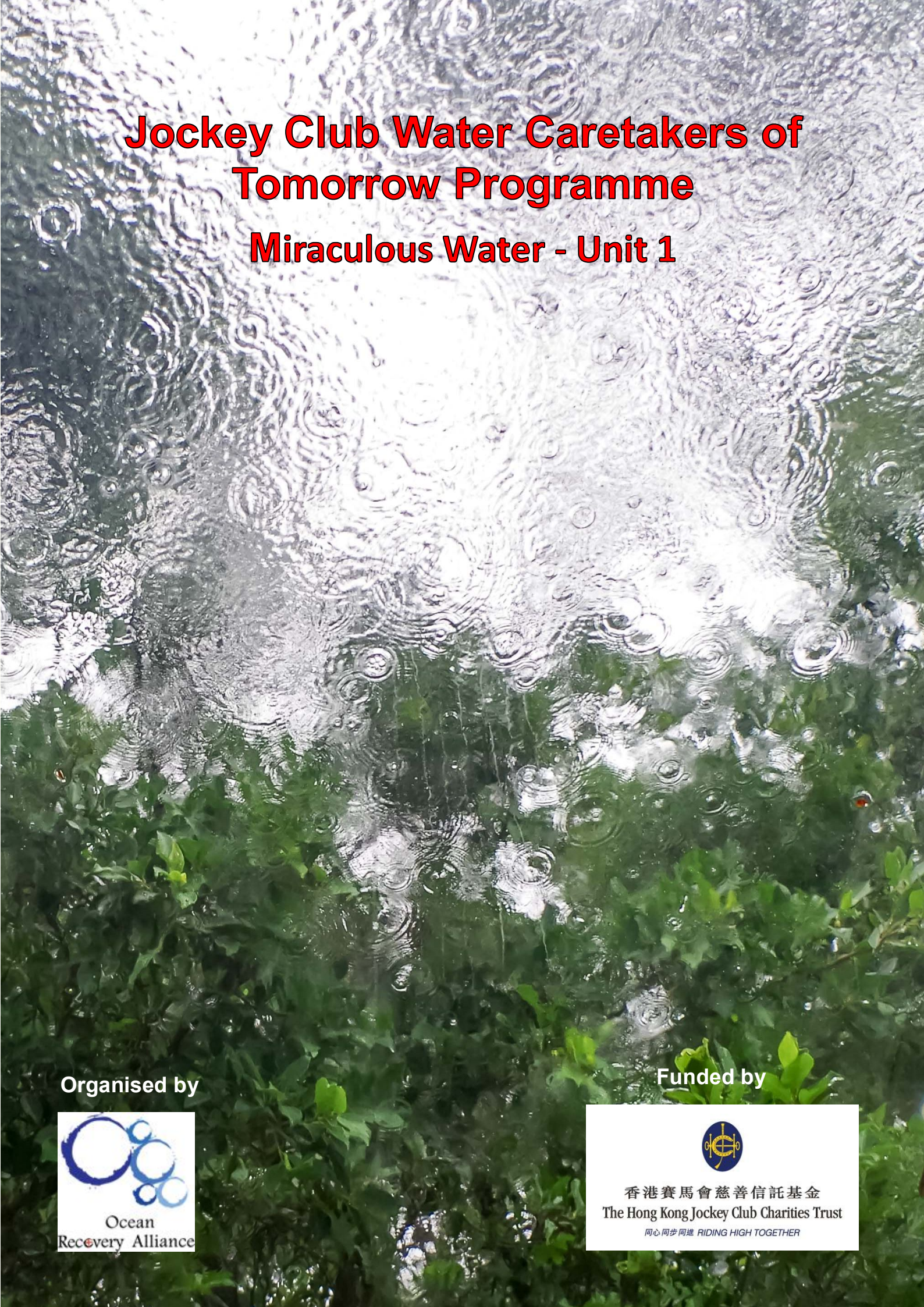

Jockey Club Water Caretakers of Tomorrow Programme

Miraculous Water - Unit 1

Organised by

Ocean Recovery Alliance

Funded by

香港賽馬會慈善信託基金
The Hong Kong Jockey Club Charities Trust
同心同步同進 RIDING HIGH TOGETHER

Ocean Recovery Alliance

香港賽馬會慈善信託基金
The Hong Kong Jockey Club Charities Trust
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About The Jockey Club Water Caretakers of Tomorrow Programme:

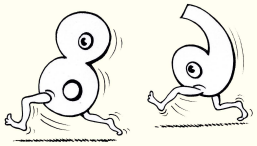
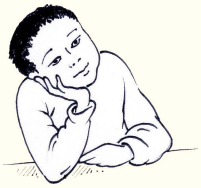
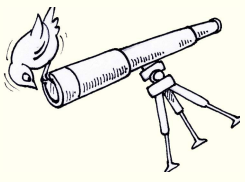
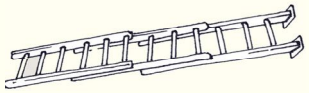
Jockey Club Water Caretakers of Tomorrow Programme is organised by Ocean Recovery Alliance, Ltd and funded by The Hong Kong Jockey Club Charities Trust. There are eight units in this program, and each of them is designed with you, a student in Hong Kong, in mind.

These are the goals for your lessons, to:

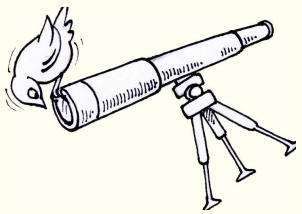
- Understand and appreciate how our water systems function on a local and global scale.
- Understand how watersheds function, and the interconnections of life within and between these watersheds.
- Be able to assess threats, such as pollution and habitat destruction, and learn how to lessen these effects.
- Be empowered to take an active role as caretakers of our water resources by sharing your commitment with your communities.

Student introduction

- You will need access to the internet.
- In some activities using the camera in your smart phone or tablet will be useful.
- Your teacher will tell you if you if your work will be done on your computer, printed paper or notebooks.

Start of a new **activity**.		A new **amazing fact**.	
Get ready to do an **experiment**.		**Fast forward** to make your contribution to improving our world.	
Identify your **misconceptions** before your move on.		**Data** will be used to solve problems.	
Identify your **prior learning**.		These are the **goals** for this unit.	
An extension activity		A **cross-curricular** activity	

Student Aims



At the end of this Unit on Miraculous Water, I will be able to:

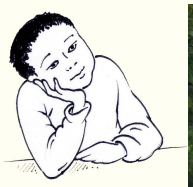
- Describe the main physical and chemical properties of water
- Use experimental methods to demonstrate the properties of water
- Define the role of water in the environment
- Apply my knowledge of the water cycle

Glossary

Aquifer	Underground layer that stores water and lets water flow through it.
Cohesion	Sticking together of particles of the same substance.
Condensation	Process of water vapour (gas state) turning into droplets (liquid state).
Dissolve	Process by which a substance mixes evenly into a liquid.
Erosion	When landforms on the surface of the Earth get broken down and the smaller fragments are transported away by wind, water and other natural processes.
Evaporation	The changing of a liquid into a gas.
Evapotranspiration	The process by which water evaporates into the atmosphere from land, water and plants.
Freshwater storage	A large enclosure that stores freshwater, e.g. a dam.
Gas	A substance that keeps expanding until it fills a space.
Groundwater	Permanent water stored in the ground.
Groundwater discharge	Where groundwater comes back to the surface via a spring or filling a lake and when people pump water from the ground.
Humidity	The amount of water vapour in the atmosphere. Warmer air can hold more vapour.
Infiltration	The filtering of water into the soil and rocks.
Liquid	A substance that flows freely which has a constant volume. It takes the shape of its container.
Permeable/ Impermeable	Permeable - a material or substance that allows liquid or gas to pass through. Impermeable - a material or substance that is a barrier and stops a liquid or gas passing through.

Polarity	A molecule or object that has different magnetic or electrical charges over itself.
Precipitation	Any type of liquid or solid water that falls to Earth, such as rain, snow and hail. Also is the process of a substance settling out of a solution.
Runoff	The draining away of water (and materials dissolved within it) from the surface of the land.
Sediment	Small fragments of solid materials such as silt, sand, gravel, carried by water or air that settle in water or on the ground.
Solution	A mixture in which particles of one or more substances (the solute) are distributed evenly throughout another substance (the solvent).
Sublimation	The process by which a solid turns into a gas without passing through the liquid state, e.g. frozen carbon dioxide.
Suspension	A mixture containing a liquid, in which visible particles slowly settle due to gravity.
Turbidity	Measurement of how clear a liquid is. Particles in a liquid prevent some or all of the light from passing through. This is a key test of water quality.
Water cycle	Describes how water moves on Earth, due to weather, evaporation, rain, etc.
Water table	The highest part in the ground that is saturated (completely filled with water).
Watershed	The boundary of land that marks where the passage of water will drain in a landscape.

What do I know?



Water Interview

- Get into groups of two.
- The first student asks the other student the first three questions.
- The first student records the answers.
- Then the second student asks the first student the next three questions and records their answers.

1. Why is Earth called the water planet?

_____

_____

2. What is so unusual and special about water compared to other substances on Earth?

_____

_____

3. Where is most of the Earth's freshwater found?

_____

_____

4. What is evaporation? What causes it on Earth?

_____

_____

5. What is groundwater and why is it important?

_____

_____

6. Why does some water run over the ground, seep into the ground or pool on the ground?

_____

_____

Lesson 1 – Water is amazing

Amazing facts

- More than 50% of your body is water and your brain is 70% water.
- 1 cubic centimetre of water weighs exactly 1 gram. A cubic meter of water weighs a ton but only at sea level and at a temperature of 17 degrees.
- Water contracts as it gets colder and then below 4 degrees it starts to expand.
- Ice is less dense than water so it floats. If ice didn't float, the bottom of our seas and oceans would be solid ice.
- A faucet dripping one drop per second will use almost 10,000 litres in a year.
- Worldwide, polluted water kills around 200 children an hour.
- In the USA, to grow the food for a family of 4 for a day requires up to 3,000 litres of water.
- Steel ships float because their weight is less than volume of water they float in because the ship is hollow and full of air. So, when a ship gets a leak, the water rushing in makes the ship heavier.
- Water in the atmosphere is a greenhouse gas, keeping the planet warmer.
- Some types of clouds can hold the heat below them, adding to the global warming while other clouds can reflect heat back into space, reducing the impact of global warming.

Search the internet for three more amazing facts about water. You could use search words such as "water amazing facts". Share your amazing facts with the class.

1. _____

_____

2. _____

_____

_____

3. _____

_____

_____

Water is the only substance on Earth that naturally occurs in all three states:

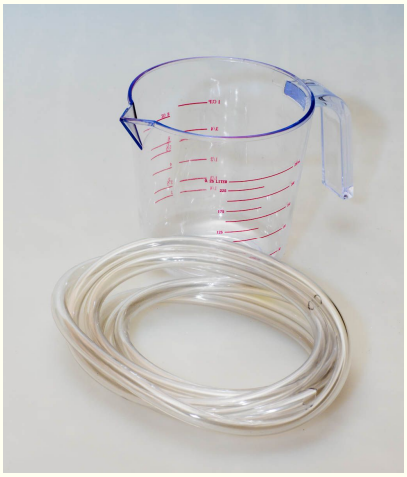
- **Liquid:** People think of water as a liquid**.** A liquid flows and takes the shape of its container. Gravity will force water to flow to the lowest level.
- **Gas:** We have different names to describe water as a gas. We call it steam when it is very hot, and water vapour and humidity at normal temperatures.
- **Solid:** When water freezes we call it ice. Ice has unusual properties. It is less dense than water so it floats.

Conducting experiments

1. Read through the setup for the experiment.
2. Record your prediction for the outcome of the experiment.
3. Gather the materials that are needed.
4. Find a suitable location to conduct the experiment.
5. Review all safety requirements including handling glassware safely and using heat and heated substances. Ask your teacher if you are not sure. Report any accidents.
6. Record your observations as you complete the experiment.
7. Clean and return equipment.

Activity 1: Physical properties of water experiments - Liquid Water

Experiment: Gravity affects water

Materials:	**Method**	
• 60 cm clear plastic tubing • Water, up to 100ml Place where it doesn't matter if some water is spilled.	1. Half fill clear plastic hose with water. Note the water level on each side of the tube. 2. Raise and lower each end of the tube and note what happens to the water levels at both ends. 3. How will you get the water out of the tube?	

Prediction:

_____

Observation:

_____

_____

Explanation:

_____

_____

Experiment: Changing shape

Materials:	**Method**	
• Different shape containers that are waterproof • Measuring jug or large beaker • Supply of water	1. Measure a volume of water. 2. Pour this water in different shaped containers. 3. Tip the container by a small angle. 4. Tip the container by a large angle over another container. 5. Find out if the shape changes if you use a larger or smaller volume of water. 6. Observe how the water occupies the container. 7. Observe the surface of the water when the container is tipped.	

Prediction:

_____

Observations:

_____

_____

Explanation:

_____

Experiment: Water pressure

Materials:	**Method**	
• Plastic bottle with two small holes, one hole near the top and one near the bottom (discuss with teacher how to safely make two small holes). • Water - enough to fill the container e.g. 1 l of water for a 1 l container.	1.Pour water into bottle. 2.Observe how the water flows out of the holes. 3.Explain how the weight of the water above affects the flow out of the lower hole.	

Prediction:

_____

_____

Observation:

_____

_____

Explanation:

_____

_____

Activity 2: It's a Gas

Experiment: Boiling hot

Materials:	**Method**	
• Equipment for safely boiling water • Beaker to contain boiled water • A cold drinking glass	1. Boil water. 2. Making sure the skin of the arm and hand does not come into contact with the steam, allow the steam to flow over the cold glass for around 5 seconds. 3. Describe the change in the appearance of the drinking glass.	

Prediction:

_____

_____

Observation:

_____

_____

Explanation:

_____

_____

Experiment: That's cool

Materials:	**Method:**	
• Clean damp cloth or tissue	1.Using the mouth, blow air across a dry forearm . 2.Make the forearm damp using the cloth. 3. Blow across the damp forearm. 4.Try to explain the reasons for any differences you observed.	

Prediction:

_____

_____

Observation:

_____

_____

Explanation**:**

_____

Experiment: Cloud in a bottle

Materials:	**Method:**	
• 1 Litre clear plastic bottle with cap • Matches • About 3 ml warm water	1. Pour a small amount of warm water into the plastic bottle. 2. Put the cap back on, but leave it loose. 3. Light the match, then blow it out so it smokes. 4. Squeeze the bottle gently a few times to suck in the smoke. 5. Close the cap. 6. Squeeze the bottle and then release it.	

Prediction:

_____

_____

Observation:

_____

_____

Based on your experiment, what do you think clouds need to have in order to form?

_____

_____

_____

Activity 3: Solid water - it's real cool

Experiment: Under pressure

Materials:	**Method**	
• Ice cube tray • Blunt dinner knife	1. Use different parts of the knife to press down and move it back and forward on the ice block - side of knife - back of knife - cutting edge of knife 2. Observe how the knife moves and if the ice melts when it is being pressed down onto the block. (The sharp end of the knife will have the greatest pressure).	

Prediction:

_____

_____

Observation:

_____

_____

Explanation:

_____

Experiment: Water level

Materials:	**Method:**	
• Beaker • Ice - 4 ice cubes • Water - 150ml • Marker	1. Place about 150 ml water and 4 ice cubes into a beaker. 2. Using a marker, mark the water level. 3. Allow the ice to melt. 4. Observe if the water level changes.	

Prediction:

_____

Observation

_____

_____

Explanation:

_____

_____

Extension Question:
Why are ice-skaters able to glide on the ice? Hint: It is for the same reason that glaciers move downhill just like water does!

Calculate this:
If an iceberg is in saltwater, only ⅛ of the iceberg can be seen above water. The rest of it is invisible, under the water's surface.

For the following icebergs, calculate how much of the ice is hidden under water:

1. Iceberg made of 1400 cubic meters of ice
2. Iceberg made of 2200 cubic meters of ice
3. Iceberg made of 16,000 cubic meters of ice

Activity 4: Chemical properties of water

Experiment: Making a solution

Materials:	**Method**	
• Water: 20 ml per trial • Sugar: 5 g per experiment • Salt: 5 g per experiment • Beaker • Filter paper • Source of heat	1. In a beaker of water stir salt or sugar until it dissolves. 2. Note if the liquid looks different. 3. Pass the liquid through filter paper and observe if the salt or sugar has been left on the paper. 4. Evaporate the liquid by heating it or leaving it in a shallow dish at room temperature.	

Prediction:

_____

_____

Observation:

_____

_____

Explanation:

_____

Experiment: Water tension

Materials:	**Method**	
• Large round coin • Pipette or dropper • Water: 10 ml • Alcohol: 10 ml	1. Slowly drop water onto a coin. 2. Count the number of drops the coin holds before the water spills over. Try to add as many drops as you can. 3. Explain why so much more water than alcohol can sit on a coin. 4. Repeat the experiment using alcohol.	

Prediction:

_____

_____

Observation:

_____

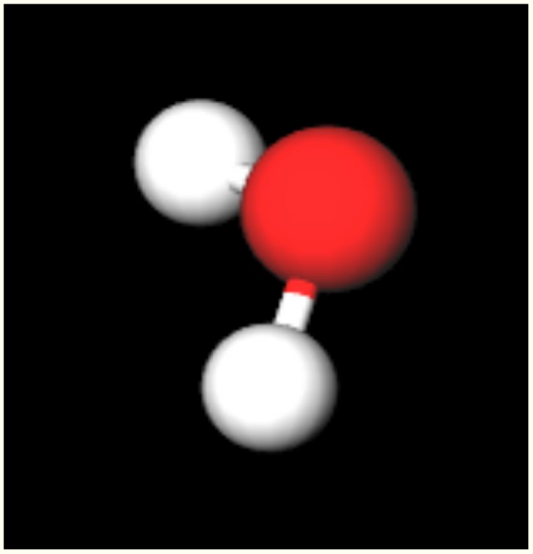
_____

Explanation**:**

Watch this video to see how salt dissolves in water.
https://www.youtube.com/watch?v=xdedxfhcpWo

In this diagram, the water molecule has two hydrogen atoms (white) and one oxygen atom (red), the two hydrogen atoms form a V shape with the oxygen. This shape makes the electrons around the hydrogen slightly positive and around the oxygen slightly negative. This is called a bipolar molecule. The bipolar nature and the shape of the molecule give water many of its properties.

Formula	**H_2O**
Molecular weight	**18.015 u**



Percent composition

H	**1.00794 u × 2**	**11.190 %**
O	**15.9994 u × 1**	**88.810 %**

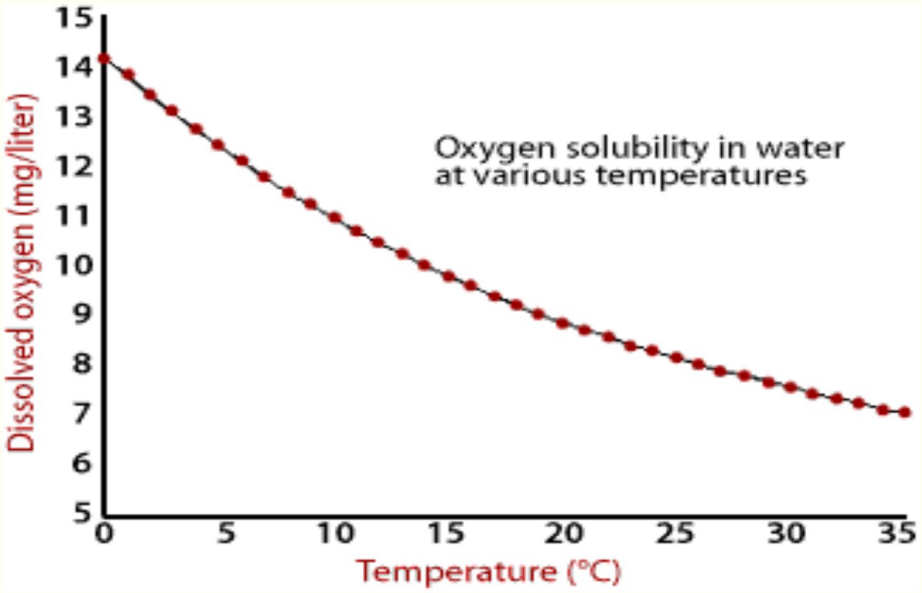
This video explains how the shape of water molecules causes its interesting properties:
https://www.youtube.com/watch?v=3jwAGWky98c

Solutions (in solution)
Why is water called "the universal solvent"? It is because it can dissolve so many different things. It is able to dissolve many substances because it is bipolar. A solution in water is when a substance is dissolved evenly through the water. The substance can't be filtered out of the water using filter paper. When the water is evaporated, the substance remains and retains the same properties.

Amazing fact
Are all solutions liquids? No, there are solid and gas solutions. Can you name any?
The air you breathe is a solution. It consists of oxygen and other gases dissolved in nitrogen. Brass is a solid solution. Tin is the solute and copper is the solvent.

Oxygen dissolves in water.

Look at the graph. The horizontal (bottom) axis is the temperature and the vertical (side) axis is the maximum amount of oxygen dissolved in the water. The graph shows the maximum amount of oxygen that can be dissolved at different temperatures.



According to the graph, what temperature can water hold the most oxygen?

_____

At what temperature does water hold the least oxygen?

_____

Extension Question: Why might a graph like the one above be useful for an ecologist?

_____

_____

Activity 5: Suspensions
A suspension is when materials float around in water. These are usually very small particles. In this experiment you will find out what is different about solutions and suspensions.

Experiment: Suspending soil

Materials per trial:	**Method**	
• 2 beakers (250 ml) • Water - 200 ml • Soil - 20 g • Filter paper - 1 round piece • Funnel • Spoon (keep the water with suspended soil for the next experiment)	1. Mix three or four spoons of soil in a jar half-filled with water and stir. 2. Record what you observe. 3. Pour the contents of the jar through a funnel with a filter paper inside. 4. Record your observations.	

Prediction:

_____

_____

Observation:

_____

Experiment: Observing the changes in a suspension

Materials:	**Method**	
• Beaker of water from previous experiment • Spoon • Mobile phone camera (keep water for next experiment)	1. Place the beaker with water and soil in a location where it won't be disturbed for half an hour. 2. Stir the water and then take a photo of the beaker. 3. Half an hour later take another photo and compare the two photos.	

Prediction:

_____

_____

Observation:

_____

_____

What is the difference between a solution and a suspension?

_____

Experiment: Turbidity

Materials:	**Method**	
• Beaker or jar • Water -100 ml • Soil - 50 ml • Spoon • Paper and thick black marker • Light source such as a torch or deck light	1. Make a 1cm grid on 10 cm square paper, using a thick black marker on white paper. use three to four spoons of soil and stir in a half filled. 2 . Place beaker on your graph. If you can't see the graph through the water pour off some water until you can. 3. Try the same with the water in the previous experiment. 4. Shine a bright light through the beaker.	

A simple way of describing turbidity is how dirty the water looks. Turbidity is different from pollution, although turbidity is often one of the measurements of how polluted water is. Turbidity is actually the amount of particles suspended in the water.

Prediction:

_____

_____

Observation:

_____

_____

Explanation:

_____

How does dirty water affect the amount of light that can pass through the water? Does a bright light shining onto the side of the beaker make much difference?

_____

_____

How are aquatic plants and animals affected if light can't penetrate the water?

_____

_____

How might suspended solids in the water affect fish, tadpoles and aquatic insects?

_____

_____

Lesson 2 – Earth the water planet

Activity 1. Water cycle

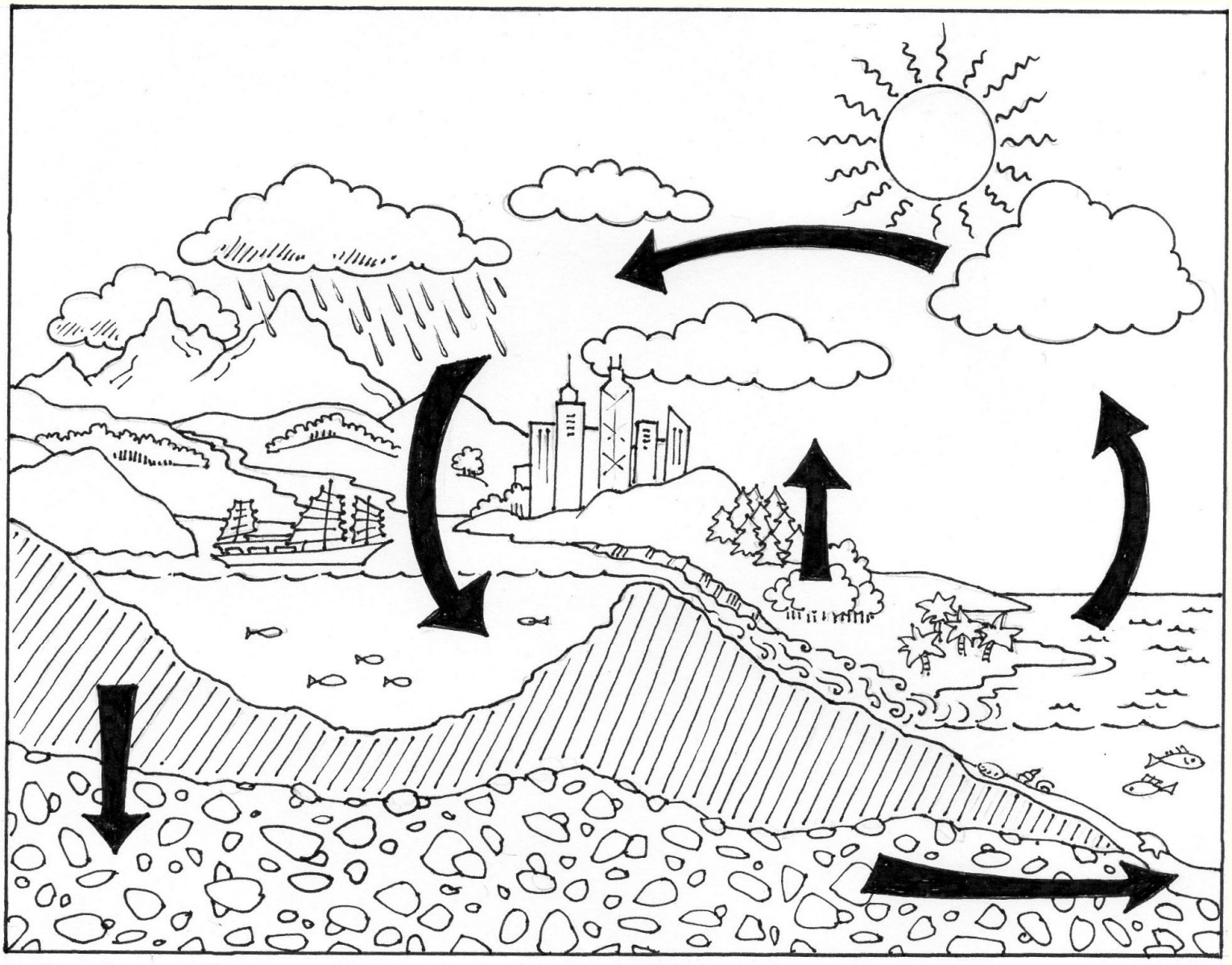
Introduction

It's no joke! Some of the atoms of water inside your body will have passed through dinosaurs and probably some very famous people. All the water on Earth has been recycled for billions of years. Who knows how many adventures the water in your body has gone through!

What do you know about the water cycle?

Annotate the water cycle diagram. Label the diagram and six arrows with the words below and add two further arrows with their words:

Evaporation	Evapotranspiration
Infiltration	Condensation
Precipitation	Runoff
Sublimation	Throughflow



Look at these websites to make sure you have used the labels correctly.

http://aqwest.com.au/Students/TheWaterCycle.aspx

http://www.educationsoutheastwater.com.au/natural-water-cycle/#evaporation

Activity 2: Mini water cycle experiment

Experiment: Mini water cycle

Materials:	**Method:**	
• Bowl • Clear wrap • Salt and spoon • Heat lamp • Water to quarter fill bowl	1. Stir some salt into a bowl of water to represent the sea. 2. If you are going to do the taste test, use drinking water and a clean spoon and bowl. 3. Place clear wrap over the bowl. 4. Place a heat lamp over but not touching the clear wrap. 5. Once water droplets have formed on the wrap, taste a droplet to find out if it is salty.	

Prediction:

_____

_____

Observation**:**

_____

_____

If the sea water keeps evaporating from the heat of the sun, why does it not keep getting saltier and saltier all the time?

_____

_____

Activity 3: Rapped in the water cycle

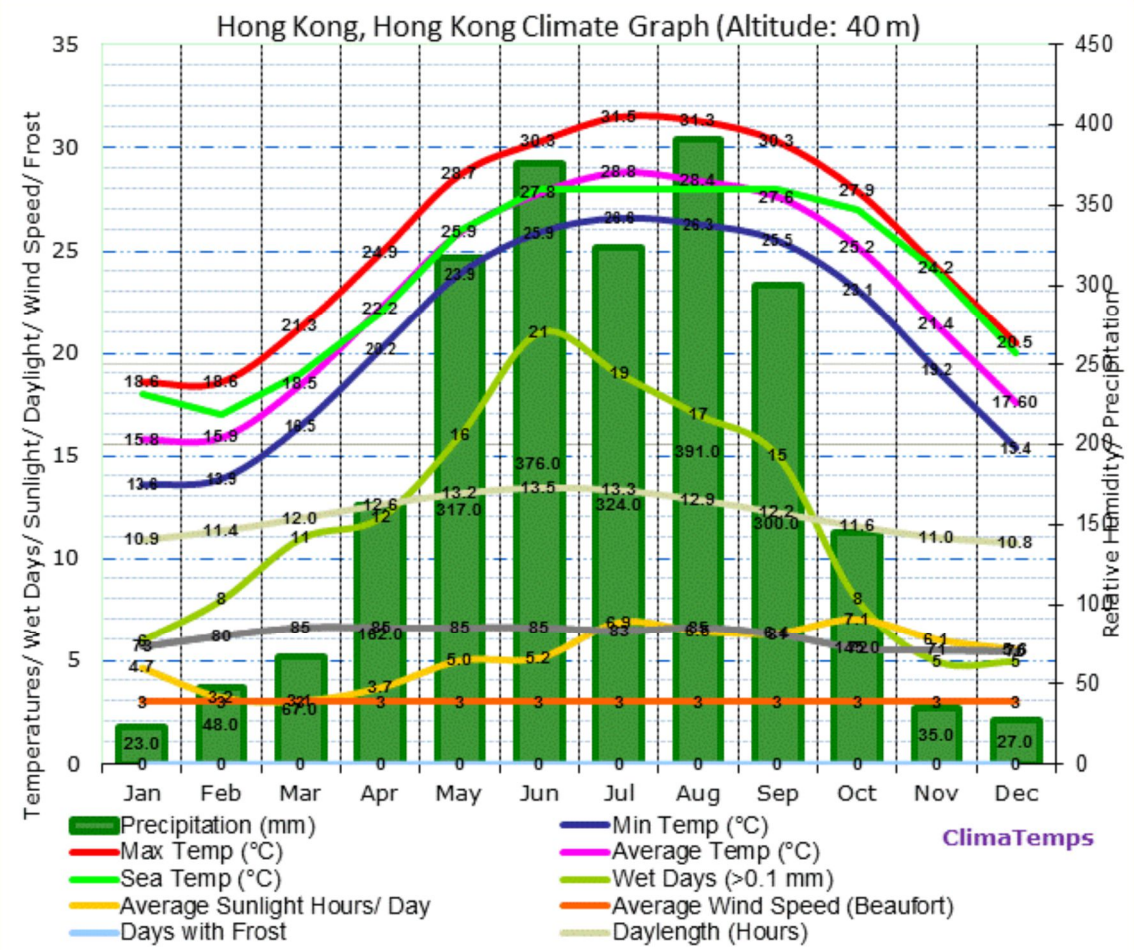
If you look at Youtube you will find a few water cycle songs. These songs seem to be made for younger kids. https://www.youtube.com/watch?v=T05djitkEFI

Your job is to write a short poem, song or rap that describes the water cycle for students your age.

An alternative activity can be to review several Youtube water cycle songs. The primary purpose of your review is to note if they have all the required information, and write up what they have gotten wrong or what they have left out.

Activity 4. Weather vs. Climate

Below is a Climate Chart of Hong Kong. Look at what the chart is measuring.



Source: http://www.kowloon.climatemps.com/

Over what period of time does the chart represent? _____

What properties are being measured? _____

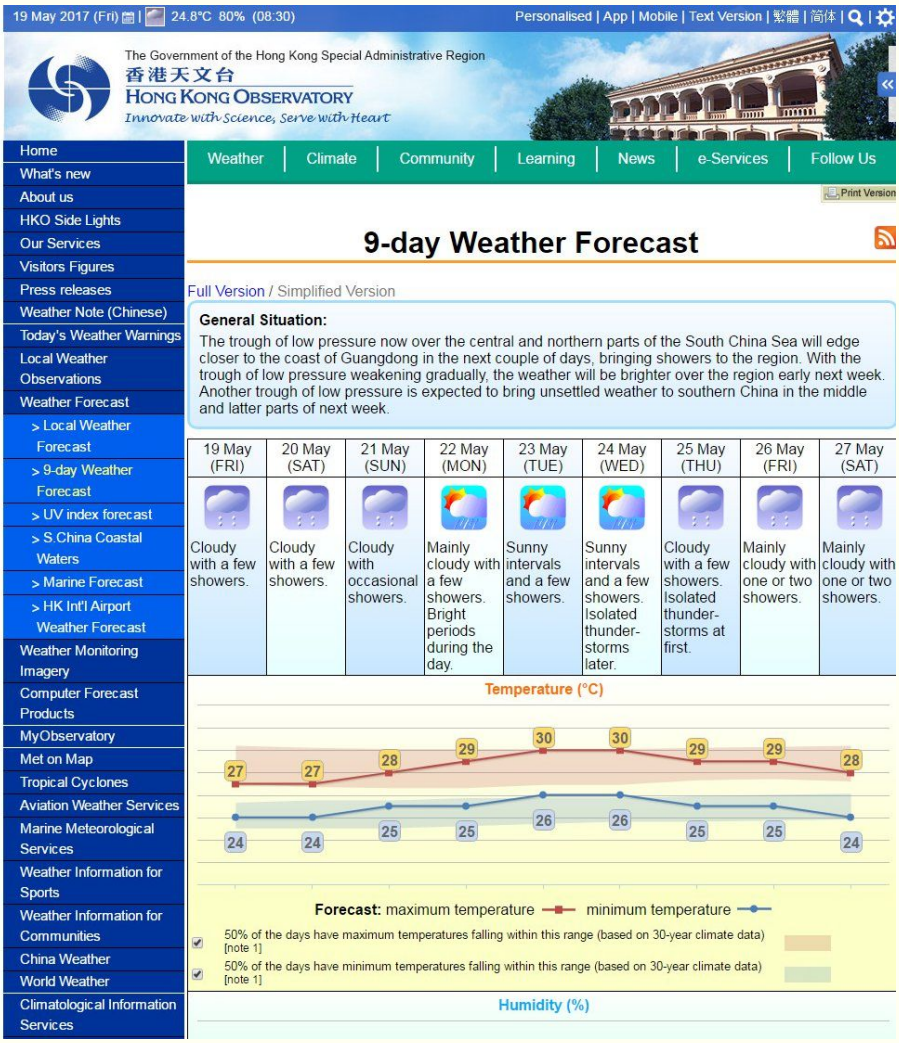
_____

How long has it taken to put the data together to get average measurements?

☐ 1 year
☐ 5 years
☐ Around 50 years

Answer - a lot longer than ten years.

This is an old Hong Kong weather forecast that includes a chart:



Source http://www.hko.gov.hk/wxinfo/currwx/fnd.htm

Over what period of time does the chart represent?

_____

What properties are being measured?

_____

_____

How long has it taken to put the data together?

- ☐ Last few days
- ☐ Last few weeks
- ☐ Last few years

Over time, would you expect big changes in a climate chart? _____

Over time, would you expect big changes in the weather forecast? _____

What is the purpose of making a climate chart? _____

_____

How useful is the climate chart in predicting weather? _____

_____

Why does the weather forecast only predict 9 days? _____

_____

What is the difference between weather and climate? _____

_____

_____

Comparing the Hong Kong climate graph, use the internet to find a similar climate map for any other place or region in the world. A good source for finding climate graphs is to look for government meteorological websites.

Place or region _____

How are the seasons different from Hong Kong? _____

_____

_____

Activity 5: Hidden water

Experiment: Permeable vs. Impermeable

You will go outdoors to find three different surfaces: footpath, bare soil and grass. Discuss with your teacher where you will find these surfaces and how you will obtain buckets of water. You will observe how the water responds to these surfaces when water is poured slowly and quickly onto them.

Materials:	**Method**	
• Small bucket with handle • Water (about 3 l) • Outdoor area	1.Slowly pour around half a litre of water on the following surfaces: • footpath • grass surface • soil surface 2. Quickly pour the other half litre of water on the same surfaces.	

What happens when water is poured onto a hard surface like a footpath?

_____

What happens to water when poured onto grass and soil?

_____

Which surfaces are permeable to water?

_____

Which surfaces are impermeable to water?

_____

Did you notice any differences in what happens to the water when it is poured slowly vs. quickly onto the surfaces? Why might this be important?

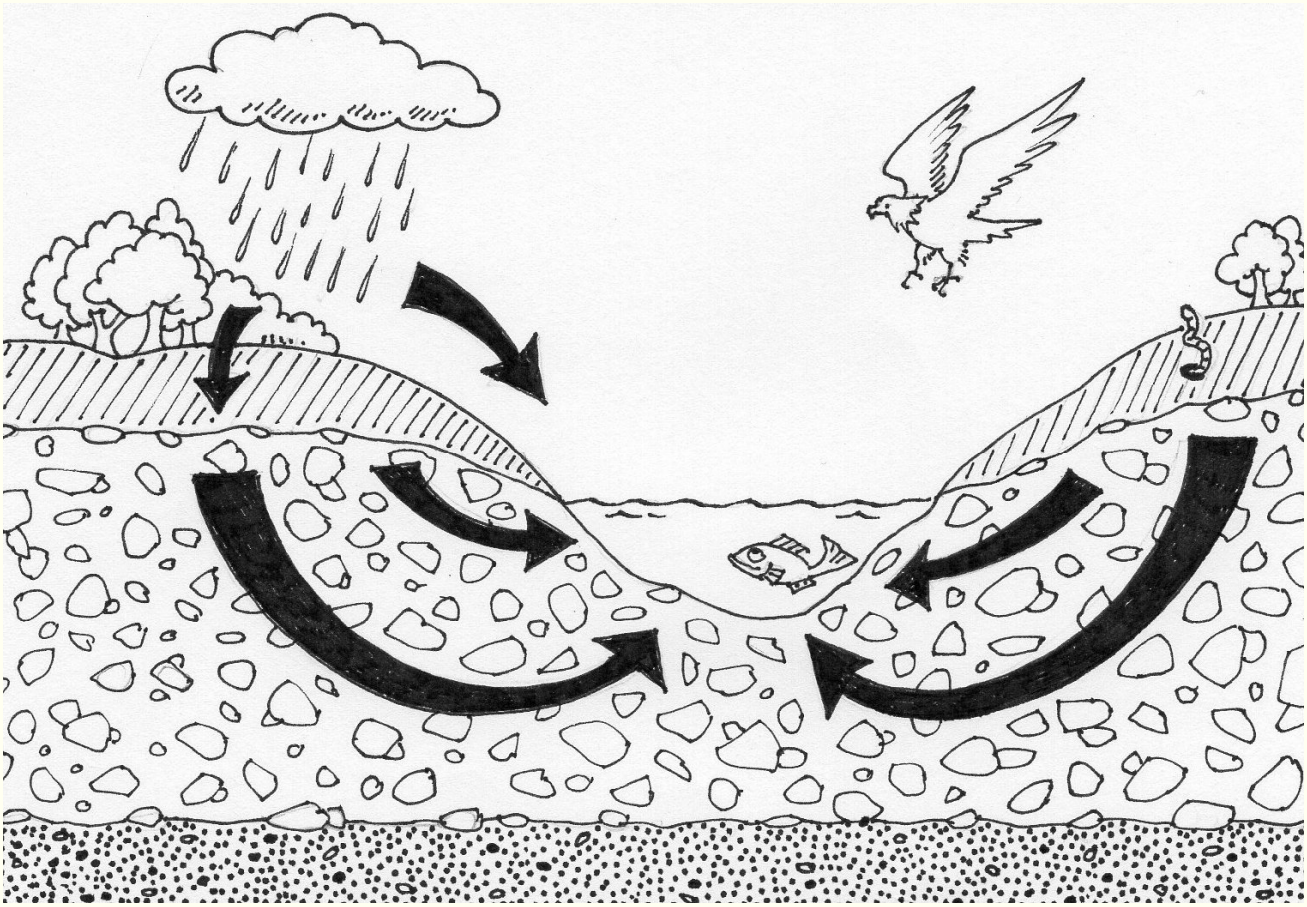
_____

Why do you think some surfaces are more permeable than others?

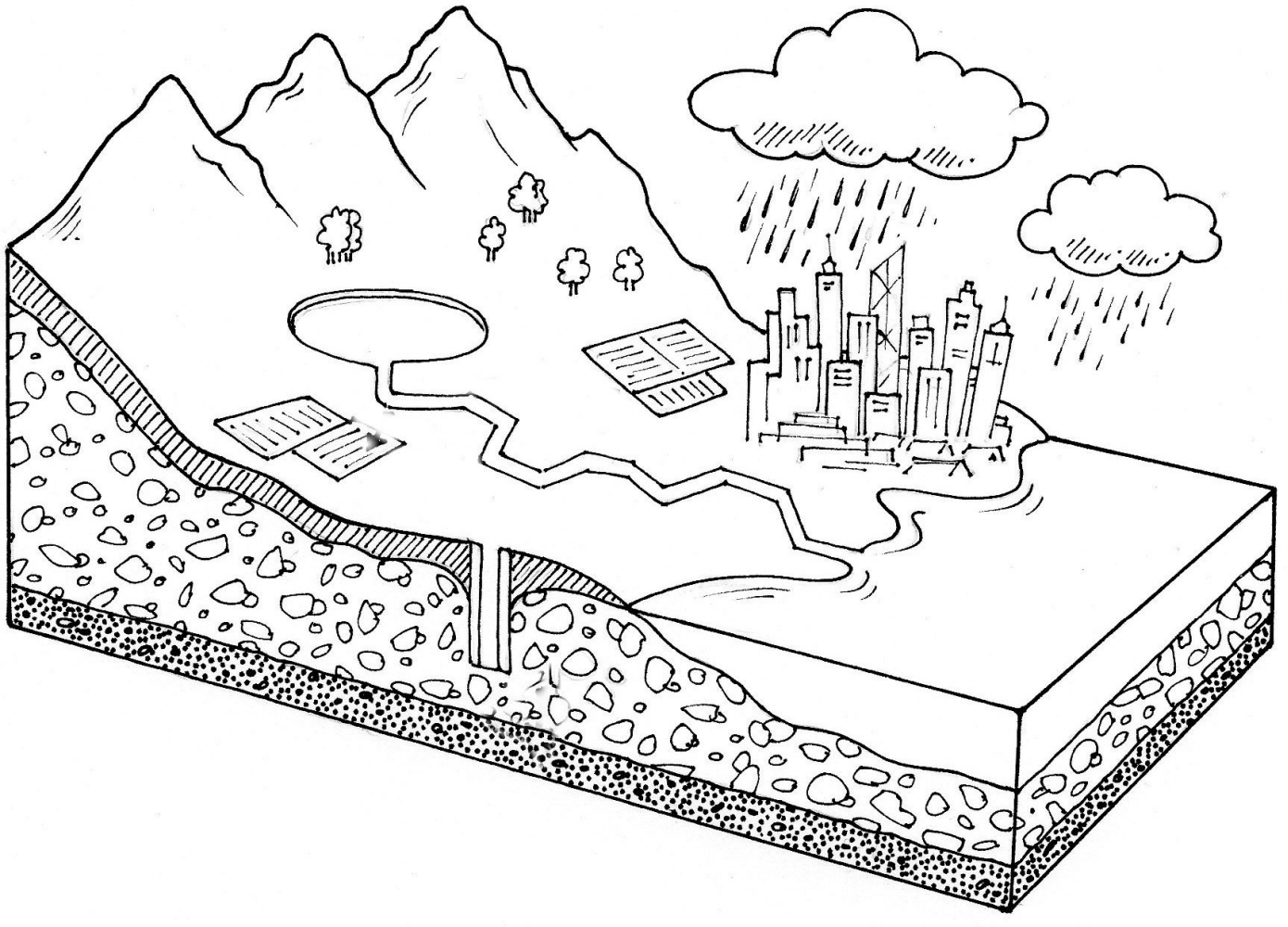
_____

The mysteries below the surface

All the water soaking into the ground must go somewhere. It travels down into the soil and rock until it hits a layer of rock that is impermeable to water. Groundwater is the water that fills the cracks and spaces in the rock and soil. The layer of groundwater can slowly flow downhill. When the groundwater reaches the surface we call it a spring. Often groundwater comes out in a hollow that creates a permanent lake.



Label the diagram to show how groundwater is a source of water storage and flows through the ground. On the diagram above, show some of the sources that could pollute the groundwater.



View the links below:
https://www.youtube.com/watch?v=oNWAerr_xEE
http://earthguide.ucsd.edu/earthguide/diagrams/groundwater/

Groundwater is replenished by rain. This is called groundwater recharge.
What would happen if more groundwater is removed by pumping and natural outflow than is replaced by rain?

_____

_____

Choose one major weather event or climatic change that changes the amount of rainfall. Modify the diagram to show what you think would happen to the water table. Examples of weather events and climate change:

- A major flood
- Long drought
- Same amount of rain each year, but most of it comes as much heavier bursts of rain
- Rain increases by 50% each year

Knowing what you do about permeable and impermeable surfaces, how do you think this affects the amount of water entering the groundwater supply?

_____

_____

How does time on the surface affect the amount of water entering the groundwater supply?

_____

_____

Lesson 3 - The Power of Water

Activity 1: Erosion, shaping the landscape

The website provides videos of raindrops hitting different surfaces.
www.videoblocks.com/video/close-up-rain-drop-drip-in-meadow-dirt-drop-on-camera-glass-4k-htpyyty/

Experiment: Drip vs splat - which causes the most erosion?

Materials:	**Method**	
• Large tray with sides (eg cat litter tray) • Sand or cat litter • Water in jug • Pipette	1. Place sand or cat litter in tray. 2. Use the pipette to make a constant drip onto one small section of the tray and note what happens. 3. Pour water from the jug in a long continuous stream onto one small section of the tray and record what happens.	

Prediction:

_____

_____

Observation:

_____

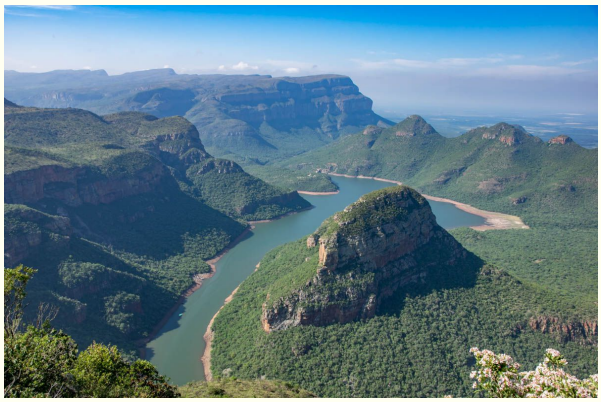
_____

Explanation:

_____

_____

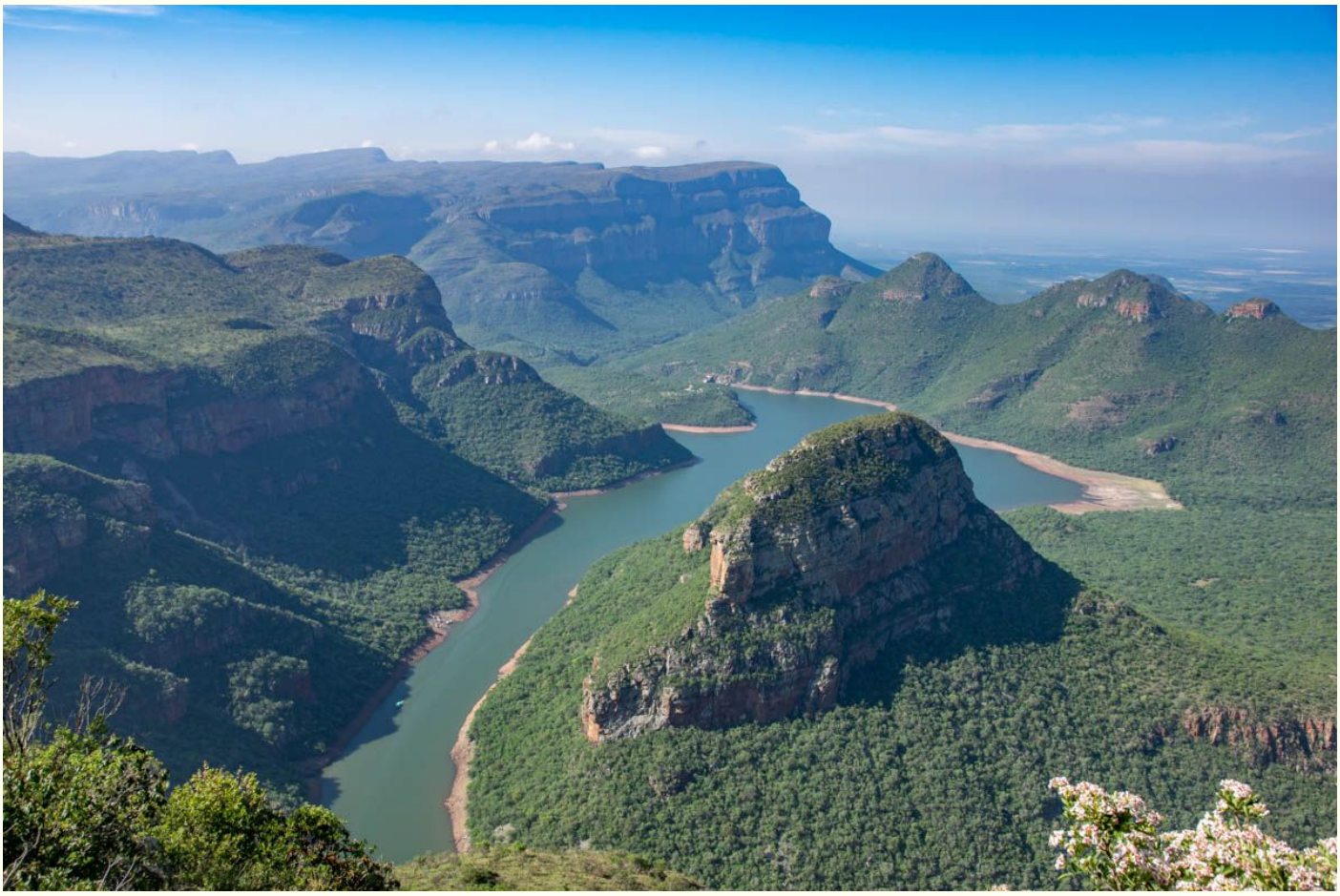
Power of water on our environment



Water has carved up the landscape. All the tallest ancient mountains have been worn down by water. They may be reduced to hills or no longer exist. Where water is having its biggest impact on the landscape, we see erosion occurring. Water may have stripped the land of soil. Water may create new gullies. The very steep landscape around Hong Kong is prone to erosion, sometimes resulting in dangerous, collapsing hillsides. The landscape must be managed so our roads and people are safe, but we should have as little impact on the environment as is necessary. Vegetation holds the soil in place and reduce erosion. In the past, some of the efforts to reduce the impact of water by concreting streams and rivers has destroyed their ecology.

Topsoil is more susceptible to erosion by rainfall when there is little or no vegetation present, like this recently burnt hillside on Lantau.

Each year annual floods eat into the hillside.



Water has worn away the softer rocks and created the world's second largest canyon which is in South Africa. It is called the Motlatse River Canyon. The light blue speck in the water near the bottom of the photo is a boat.

Activity 2. Protecting the landscape

How do these structures in Hong Kong manage water to protect the landscape?

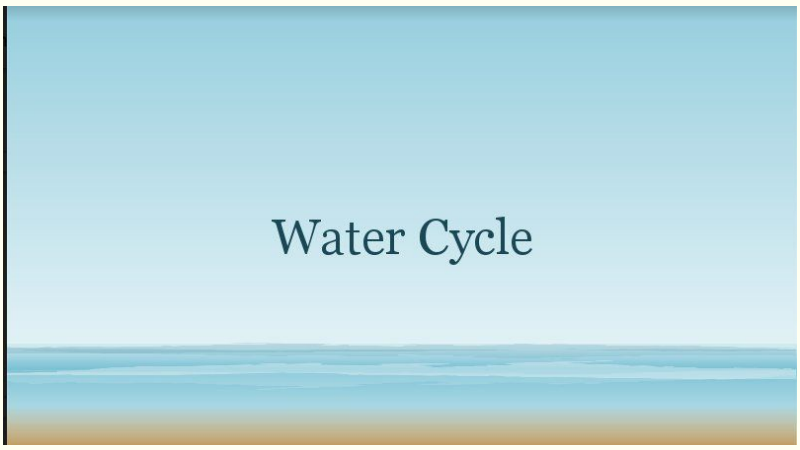
Structure	What is the function?
	
	
	
	

Activity 3: Water Cycle Review - Make it Your Own

Download the Water Cycle Powerpoint from the resources.

This Powerpoint has a number of photos that show parts of the water cycle. Add text to the photos to explain how the photos fit into the water cycle.



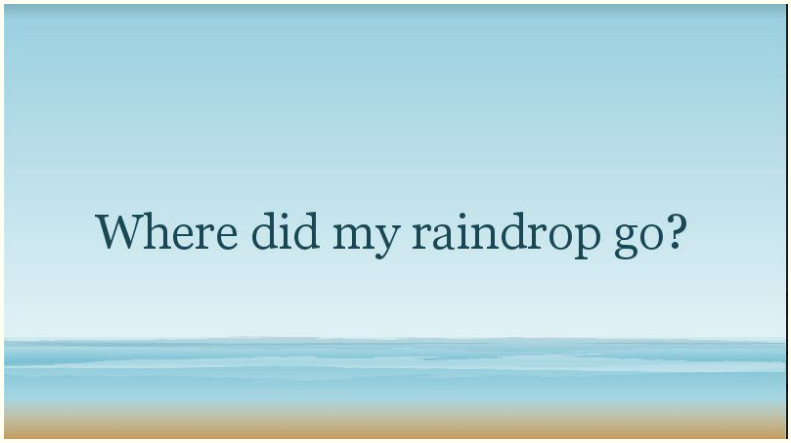
Get into groups of three and comment on each other's water cycles. If you found out more information from your group, add this to your water cycle. If you can't agree on some of the information, discuss it with the class.

As a class, go through the slides, confirming that what you have written explains the water cycle.

Activity 4: Looking forward - Where did my raindrop go? - Powerpoint

Download the "Where did my raindrop go?" Powerpoint .

When rain falls it will start a journey. It may naturally end up in the sea or be transpired in a forest, or it could be diverted by our pipes, drains, etc.



Choose one of the five ways your raindrop could have travelled when it fell onto Hong Kong. Go through the entire cycle so that your raindrop eventually returns to the cloud. (Scientifically the molecules in a raindrop would mix with other water and all the molecules would be scattered). The raindrop:

1. Landed in a stream then into a river
2. Landed on a farm
3. Went into a reservoir
4. Landed in the streets of Hong Kong
5. After it landed in a forest, it was absorbed by a tree

Only use the photos you need, deleting those that are not part of your raindrop's journey. Use the photos provided and add photos and diagrams to explain your story. When the stories are complete, get In groups of five representing each of the five journeys and share your stories.

Tell the Story

Turn your water drop journey into a storybook for a lower grade class in your school.

1. Decide what storyline you would like to tell.
2. Your story will need a new, interesting title.
3. If you are making it into an adventure, make sure that the main points remain factual.

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