- 6 raisins
- Lemonade, soda or clear fizzy drink



1. Place some raisins at the bottom of a large glass jar or beaker. The container must be clean and free from detergent.
2. Cover well with lemonade or soda water (anything with fizz).
3. Observe for at least 5 minutes

What did you observe? \_\_\_\_\_

\_\_\_\_\_

Explain why this happened \_\_\_\_\_

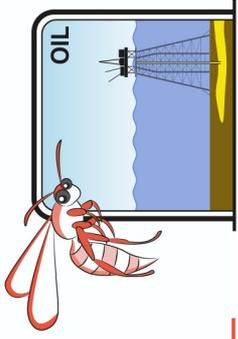
\_\_\_\_\_

What can be done to more easily raise viscous oil to the wellhead? \_\_\_\_\_

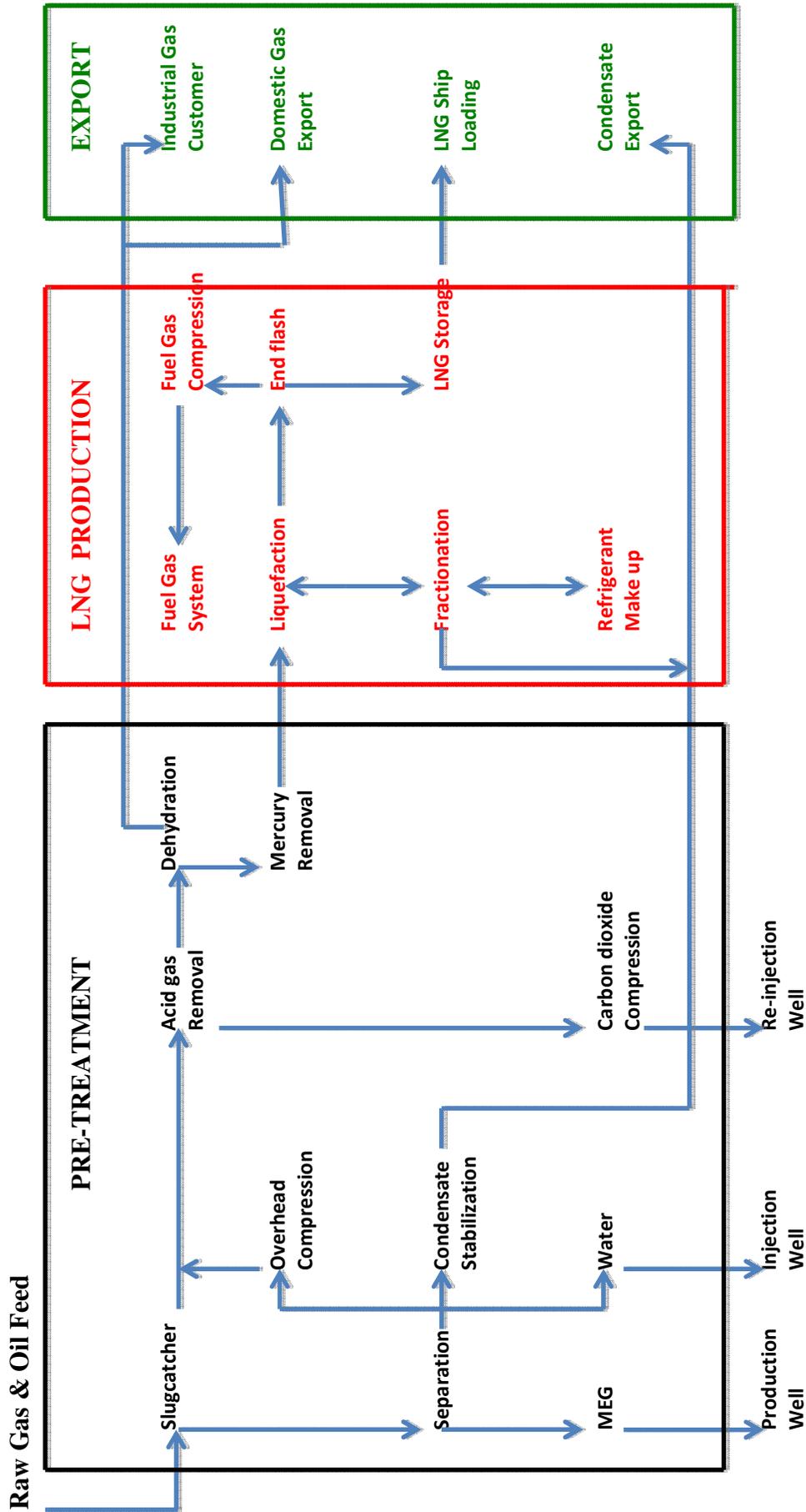
\_\_\_\_\_



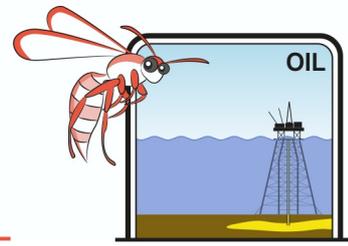
In onshore areas producing little oil, a donkey pump or pump-jack can be used to pump shallow oil to the surface when reservoir pressure falls.



# LNG Gas & Oil Treatment - Flow Plan

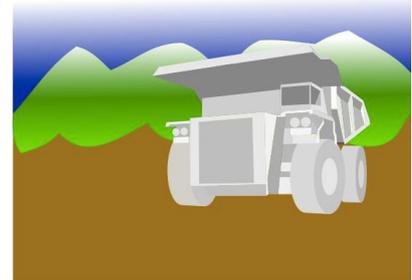


## Safety In The Oil & Gas Industry - Teacher Notes



Humans are a major resource for any industry. Most trades people and professionals are well over twenty years old before they begin to become employable. A broken piece of machinery may take weeks to replace. An appropriately trained human may take longer. It is more profitable to maintain the health and safety of personnel than to have to find trained replacements and retrain them in company specific requirements.

**Interesting fact** *In Western Australian mines and open cuts, some companies' dump truck drivers use the right hand side of the road whilst others use the left. Large companies use specific types and makes of equipment. Difficulty in finding jobs can be partly put down to experience with specific equipment rather than lack of general experience.*



Companies require personnel to have MARCSTA training (Mining and Resource Contractors Safety Training Association) before being considered for on-site employment. This not for profit registered training organisation provides quality comprehensive safety and health programs for organisations contracting to the mining industry.

Workers involved in construction are required to have a "White Card" (formerly a blue card) in construction safety before they can enter a site.

Beyond the front office all on-site staff wear personal protective equipment (PPE) such as helmets, overalls, goggles and gloves when in the workspace. Safety officers check that PPE is present, worn and well maintained. Regular safety drills are carried out to ensure people can be expected to react in a specific way to a specific problem. Everyone is responsible for theirs and other's safety. Bonuses are often awarded for accident free periods. If accidents occur they have to be reported to the Department of Mines and Petroleum who will send investigation officers to investigate major incidents  
<http://www.dmp.wa.gov.au/6694.aspx>



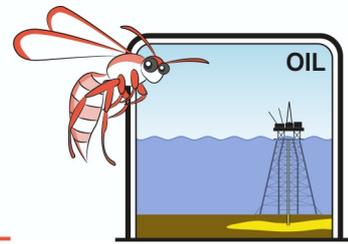
Even if you only visit a mine site, there is a mandatory safety induction lecture and often you cannot leave the vehicle you travel in unless it is to visit the office. All travelling has to be accompanied by a safety vehicle with flag and two-way contact.



Care for the health of their employees extends in many cases to supporting healthy eating and exercising strategies in worksites. Many large company messes have colour-coded labels indicating which foods to eat a lot of and which to only eat a little. Random breathalysing is not uncommon. Wet messes (areas serving alcohol) commonly serve light beer and wine in restricted quantities.

Trained safety personnel are always present and have plans for dealing with possible incidents.

## Safety In The Oil & Gas Industry - Teacher Notes

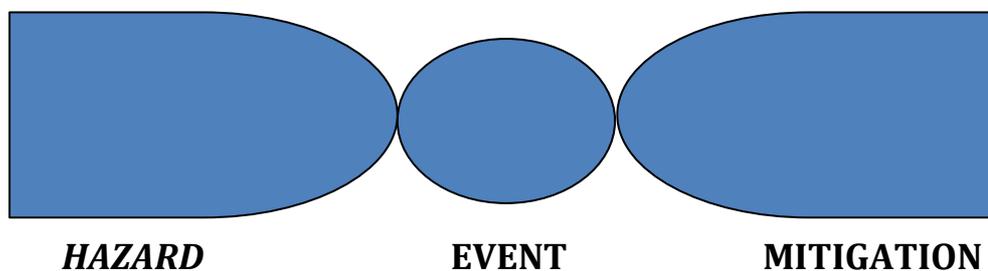


In the oil and gas industry, personnel are trained to:

1. Spot the **HAZARD**.
2. Take measures both physical and behavioural to prevent the event that the hazard might have caused (**TRAINING**).
3. **MITIGATE** effects of the event if it occurs.
4. **Have a successful outcome**

The third step is necessary because humans can make serious mistakes. There are tales of people thinking they could safely enter gas filled rooms if they just held their breath or dropping tools into conveyor belts and reaching down to retrieve them.

They call this approach the “Safety Bow Tie”.



Students may need to know that “mitigate” means lessen, moderate or diminish.

An example could be:

**HAZARD**      Hole in floor

**TRAINING**      Spot the hazard. Isolate, erect barriers, erect signs, PPE shoes with non-slip soles, hard hat for head protection. Notify Safety Officer to organise repair.

**EVENT**              Someone accidentally slips into the hole

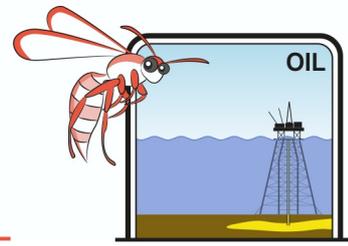
**MITIGATION**      Safety officer notices event and organises First Aid to worker. Hole is isolated and scheduled for repair.

**OUTCOME**      Source of danger removed and worker supported to return to work.

The worksheet encourages students to see if they can organise a “Safety Bow Tie” for an event that might happen at school. Suggestions would be:

- A hole appears in the play area at lunch time
- A kindergarten kid pulls a piece of fence down on themselves
- The climbing frame starts to wobble
- There is a broken glass on the classroom floor
- Somehow, a toddler has got into the school swimming pool

## Safety In The Oil & Gas Industry - Student Activity



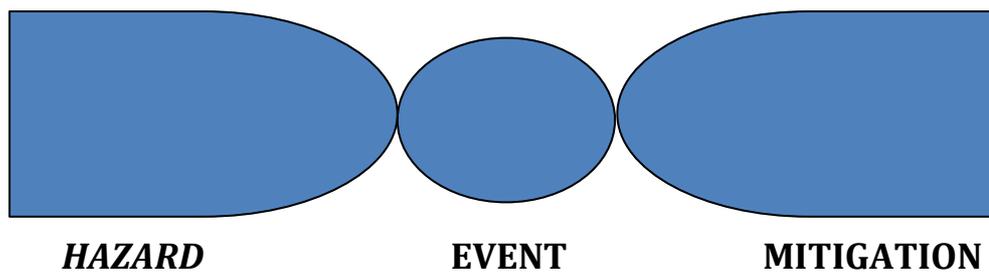
Humans are a major resource for any industry. Most trades people and professionals are well over twenty years old before they begin to become employable. A broken piece of machinery may take weeks to replace. An appropriately trained human may take longer.

In the oil and gas industry, personnel are trained to:

1. **Spot the HAZARD.**
2. **Take measures both physical and behavioural to prevent the event that the hazard might have caused (TRAINING).**
3. **MITIGATE effects of the event if it occurs.**
4. **Have a successful outcome**

The third step is necessary because humans can make serious mistakes. There are tales of people thinking they could safely enter gas filled rooms if they just held their breath or dropping tools into conveyor belts and reaching down to retrieve them.

They call this approach the “Safety Bow Tie”.



Suggest a potential hazard that you might spot at school and show it could be dealt with using the “Safety Bow Tie” method.

**HAZARD**

**TRAINING**

**EVENT**

**MITIGATION**