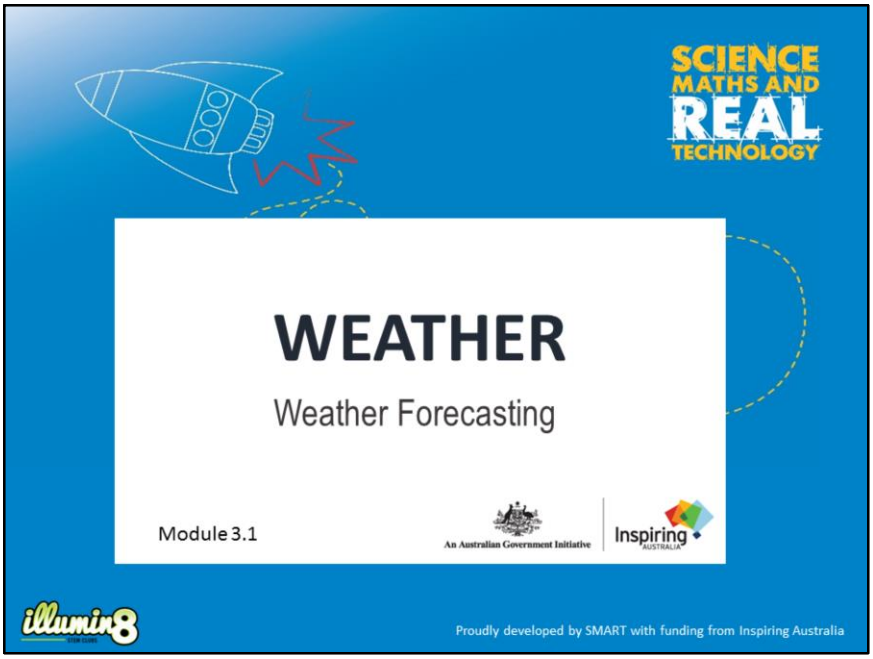


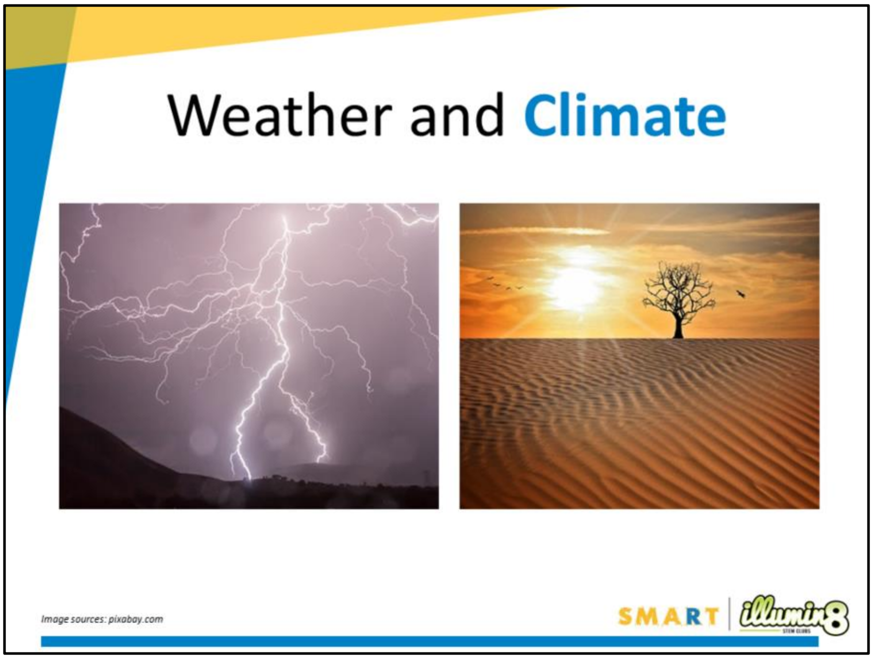
Welcome back, and welcome to new participants!
In this Module, Module 3.1 we're going to explore the science around WEATHER!
Today's session explores weather forecasting.

Ask students if they can think of ways the weather impacts peoples lives.
It is useful to be able to forecast, or predict, what the day to day weather will be.
Weather has a huge impact on how we go about our daily lives:

- It can determine what activities we can do each day.
- It can affect our food supply.
- It can also have a big impact on our safety (air travel, ocean travel, storms, floods, fires).

For example:

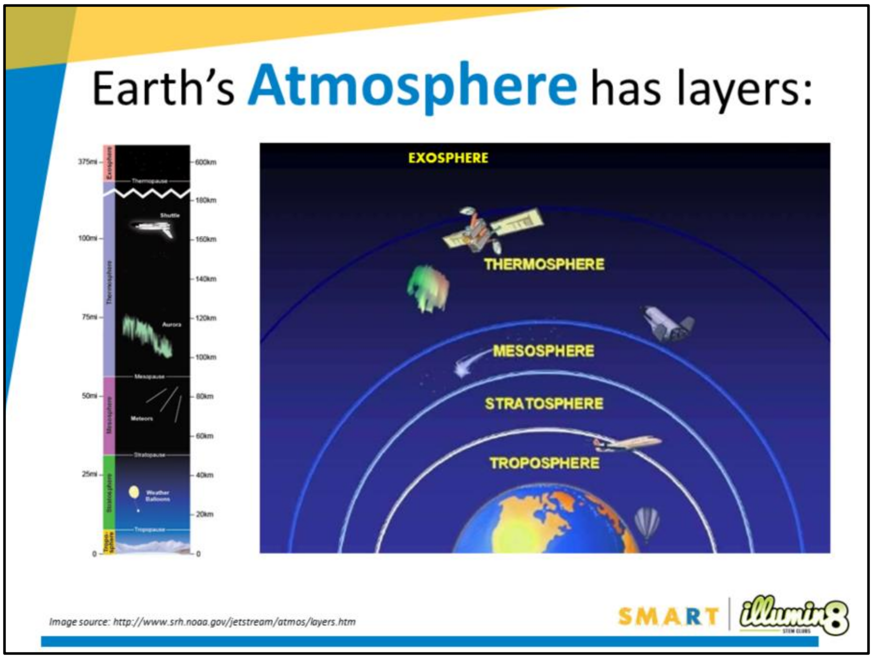
- if it rains, your soccer game might be cancelled or you might decide against going for a swim.
- if hot temperatures and winds occur for a period of time there could be danger of a bushfire starting.
- if adverse weather like hail falls on our food crops, they may be ruined and cause shortages of certain foods.



The difference between weather and climate, is a measure of time.
Weather is the way the atmosphere is behaving in a short time frame. Our weather can change quickly from day to day, and hour to hour.
Climate is the way the atmosphere behaves over long periods of time, ranging from a single month to millions of years. Climate describes long-term, average weather conditions. Climate conditions can change very slowly over a long time, due to both natural and man-made causes

For example, Australia usually expects a hot summer, and a cold winter. This is the way our climate behaves.
The actual conditions we experience on a certain day, is the weather! We may experience a cooler than normal day during the summer months, even though we know summer is typically a hot period for our climate.

The science of understanding our day to day (and hour to hour) weather is called *Meteorology.* The science of understanding the climate is called *Climatology.*



The weather conditions we experience on the ground are actually formed up in the **atmosphere!**

The atmosphere is the name we give the blanket of air surrounding the earth (and other planets).

There are 5 main layers in the atmosphere above the Earth: Troposphere, Stratosphere, Mesosphere, Thermosphere, Exosphere.

The troposphere is the layer closest to earth. Almost all common weather we see on earth occurs in the ***Troposphere*.** It is between 7 kilometres and 18 kilometres thick! Some weather also occurs in the Stratosphere.

There are tiny particles of dust within our atmosphere.

https://www.nasa.gov/mission_pages/sunearth/science/atmosphere-layers2.html

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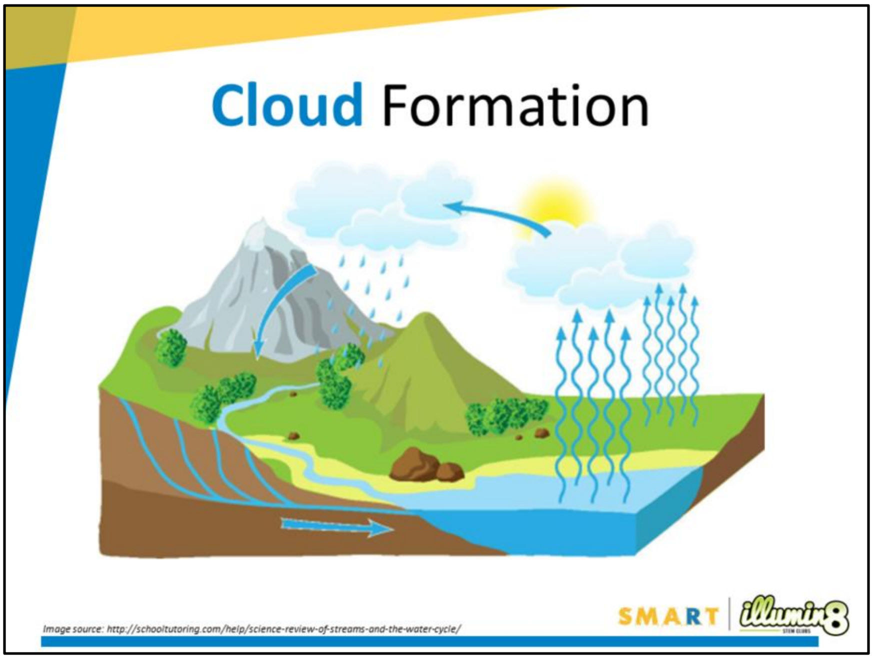
Extension facts:

- The troposphere is the lower layer of atmosphere which reaches to the surface of the earth. Temperature and pressure decrease as you travel up through the troposphere, and it gets colder as you move away from the earth within the troposphere.
- The troposphere holds almost all the atmospheric water vapour
- The troposphere and tropopause (the area before stratosphere begins) are known as the lower atmosphere.
- The stratosphere holds about 19% of the atmosphere's gases. Along with the mesosphere,

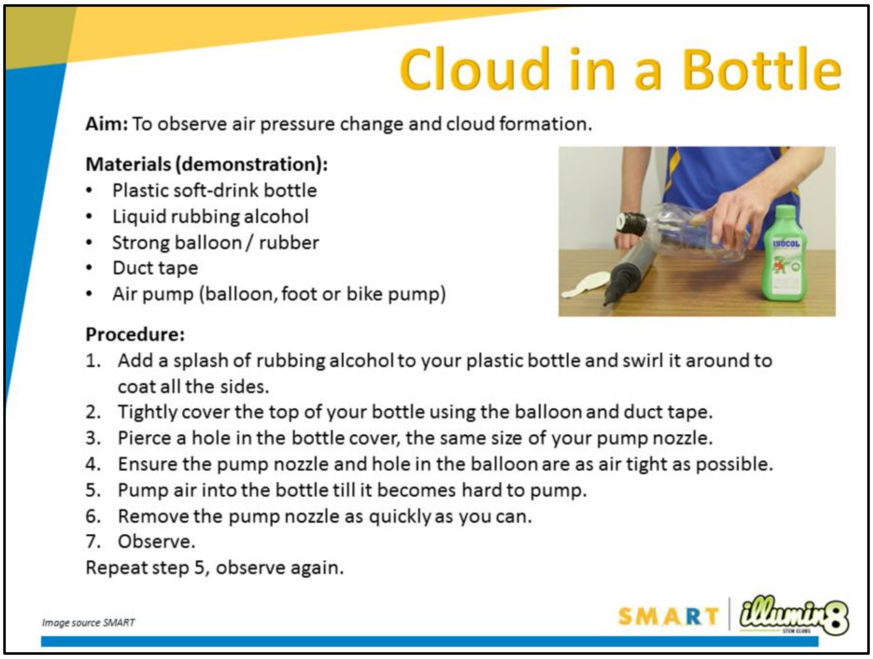
it makes up the middle atmosphere. It also contains the ozone layer. The formation of ozone produces heat, so the top of the stratosphere is actually warmer than the lower parts.

- The mesosphere is more dense and the temperature increases toward to bottom of the layer. The dense gases can slow meteors down as they hurtle toward earth.
- The thermosphere is also known as the upper atmosphere. Temperatures at the bottom of this layer can be as cold as -120 °C and the upper part can reach 2000 °C. This is because some of the sun’s radiation is absorbed, causing the gases to heat up.
- The exosphere is the outer-most layer which borders the rest of outer-space. Space shuttles orbit the earth just outside the exosphere.



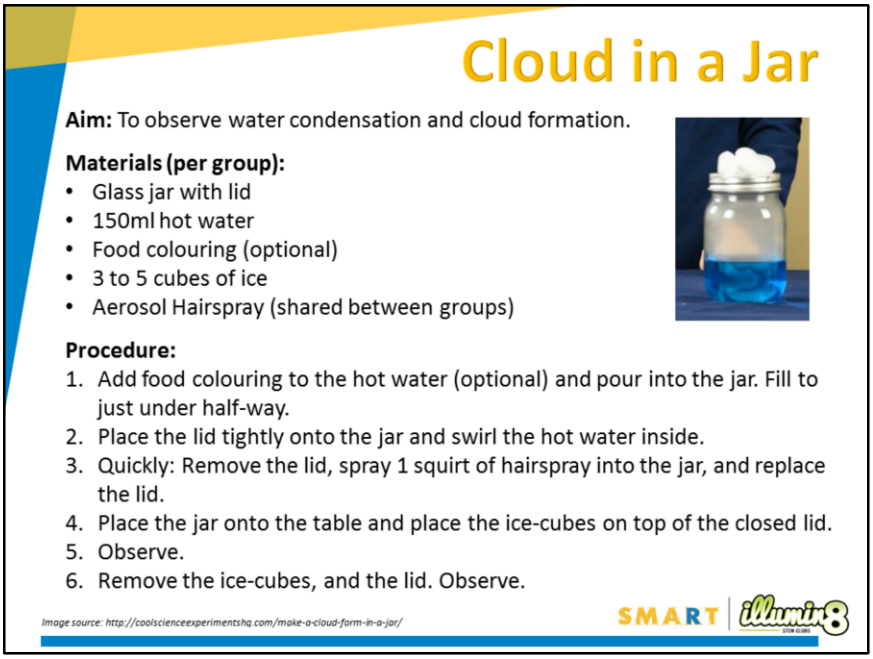
Clouds have their origins in the water that covers 70 per cent of the Earth's surface!
Every day, liquid water in the ocean, lakes, rivers, ground and in plants, heats up, changes into gas form, and rises up into the atmosphere. We call this process **evaporation.**
As air containing water vapour rises up through the atmosphere, it encounters lower pressures and temperatures, causing it to expand and cool down. As air cools, it can hold less water vapour. The water vapour **condenses** into tiny water droplets, which form around tiny dust particles in the atmosphere. These water droplets are a million times smaller than rain drops. As they join together, they forming **clouds.** Whenever clouds appear, they provide visual evidence of water in the atmosphere.
As more and more water vapour condenses within a cloud, the droplets of liquid water continue to bump into each other, join together, and get bigger, until they are too heavy to stay in the cloud, and they fall as rain! If it is cold enough, the water droplets will freeze and fall as snow or hail.
This process of water evaporating and condensing into clouds and then falling as rain is called **the water cycle.**
Remember, water vapour is what you see when you boil a kettle, and steam comes out. It is the gas form of water, and is formed when liquid water molecules are heated up.

http://splash.abc.net.au/home#!/media/30186/where-does-rain-come-from-



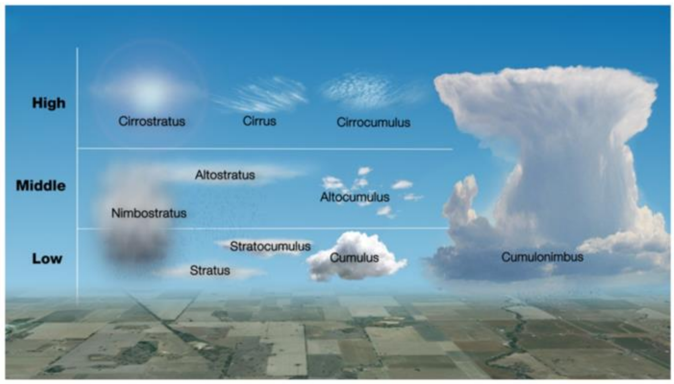
This experiment is a facilitator demonstration.
Refer to the Module 3 Risk Assessment before undertaking the experiment.
Refer to coordinators notes for Experiment E3.1.2.
Encourage students to form a hypothesis prior to conducting the experiment about what might happen. Discuss observations and results and compare to hypotheses after the experiment.

This experiment is demonstrated in the Module 3 video.
Online link: https://www.stevespanglerscience.com/lab/experiments/cloud-in-a-bottle-experiment/



This experiment is a facilitator demonstration.
Refer to the Module 3 Risk Assessment before undertaking the experiment.
Refer to coordinators notes for Experiment E3.1.3.
Encourage students to form a hypothesis prior to conducting the experiment about what might happen. Discuss observations and results and compare to hypotheses after the experiment.

The ten main types of cloud



https://youtu.be/3WaAaMaQftg
Video: What's that Cloud? (Bureau of Meteorology)

Image source: http://media.bom.gov.au/social/blog/895/whats-that-cloud/

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There are a many different cloud types! All clouds are actually white in colour, but when viewed from the ground, some appear grey or dark grey according to their depth and shading from higher cloud. You'll generally notice two different appearances of clouds, layers of cloud that look like sheets, and clumpy clouds that look like smoke plumes.

Clouds are given **Latin names** which describe their characteristics, including:

- cirrus (a hair)
- cumulus (a heap)
- stratus (a layer)
- nimbus (rain-bearing).

The ten main types of clouds are: Stratus, Stratocumulus, Cumulus, Nimbostratus, Altostratus, Altocumulus, Cirrostratus, Cirrus, Cirrocumulus and Cumulonimbus.

Did you know clouds can actually help scientists forecast the weather? For example:

Stratus: found in the low levels of the atmosphere, tend to produce a light drizzle;

Altostratus: ('alto' meaning high), found in the middle level, tend to be very good rain producing systems

Nimbostratus: are formed when altostratus undergoes further vertical development, allowing the cloud to hold more moisture, and causing the cloud base to lower and produce heavier rainfall

Clouds are categorised based on their height, shape, colour and associated weather.

- Low clouds are formed between the Earths surface up to 2.5km into the atmosphere.

- Middle clouds form between 2.5km and 6km above the Earth's surface.
- High clouds are more than 6km above the Earth.

Video: What's that Cloud? (Bureau of Meteorology) https://youtu.be/3WaAaMaQftg

Any water vapour that falls to the ground from the atmosphere is called **precipitation**. This includes: rain, hail and snow.
Discussion:
How do we know when it's going to rain?
Ideas: see grey clouds in the sky, temperature, smell, weather forecast, sky colour, achy joints / bones, see ants running around.

Video: How do you know when rain is coming:
http://splash.abc.net.au/home#!/media/30177/how-do-you-know-when-rain-is-coming-

Rain Cloud

Aim: To simulate rain falling from clouds.

Materials (per group):
- 2 clear cups or jars
- 250ml water
- Food colouring
- Pipette or straw
- Handful of shaving cream

Procedure:
1. Pour water into cup 1, filling to approx. 3/4 full.
2. Pour remaining water into cup 2, add a few drops of food colouring. Stir.
3. Place a cloud of shaving cream onto the surface of the clear water in cup 1.
4. Using the pipette (or straw), add droplets of the coloured water to the top of the cloud.
5. Observe.

Image sources: https://www.teachpreschool.org/2012/03/10/clouds-in-jars-and-on-the-table-top-too/ http://www.kidspot.com.au/things-to-do/activity-articles/rain-cloud-in-a-jar-science-experiment/news-story/15c6693d124b82a9b0a968efa4d76a03?

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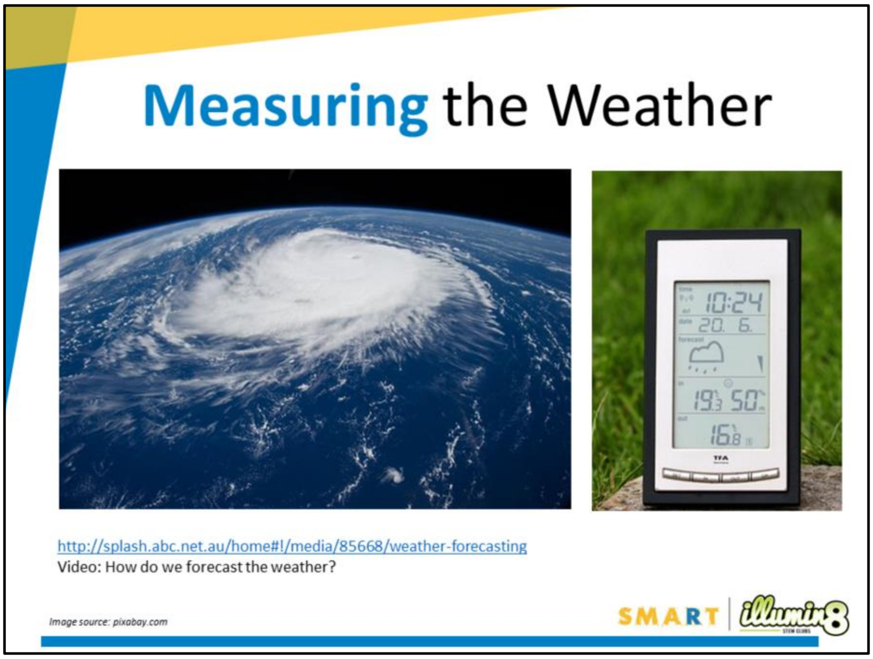
Refer to the Module 3 Risk Assessment before undertaking the experiment.
Refer to coordinators notes for Experiment E3.1.4.
Encourage students to form a hypothesis prior to conducting the experiment about what might happen. Discuss observations and results and compare to hypotheses after the experiment.



Weather measurements can be made by modern equipment in automatic weather stations, or they can be collected by observers using older techniques.

Weather stations measure:

- temperature,
- air pressure,
- wind,
- rainfall, and
- humidity.

Automatic stations can record measurements as often as every minute.

Observing the weather can help scientists to study what is happening now, and what has happening in the past. Past and current weather observations provide useful data for scientists, to use in complex mathematical equations, to predict likely changes to the atmosphere and weather over the coming hours and days. This is called **forecasting.**

http://splash.abc.net.au/home#!/media/85668/weather-forecasting

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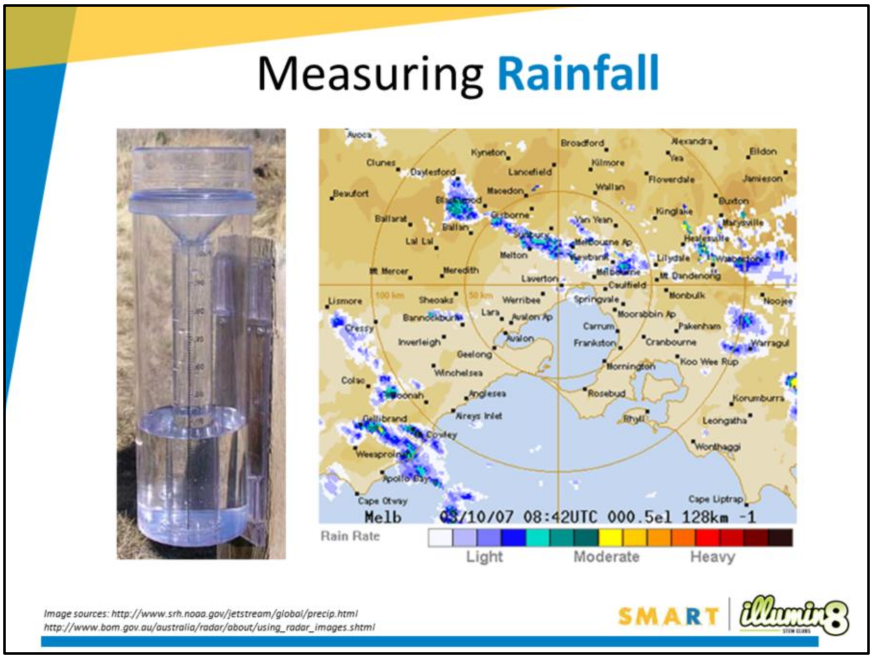
Extension:

In Australia, the Bureau of Meteorology (BOM) operates more than 600 automatic weather stations across the country, including several offshore on reefs and islands.

In some locations, the BOM also use high-tech weather balloons, which measure the temperature and wind speed within the atmosphere as they rise. They use radar to track the

weather balloons, and also use radar to measure where and how heavy rainfall is.
Ships and aircraft assist with weather observations from remote areas of the ocean and the upper atmosphere.
The BOM also receive continuous weather information from 2 advanced weather satellite networks, Japan’s MTSAT satellites and China’s Feng Yun-2 network.
http://media.bom.gov.au/social/blog/314/three-steps-to-australias-best-weather-forecasts/
Video: About Satellite Images:
http://www.bom.gov.au/australia/satellite/about_images.shtml



One way we measure and record rainfall with **rain gauges.** Rain gauges measure the amount of rain that falls in one place. They can be manual (checked by people) or automatic (observations measured and recorded electronically). The unit of measurement for rain gauges is most commonly **mm** (millimetres).

The Australian Bureau of Meteorology's radar images are available on the internet, and show current the location of rain in relation to local features such as the coastline, with different colours used to depict rainfall intensity. For example off-white represents light drizzle, while dark red is used to depict very heavy rain (possibly containing hailstones). There are fifteen levels of rainfall intensity shown on the radar images, each level provides an approximate indication of the rainfall rate in millimetres per hour.

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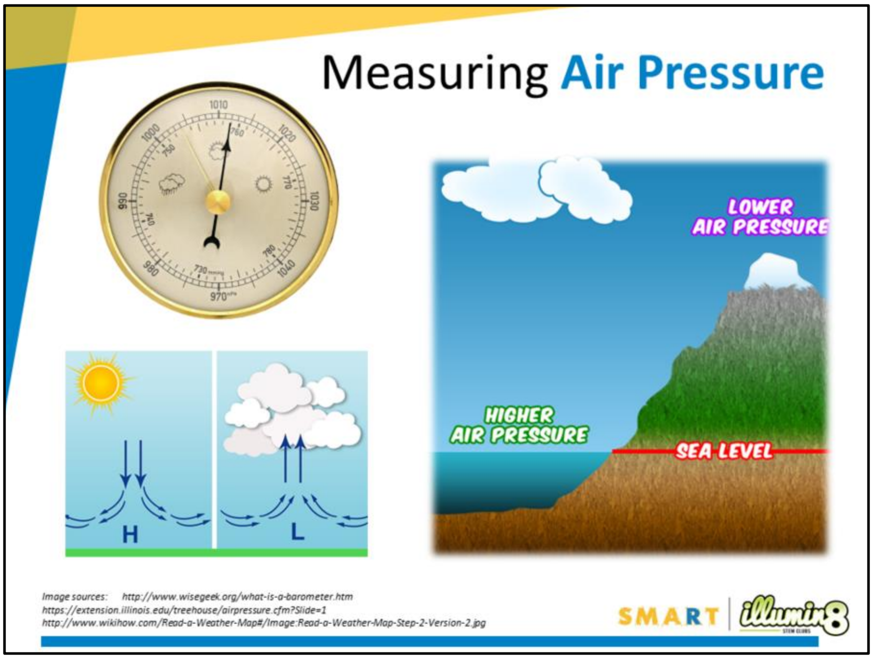
A standard rain gauge is a circular funnel, with a diameter of 203mm (8 inches!). They can usually record up to 25mm of precipitation. Any excess rainfall is captured in an outer (often metal) cylinder. The top of a standard rain gauge positioned is 0.3m (30 centimetres) above the ground.

http://www.bom.gov.au/climate/cdo/about/rain-measure.shtml

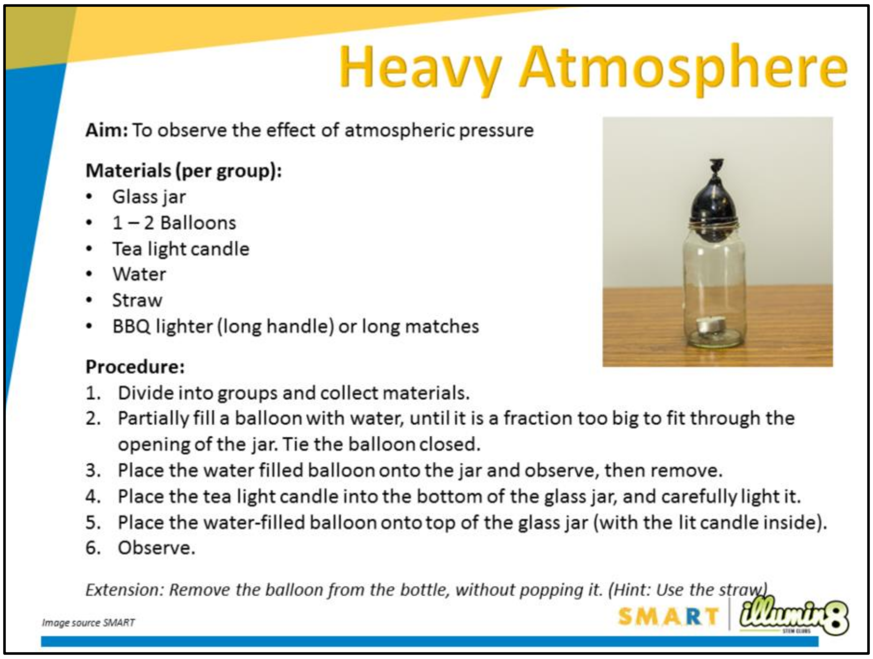


Our atmosphere is made up of air!
When talking about the weather, we describe air pressure as *atmospheric or barometric pressure*.
When we measure air pressure, we measure the ‘weight’ of the earth’s atmosphere on a certain place.
The more air above us, the higher the air pressure will be.
As we rise up through the atmosphere the air pressure gets lower, because there is less air weighing down on us.
Air pressure is measured using a **Barometer.** You can see that the barometer indicates low pressure as bringing bad weather (cloudy) and high pressure as bringing fine weather (sunny).

High and low air pressure:
When air heats up, its particles more around faster and spread out, and it becomes less dense.
Hot air naturally rises up into the atmosphere, to sit above more dense, cooler air, and this process creates a **low pressure (L)** system. Low pressure weather systems generally bring bad weather (clouds and rain)!
When air cools down, its particles move closer together, and it becomes more dense

and sinks toward the ground. This sinking air presses down on the earth, giving us a **high pressure (H)** system. High pressure weather systems generally bring good weather (hot, sunny).

The standard units of measure for air pressure are called Hectopascals (**hPa)**. 1 hPa unit is equal to 100 Pascals, or 1 millibar. The units of atmospheric pressure historically used were called ‘bar’. Some countries still use the pressure measurement ‘psi’, pounds per square inch.



This experiment demonstrates atmospheric pressure change.
Refer to the Module 3 Risk Assessment before undertaking the experiment.
Refer to coordinators notes for Experiment E3.1.1.
Encourage students to form a hypothesis prior to conducting the experiment about what might happen. Discuss observations and results and compare to hypotheses after the experiment.

Wind speed and direction can have big effects on weather.
Wind blows because air naturally moves from areas of high pressure, to areas of low pressure. The greater the pressure change, the faster the wind.
A **wind sock** or **weather vane** measures wind direction. This is reported as directions on a compass: **N, S, E, W**.
An **anemometer** measures wind speed. The cups of an anemometer catch the wind, causing them to spin. The speed of the spinning cups is measured in kilometres per hour **(km/h).**
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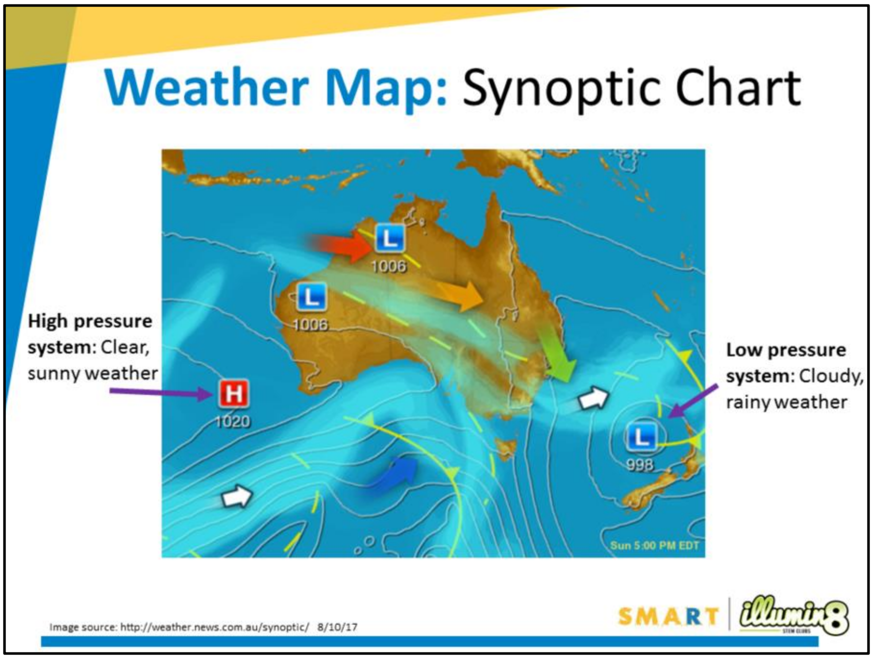
A wind that blows mainly from a single direction, at a particular location on or during a particular season, is called a **prevailing wind.** If prevailing winds change direction, weather may be out of the ordinary for that location or season.



A weather map showing the air pressure, rainfall, wind and temperature patterns is called a **synoptic chart.** These maps show a short-term forecast, a snapshot of atmospheric conditions at a particular time.

- Arrows on the map point in the prevailing direction of winds.
- Light blue areas show areas experiencing rainfall.
- Symbols ‘L’ and ‘H’ indicate low and high pressure systems.

Whether there is a high or low pressure system above an area has a huge effect on the weather experienced.
The air in a high pressure system is always trying to move towards a low pressure system.
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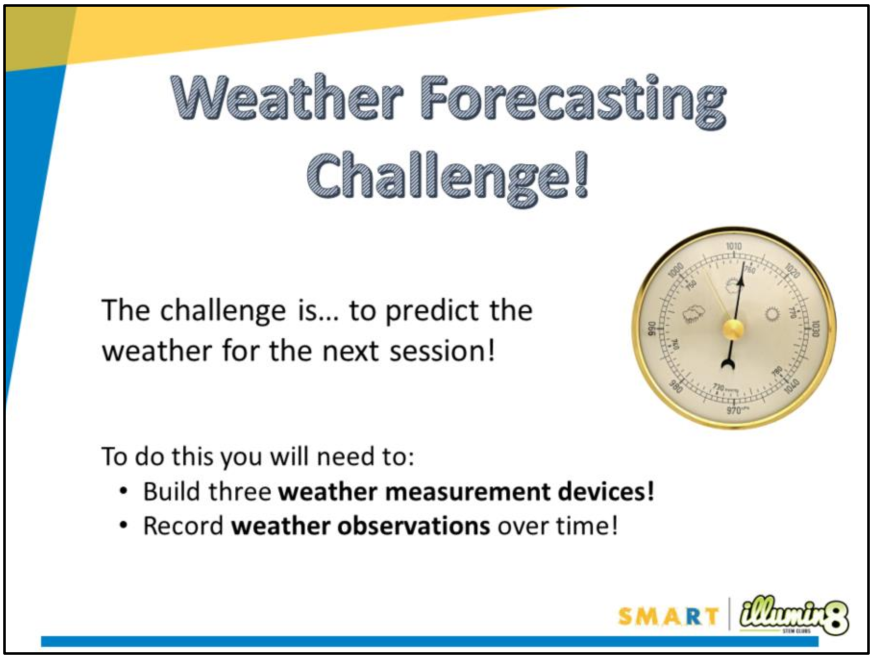
EXTENSION:
The white lines on the weather chart are called **isobars.** They show places with the same pressure. When the isobars are close together the wind is likely to be stronger, than in places where the isobars are spread further apart.
The yellow lines on the map indicate moving weather features, for example **cold fronts.** A cold front occurs when a mass of cold, dense air pushes up under a mass of warm air, forcing it to rise. As the warm air rises, it cools and condensation takes place (clouds form, and it may rain). Lower (colder) temperatures are experienced once the front has passed.

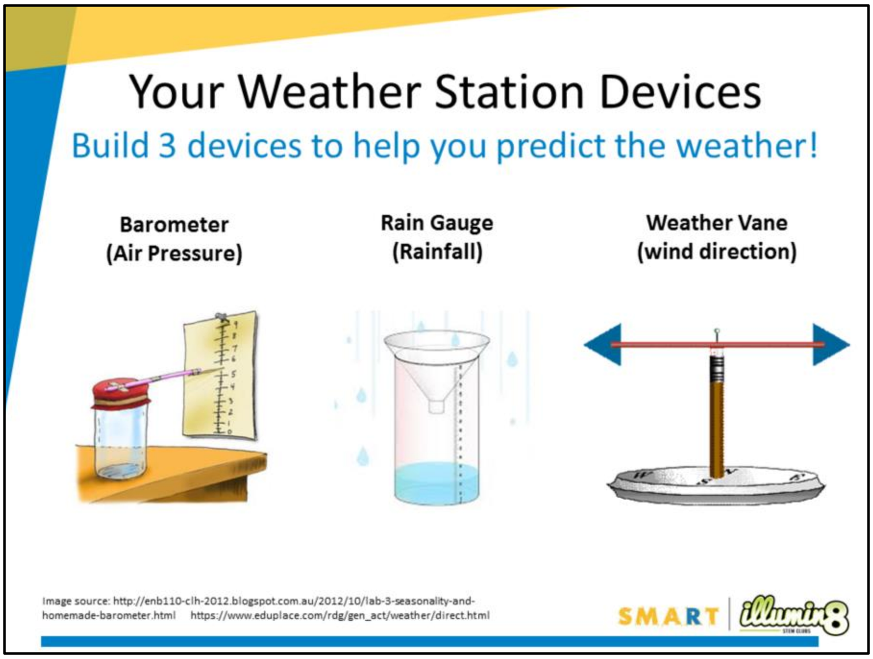
High Pressure System. Typically: Stable conditions, gentle winds, clear skies, little chance of

rain. Air pressure increases towards the centre of the system. Air flows out of the high pressure system in an anti-clockwise direction.
Low Pressure System. Typically unstable weather conditions, cloudy skies, rain, strong winds. Air pressure decreases towards the centre of the system. Air flows in a clockwise direction in a low pressure system n the Southern Hemisphere (and anti-clockwise in the Northern hemisphere!)

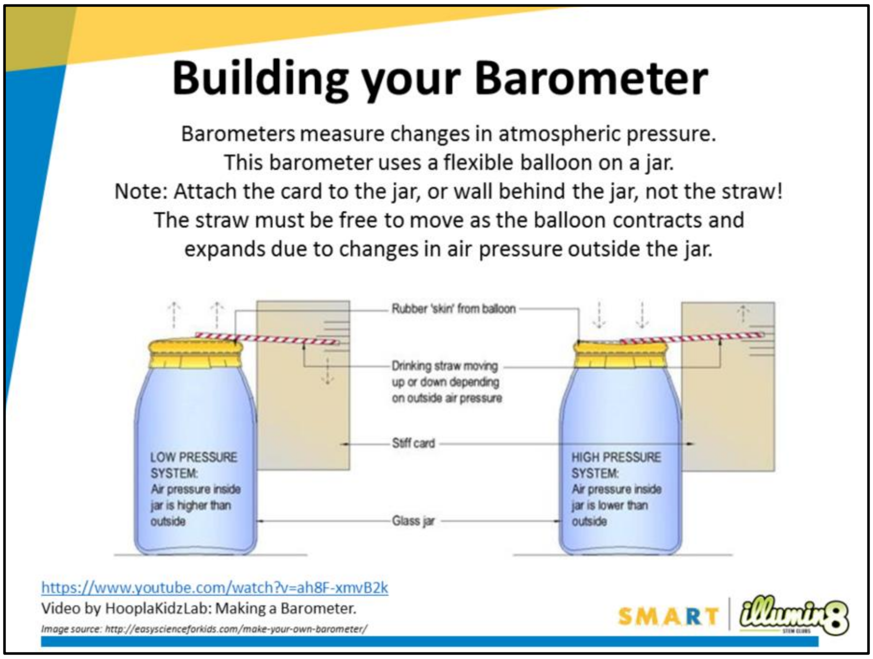
http://www.geogspace.edu.au/verve/_resources/2.3.2.2_1_weather_maps.pdf



Provide students with the weather diary / observation hand out. If they have time to complete this for the days leading up to the next session, they may be able to predict the next session's weather!



This week students will build their own weather station devices.
Students may choose to build 1 of each individually, or form groups of 3 and share the devices.
Provide students with the planning sheets and a range of materials for each device.
Encourage the barometer to be built first, so that a reading can be taken when the device is complete, and again at the end of the session.



Encourage students to make the barometer first. That way, they can take a reading when the barometer is completed and another toward the end of the session, and observe any change in air pressure during the session.
The balloon will need to be stretched as flat as possible across the jar. A mark should be made on the card to indicate the starting point for the straw, then write 'High' at the top of the card, and 'Low' at the bottom.

As the pressure in the atmosphere increases, air will push harder against the balloon on the jar. This is because the air in the jar is of lower pressure compared to outside, and air always wants to move from high to low. The high outside air pressure pushes the balloon into the jar, and this causes the straw to angle upwards. The reverse happens when the outside atmospheric pressure drops. Therefore the high pressure mark should be at the top of the page and low pressure mark at the bottom.

HooplaKidsLab Barometer Making Video: https://www.youtube.com/watch?v=ah8F-xmvB2k

Building your Weather Vane

Weather vanes indicate which direction the wind is blowing!

Use a compass so the vane can be set up to indicate if the wind is blowing north, south, east or west.

The tail fin must be bigger than the arrow fin.

The wind will catch the arrow tail and cause the arrow to point in the direction the wind is coming from. Weather vane arrows always point toward the on-coming wind.

Wind direction

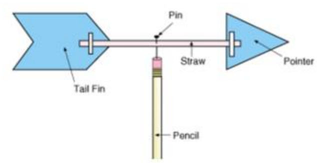


Image sources: http://www.nsta.org/publications/news/story.aspx?id=40875
http://preservinghomebasics.com/2011/11/weather-crafts-for-children

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Provide students with the Weather Vane planning sheet and a range of materials to choose from.
There are no right or wrong designs!
Students taking home the weather vane to measure wind direction at home will need access to a compass at home to set the weather vane up accurately. Most mobile phones will have a free compass application, in built or downloadable. Students could also take note of which direction the sun rises at their home, and which direction it sets, to align the weather vane East / West.

Encourage students to be creative with their designs.
Key features: opening to capture rain, measurement system to measure depth of rain collected.
Students may like to fill the base of their container (if the base / bottle is not flat) to improve the zero reading.

References

Climate and Weather

https://www.nasa.gov/mission_pages/noaa-n/climate/climate_weather.html

Clouds

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Atmosphere

https://www.nasa.gov/mission_pages/sunearth/science/atmosphere-layers2.html

Air Pressure

http://www.abc.net.au/science/articles/2013/01/31/3679358.htm

https://www.livescience.com/40664-balloon-barometer-science-fair-project.html

Weather Measurement

http://splash.abc.net.au/home#!/media/85668/weather-forecasting

http://www.metoffice.gov.uk/learning/weather-for-kids/weather-station/rain-gauge

http://splash.abc.net.au/home#!/media/528041/day-in-the-life-of-a-meteorologist

http://splash.abc.net.au/home#!/media/527997/a-day-at-the-geraldton-weather-station

http://splash.abc.net.au/home#!/media/30213/making-a-rain-gauge

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