Curriculum Units by Fellows of the Yale-New Haven Teachers Institute
2015 Volume III: Physics and Chemistry of the Earth's Atmosphere and Climate

Planet Protectors

Curriculum Unit 15.03.07
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Introduction

One of the things I love most about being a teacher is that each day I get to see the direct impact of the work I do. Over the past four years, I have seen just how high the stakes are for my students. But every skill or life-lesson I teach them can open the door for opportunities and put them on the life path to becoming engaged global citizens in an every changing society. Humans significantly affect and alter the composition of the Earth's atmosphere through our release of chemicals, such as chlorofluorocarbons (CFCs) and carbon dioxide. These chemicals deplete our precious ozone layer and cause changes to the Earth's temperature.

This curriculum unit focused on the physics and chemistry of the Earth's atmosphere and climate will foster the creation of more global students and citizens capable of making informed decisions about our planet. This unit fosters transformational change by impacting all areas of my students' lives, from academic growth to problem solving and career development. Academically, students will gain exposure to real world scientific connections. They will engage in cutting edge work of the discipline, through topics such as the balance of thermal energy from the sun, the ozone layer, and the effects of increasing carbon dioxide levels. Also, this unit will focus on problem solving. My students, like scientists, will practice thinking critically and creatively to solve problems that relate to the world around them and other fields of science and mathematics. And finally, this unit will provide students with a deeper understanding of STEM careers and hopefully spark their interest in pursuing a degree in science, technology, engineering, or mathematics so show others the importance of protecting Earth so it can continue to protect us.

The New Haven 6th grade general science curriculums focus heavily on the energy in the earth's systems. The 8 th grade curriculum includes a unit on solar system motion. This unit invites students to examine how the position of the Earth in the solar system affects conditions on our planet such as, seasons and Earth's temperature.

Students will explore the blanket of gases that the surround the Earth, called the atmosphere. The atmosphere is made up of 78 percent nitrogen, 21 percent oxygen, and the remaining 1 percent is composed of argon, water vapor, carbon dioxide, and other gases. This will also tie in connections to a previous unit where the students learned elements on the periodic table and the states of matter. The unit will also cover the layers of the Earth's atmosphere. Students will compare and contrast the different layers based on their temperature, location, and characteristics. The five layers the students will investigate are the troposphere, stratosphere, mesosphere, thermosphere, and exosphere. One of the essential questions the students will investigate is: What would happen if the layers of gas around Earth absorbed all of the sun's energy?

The "Planet Protectors" curriculum unit will address the balance of thermal energy from the sun in determining the Earth's temperature, the ozone layers and their destruction by CFCs. I want students to create a culminating project in which they each produce a public service announcement that urges citizens to become "Planet Protectors" and ways that we can help ensure the Earth's atmosphere provides Earth with protection for years to come. [10]

What is the atmosphere?

The Earth's Atmosphere [5]

An invisible blanket of gases called the atmosphere surrounds the Earth. Air is one of the main elements that makes life on Earth possible. Air, which makes ups the Earth's atmosphere is made up of a variety of gases and other particles. The most abundant gas in the Earth's atmosphere is nitrogen. [4] Nitrogen (N_2) composes 78% of the atmosphere. Oxygen (O_2) makes up about 21% and Argon (Ar) is about 0.9%. The remaining 0.1% is made up of water vapor, carbon dioxide (CO_2), methane (CH_4), nitrous oxide (NO_2), ozone (O_3), and hydrogen. [4]

The Earth's atmosphere extends outward to approximately 6,000 miles and the atmosphere changes as you go further from the Earth's surface. However, the majority of that atmosphere is compressed into the first 16 miles. The further up into the atmosphere you go the less compressed the atmosphere becomes because there is less pressure being exerted. [5]

Layers of the Atmosphere [5]

In order to better understand our atmosphere scientists have divided it into several layers. These layers are named based on the characteristics of the gases found at that height and their temperatures. They resemble a layered cake and each layer in our atmosphere is a sphere covering the entire Earth. Air pressure, or the weight of the air above a given location, is greatest at the Earth's surface. For example, at sea level, molecules of air are packed close together. Air pressures decreases though as one moves upward into the atmosphere. So the air molecules outside of an airplane are further apart. Some layers contain gases that readily absorb the sun's energy, while others do not. The five many laser of the Earth's atmosphere include the troposphere, stratosphere, mesosphere, thermosphere, and exosphere.

The first layer of the atmosphere is made out of the gases that we breathe everyday and is closest to the ground. This layer is called the troposphere. On average the troposphere extends from the surface of the Earth upwards to a height of 7 miles. The troposphere is the layer that we live in and where all weather occurs. It contains almost all of the Earth's carbon dioxide, water vapor, air pollution, weather, clouds, and living things. The temperatures in this layer are warmest at the surface of the Earth and they decrease higher in the troposphere. The troposphere is unique in that it receives convective heat transfer, where all other layers transport heat through radiation. There is also no water vapor at higher layers in the atmosphere because water is frozen out at the troposphere. [11]

The next layer of our atmosphere is called the stratosphere. The air here is very thin and contains little moisture. Air in the lower stratosphere is very cold. At the top of this layer a thin layer of ozone is found. The ozone layer helps to protect Earth from the sun's harmful ultraviolet (UV) radiation by absorbing it. And temperatures near the ozone layer are warmer as a result.

Above the stratosphere lies the mesosphere, the middle layer of the atmosphere. This layer is the coldest layer. And it is also where meteors falling to the Earth often burn up, which can cause métier showers.

Next, lies the thermosphere. Air here is extremely thin and temperature increases with altitude. The thermosphere is composed of a sub-layer to the atmosphere called the ionosphere. The ionosphere contains particles that have become electrically charged by the sun's energy. Beautiful displays of colors in the night sky, called auroras, occur here.

The final layer or outermost layer of the atmosphere is the exosphere. Some satellites, such as the International Space Station actually orbit the Earth here. Beyond the exosphere lies outer space.

Even though scientists have given special names to the boundary between each layer, this does not mean that there is an actual clearly visible border. If you were traveling up through the atmosphere in a rocket ship, you would not see any sudden changes as you went from one layer to the next. Instead, the change is gradual. The troposphere slowly changes, mixing with the stratosphere. The higher you travel the less and less the air around you will resemble the air found in the troposphere and the more and more it will resemble the air found in the stratosphere.

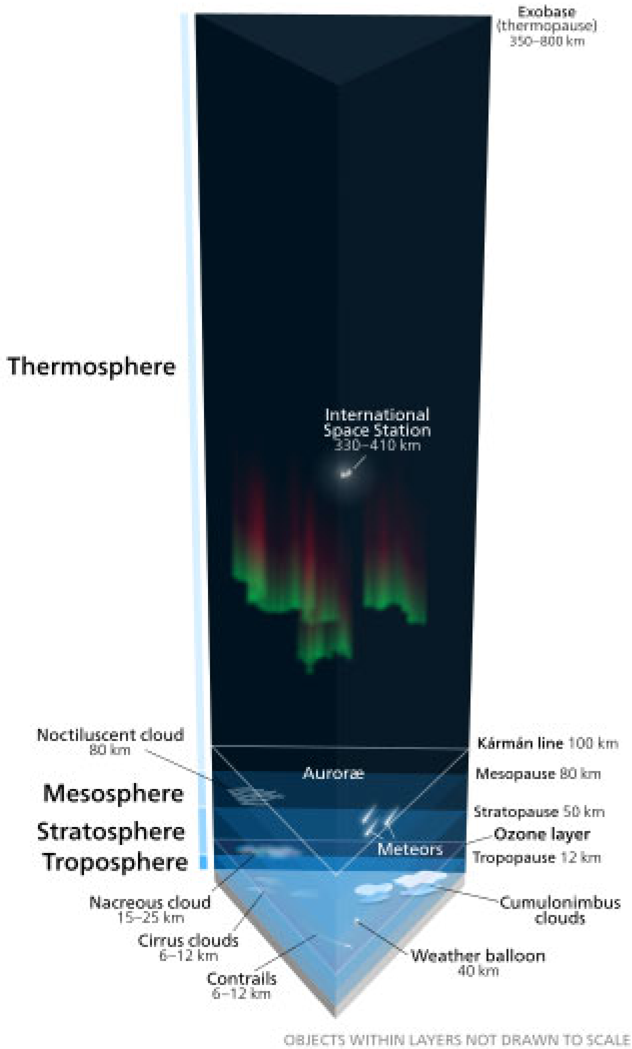

Figure 1. Earth's atmosphere by Kelvinsong - Own work. Licensed under CC BY-SA 3.0 via Wikimedia Commons. [7]

The Ozone Layer [5]

An important gas in the stratosphere and mesosphere is ozone. Ozone is a molecule made up of three oxygen atoms. This gas is mainly found in a layer of the atmosphere commonly referred to as the ozone layer. The ozone layer is found approximately 9 miles above the surface of the Earth, and continues onward to about 30 miles above Earth's surface. [5] The ozone is formed by interactions of ultraviolet radiation in sunlight with oxygen. This gas has the unique ability to absorb the Sun's ultraviolet radiation. Like a giant sheet of sunscreen it protects humans, animals, and plants from getting too much of the Sun's brutal ultraviolet rays. Without this protection conditions on this planet would become very hazardous. [5]

The Greenhouse Effect [8]

While greenhouse gases make up less than 0.1% of atmosphere they are what make the Earth inhabitable. The greenhouse effect is necessary for human life on Earth because without it the planet would not be warm enough. However, problems for humans, plants, and animals can arise when the greenhouse effect becomes stronger and the Earth becomes warmer than usual. [8]

It is carbon dioxide that is responsible for over 60% of this stronger greenhouse effect. Humans rely on the burning of coal, oil, and natural gas for energy. When these fossil fuels are burned carbon dioxide is released into the atmosphere. While this gas does occur naturally in the atmosphere it is not found in such high concentrations. [8]

One experience students may have to the greenhouse effect is the feeling of getting into a car on a hot summer day. The air inside the car feels much warmer than the air outside the car because it is trapped. While on Earth there are no physical boundaries in the atmosphere there are gases that actually hold the heat in. While greenhouse gases (discussed below) make up less than 0.1%. [8]

This carbon dioxide produced by humans then enters the natural carbon cycle. The carbon cycle involves the exchange of billions of tons of carbon each year between the atmosphere, oceans, soil, plants, and fossil fuels and cement production. [3, 8]

Many billions of tons of carbon are exchanged naturally each year between the atmosphere, the oceans, and land plants. This exchange is known as the carbon cycle. [3] The exchanges of this natural system are well balanced. Carbon dioxide levels appear to have varied little for the 10,000 years before 1800. In the last 200 years, however, levels of carbon dioxide in the atmosphere have increased well above those levels. [3, 8]

Greenhouse Gases [8]

Water Vapor

Water vapor (H_2O) is the most abundant and important greenhouse gas because it acts as a feedback to the climate. When the Earth's atmosphere warms up the amount of water vapor also increases. The possibility of clouds and precipitation also increases, therefor creating an important feedback loop to the greenhouse effect. [8]

Carbon Dioxide

Carbon dioxide (CO_2) is another important component in the atmosphere. This natural gas is released by natural process by humans though respiration and volcanoes during eruptions. Humans have also cause an increase in carbon dioxide by deforestation and the burning of fossil fuels. It has gained particular attention due to the increasing rate of carbon dioxide. Since the Industrial Revolution, CO_2 concentrations have increased by more than a third. [8]

Methane

Methane (CH_4) is a hydrocarbon gas produced through natural sources as well as human activities such as, the decomposition of wastes in landfills, agriculture, and manure management. While methane is a more active greenhouse gas than carbon dioxide, it is found in much smaller amounts in the atmosphere. [8]

Nitrous Oxide

Nitrous oxide (NO_2) is a powerful greenhouse gas created through the production of fertilizers and nitric acid and the burning of fossil fuels and biomass. [8]

Chlorofluorocarbons

Chlorofluorocarbons (CFCs) are synthetic materials. The production and release of these compounds into the atmosphere is now regulated through international agreements, as CFCs have contributed to the destruction of the ozone layer. After their ban, scientists have created ways replace their use in refrigerators. [8]

Weather and Climate [11]

Often, the terms weather and climate are used interchangeably. Climate is a system made up of many different factors including the Earth's water, clouds, atmosphere, and temperature that all work together to produce weather. Weather refers to the state of the atmosphere in a particular place and time. Also, weather occurs over short time periods. For example, a meteorologist's weather prediction usually forecasts days or weeks. Looking at weather change involves patterns over days, weeks, or months. While studying climate change requires studying long-term trends over 20, 50, or even 100 years. Weather affects many of our daily decisions. Climate affects long-term decisions and trends in plants and animals. [11]

Water Conservation [12]

Water covers three-quarters of the Earth's surface. This water is the only water that will ever be available to the planet. However, only a fraction of this water is usable fresh water, since 97% of the Earth's water is salt water. Another 2% of fresh water is stored in glaciers, ice caps, and on top of snowy mountains. The remaining 1% is the Earth's daily water supply. This fresh water is found underground and in lakes, rivers, and streams. [12]

Fresh water is used for a variety of purposes. About 42% of fresh water is used for agriculture. Another 39% is used for the production of hydroelectricity, 11% is used for homes, offices, and hotels, and the remaining 8% is used for manufacturing and mining. It is so important to keep this fresh water clean. Humans are responsible for releasing often harmful chemicals and substances into the water system. In 1972,Congress passed the Clean Water Act, which stared national conservation efforts to clean up our nation's waters. With an ever growing population, water quality and quantity is a major concern. [12]

Teaching Strategies

Weather vs. Climate [11]

Students will likely know about different weather phenomena, but may confuse weather and climate. [11]

Directions [11]

Read the following statements and write weather (W), climate (C), or both (B).

1. The year 1976 was one of the hottest on record.
2. 1992 was one of the coldest summers on record.
3. Cities near the ocean tend to be wet.
4. Florida is hotter than Alaska..
5. It might snow in Florida tomorrow.
6. It rained on June 8 th .
7. It is supposed to rain this weekend.
8. Today it was colder than usual.
9. Germany is a cold country.
10. Summer is hot.
11. The hottest recorded temperature of all time was 136°F in Libya.
12. It rains every October.

Key

W, W, C, C, W, W, W, B, C, C, W, C

Solar Cookout [16]

There are many types of solar power, two are thermal direct conversion and photovoltaic. Photovoltaic solar power creates energy by converting solar power into electricity using solar panels. Solar thermal energy, on the other hand, uses direct solar power from the sun by converting solar energy into heat. Solar ovens do not require the use of electricity because they use solar thermal energy to cook the food. In other words, solar cookers can be used anywhere that is exposed to lots of sunlight. People around the world utilize these to cook food and pasteurize water for drinking. They are particularly beneficial because they do not pollute the environment since they use sunlight, a free, renewable energy source. [16]

Solar cookers rely on three basic scientific principals: concentrating sunlight, converting light to heat, and trapping heat. Aluminum foil or mirrors can be used to reflect the sunlight so that it is more concentrated and creates a stronger energy. Light can be converted to heat through the use of a black surface on the inside of the cooker. Black surfaces absorb heat, which allows the cooker to stay hot. Finally, the use of a plastic cover allows the air inside the cooker to be isolated from the air outside the cooker. This plastic creates a greenhouse effect, allowing heat in without allowing it out by suppressing convection. [16]

Figure 2. Photo of solar oven.

There are two major environmental benefits that solar ovens offer. First, they prevent deforestation. Wood fuel is a major source of energy for cooking. Using just one solar cooker can save up to one ton of wood per year, which can reduce a families wood fuel needs in half. Additionally, solar cookers prevent pollution. Other sources of energy, such as wood and gas, pollute the air. Solar ovens create a pollution-free alternative and sociological advantage. [16]

A great way for students to learn about this alternative energy source is by actually building a solar cooker using household materials such as, a pizza box, aluminum foil, black paper, plastic wrap, and a pencil. Create a solar cooker design challenge entry form. Have students work in small groups and create a name for their solar cooker, a list of materials they used to create it, and draw and label a diagram of the solar cooker. Students can also be asked to write a paragraph explaining how their solar cooker works and why their design is the best. [16]

Hosting a solar cookout is a fun way to bring a school community together in support of a common goal of exploring alternative energy sources. This solar cookout can be planned in collaboration with Earth Day by creating a Save-The-Earth themed picnic! Or the project is an awesome inquiry based design challenge. Hosting a solar cookout can allow middle school students to inform the rest of the school about a renewable and sustainable form of alternative energy – solar energy. Solar panels are used to gather energy from the sun. These ovens are of particular interest in developing countries in order to lesson air pollution and deforestation. [16]

Some students may choose to use a simple pizza box design, while others may choose to research different solar cooker designs or come up with their own model. Some variables that students might choose to investigate, to see how the temperature inside the cooker is affected, include: sunny versus cloudy, shade versus direct sun light, the shape of the box, the color of the paper, angle of the flap, type of plastic, amount of foil. [16]

Greenhouse in a Jar Lab [8]

Question

How does the presence of increased levels of CO2 affect the temperature inside a bottle when exposed to heat? [8]

Materials

The materials that are needed for this experiment include: two clear 2 liter soda bottles with labels removed, tin foil, two thermometers, one 250 mL beaker, water, one Alka-Seltzer tabled, one 150 watt light fixture, one ruler, one stop watch. [8]

Procedure [8]

1. Set up a lamp on the table.
2. Place the 2 liter bottles next to each other side by side about six inches away from the lap.
3. Add 200 mL of water to each bottle.
4. Hang the thermometer in one of the bottles so that it is in the middle, the thermometer should not touch the water. It is important to make sure that the temperature can be read. Use the tin foil to seal the bottle and hold up the thermometer. This bottle is the control bottle.
5. Break an Alka-Seltzer tabled in half and place both pieces in the second bottle. Quickly hang the second thermometer and close the top with tin foil as was done with the first bottle. This is the experimental bottle.
6. Turn on the lamp and make sure it shines evenly on both bottles.
7. Record the temperature of both bottles every two minutes for the next twenty minutes.

Water in the World Demonstration [12]

In this demonstration students can see visually how much of different types of water are on our planet. Begin by placing 5 gallons of water in a tank. This tank represents all of the water in the word. Ask students to predict how much water is in oceans, the ground, rivers, ice caps/glaciers, freshwater lakes, inland seas/salt lakes, and the atmosphere. Remove 18 ounces of water from the tank using a measuring cup.. Using green food coloring, color the rest of the water in the tank green. This represents all the water in the oceans. The water in the measuring cup represents water that is not ocean water. Next, pour 15 ounces of the water in the measuring up into an ice cube tray. This water symbolizes water in ice caps and glaciers. The remaining 3 ounces represents the Earth's available fresh water. Place a drop of water (0.5 ounces) into a student's hand to represent the water found in fresh water lakes and rivers. The final 2.5 ounces is ground water. Pour it into a cup of sand to demonstrate this. [12]

How Much Water Do You Use? [12]

This activity is designed to help students become aware of how much water they use on a weekly basis. Have students read the story, "The Case of the Mysterious Renters" and complete a survey to find out how much water they use in their home each week. Record the activity, times were day, weekly total, water per activity, and the total water used. [12]

Survey [12]

Toilet Flushing: ___ weekly total x 5 gallons = _________

Short Shower (5-10 minutes): ___ weekly total x 25 gallons = _________

Long Shower (> 10 minutes): ___ weekly total x 35 gallons = _________

Tub Bath: ___ weekly total x 35 gallons = _________

Teeth Brushing: ___ weekly total x 2 gallons = _________

Washing Dishes with Running Water: ___ weekly total x 30 gallons = _________

Washing Dishes by Filling a Basin: ___ weekly total x 10 gallons = _________

Using the Dishwasher: ___ weekly total x 20 gallons = _________

Washing Clothes: ___ weekly total x 40 gallons = _________

Follow-up Questions [12]

Ask students to think about the following questions: Which activity happened most often? Which activities use the most water? Why might your answers differ from that of your classmates? Ask students to brainstorm a list of ways families can conserve water at home. Ask students to then create a public service announcement, poster, or video encouraging students to conserve water.

For example, two-thirds of the water used in the average home is used in the bathroom for activities such as showering, bathing, and flushing the toilet. By taking shorter showers that are less than five minutes families can conserve gallons of water each week. In the kitchen and laundry room, families can wait to run only full loads of dishes or clothes. [12]

Estimating Bottled Water Use [13]

Another great activity is to estimate how many plastic disposable water bottles are made each year. Even though Connecticut has a $.05 bottle fee, it can be assumed that many are not recycled. A class could estimate how much carbon, from oil or other fossil fuels, is used each year and find the percent of the United States energy budget it uses. [13]

Bottled Water and Energy Use [13]

The rising use of bottle water raises questions about the product's economic and environmental costs. One of the most significant concerns are the resources required to produce the plastic bottle, which both energy and water. According to the Beverage Marketing Corporation, Americans bought a total of 31.2 billion liters of water in 2006. Most of this water is sold in polyethylene terephthalate (PET) bottles. PET bottles are produced from fossil fuels, such as natural gas. This water bottle production required about 900,000 tons of plastic. [9]

According to the Pacific Institute in 2006 producing bottled water for American consumption required the equivalent of more than 17 million barrels of oil. This bottled water production produced more than 2.5 million tons of carbon dioxide. [9]

One great classroom activity is having students figure these statistics out for themselves. Pose to your students some of the following calculations: [13]

According to the plastics manufacturing industry, it takes around 3.4 megajoules of energy to make a typical one liter plastic bottle, cap, and packaging. How much energy is required to make enough plastic to bottle 31.2 billion liters of water? Answer: 106 billion megajoules of energy.

If a barrel of oil contains around 6 thousand megajoules. How many barrels of oil were needed to produce the plastic bottles used in 2006? Answer: 17 million barrels of oil

Every ton of PET manufactured produces around 3 tons of carbon dioxide. How much carbon dioxide was release in 2006 from bottled water production? Answer: 2.5 million tons.

The Pacific Institute estimates that twice as much water is used in the production of plastic bottles. How much water is used to make 1 liter of water? Answer: 3 liters of water.

Appendix A. Implementing District Standards

Current Connecticut Standards

Content Standards

Energy in the earth's systems — How do external and internal sources of energy affect the earth's systems?

Standard 6.3 — Variations in the amount of the sun's energy hitting the earth's surface affects daily and seasonal weather patterns and climate on a long term scale (20,000 years).

Standard 6.3.a. Local and regional weather are affected by the amount of solar energy the area receives and proximity to a large body of water.

This unit addresses the Connecticut Content Standards related to Energy in the Earth's System. More specifically it seeks to answer the question: How do external and internal sources of energy affect the earth's systems? It addresses Connecticut Science Standard 6.3a.

CMT Expected Performances

C7. Describe the effect of heating on the movement of molecules in solids, liquids and gases.

C8. Explain how local weather conditions are related to the temperature, pressure and water content of the atmosphere and the proximity to a large body of water.

C9. Explain how the uneven heating of the earth's surface causes winds and affects the seasons.

Current New Haven Curriculum Standards

Grade-Level Concepts

Students should understand that…

1. Earth is surrounded by layers of gases (atmosphere) that influence the environmental conditions on its surface. Earth's atmosphere (air) is a mixture of different amounts of gases (mainly nitrogen and oxygen, along with small amounts of carbon dioxide, water vapor and other gases).
2. Weather on Earth is caused by the daily changes in the temperature, pressure and amount of moisture in the lower atmosphere.
3. Climate is the long-term conditions experienced by different regions on earth, and is influenced by the amount of solar energy penetrating the atmosphere to reach Earth's surface.
4. The atmosphere allows solar energy to pass through it and reach Earth's surface. Carbon dioxide and water vapor in the atmosphere absorb some of the outgoing heat energy, preventing it from going back into space.
5. The molecules that make up all matter are in constant motion. Solids, liquids and gases differ in the movement and arrangements of their molecules. Molecules in gases move randomly and independently of one another. Molecules in liquids move around each other randomly, but are loosely held together by an attraction force. Molecules in solids are closely locked in a patterned position and can only vibrate back and forth. The closer the molecules, the greater their density.
6. When heat energy is added to a substance, its molecules move faster and spread apart from each other. When heat energy is removed, molecules move slower and come closer together.
7. Matter changes state (phase change) due to the absorption or release of heat energy. If enough heat energy is absorbed, the molecules of a solid overcome the forces holding them together, move farther apart and change to a liquid state (melt); molecules of a liquid may change to a gas (vaporize). Conversely, if enough heat energy is released to the surroundings, then molecules of gases will move closer together and become liquid (condensation) or solid (freezing).
8. Solar energy is absorbed by different surfaces on the earth and radiated back to warm the atmosphere. Land absorbs solar energy at a faster rate, and releases it at a faster rate, than water. Air temperature above the land or water depends on the amount of solar radiation absorbed.
9. Air molecules constantly press on and around objects on Earth (air pressure). Due to the pull of Earth's gravity and weight of are above, air pressure close to Earth's surface is always greater than air higher in the atmosphere. Temperature of air molecules affects their density. Cool, dense air molecules sink and exert greater pressure on Earth; warm, less dense air molecules exert less pressure on Earth's surface and rise.

10. Wind is caused by air moving from areas of high pressure to low pressure. Local winds result from air pressure differences caused by uneven heating of land and water. Near coastal areas, land and sea breezes change predictably during the day/night cycle due to temperature differences above land and water.
11. Global winds are caused by the rising of warm equatorial air and the sinking of cold polar air.
12. Water on Earth evaporates into the atmosphere (humidity) driven by energy from the sun. Higher temperature causes more evaporation. Clouds form when warm, moist air evaporates, rises and cools, causing its molecules to condense onto tiny dust particles suspended in the air. Different cloud formations are associated with different weather.
13. Weather on Earth is caused by daily variations in the temperature, pressure and humidity of different bodies of air (air masses). Decreasing air pressure usually indicates that cloudy, wet weather is approaching. Increasing air pressure usually indicates that clear, dry weather is approaching.
14. Areas of warm air meet areas of cold air at a “front.” Precipitation generally results where a cold and a warm air mass meet. Areas of cold air move under areas of warm air, forcing the warm air to rise, cool and condense to form clouds; areas of warm air move above areas of cold air, causing warm air to rise, cool and condense to form clouds.
15. Connecticut weather is influenced by its closeness to the Atlantic Ocean and Long Island Sound. Water temperature causes coastal temperatures to be cooler in summer and warmer in winter than temperatures inland.
16. Connecticut often has rapidly changing weather because three patterns of moving air interact here: cold, dry air from the north, warm, moist air from the Atlantic Ocean coastline, and air moving across the US from west to east.

Grade-Level Expectations

Students should be able to:

1. Compare the composition and functions of the earth’s atmospheric layers.
2. Explain how changes in temperature, pressure, moisture and density of air create weather.
3. Describe differences between climate and weather.
4. Demonstrate the arrangement and motion of atoms or molecules in solids, liquids and gases.
5. Predict the phase change that will result from the absorption or release of heat energy by solids, liquids or gases.
6. Create models or diagrams that demonstrate how solar energy drives different phases of the water cycle.
7. Design, conduct and report in writing an investigation to compare the heat absorption and release rates of water and earth materials.
8. Compare and contrast conditions that cause local sea breezes/land breezes and global wind patterns.
9. Predict the type of weather that may result given certain cloud types, warm and cold fronts and air pressure.
10. Explain the causes of temperature differences between coastal and inland areas.

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