**SCIENCE 10 - Weather Dynamics**

* *Students are expected to :*
	+ - Identify questions to investigate that arise from considering the energy transferred within the water cycle.
		- Describe examples that illustrate the atmosphere and hydrosphere are heat sinks in the water cycle.
		- Explain how scientific knowledge evolves about changing weather patterns with new evidence about changes in ocean temperature.

**Weather Dynamics**

* 1 – Intro to Meteorology
* 2 – The Atmosphere
* 3 – Sun’s Solar Energy
* 4 – Heat Transfer
* 5 – Water Cycle
* 6 – Seasons
* 7 – World Wide Currents
* 8 – Forecasting Weather

**Meteorology** - **The study of the Earth’s atmosphere and weather systems.**

**Climate- A widespread, long-lasting and recurring conditions of the atmosphere.**

**Weather** - **The day to day changes in the atmosphere at a particular** **location** **on Earth.**

**Four Spheres of Earth**

* Litosphere – stone
* Atmosphere – air
* Hydrosphere – water
* Biosphere – life

**Layers of Atmosphere**

* Troposphere
* Stratosphere
* Mesosphere
* Thermosphere
* Exosphere

**Keeping in the Heat**

* Why doesn’t thermal energy radiate into space at night?
* The greenhouse gases act as a heat sink. They absorb thermal energy and radiate the energy in all directions.
* These gases cause the troposphere—where weather occurs—to retain more heat than it would if these gases were not present.

**Sun’s Solar Energy**

The Atmosphere: Energy Transfer and Properties

Earth’s Energy Budget

* Solar energy travels to Earth by a process called **radiation**− thermal energy transfer in which atoms or molecules give off energy as electromagnetic waves when they interact with matter such as air, water, or soil.
* Solar energy is reflected, absorbed, or emitted (given off) by matter as it travels through the biosphere.
* The various wavelengths of solar energy are affected differently when they reach Earth.
* Earth maintains an energy and temperature balance because approximately the same amount of energy enters and leaves Earth’s atmosphere.

**Factors Affecting Absorption of Energy**

* Both the colour and type of a substance affect its ability to absorb energy.
	+ Dark colours absorb energy.
	+ Light colours reflect energy.
* A substance’s *albedo* is the amount of energy its surface can reflect.

*Give an example of a substance that has a high albedo and a substance that has a low albedo.*

**Factors Affecting Absorption of Energy**

* Different substances absorb energy at different rates.
* The property of a substance that involves how a substance absorbs and releases energy (and how quickly) is called its *specific heat capacity.*
* Water has a high specific heat capacity. Water heats up and cools off more slowly than land does. Both water and land heat up and cool off more slowly than air does. Water is a **heat sink.**

**Thermal Energy Transfer by Conduction, Convection, and Radiation**

Thermal energy is transferred from a warmer object to a cooler object, and it is transferred in three ways.

* **Radiation** is the transfer of thermal energy by electromagnetic waves.
* **Conduction** is the transfer of thermal energy between two objects or substances that are in direct contact.
* **Convection** is the transfer of thermal energy by the movement of heated material (liquids or gases) from one place to another.

**Atmospheric Pressure**

* At sea level, the atmospheric pressure is about 101.3 kPa.
* As altitude increases, atmospheric pressure decreases.
* As altitude increases, temperature decreases.
* As altitude increases, the density of the atmosphere also decreases.
* Meteorologists—scientists who study weather– use atmospheric pressure readings to predict changes in the weather.
* A decrease in atmospheric pressure suggests that warm, humid air is approaching and that the temperature will increase.
* An increase in atmospheric pressure suggests that cool, dry weather is approaching.

***Review***

* Weather refers to physical conditions of the atmosphere at a specific time and place.
* Earth’s energy budget is maintained by radiating as much energy into space as Earth absorbs from the Sun. Albedo and specific heat capacity affect how much of the Sun’s energy is absorbed by Earth’s surfaces.
* The vast amount of water on Earth acts as a heat sink that has a significant influence on temperature.
* Radiation, conduction, and convection transfer thermal energy through the atmosphere.
* Atmospheric pressure decreases as altitude, temperature, and humidity increase.
* Changes in the state of water involve absorption and release of thermal energy.

**Water Cycle**

The Role of Water in Transferring Energy in the Atmosphere

* Because of water’s high specific heat capacity, a lot of energy is needed to change the temperature of water.
* Oceans and lakes have a moderating effect on air temperature for nearby land because of water’s high specific heat capacity.

**WATER CYCLE**

**The Causes of Weather**

* The amount of solar energy that Earth receives every year is the same amount that Earth radiates back into space. The distribution of this energy is not equal throughout Earth. Three factors affect the distribution of solar energy on Earth.
* Earth’s curved surface
* Earth’s tilt on its axis
* Earth’s orbit

**How Earth’s Curved Surface Affects Weather**

* The amount of solar energy that reaches different regions of Earth varies because of Earth’s curved surface.
* The concentration of light that warms Earth’s surface is unequally distributed.
* How Earth’s Tilt Affects Weather
* Earth’s tilt causes the yearly pattern of changes called seasons.
* As Earth orbits the Sun, the northern hemisphere is sometimes tilted toward the Sun and at other times it is tilted away.

**How Earth’s Orbit Affects Weather**

* The shape of Earth’s orbit affects how much solar energy it receives.
* When Earth’s orbit is more oval, Earth gets much more solar energy when it is nearest the Sun than when it is farthest from the Sun.
* When the orbit is circular, solar energy is more evenly balanced during the year.

**World**

**Wide Currents**

**Air Masses**

***High Pressure Systems***

* When an air mass cools over an ocean or a cold region of land, a **high pressure system** forms.
* As the air mass cools, the air mass becomes more dense.
* When the air mass contracts, it draws in surrounding air from the upper atmosphere.

***Low Pressure Systems***

* The Coriolis Effect and Wind
* Global Wind Systems

***Jet Streams***

* A large temperature gradient in upper-level air, combined with the Coriolis effect, results in strong westerly winds called *jet streams*.
* A jet stream is a narrow band of fast-moving wind.
* A jet stream can have a speed up to 300 km/h or greater at altitudes of 10 km to 12 km.
* Storms form along jet streams and

generate large-scale weather systems.

***Fronts***

* A **front** is a zone that develops as a result of the meeting of two air masses with different characteristics.
* Each air mass has its own temperature and pressure.
* An approaching front means a change in the weather, and the extent of the change depends on the difference between conditions in the air masses.
* Fronts usually bring precipitation.

***Extreme Weather***

* Thunderstorms are extreme weather events that include lightning, thunder, strong winds, and hail or rain.
* A tornado is a violent, funnel-shaped column of rotating air that touches the ground.
* When tornados form over
water, waterspouts occur.

**What causes a thunderstorm?**

* The tropics, the regions closest to the equator, are the ideal location for the formation of intense storms called tropical cyclones to occur.
* Wind speeds of tropical cyclones may reach 240 km/h.
* Tropical cyclones are also called cyclones, typhoons, or hurricanes.
* Hurricane season extends from late summer to early fall.

**Key Concepts Review**

* Earth’s shape, tilt, and orbit affect weather.
* Five main air masses affect North America. The cooling and warming of air masses creates high and low pressure systems, respectively. Fronts form where two air masses meet.
* The Coriolis effect and differences in atmospheric pressure create global wind systems.
* Rapidly rising warm air results in extreme weather such as tropical cyclones, thunderstorms, and tornadoes.

**Clouds**

* What can clouds tell us about the weather?

***A cloud is made up of tiny water droplets and/or ice crystals, a snowflake is a collection of many ice crystals, and rain is just liquid water.***

* **Importance of Clouds**

 **The presence of clouds in the sky is one type of signal to meteorologists that there will be changes in the weather. Predicting the weather requires the understanding of the different types of clouds.**

* **To better communicate and understand the many cloud forms in the sky, meteorologists identify clouds based on five basic cloud characteristics:**

1. The altitude at which they occur

2. Color

3. Density

4. Shape

5. Degree of cover.

***Types of Clouds***

**There are 3 main types of clouds:**

* Cumulus or fluffy clouds
* Stratus or layered clouds

Cirrus or thin feathery clouds

**CIRRUS**

*The long stringy cirrus clouds are called "mares' tails."*

**STRATUS - Low Clouds**

* **Stratus**
* **Stratocumulus**
* **Nimbostratus**
* **Stratus Clouds**

**CUMULUS**

*Fair weather cumulus have the appearance of floating cotton and have a lifetime of 5-40 minutes. The word cumulus comes from the Latin word for a heap or a pile. Cumulus clouds are puffy in appearance. They look like large cotton balls.*

*Harmless fair weather cumulus clouds can later develop into towering cumulonimbus clouds associated with powerful thunderstorms.*

**Where to Find Weather Data**

* **Local newspaper**
* **Environment Canada’s weather website:**
	+ **Nova Scotia:**

[**http://www.weatheroffice.gc.ca/forecast/canada/index\_e.html?id=NS**](http://www.weatheroffice.gc.ca/forecast/canada/index_e.html?id=NS)

* + **Halifax:**

[**http://www.weatheroffice.gc.ca/city/pages/ns-19\_metric\_e.html**](http://www.weatheroffice.gc.ca/city/pages/ns-19_metric_e.html)

* + **The Weather Network’s local forecast for Halifax:**

[**http://www.theweathernetwork.com/weather/cities/can/Pages/CANS0057.htm**](http://www.theweathernetwork.com/weather/cities/can/Pages/CANS0057.htm)

**Weather Data Definitions**

* **Temperature:**
	+ The amount of heat retained in the atmosphere.
	+ We usually record expected high temperature and low temperature.
	+ Measurement: ˚C
	+ Pressure/Tendency:
	+ The weight of the atmosphere.
	+ Also known as atmospheric pressure or barometric pressure.
	+ Two types: low pressure (heavy precipitation, overcast conditions) and high pressure (clear, cool weather)
	+ Measurement: kPa
* **Visibility:**
	+ The greatest distance an object can be seen & identified.
	+ The maximum visibility on a clear day is 11 kilometers
		- A flat horizon will fall away to a point that surface conditions cannot be observed.
	+ Measurement: km
* **Humidity:**
	+ Percentage of water vapour in atmosphere at a specific temperature.
	+ Usually, the warmer the air, the higher its capacity for holding water vapour.
		- Each specific temperature has a holding limit for water
		- The actual amount of water held in the air can be represented as a percentage.
	+ Measurement: %
* **Dew Point:**
	+ The dew point is a measure of atmospheric moisture.
	+ The temperature at which air must be cooled in order to form water droplets.
	+ As the surface of the earth cools at night, warm moist air near the ground is chilled. Water vapour in the air condenses into droplets on the grass and other objects.
	+ Measurement: ˚C
* **Wind:**
	+ Wind is the horizontal movement of air.
	+ Speed and direction are always given; measure of wind velocity.
	+ A "north wind" is coming from the north and is blowing towards the south.
	+ Wind direction tells where the wind is blowing from.
	+ Measurement: km/hr + direction
* **Level of Precipitation:**
	+ When suspended particles become too heavy to remain in clouds, they fall to the earth as precipitation.
	+ Precipitation: hail, rain, freezing rain, sleet, or snow.
	+ We measure how much actually falls.
	+ Measurement: mm
	+ Ceiling:
	+ The ceiling is the height of the lowest layer of clouds.
	+ Ceiling is a measurement primarily used by the aviation industry
		- Pilots need to know the height of the clouds they will be flying in.
		- Ceiling is reported in feet, the standard for the aviation industry.
	+ Measurement: ft
* **Assignment:**
	+ **You will be required to research a particular topic about weather.**

**References**

[Videos:](http://www.harcourtschool.com/activity/science_up_close/610/deploy/interface.html)

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