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Grade Five

Weather Watch

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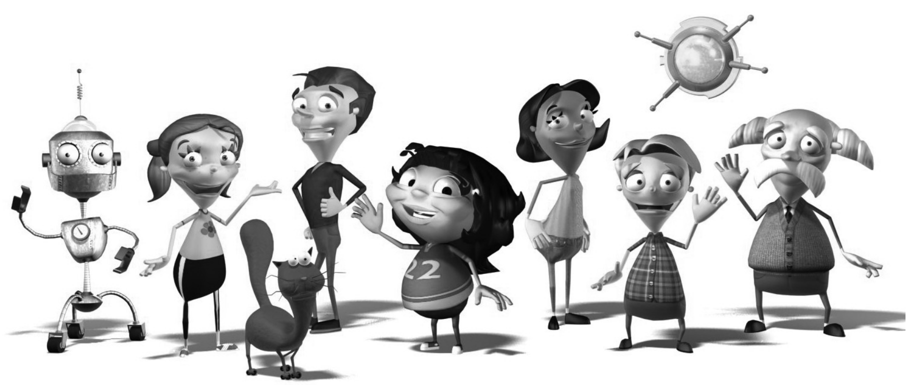

Weather Watch

Before You Begin

Students learn about weather phenomena and the methods used for weather study. They learn to measure temperatures, wind speed and direction, the amounts of rain and snow, and the amount of cloud cover. In studying causes and patterns of air movements, students learn about the effects of uneven heating and cooling and discover the same patterns of air movement in indoor environments as are found outdoors. They also learn about human actions that can affect weather and climate and study the design and testing of clothing used as protection against the weather.

Topic D: Weather Watch

(Suggested time: 6 – 8 weeks)

The majority of this unit is best done during a season with a wide variety of weather, such as fall or spring. However, it is beneficial to be on "weather watch" during the full school year. Have the students keep weather journals. Take advantage of seasonal changes; measure the amounts of rain and snow when they fall. It is beneficial for students to see actual meteorological equipment in addition to the instruments they construct. If you intend to borrow equipment, have a guest speaker bring equipment, or have your class tour a weather station; advanced planning is advisable.

Safety Issues

- Discuss dangers of lightning with students. Inform them that they should not be the tallest, or be under the tallest, thing during a thunderstorm. Also, if they feel a "tingling sensation," it could mean lightening is about to strike. They should immediately crouch into as small a ball as possible.
- If students are using tools to construct their weather instruments, they should be closely supervised.

Background Information

Are you someone who equates the word *weather* exclusively with storms? True, we don't tend to pay much attention to weather unless it threatens to affect us adversely. However, the term encompasses all day-to-day variations in temperature, humidity, *barometric pressure* (air pressure), wind conditions and precipitation—sunny, warm weather included. Note that climate and weather are not one and the same thing. *Climate* refers to the long-term weather trend in any given region of the world. For instance, a few days of rainy weather in February do not change the fact that Las Vegas enjoys a hot desert climate most of the year.

Patterns of Air Movement

All weather, good and bad, is the result of local and global energy exchange processes. Every day the Earth is bombarded by energy from the Sun. Nearly 40% of this energy is reflected back into space. Weather systems arise as a direct consequence of the different rates at which air, land and water absorb and radiate the remaining 60% of this incoming solar energy. Ocean currents and wind are responsible for distributing the energy over the globe.

Water retains the heat it absorbs to a much greater extent than land. Though temperatures on land can fluctuate greatly from day to night and from season to season, the temperature of an open body of water changes relatively little. During daytime and during the hot summer months, the air above land is warmer than the air over water. This warm, less-dense air rises, and cool, moisture-laden air from the ocean rushes inland to take its place, creating breezes that blow in from the sea *(sea breezes)*. At night and during the cold winter months, the air above open water is warmer than the air over land, so the process is reversed and breezes blow out to sea *(land breezes)*.

Water Cycle

The solar energy stored in bodies of water is transferred to the atmosphere primarily through water vapour. Water vapour is generated by the process of *evaporation*, the release of water molecules from moist or wet surfaces. How fast water evaporates is a function of air temperature, wind speed and how much moisture the air is able to absorb. Warm air can hold greater amounts of moisture then cold air: in fact, 27°C air can hold six times as much water vapour as air at 0°C. It is estimated that, on average, a water molecule evaporated at the Earth's surface spends roughly 10 days in the atmosphere and travels anywhere from 5,000 to 10,000 kilometres before it returns to the ground in some form of precipitation.

Clouds

Clouds are formed when warm, moisture-laden air rises through the atmosphere to regions of increasingly lower *atmospheric pressure* (the average value of atmospheric pressure at sea level is about 1,013 millibars; this figure decreases about 100 millibars for every kilometre above sea level). As the air rises, its temperature gradually drops to the *dew point*; water droplets condense and clouds form. If it is cold enough, snowflakes form instead of raindrops. This can happen even on a hot summer day. *Thunderheads* rise so high into the sky that their upper parts extend into extremely cold layers of the atmosphere where moisture turns to snow. Normally, this snow melts into rain before it ever reaches the ground. However, if there is a strong updraft within the cloud, the partially melted snow is blown back up into the cooler regions where it is refrozen into *hail*. In fact, if the updraft is extremely strong, a single hailstone can be blown back into the freezing region several times, accumulating moisture and becoming larger with every trip upward.

There are four categories of cloud based on general appearance: *cirrus* (wispy, high clouds), *cumulus* (billowy clouds), *stratus* (layer clouds) and *nimbus* (rain clouds). These appear in various combinations depending on altitude. At high altitudes (5-13 km) you find cirrus, cirrocumulus and cirrostratus clouds. Middle altitudes (2-7 km) are the realm of altocumulus, altostratus and nimbostratus clouds. Low altitudes (0-2 km) harbour stratocumulus, stratus, cumulus and cumulonimbus clouds.

Clouds are generally associated with *low pressure systems* (areas of the atmosphere where less-dense air is rising). As a low pressure system approaches, you will see streaks or wisps of high, cirrus clouds for two or three hours. Over the next few hours, these gradually thicken into an increasingly dense, increasingly lower layer of stratus cloud. Small clumps of cumulus and cumulonimbus clouds begin to form below the stratus layer. The wind picks up, the barometric pressure and temperature begin to fall and soon the rain starts.

Weather Instruments

A *meteorologist* (a person who studies weather) uses many different instruments to measure local weather conditions.

- A *barometer* is used to measure *atmospheric pressure* (the force of the atmosphere on a unit area of surface). Measurements are in millibars. Generally, poor weather is associated with low pressure, and clear skies with high pressure.
- *Wind direction* (for example, the direction it is blowing from) is measured by a free-swinging *weather vane* in degrees clockwise from North. *Wind speed* is measured in knots. One way of doing this is by using a *cup anemometer*. This device has three cups on spokes radiating from a shaft

attached to a small electric generator. As the wind spins the cups, the shaft is turned and an electric current is generated and recorded. Its strength can be calibrated to the wind speed.

- *Precipitation* (rainfall or snowfall) can be measured by noting the depth (in millimetres) of precipitation that has accumulated in a straight-walled container over a 24-hour span. Meteorologists use slightly more sophisticated devices, but they work on the same principle.
- *Temperature* readings (°C) are made in the shade, roughly a metre above ground. If a thermometer is left out in direct sun, it records the temperature of the glass containing the mercury, not the temperature of the surrounding air.
- *Humidity* (the amount of water vapour in the air) can be measured several ways. The most commonly heard measurement is *percent relative humidity*, measured by an instrument called a *psychrometer*. This device compares current conditions against a situation of 100% humidity (for example, total wetness: fog or rain). You can prove the air contains water by placing ice in a dry, waterproof container. Soon water droplets will accumulate *(condense)* on the outside of the container. The moisture can't have come through the waterproof container from the inside, so it must have been present in the surrounding air all along.
- *Satellites* orbiting the Earth collect weather information and can show weather patterns that cannot be seen from Earth.

All the above measurements are taken in an effort to track weather systems and predict upcoming local conditions. It is important to know what to expect in advance so people can prepare for adverse situations such as hurricanes, tornadoes, freezing temperatures, hail storms, floods, droughts and overexposure to ultraviolet radiation.

How Human Actions Affect Climate

Through the centuries, humankind has dreamt of being able to affect these elements, and to some degree we have—both intentionally and unintentionally. Cloud seeding has been developed to coax rainfall onto areas that badly need moisture, and to prevent formation of hail (although the jury is still out on the validity of this technique). Deforestation, on the other hand, has unintentionally brought about a drier, hotter climate in some parts of the world. And, on a global scale, we might be doing even more serious damage. A delicate balance exists between the amount of energy absorbed by the Earth during the day and the amount radiated at night. The long wave-lengths of the radiated energy can be absorbed by water vapour, clouds and carbon dioxide present in the atmosphere. As the carbon dioxide level increases due to human industrial activities, more radiated energy remains trapped in the atmosphere. It is believed that, over time, the average air temperature will rise and with it the amount of water vapour absorbed in the air, so even greater amounts of radiated energy will become trapped. This scenario of escalating global heating is often referred to as the *enhanced greenhouse effect*.

On a more positive note, technology has allowed us to develop materials and fabrics that protect us from the drastic range of weather elements present on our planet. Surprisingly, much of this technology is a spin-off from space research where lightweight fabrics capable of protecting astronauts from extreme heat and cold was a priority.

Elementary Science Program of Studies

General and Specific Learner Expectations

The following general and specific learner expectations have been taken directly from the 1996 Elementary Science Program of Studies. The specific learner expectations (SLEs) are referred to by number in the second column of the activities table.

General Learner Expectations

Students will be able to:

- Observe, describe and interpret weather phenomena, and relate weather to the heating and cooling of the Earth's surface.
- Investigate interactions between weather phenomena and human activity.

Specific Learner Expectations

Students will be able to:

1. Predict where, within a given indoor or outdoor environment, one is likely to find the warmest and coolest temperatures.
2. Describe patterns of air movement, in indoor and outdoor environments, that result when one area is warm and another area is cool.
3. Describe and demonstrate methods for measuring wind speed and for finding wind direction.
4. Describe evidence that air contains moisture, and that dew and other forms of precipitation come from moisture in the air.
5. Describe and measure different forms of precipitation; in particular, rain, hail, sleet, snow.
6. Measure at least four different kinds of weather phenomena. Either student-constructed or standard instruments may be used.
7. Record weather over a period of time.
8. Identify some common types of clouds and relate them to weather patterns.
9. Describe the effects of the Sun's energy on daily and seasonal changes in temperature—24-hour and yearly cycles of change.
10. Recognize that weather systems are generated because different surfaces on the face of the Earth retain and release heat at different rates.
11. Understand that climate refers to long-term weather trends in a particular region and that climate varies throughout the world.
12. Recognize that human actions can affect climate and identify human actions that have been linked to the greenhouse effect.

13. Appreciate how important it is to be able to forecast weather and to have suitable clothing or shelter to endure various types of weather.
14. Test fabrics and clothing designs to choose those that most effectively meet the challenges of particular weather conditions; e.g., water resistant, wind resistant, protection from cold.

Cross-curricular Connections

Mathematics

- Measure precipitation, temperature, wind speed, etc.
- Graph weather data.

Art

- Draw clouds, creating weather collages.

Social Studies

- Study how people's lives are influenced by climate around the world.

Children's Alternative Frameworks

Children find it difficult to believe that water is in air since they cannot see it. Differences in air pressure, leading to wind, is usually interpreted as being a push. Moving air is actually always being pulled from colder to warmer regions. This understanding will help when it comes to grade 6 Flight (Bernoulli's Principle).

Activities

Classroom teachers have identified the following activities that may be done to address the Specific Learner Expectations (SLEs) in the Program of Studies. The list is not prescriptive and teachers may select activities that are most appropriate for their students.

Activities have been listed under two headings: Key Activities and Extension Activities. Key activities are supported by authorized resources and identify "powerful and practical" means for achieving learner expectations. Extension activities represent alternative ways of achieving or supporting learner expectations.

Key Activities

Key Activity	SLE	Print Resources	Essential Materials	Comments
Increasing awareness of weather and determining students' prior knowledge about weather		*Innovations in Science, Level 5, Weather Watch (Hunting for Weather)*, p. 8 *Explorations in Science, Level 5, Whatever the Weather (Discovery Circle)*, p. 8		Another way to discover students' prior understanding is to have them respond to a variety of questions in their journals or notebooks. For example: What do you think the following terms mean: wind speed, humidity, air pressure, etc.? What causes it to rain?
Predicting and measuring temperature in a wide variety of locations within an environment	1	*Explorations in Science, Level 5, Whatever the Weather (How Hot Is It?)*, p. 10	thermometers	After choosing an environment (school grounds, school building, classroom), have students first predict and then measure temperatures to test their predictions.
Setting up a weather station and recording weather over a period of time	3, 4, 5, 6, 7	*Explorations in Science, Level 5, Whatever the Weather (Weather Instruments)*, p. 12 *Explorations in Science, Level 5, Whatever the Weather (Weather Station)*, p. 14 *Innovations in Science, Level 5, Weather Watch (Gauging Rain)*, p. 18 *Innovations in Science, Level 5, Weather Watch (Rising Temperatures)*, p. 28 *Innovations in Science, Level 5, Weather Watch (Catch the Wind)*, p. 32	thermometers (avoid mercury thermometers as mercury is toxic), barometers, plastic drinking straws (clear), mirrors, wood bases and posts, hammer and nails, plastic pop bottles, food colouring, tin cans, Ping Pong balls, protractors, funnels, coat hangers, balsa wood, dowel, glass jars, balloons, compasses	The weather station should be set up early in the unit so students can record weather data over a long period of time. Weather instruments may be standard or student constructed. Having students build their own devices has certain advantages, including a more hands-on approach as well as a technological aspect. Setting up a weather station that measures at least four different weather phenomena (including precipitation, wind direction and wind speed), ensures you have covered SLEs 3, 4, 5 and 6. The references cited have a variety of weather instruments that could be constructed by students.

Key Activity	SLE	Print Resources	Essential Materials	Comments
Setting up a weather station and recording weather over a period of time (cont'd)		*Innovations in Science, Level 5, Weather Watch (Whirl Wind)*, p. 35 *Innovations in Science, Level 5, Weather Watch (Under Pressure)*, p. 38 *Delta Science Modules: Weather Instruments, Teacher's Guide* (Paldy) *(Air Temperature)*, p. 6 *Delta Science Modules: Weather Instruments, Teacher's Guide* (Paldy) *(Air Pressure and Barometric Changes)*, p. 9 *Delta Science Modules: Weather Instruments, Teacher's Guide* (Paldy) *(Wind Direction and Wind Speed)*, p. 12 *Delta Science Modules: Weather Instruments, Teacher's Guide* (Paldy) *(Precipitation)*, p. 20 *Science Activity Books: Be Your Own Weather Expert* (Kelly) *(Making a Barometer)*, p. 15 *Science Activity Books: Be Your Own Weather Expert* (Kelly) *(Making a Wind Vane)*, p. 19 *Science Activity Books: Be Your Own Weather Expert* (Kelly) *(Anemometer)*, p. 20 *Science Activity Books: Be Your Own Weather Expert* (Kelly) *(Making a Rain Gauge)*, p. 25		

Key Activity	SLE	Print Resources	Essential Materials	Comments
Examining how the water cycle works and setting up models to demonstrate it	4	*Explorations in Science, Level 5, Whatever the Weather (Getting Wet)*, p. 16 *Explorations in Science, Level 5, Whatever the Weather (Making Dew)*, p. 20 *Explorations in Science, Level 6, Water Works (Recycled Water)*, p. 14 *Innovations in Science, Level 5, Waterworld (The Water Cycle)*, p. 102 *Innovations in Science, Level 5, Waterworld (Still Surviving)*, p. 106 *Eye Witness Books: Weather* (Cosgrove) *(Water in the Air)*, p. 22 *Science Turns Minds On: Oceans of Air, Teacher's Guide* (Atwater et al.) *(The Water Cycle)*, p. 38	electric kettles, ice, pan, cookie sheet, plastic bags ice cubes, water glasses, thermometers electric kettle, ice cubes, plastic bottles pails, plastic wrap, marbles or clean stones	Some of the activities require an electric kettle. Due to the inherent dangers of hot steam, these activities should be closely supervised or done as a demonstration. The solar activities are a practical application of the water cycle. An excellent extension is to have students write about the exciting travels of a water molecule from one state to another. Another natural extension would be to measure humidity in the air. See Extension Activity 1.
Testing fabric's ability to withstand different weather conditions	13, 14	*Innovations in Science, Level 2, Whatever the Weather (Cold Stoppers!)*, p. 13 *Innovations in Science, Level 2, Whatever the Weather (Drip Dry)*, p. 18 *Innovations in Science, Level 2, Whatever the Weather (Windbreakers)*, p. 26 *Innovations in Science, Level 2, Whatever the Weather (Hot Stuff)*, p. 30	alcohol thermometers, variety of clothing material, aluminum foil, plastic wrap, eyedroppers, confetti, outdoor clothing	
Designing and constructing clothing to meet different weather conditions	13, 14	*Innovations in Science, Level 2, Whatever the Weather (Suit Up)*, p. 33 *Explorations in Science, Level 5, Whatever the Weather (Dressing for the Weather)*, p. 30	variety of fabrics, glue materials brought from home or created in the classroom, tape recorder	This offers one approach to this SLE. Supplemental Activity 2, Appendix B, has some adaptations and additional ideas.

Key Activity	SLE	Print Resources	Essential Materials	Comments
Investigating cloud types and weather patterns	8	*Explorations in Science, Level 5, Whatever the Weather (Clouds in a Bottle)*, p. 25 (see also Line Master 30) *Innovations in Science, Level 5, Weather Watch (Collecting Clouds)*, p. 11 *Delta Science Modules: Weather Instruments, Teacher's Guide* (Paldy) *(Observing Clouds)*, p. 18 *The Science Collection: Weather* (Riley) *(Clouds)*, p. 32 *Science Activity Books: Be Your Own Weather Expert* (Kelly) *(Clouds)*, p. 22	hot water, clear glass bottle, ice, matches, strainer clear glass wide-mouth jars, ice, hot water, strong plastic bags, elastics	This activity of making a cloud in a bottle makes an interesting introduction to clouds and reinforces the water cycle concept. As an open flame is involved, this needs to be closely supervised. To meet SLE 8, students need to gain a basic understanding of the types of clouds. Perhaps the best way to get students to relate cloud type to weather patterns is to include cloud observations during the weather station activity (Key Activity 2). After recording cloud observations over a period of time, students will be able to identify the correlation between cloud types and weather patterns.

Extension Activities

Extension Activity	SLE	Print Resources	Essential Materials	Comments
Measuring humidity	4	*Delta Science Modules: Weather Instruments, Teacher's Guide* (Paldy) *(Relative Humidity)*, p. 16	thermometers, cloth or shoelace	This activity extends SLE 2 and could be used as one of your weather phenomena in SLE 5 as long as temperatures are above freezing.
Researching and reading about extreme weather phenomena	13	*Explorations in Science, Level 5, Whatever the Weather (Weather It's Fact or Fiction)*, p. 31	reference books, trade books, magazines, newspapers, *Farmer's Almanac*, *Guinness Book of World Records*	The extent of investigation into extreme weather phenomena could take the form of a research project or a reading assignment. Children could also do some descriptive writing of their own weather stories.
Making a tornado	6	*Explorations in Science, Level 5, Whatever the Weather (Make a Tornado)*, p. 27 *Innovations in Science, Level 5, Weather Watch (Wild Weather)*, p. 42	two 2-L clear plastic pop bottles, duct tape or commercial tornado tube two 2-L clear plastic pop bottles, Plasticine	Commercial tornado tubes are available from science suppliers and science stores. They are relatively inexpensive and effective.
Investigating what causes the cycle of the seasons and climates	9	*Science Activity Books: Be Your Own Weather Expert* (Kelly) *(Why We Have Seasons)*, p. 12	light bulb and fixture, globe or large ball	The cycle of the seasons can be demonstrated more effectively by using a bulb and globe as a class demonstration or, preferably, in small groups.
Greenhouse effect	11, 12	See Supplemental Activity 3, Appendix B at the end of this unit	thermometer, Ziploc bag, 2 empty soup cans, water	
Differential heating and responding air movement	2, 10	See Supplemental Activity 4, Appendix B at the end of this unit	fish tank, 2 styrofoam cups, 2 balloons, water, red and blue food colouring, tape, washers	
Investigating the effects of weather exposure on a variety of materials	14	Appendix A—Supplemental Activity 1, *The Effects of Weathering*	see appendix at end of this unit	*The Effects of Weathering* is a natural extension when connected with Key Activity 2, building a weather station. With a little more organization, an excellent opportunity for scientific observation can be created.

Assessment

For a broader discussion of science classroom assessment techniques see *Assessing Student Learning* in the introduction of this publication on p. 15. Good places to begin looking for the unit-related ideas are *Explorations in Science* assessment handbooks, *Innovations in Science* teaching notes, Unit tests and Portfolio ideas, Alberta Education sample tests at **www.education.gov.ab.ca** and Alberta Assessment Consortium at **www.aac.ab.ca**

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Appendix

Supplemental Activity 1

The Effects of Weathering

Materials

- weather instruments from Key Activity 4
- cloth material from Key Activity 7
- additional materials such as plastics, wood and metals

This activity involves exposing different materials to the weather for an extended period of time. Since the weather instruments from Key Activity 2 will be out in the weather for at least six weeks, these are natural subjects of the experiment. Other materials could be exposed at the weather station, such as clothing, metals, etc. These materials should be exposed equally, as long as possible, and should be secured so they will not blow away. Matching materials should be stored inside, away from any weathering, to compare after the weathering process. Have students make detailed observations comparing the materials.

Supplemental Activity 2

Designing and Constructing Clothing

Materials

- a wide variety of fabric
- sewing materials or other means of connecting materials (staples, glue)

Note: This activity is best completed after Key Activity 6 (testing fabric's ability to withstand different weather).

Getting Ready: Besides collecting a variety of materials, you may wish to introduce the activity by having students bring a variety of outfits suitable for a wide variety of weather conditions. Discuss how the clothes are designed and why. *See Explorations in Science. Level 5, Whatever the Weather (Dressing for the Weather),* p. 30, for one approach to this.

In this activity, a number of problem-solving situations could be presented to small groups involving a variety of weather conditions and clothing requirements (e.g., design an outfit that will keep out wind and rain yet allow the wearer to be active and not overheat; design an outfit that has high insulation value). Doll-sized models would be best if materials are limited. This could lead to an interesting fashion show at the end. It is recommended that students first produce a design using paper and pencil, then produce a pattern and finally an outfit.

Supplemental Activity 3

The Greenhouse Effect

• Addresses SLE 12 and 11 (not otherwise addressed in Key Activities)

Materials

• 2 thermometers
• Zip-loc plastic bag
• 2 empty, clean soup cans
• water

Procedure

• Fill both cans with tap water.
• Take the temperature of the water in both cans.
• Place one can in the Zip-loc bag and seal it.
• Put both cans in a sunny spot for an hour.
• Take the temperature of the water in both cans again.

Explanation

• Greenhouse gases have been in our atmosphere for billions of years and they are responsible for our planet's warm temperatures, even at night when the sun is not in the sky. Much of the Sun's energy (in the form of heat) is absorbed by the surface of the Earth, but the remainder is reflected off of the surface back toward the atmosphere. Some of this energy will escape, but the layer of greenhouse gases redirects much of it back to Earth. In this way, we have enough stored heat energy to get us comfortably through the long, cold night.

• Pollution, particularly carbon dioxide emitted from burning fossil fuels, is causing the greenhouse gas layer to become more prominent, thus trapping more heat than it used to. This is causing the surface temperature of the Earth to heat up more than it would under natural conditions.

• The Zip-loc bag in the experiment represents the layer of greenhouse gases around the Earth, and it shows the dramatic effect this can have on temperatures.

Can	Temperature (°C) Before Warming	Temperature (°C) After Warming
Without bag		
With bag		

Supplemental Activity 4

Differential Heating and Responding Air Movement

• Addresses SLE 2 and 10

Materials

• fish tank
• 2 small Styrofoam cups
• 2 balloons
• room temperature, hot and cold water
• ice cubes
• red and blue food colouring
• tape
• several washers for weight

Procedures

• Fill the fish tank with room temperature water.
• Place red food colouring and hot water in one cup. Place several washers in for weight. Seal by stretching balloon over the top and taping in place.
• Place blue food colouring and cold water with ice cube in the other cup. Place several washers in for weight. Seal in the same way as the above cup.
• Place cups upside down (balloon side down) on opposite ends of the aquarium.
• Poke a small hole in the bottom of each cup and observe what happens to the coloured water.

Explanation

• Land and water surfaces heat differently. Land tends to heat up quickly and get hotter than water, but then it cools down quickly and gets colder than water. This means that during the day, land areas on our planet are warmer than water but at night, land areas are cooler. This temperature difference sets up convection currents that cause air to move from high-pressure cold regions to lower pressure warm regions.
• The warm water in the experiment rises up toward the surface of the fish tank. This is like the warm air rising up off of the surface of the land during the day. The colder water sinks to the bottom and this represents cool air over the water during the day. As the warm air rises, cool air rushes in to take its place so in the daytime, you have a breeze coming in off of the water (sea breeze). At night, the breeze goes out (land breeze) since the water is now warmer than the air over the land.