Earth Science 11 - Week 2: April 20 – 24

Anticipated time required: 3 hours

New learning objective: **Atmospheric Properties, The Coriolis Effect**

Goals to be completed:

1. Understand and describe atmospheric properties including temperature, air pressure and density and describe how they affect common occurrences such as wind and humidity

2. Describe what the Coriolis effect is and how it impacts global wind systems

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This PDF package contains several notes, examples and videos. Please read through the lesson package and watch all of the videos included within it (the videos are short, not to worry). The only formal portion that you are required to submit is the section titled "atmospheric properties summary" and "Coriolis Effect Worksheet". These can be sent to Charlie.feht@yesnet.yk.ca either as a scanned and uploaded PDF attachment to email, or as a jpeg image file.

Upcoming next week:

Global wind systems and air fronts

Section 1: Atmospheric Properties

Please watch the following introductory video to local and global atmospheric properties prior to reading the notes below:

https://www.youtube.com/watch?v=M04kSO7BSgo

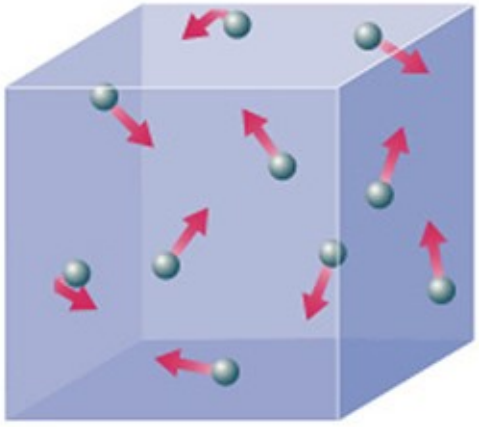
Temperature, air pressure and humidity are all atmospheric properties that influence the weather we experience every day. They influence not only cloud formation and wind systems, but also extreme weather events such as tornadoes and hurricanes.

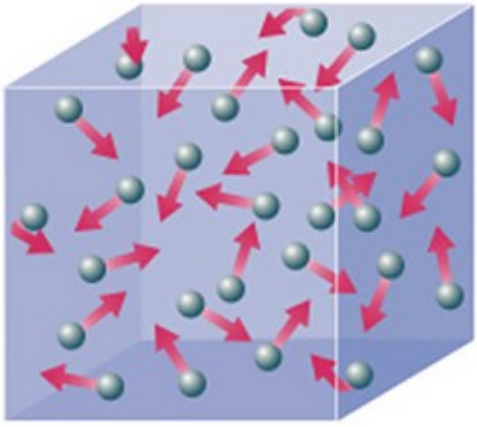
Property #1: Temperature

The temperatures we feel on a daily basis are a result of energy transfer occurring in the atmosphere. Atoms and molecules possess **kinetic energy** which allows them to move in random patterns of motion throughout the atmosphere. When the energy in an entire system is in motion, it is said to have a specific **thermal energy**.

Review Video on kinetic energy and kinetic molecular theory:

https://www.youtube.com/watch?v=1Jtw8g795Us





Thermal energy (heat) can be transferred from regions with high thermal energy values to regions with low thermal energy values by 3 ways:

1. Radiation – Electromagnetic waves of energy in the form of visible light and infrared light emitted from the sun. These light waves are absorbed or reflected based on physical characteristics of a specific area. An objects ability to reflect heat is measured by its **albedo**. A high albedo indicates a high ability to reflect heat.

Ex. High absorption, low reflection of heat (**low albedo**) → Black asphalt shingles

Ex. Low absorption, high reflection of heat (**high albedo**)→ Snow

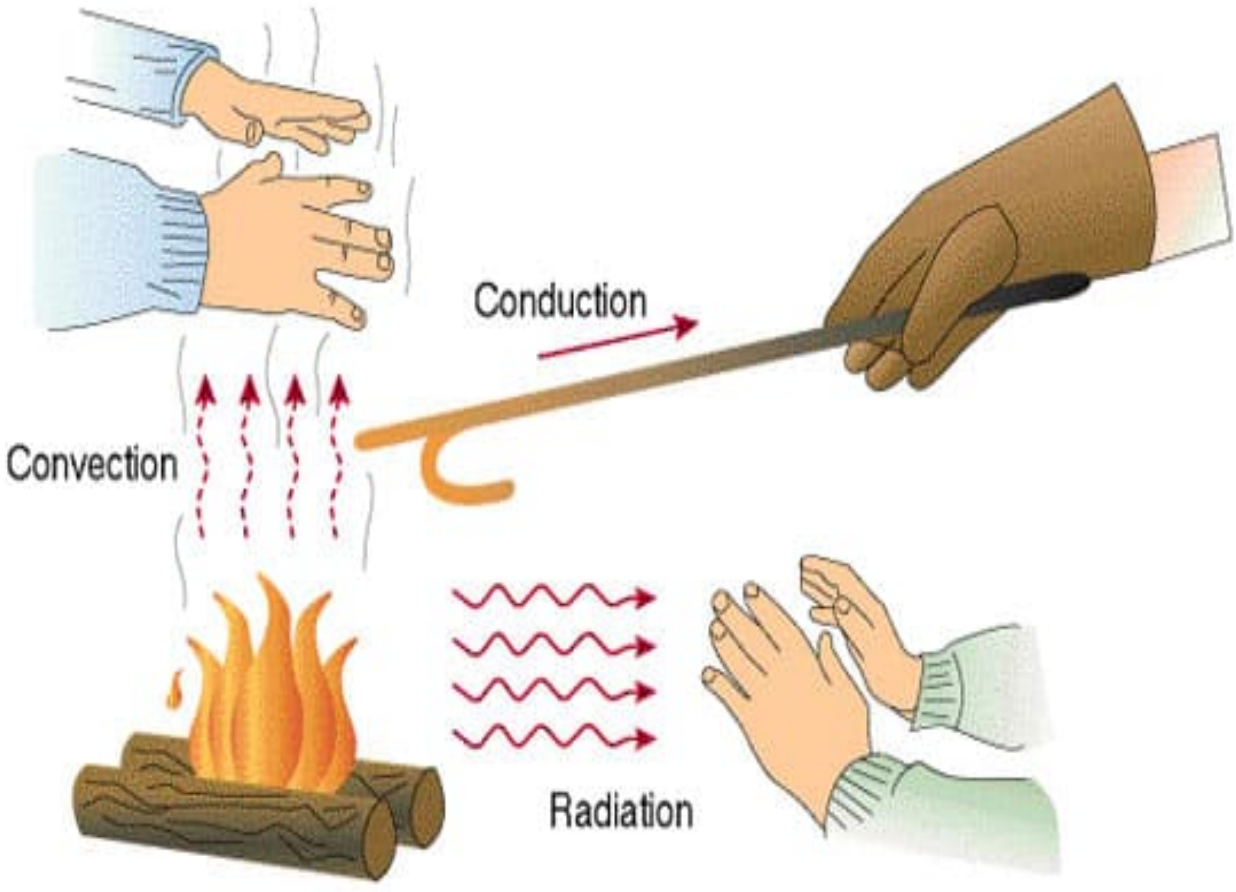
2. Conduction – When the thermal energy between two objects is different, and the objects come into contact with each other.

   Ex. A hot plate heating up a beaker

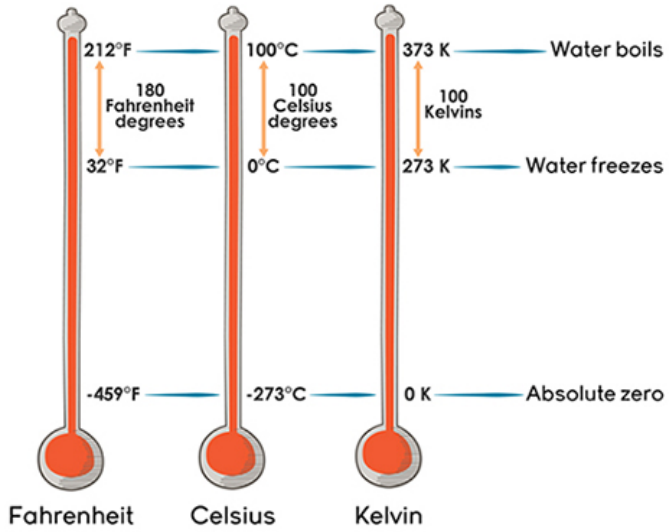
3. Convection – Transferring thermal energy from one area to another by movement of liquids or gasses possessing higher thermal energy than the surrounding region.

Ex. Warm air close to the Earth's surface becomes heated and rises. As it rises it transfers its high thermal energy to the surrounding region and cools again, resulting in the air sinking again.

Summary video: https://www.youtube.com/watch?v=HpCvWuvCUoA



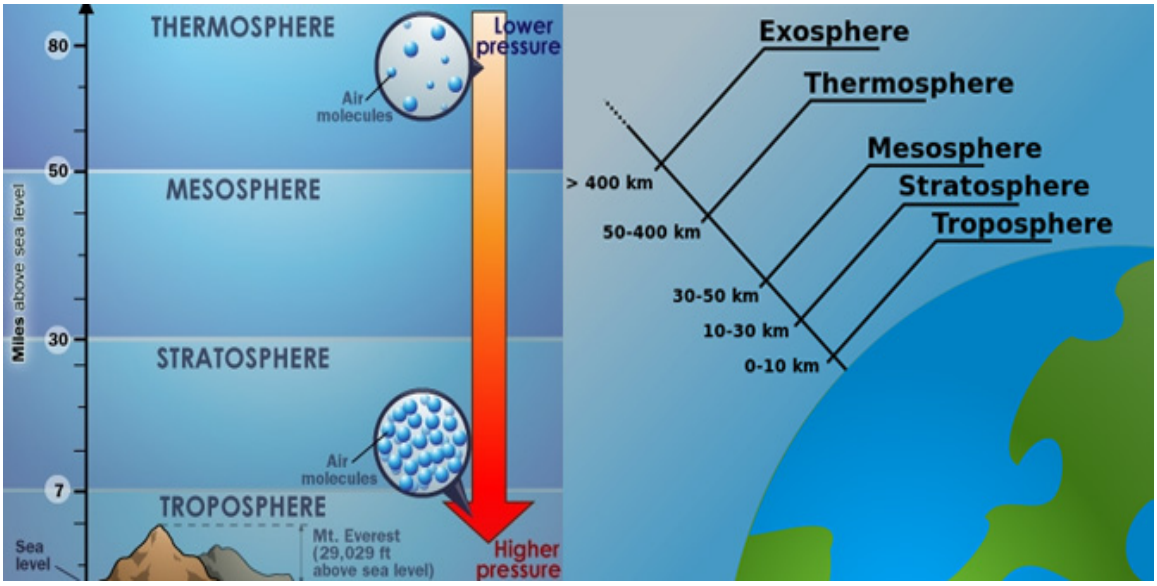
Measuring Temperature



Temperature is commonly measured on three different scales; °Celsius/Centigrade (used by the entire world besides the USA), °Fahrenheit (used explicitly by the USA), or Kelvin (used by scientists everywhere). The Kelvin scale measures temperature based on motion of particles, where 0 Kelvin corresponds to zero motion of any particles and is dubbed "absolute zero". There is no colder possible temperature.

<u>Property #2:</u> Air pressure and density

Air pressure is the pressure exerted on a surface by weight of the atmosphere above the surface. By this definition, it is no surprise that air pressure is the higher closer to sea level and lower as you climb in altitude – There is more atmospheric gas pushing its weight down upon you at sea level!



Watch the summary video on air pressure here:

https://www.youtube.com/watch?v=VDf00z8sMFw

Relationship

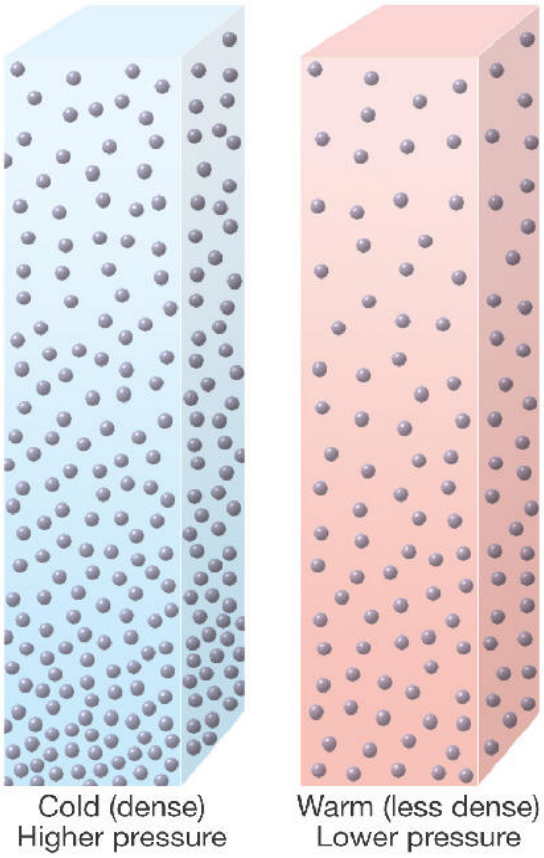
Pressure and density both decrease with an increase in altitude

So how does air temperature affect this relationship?

1. Cold air is more dense than warm air and therefore exerts more pressure
2. Warm air exerts less pressure than cold air and is therefore less dense

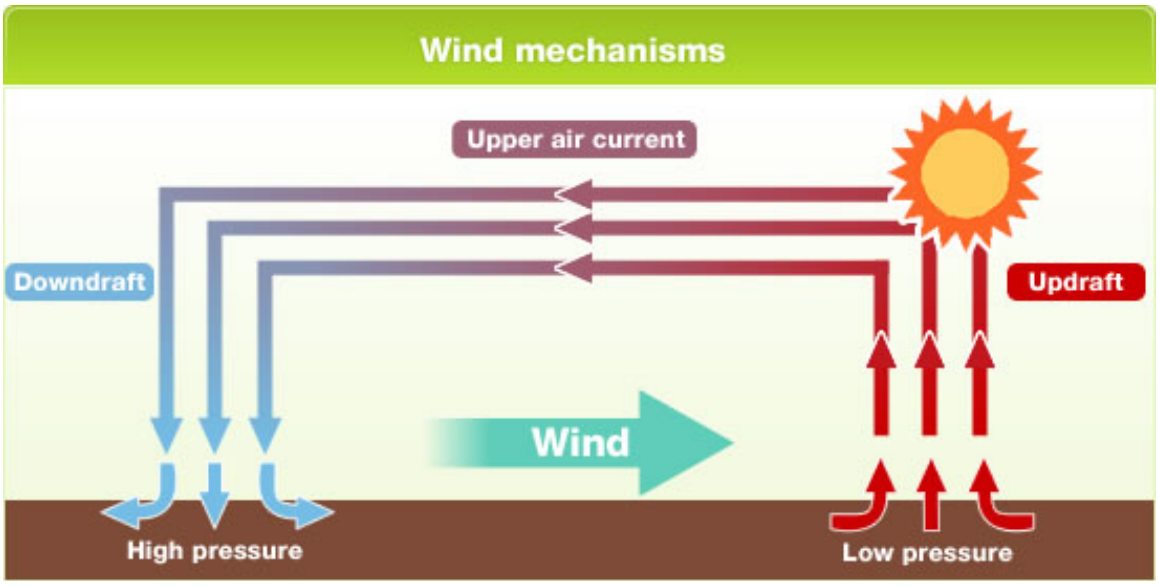
Why?

Cold air has molecules that are tightly packed together than warm air.
Fewer molecules in an atmospheric system decrease the pressure exerted.



Wind:

A direct result of changes in pressure and density. Air will always try to move from an area of high density/pressure to an area of low density/pressure. Since cold air is more dense and creates more pressure, it will move towards areas of warm air that has a low density and less pressure. Wind speed is controlled by these pressure differences as well as altitude. If the pressure difference is large, the wind will blow very fast.



If the wind has nothing impeding its motion, it will also move very fast. This is why wind speeds are typically higher as you gain altitude, or when you are in an open space like a prairie. There are fewer objects to impede the motions of the wind!

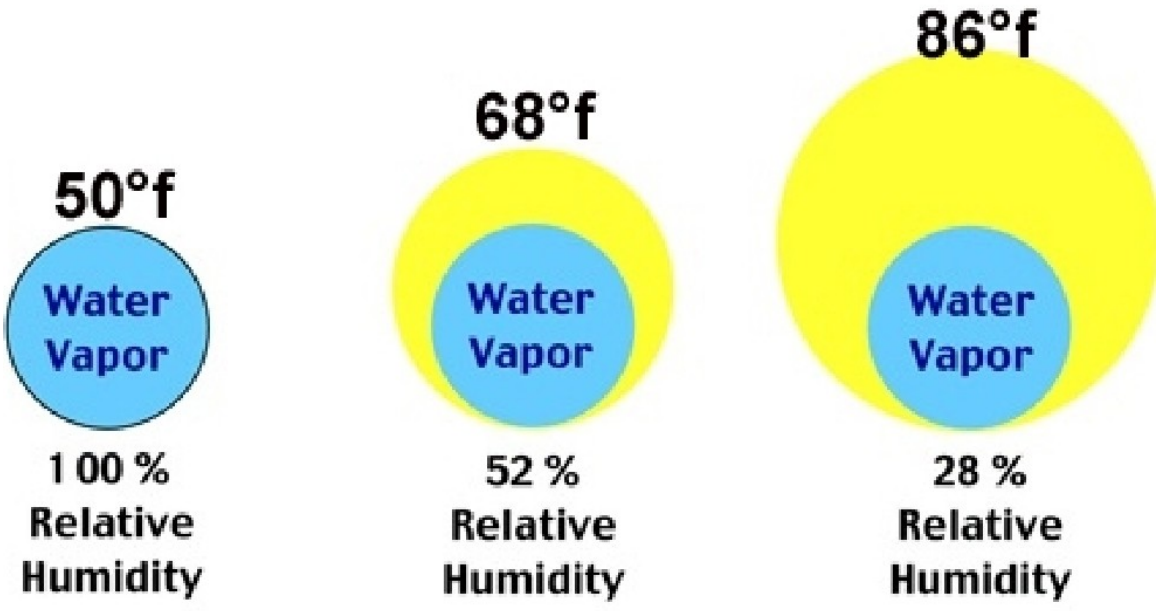
Summary video:

https://www.youtube.com/watch?v=uBqohRu2RRk

Humidity:

Humidity is the amount of water vapor present in the atmosphere in a given region. When the water vapor in a specific volume of air has reached its maximum point, the air is considered saturated. That means that the air is full of water and cannot hold any more vapor.

Relative Humidity – The amount of water vapor in the air relative to the maximum amount of water vapor needed for the air to be considered saturated.



Warmer air possesses a much higher saturation level than cold air. This allows warm air to hold a great deal more water vapor than cold air. However, if the temperature of the warm air system were to drop, the ability of the air to hold onto this vapor would also drop. This results in the vapor condensing out of the air, known as the **dew point** of the system. If the dew point is nearly the same as the air temperature, relative humidity is high.

Please watch the following video up until the 6 minute mark to summarize what is humidity, relative humidity and dewpoint.

https://www.youtube.com/watch?v=e6xC7povssE

Section 2: The Coriolis Effect

Please watch the introductory video: https://www.youtube.com/watch?v=HIyBpi7B-dE

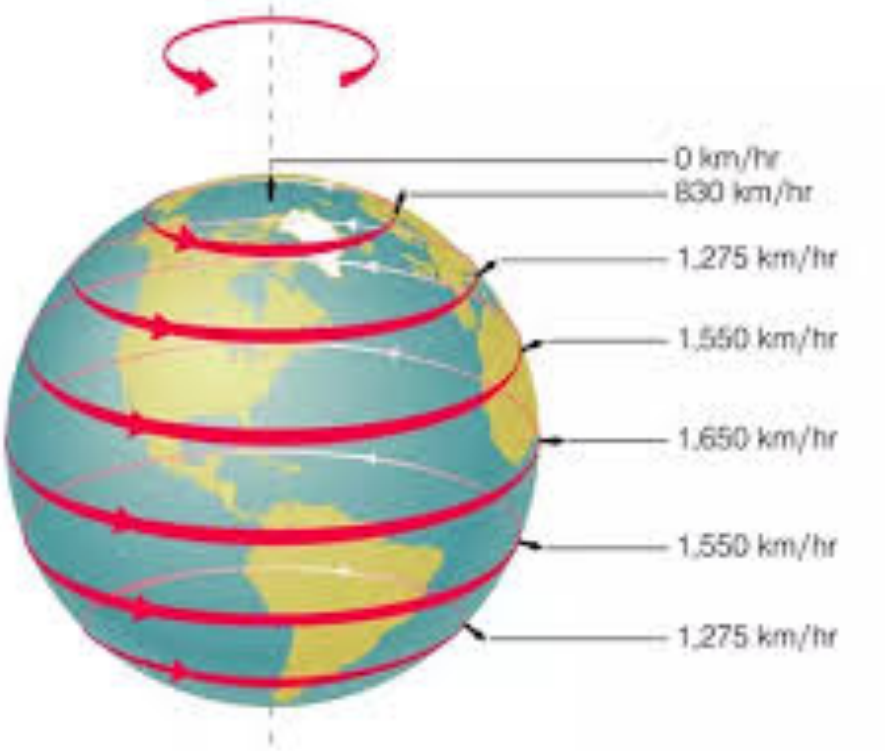
The Coriolis effect is the curved motion of the earth's fluids (wind and water) due to the rotation of the planet. The Coriolis effect has a crucial impact on ocean currents and wind directions.

The reason that these fluids deflect in a curved motion has to do with the difference in rotational velocity of the earth at different latitudes. Just like how the tips of a wind mill blade spins much faster than the base of a windmill blade, the widest section of the earth (the equator) spins much faster than the thinner regions do (north and south pole).

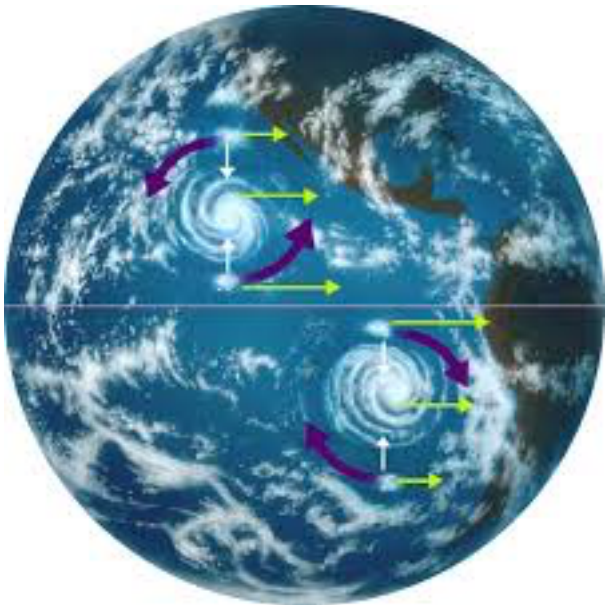
Lets check the math behind this:

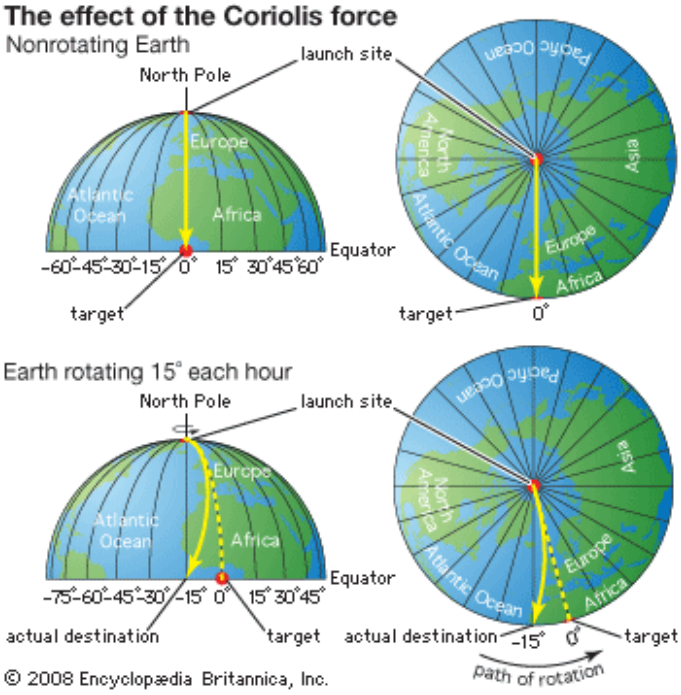
1. The earth's circumference at the equator is approximately 40,075 km, and it completes one full rotation in 24 hours. That means that 40,000 km/24h = a rotational speed of **1,669 km/h**
2. The earths circumference at the arctic circle is a meager 17,662 km, and it also completes one full rotation in 24 hours. That means that 17,662 km/24h = a rotational velocity of **736 km/h**

See the difference in rotational velocity of the earth depending on your latitude? This difference is what causes fluids like air to deflect in a curved pattern.



The Coriolis effect causes fluids in the northern hemisphere to deflect to the right, and fluids in the southern hemisphere to deflect to the left. This is why hurricanes spin counter clockwise in the northern hemisphere, and clockwise in the southern hemisphere.





The following two videos summarize the Coriolis effect on the atmosphere:

https://www.youtube.com/watch?v=1Y1Qi821n-s

https://www.youtube.com/watch?v=mPsLanVS1Q8

Atmospheric Properties Summary

1. Explain the difference between the three ways thermal energy can be transferred in the atmosphere.

2. What is albedo? Provide an example not included in this lesson package of something that would have a high albedo, and something that would have a low albedo.

3. How is the Kelvin temperature scale difference from other temperature scales?

4. Which layer of the earth contains the greatest air pressure? Why is this?

5. What would you expect to happen to the density and pressure of an air mass that drifts towards the equator, vs. an air mass that drifts towards the poles?

6. How is wind generated?

7. Fill in the blanks below:
    a. When air holds 100% of the water it is capable of holding, the air is _____

    b. The amount of water vapour that air can hold depends on the _____

    c. If relative humidity is 100% at 50°F, and 75% at 86°F, there is likely greater water vapour in the _____°F scenario

    d. If the outside temperature is 25°C and has a relative humidity of 80%, the _____ will only be reached for the water to evaporate out of the air if the temperature _____.

Coriolis Effect Worksheet

Directions: Use your class notes and outside sources to help you answer the following questions.

1. What causes the Coriolis Effect to occur?

2. Even though it takes any location on earth 24 hours to complete one rotation, not all locations move around at the same speed. Which latitude on earth travels at the fastest speed? EXPLAIN WHY

3. When a free-moving object moves from the North Pole (90°) towards the equator (0°), it curves from its intended path since:

4. In the Northern Hemisphere, free-moving objects traveling over large distances are deflected to the _____ of their intended path of motion.

5. In the Southern Hemisphere, free-moving objects traveling over large distances are deflected to the _____ of their intended path of motion.

6. If a missile is launched from the North Pole, toward an object on the equator, should it be aimed to the left, to the right, or directly at its target? EXPLAIN YOUR ANSWER.

7. If a missile is launched from the equator toward an object in the Northern Hemisphere, should it be aimed to the left, to the right, or directly at its target? EXPLAIN YOUR ANSWER.

8. A flight from Hartford, CT to Seattle, WA takes about 6 hours. The return trip takes about 5 hours. The reason for this is related to the concepts you are learning about. Why does this happen?

9. Draw the global wind patterns and label a) zones of H and L pressure b) wind directions c) names of the winds. (See if you can do it without notes)