Objective 5 – The student will demonstrate an understanding of Earth and Space systems.

TEKS 8.10 B

Red at Night, Sailor's Delight

TAKS Objective 5 – The student will demonstrate an understanding of Earth and Space systems.

Learned Science Concepts:

- ➡ **Complex interactions occur between matter and energy.**
- Cycles exist in Earth systems.
- Characteristics of the universe.
- Natural events and human activity can alter Earth systems.

TEKS Science Concepts 8.10

The student knows that complex interaction occur between matter and energy. The student is expected to:

(B) Describe interactions among solar, weather and ocean systems.

Overview

Systems can work together with major consequences. The weather system is affected by the ocean system and the solar system. In return the ocean system is affected by the weather system. Students will learn how energy is transformed between systems and the results that occur. They will understand how specific heat capacity differences between land and water cause pressure differences causing winds, weather and storms. Students will also understand how weather is different on Earth than on other planets in the solar system due to our atmosphere and oceans.

Instructional Strategies

Students will do hands-on activities to develop the concepts of differentiated heating and air currents. The will see examples of extreme weather in video. They will discuss and research weather on other planets.

Objectives

1. The student can describe how radiant energy from the Sun affects weather on Earth and the other planets.
2. The student can explain how the ocean affects weather.
3. The student can describe how the Moon and Sun affect the ocean.

TEKS 8.10 B

For Teacher's Eyes Only

Of all the planets in the solar system, Earth has a unique position and composition. Earth has an atmosphere that helps protect it from some of the Sun's radiation and yet allow enough radiation to reach the Earth to be absorbed and transformed into heat. The atmosphere also helps increase the amount of heat on Earth by changing radiation to heat and then into new radiant energy directed back at Earth.

The upper atmosphere, the ozone, traps high energy radiation before it reaches the Earth and causing extreme sunburn and other unwanted effects. During periods of solar flares and high numbers of sunspots, the high energy is increased and more reaches the Earth causing problems with communication, power companies, weather and perhaps even some animal species. The high level of sunspots occurs at a fairly predictable time pattern of every eleven years.

Mercury and the Moon have practically no atmosphere. Radiant energy from the Sun is absorbed and changed into heat. Without an atmosphere the heat does not distribute over the surface. Where the Sun's rays do not strike or during nighttime, the surface cools by radiating energy back into space. An astronaut floating in space, for example, will be very hot on the side facing the Sun and very cold on the side away from the Sun. Only the spacesuit provides protection.

Venus has a very, very dense atmosphere that would crush a person who could make it to the surface of the planet. The atmosphere traps a lot of heat energy and thus the surface of Venus is very hot. Water cannot exist at such high temperatures and Venus has no oceans.

The gaseous giant planets have no surface as we know it and are all atmospheres. They are also very far from the Sun and are cold. When a storm begins like the giant red spot on Jupiter, there is no land to create friction and transform energy slowing and stopping the storm. Unlike hurricanes on Earth that die down after reaching land, the giant red spot has been swirling for over 300 years with no sign of stopping.

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Student Misconceptions

☒ Misconception

The seasons are caused by the distance the Earth is from the Sun.

☑ Science Concept

Summer is due to the tilt of the Earth that causes a more direct sunlight for longer of periods of time. In the winter the opposite situation exists where the Sun does not get as high in the sky and is not visible as long. The equator region experiences other kinds of weather change.

🛠Rebuild Concept

Use the introduction of discrepant ideas to dispel the myth. Examples include: If the summer is when the Earth is closest to the Sun, why does the southern hemisphere have winter and cold weather during the northern hemisphere summer; The Earth's distance from the Sun is almost always the same; The Earth is slightly closer to the Sun during summer in the northern hemisphere.

☒ Misconception

Water spirals down a pipe one direction in the northern hemisphere and the opposite direction in the southern hemisphere because of the Coriolis Effect.

☑ Science Concept

The direction water runs down a drain is due to the plumbing and not the spin of the Earth.

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🛠Rebuild Concept

Testing the direction water drains down a pipe could be a take-home project. Students check sinks, tubs and toilet bowls then compile results in class. The direction of the spin can be changed by using a circular motion of the hand in the water. Encourage students to test ideas and gain first hand knowledge.

☒ Misconception

The Earth is warmed by heat from the Sun.

☑ Science Concept

Heat is energy of moving particles. Between the Sun and the Earth there is nothing to carry heat energy. Warming occurs when radiation or light from the Sun is absorbed by the Earth and its atmosphere and is then changed into heat energy.

🛠Rebuild Concept

Compare heat energy to radiant energy. A vacuum thermos is used to keep heat energy in or out. An umbrella blocks the Sun's rays (radiation) and keeps a person cooler. Space objects with little or no atmosphere such as Mercury or the Moon are very cold on the side opposite the Sun and hot on the side facing the Sun. Reinforce the concept of heat discussed in the TAKS Objective 3.

Student Prior Knowledge

Students should understand the concept of a system. (TEKS 6.5 and 7.5) Students should understand that energy can be transformed from one type to another. (TEKS 6.9 and 7.8) Students should know the components of the Solar system. (TEKS 6.13 and 7.13) They should be able to identify the components in the Earth-system that are responsible for weather changes. (TEKS 8.14)

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5 E's

Engage

Engage 1

Show the Xtreem Science News video about Sunspots Spotted. This video provides references to extreme results that solar flares and sunspots can produce on Earth. Use this as a lead into interactions between the Sun and the Earth.

Engage 2

Show a violent weather clip of a hurricane or typhoon. This can lead into discussion of how the ocean might affect the weather on land.

Explore

Demonstration: Blowing Smoke

Class Time: 5 minutes

Objective 1: The student can explain how the ocean affects weather.

Objective 2: The student can describe how radiant energy from the Sun affects weather on Earth and the other planets.

Process Skills: TEKS 8.3 (C) – The student is expected to represent the natural world using models and identify their limitations.

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Materials:

Two 2-liter plastic soda bottles with labels removed and no caps
Ziploc Sandwich bag full of ice
Sand
Hotplate
Incense stick

Preparation: Cut the top off one bottle and the bottom off the other. The two remaining pieces should slip together to form a very tall bottle. Heat the sand in a container over the hotplate until it is very warm but not hot enough to melt the plastic bottle. Put the sand in the bottom portion of the bottle. Tape the bag of ice on the inside of the bottle top close to the bottle neck. Slip the two pieces of bottle together.

Procedure: Light the incense and stick it into the bottle. It might be more useful to put a little hole in the bottle toward the bottom (above the sand line so it does not spill out) and toward the top. Insert the incense stick into the bottom hole and let students react. Stick it into the top hole and let students react. If possible, check the affect of turning the bottle on its side before inserting the lit stick. This demo models the how air currents flow due the differences in temperature.

What would happen if there was no air in the bottle? (The warm sand would radiate some energy which would strike the ice. The ice would then change some of the radiation into heat.)

EXPLAIN

Warmer air tends to rise and cooler air moves in beneath it. Using the smoke produced in the Explore demonstration, the movement or current of the air can be seen. Cooler air masses have higher air pressure than warm air masses. The Elaborate 1 experiment demonstrates the differentiation of heat absorption and radiation between land and water. Because land and water heat capacities (See TAKS Objective 3) are different, the air masses blanketing each are different. This results in higher and lower air pressure masses and the movement of air producing weather.

Show students pictures of tides. Draw a model of the Earth, Sun and Moon showing how force of gravity differences cause the waters closest to the Moon to bulge out, the Earth to be pulled a little toward the Moon and

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away from the water on the opposite site. There are good animations of this on the Internet that simulate tides.

ELABORATE

Elaboration 1

Experiment: Wind and Water

Class Time: 1 class period

Objective 1: The student can explain how the ocean affects weather.

Objective 2: The student can describe how radiant energy from the Sun affects weather on Earth and the other planets.

Process Skills:

> TEKS 8.2 The student is expected to (A) plan and implement investigative procedures including asking questions, formulating testable hypothesis, and selecting and using equipment and technology, (B) collect data by observing and measuring, (C) organize, analyze, evaluate, make inferences and predict trends from direct and indirect evidence, and construct graphs, tables, maps and charts using tools including computers to organize, examine and evaluate data.

Materials:

> A container of dirt and an equal size container of water
> Bright, hot incandescent lamp
> Two thermometers
> Timer
> Graph paper

Experimental controls: Before setting up the experiment, allow students to discuss in their groups what factors are important to control and keep constant. Have them discuss how they will go about setting up the experiment to make sure results are reliable. After group discussions, have a group spokesperson report group decisions. (Examples include keeping the light an equal distance from the dirt and the water and keeping track of

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the time the temperature reading is made.) If students have a question about whether some factors are important or not, this can be made part of the experiment and a question that can be answered as part of the procedure.

Procedure: Arrange the dirt, water, and lamp so that the lamp is close to both. Place thermometers in the dirt and water. Periodically (decision made by group such as every minute or 3 minutes) record the temperature of each container. After 10-20 minutes (depending on class time) take the light away and continue recording temperature. Graph the temperature (y-axis) versus time (x-axis). If possible use a computer spreadsheet program for this. What conclusions can be drawn?

Alternate: Give each group a different kind of dirt or sand such as black soil, clay soil, light sand and dark sand. Allow the groups to compare results and apply conclusions to the heating of the Earth's surface.

Elaboration 2

Activity: Where the wind blows…

Class Time: 30 minutes

Objective 1: The student can explain how the oceans affect weather.

Objective 2: The student can describe how radiant energy from the Sun affects weather on Earth and the other planets.

Procedure:

1. Investigate web sites to find out about weather on other planets. Compare atmospheres, distances from the Sun, land features such as volcanoes or bodies of water, types of storms and duration, lengths of day/night and year.

2. Create a flyer to represent the planet's weather.

3. Discuss why the differences exist in weather patterns.

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EVALUATE

Let each student pick an extreme event such as the oceans all dry up, the atmosphere suddenly disappears, the Sun or Moon moves significantly closer or further away, or all the land becomes flat and sandy. Have students to imagine how the weather would change as a result. Let students write a paper, song, poem or make a drawing describing their ideas. Students should include comments on temperature, air current patterns, storms, tides and waves, and other ideas of their choices. Work together as a class to build a rubric for grading the project.

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TEKS 8.12 A

The Never Ending Cycle

TAKS Objective 5 – The student will demonstrate an understanding of Earth and Space systems.

Learned Science Concepts:

- Complex interactions occur between matter and energy.
- ➡ **Cycles exist in Earth systems.**
- Characteristics of the universe.
- Natural events and human activity can alter Earth systems.

TEKS Science Concepts 8.12

The student knows that cycles exist in Earth systems. The student is expected to:

(A) analyze and predict the sequence of events in the lunar and rock cycles.

Overview

After learning the TEKS concepts, students will understand the phases of the Moon and the relationships between Moon phase, position of the Moon in the sky, orientation of the Moon compared to the Sun, and the significance of the time of day or night. Students will use this information to predict the position and phase of the Moon during the month. Students will also understand that rocks are always changing through weathering, pressure and heat. Students will be able to use this knowledge to predict what will happen to rocks as they experience the cycle of change.

Instructional Strategies

In these lessons, students focus on identifying patterns and making predictions from known patterns. They will then test these predictions and explain why some predictions are inaccurate. Students will work with common materials to model the rock cycle. Students will do pencil and paper activities that reinforce the concepts learned about the patterns of different cycles.

Objectives

Lunar Cycle Objectives

1. The student will be able to analyze and predict the phases of the Moon.
2. The student will be able to determine which part of the Moon can be seen from Earth during each phase.
3. The student will be able to predict the rising and setting of various phases of the Moon.

Rock Cycle Objectives

4. The student will be able to observe playground sand under a microscope and predict which rock it came from.
5. The student will be able to predict the events in the rock cycle.
6. The student will be able to diagram and explain the rock cycle.

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For Teacher's Eyes Only

The Lunar Cycle

The Moon's appearance goes through phases. The amount of the Moon we can see changes over time in a cycle that repeats itself approximately every 29.5 days. The cause of these phases is the relative positions of the Sun, Earth and Moon. Half of the Moon is always illuminated by the Sun but as the Moon moves in its orbit, different portions of it appear (to us) to be lit.

Lunar Phases

During a full Moon the Sun and Moon aligned on opposite sides of earth. The Sun illuminates the entire side of Moon that faces the earth.

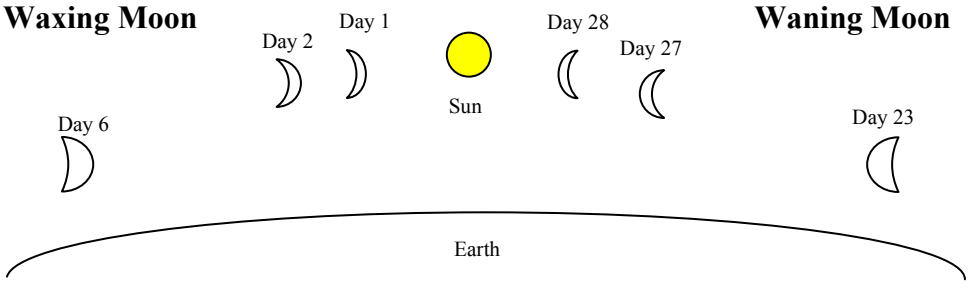
At the New Moon phase the sun and Moon aligned on same side of earth. The Sun illuminates the side of Moon that is away from earth and the Moon is only up during the day so normally we never see a new Moon.

During the first quarter* and third quarter* phases the Sun-Moon-Earth angle is 90 degrees. Half of the Earth-facing side of Moon is illuminated and half is in shadow.

*Quarter means a quarter of way through cycle, not a quarter illuminated.

Waxing and Waning

The terms waxing and waning are used to indicate whether or not the phase of the Moon is getting larger – going from new Moon to full Moon or getting smaller – going from full Moon to new Moon. A waxing Moon (getting larger) is moving away from the Sun's position each day and a waning Moon (getting smaller) is moving toward the Sun's position each day.



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Size of the Moon

The human eye cannot get a direct measurement of the size of the Moon, the Sun or any other celestial body because when we look at the sky, we lack depth perception. This means that when we look up at the sky, all the stars and planets appear to be at the same distance from us. The only things we can measure when we look at the sky are angular sizes and angular distances. If you divide the whole celestial sphere in 360º just as you would do for a circle, you can talk about the angular size of objects or their angular distance (the angle that appear to separate the two objects on the celestial sphere). When we calculate these angles for the Moon and the Sun, we get almost the same outcome: 0.5 degrees.

To approximate angular distances hold your arm fully extended in front of you. Close your fist and look at it superimposed with the objects you are trying to measure the angular distance between. From one edge of your fist to the other is about 10 degrees and one knuckle is about 2.5 degrees. The little finger held at arm's length covers about 1 degree.

Name the Phases

As seen in the diagram, Earth-Sun-Moon, if the Sun is located off to the right of the picture, the Earth and Moon are illuminated as shown. No matter what phase the Moon is in, half of it is always lit by the Sun.

We can see the lighted side of the Moon that is facing the Earth from the horizon to horizon as indicated by the circle showing the orbit of the Moon.

For example, if the Moon is at position 1 in the diagram the half of it that is lit by the sun is facing away from us, so we do not see the Moon at all. This is called the new Moon. When the Moon is at position 5 we see entire face of the Moon that is lit up. This phase is called the full Moon.

The words waxing and waning distinguish the two repeating phases – crescent and gibbous. Waxing is defined as getting larger and waning is defined as getting smaller. This refers to the lit side of the Moon. So a waxing crescent is the phase where the lighted portion is getting larger between the new Moon and the first quarter. A waning crescent is the phase where the lighted portion is getting smaller between the last quarter and the new Moon. The defining line separating the dark area and light area of the Moon is called the Terminator.

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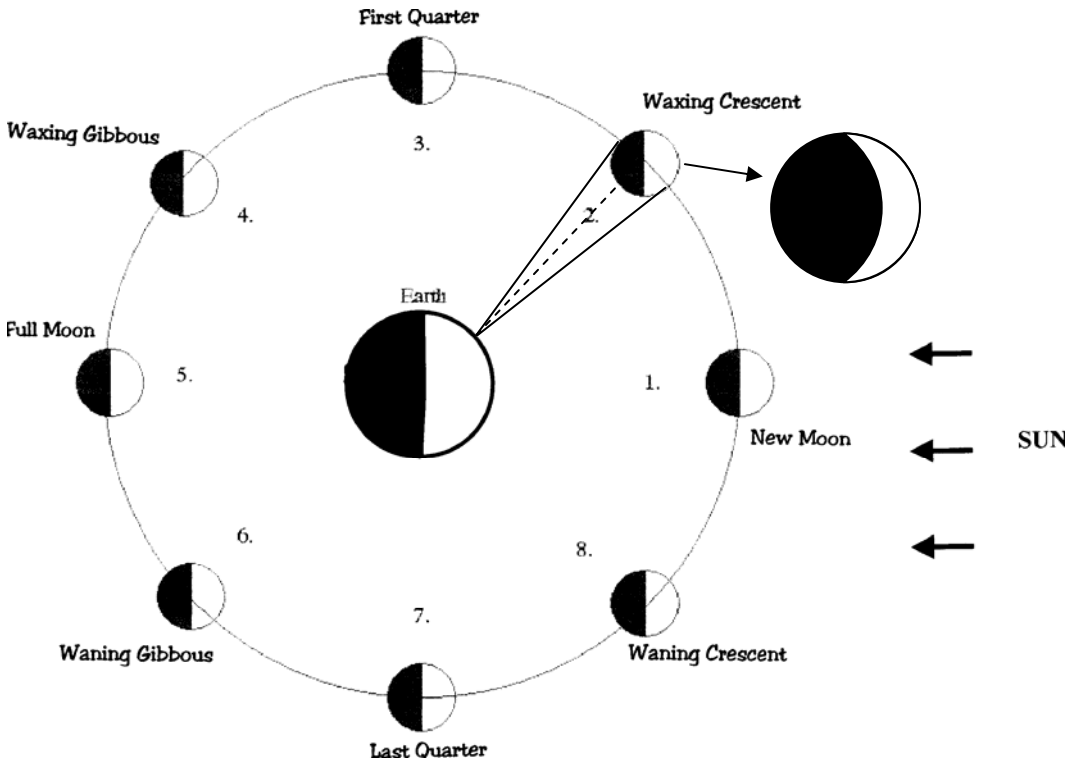
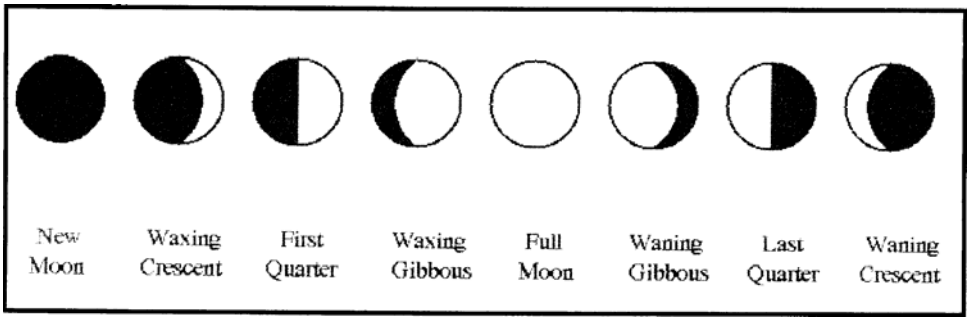
The diagram below shows what the different phases look like as seen from



Earth-Sun-Moon

Earth. During the phases new Moon through full Moon the amount of lighted area increases over time and that lighted area is seen on the right side of the Moon. During the phases full Moon through new Moon the amount of lighted area decreases over time and that lighted area is seen on the left side of the Moon.



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The Rock Cycle

Formation of Rocks

Igneous rocks are formed from the cooling of molten rock. There are two types of igneous rock: *volcanic* igneous rocks formed from molten rock that cooled quickly on or near the earth's surface and *plutonic* igneous rocks are the product of the slow cooling of molten rock far beneath the surface. Sedimentary rocks are formed in layers as the result of moderate pressure on sediments that have accumulated from weathering. Metamorphic rocks are formed from rock (either igneous or sedimentary) under intense heat and/or pressure at great depths beneath the earth's surface.

Rock Recycling

The recycling of rocks can occur in a variety of ways. It is a very long process relative to the Earth's geological history. In a simplified rock cycle

(A) Liquid (molten) rock material solidifies either at or below the surface of the earth to form igneous rocks.

(B) Uplifting of the igneous rocks creates mountains.

(C) These igneous rocks are exposed at the surface allowing weathering to occur. This breaks them down into smaller grains producing rock fragments.

(D) The fragments are transported by wind, water and gravity and eventually deposited as sediments.

(E) The sediments are deposited in layers and become compacted under pressure and cemented forming sedimentary rocks.

(F) The next step in the process occurs when the sedimentary rocks are again placed under pressure where the heat energy is great enough to remold the rock and form metamorphic rocks. Changes in temperature, pressure and/or the chemistry of the rock can cause chemical and/or physical changes in igneous and sedimentary rocks to form metamorphic rocks.

(G) When exposed to higher temperatures, metamorphic or sedimentary rocks may be partially melted

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resulting in the creation once again of igneous rocks thus starting the cycle all over again.

In this model cycle, shortcuts are common. For instance, igneous rocks may never be weathered, but instead be re-melted during metamorphism without experiencing a sedimentary stage. Alternatively, metamorphic rock may be uplifted away from the influence of pressure and heat, to be weathered and removed as sediment. The rock cycle is a naturally changing process, like the lunar cycle. The difference lies in the fact that the rock cycle takes much longer to complete and is driven by plate tectonics.

Uses of the Rock Cycle

The rock cycle shows how igneous, metamorphic or sedimentary rock may be weathered and transported as fragments and dissolved sediment. It also explains why fossils occur most often in sedimentary rock. The fossils tend to be destroyed in the heat and pressure that metamorphic and igneous rocks undergo.

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Student Misconceptions

☒ Misconception

The phases of the Moon happen when the Earth's shadow falls on the Moon's surface.

☑ Scientific Concept

The side of the Moon that is facing the Sun is always lit except during a lunar eclipse. From the Earth different angles of the Moon are visible depending on the relative positions of the Sun, Moon and Earth. These different angles of illumination create the different phases.

🛠 Rebuild Concept

Use kinesthetic and visual techniques to dispel the idea that phases are caused by the Earth's shadow. Place a bright light in the corner of the classroom. Have a student stand far from the light and a few feet from a wall. Discuss the position of the shadow and how only if an object were in that very spot would the shadow fall on it.

☒ Misconception

The far side of the Moon is the same as the dark side of the Moon.

☑ Science Concept

Because we always see the same side of the moon people confuse the far side of the moon with the dark side of the moon. The moon does spin on its axis just like the Earth. Just like the Earth, part of the moon is always in shadow (night) but this part changes so no part of the moon is always in darkness and no part of the moon is always in light. We do not see the far side of the moon but because of various idioms in our language people refer to the far side of the moon as the dark side of the moon and so cause a misconception.

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🛠 Rebuild Concept

Select a Moon model such as a white ball or even a person. Move the Moon model around the classroom and show students that one side is always lit, though not always the side seen from Earth.

☒ Misconception

The Moon only shines at night.

☑ Science Concept

Except close to New Moon, when the Sun is too bright for the Moon to be seen, and Full Moon, the Moon can be seen during certain times of every day.

🛠Rebuild Concept

Take students outside to see the Moon during the day. Discuss the Moon phase and position of the Moon in the sky compared to the position of the Sun.

Student Prior Knowledge

TEKS 6.5A Students identify and describe a system that results from the combination of two or more systems such as in the solar system.

TEKS 7.13A Students identify and illustrate how the tilt of the Earth on its axis as it rotates and revolves around the Sun causes changes in seasons and the length of the day.

TEKS 6.6C Students identify forces that shape features of the Earth including uplifting, movement of water, and volcanic activity.

TEKS 7.14B Students analyze effects of regional erosional deposition and weathering.

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5 E's

Lunar Cycle

Engage

Show the Extreme News clip featuring news anchor Luna Tique in The Terminator. This production features the sighting of the Terminator on the Moon. This can begin discussions on the phases of the Moon.

Explore

Exploration 1

Activity: My Birthday Moon (See Black-Line Masters)

Class Time: 20 minutes

Objective: The student will be able to analyze and predict the phases of the Moon.

Process Skills:

TEKS 8.2 (C) The student is expected to organize, analyze, evaluate, make inferences and predict trends from direct and indirect evidence.

Materials:

My Birthday Moon worksheet (See Black-Line Masters)
Internet or Starry Night software

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Students find the phase of the Moon that was present on their birthday and several other days in their birth month and year. They analyze the pattern and predict the shape of the Moon before and after their birthday.

Exploration 2

Activity: Analyzing a Moon Phase Calendar (See Black-Line Masters)

Class Time: 10 minutes

Objective: The student will be able to analyze and predict the phases of the Moon.

Process Skills:

> TEKS 8.2 (C) The student is expected to organize, analyze, evaluate, make inferences and predict trends from direct and indirect evidence.

Students observe pictures of the phases of the Moon for one-month cycle. Students analyze the patterns found on the calendar.

Explain

The Moon rises about one hour later every day. During a New Moon, the Moon is in the same longitudinal position in the sky as the Sun. The next day it will be about 12 degrees to the left (lagging) the Sun. So if the Sun rises at 6:00 AM, the Moon will rise just before 7:00 AM. The day after that the Moon will rise before 8:00 AM and so on. During a full Moon, the Sun and Moon are on opposite sides of the Earth. With practice, a person could tell the time of day by the position and phase of the Moon. Daylight savings time throws the calculations off by an hour.

Answers to Analyzing the Patterns of Moon Phases

1. Lighted area is getting larger.
2. Lighted area is getting larger.

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3. Lighted area is getting smaller.
4. Lighted area is getting smaller.
5. In the second week the lighted area is getting larger and in the third week the lighted area is getting smaller.
6. During the first week the lighted area is on the right side of the moon and during the fourth week the lighted area is on the left side of the moon.
7. Yes, the same pattern holds true.
8. New moon – the entire circle should be colored in.
9.

Labeling the Moon Phase Calendar

Day 1	New Moon (already labeled)
Days 2-6	Waxing Crescent
Day 7	First Quarter
Days 8-13	Waxing Gibbous
Day 14-15	Full
Days 16-20	Waning Gibbous
Day 21	Last Quarter
Day 22-27	Waning Crescent
Day 28	New Moon

Elaborate

Activity: Using a Moon Clock to Tell Time (see Black-Line Masters)

Class Time: 30 minutes

Objective: The student will be able to analyze and predict the phases of the Moon.

Process Skills:

TEKS 8.4 (B) The student is expected to extrapolate from collected information to make predictions.

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Materials:

Moon Clock (see Black-Line Masters)
Scissors
Brad fastener

Students make a Moon clock and predict the rising and setting of various phases of the Moon. Students will take the Moon clock home to observe the Moon and check for accuracy.

Evaluate

Assessment tools: Moon Phases Quiz (see Black-Line Masters)

Students are given real pictures of various phases of the Moon and are asked to place them in order while naming the phases.

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TAKS question:

Observe the following pattern found in the lunar cycle.

Which of the pictures below would you predict to be next in the lunar cycle?

* Correct answer

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My Birthday Moon

Purpose: To determine the shape of the moon that was present on student's birthday and predict moon phases through observed patterns.

Materials and Resources:

Internet access: Website http://tycho.usno.navy.mil/vphase.html
Moon Phase Calendar

What to Do:

1. Access the website given in the materials above.
2. Enter the day, month and year in which you were born.
3. Draw how the moon appeared on your actual birthday in Chart 1.
4. Determine the shape of the moon for the days in Chart 1 using the Moon Phase Calendar.
5. Predict the shape of the moon that would be present three days after your birthday.
6. Draw it in Chart 2.
7. Continue with all the other moons.
8. Use the internet site to check to see if your predictions were correct.
9. Answer the questions.

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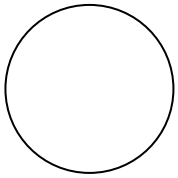
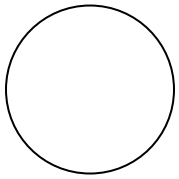
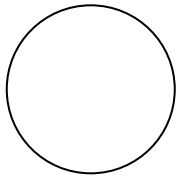
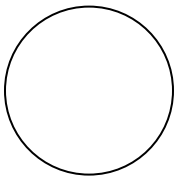
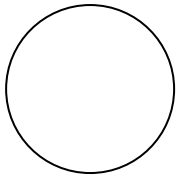
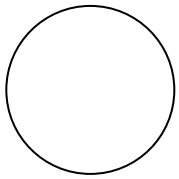
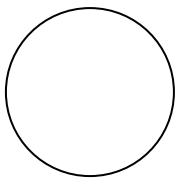
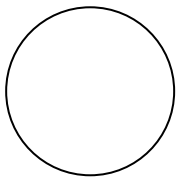
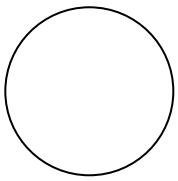
CHART 1

My Birthday Moon	6 days after my birthday	12 days after my birthday
		
Date _____	Date _____	Date _____

18 days after my birthday	24 days after my birthday	30 days after my birthday
		
Date _____	Date _____	Date _____

MY PREDICTIONS

3 days before my birthday	9 days after my birthday	21 days after my birthday
		
Date _____	Date _____	Date _____

TEKS 8.12 A

Questions:

1. What patterns do you see as the moon goes through its cycle?

2. Approximately how many days does it take the moon to go through its cycle?

3. What else do you know about the moon phases?

TEKS 8.12 A

ANALYZING A MOON PHASE CALENDAR

Purpose: To observe a calendar of moon phases and analyze the sequence of events so that one can predict the next phase.

Materials: Moon Phase Calendar

What to Do:

1. Observe the Moon Phase Calendar that has been given to you.
2. Analyze the patterns by answering the following questions.

Questions:

1. What pattern do you see in the first week of moon phases?

2. What pattern do you see in the second week of moon phases?

3. What pattern do you see in the third week of moon phases?

4. What pattern do you see in the fourth week of moon phases?

5. What is the difference between the second week and third week?

TEKS 8.12 A

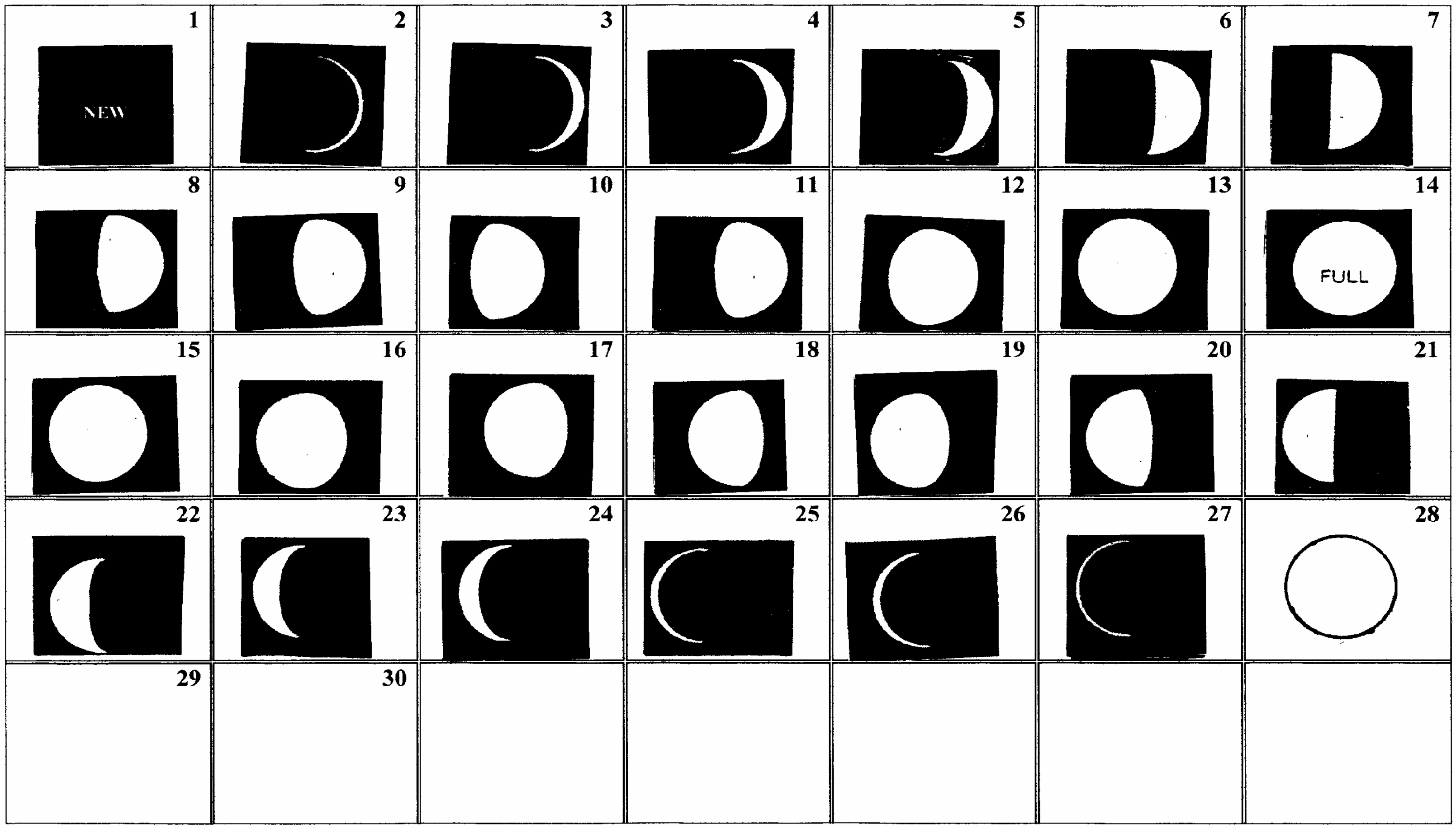
6. What pattern do you see concerning the lit side of the moon between the first and fourth week?

7. Does this same pattern hold true in the second and third week?

8. From your study of the patterns found in the phases of the moon predict what phase will be found on the 28th day of the month. Shade in the moon on your calendar.

TEKS 8.12 A

MOON PHASE CALENDAR



USING A MOON CLOCK TO TELL TIME

Purpose: To predict the rising and setting of various phases of the moon.

Materials: Moon Clock, pair of scissors, brad fastener

Construction

1. Cut out both pieces of the Moon Clock.
2. Use the tip of the scissors to punch a small hole through the X in each piece.
3. Place the smaller portion on the top of the larger circle and push the brad through both holes.
4. Spread the brad out so that the smaller portion rotates freely.

Learning to Use It

1. Hold your moon clock so that you can read the words Southern Horizon on the smaller portion and they are right side up.
2. Turn the smaller portion so that the arrow above the S points to the Full Moon.
3. Read the time above the arrow. (Midnight) This is when the full moon will be the highest in the sky.
4. Place the Full Moon so it is above the letter E. This represents the eastern horizon where the moon rises.
5. Read the time above the S arrow. (6 PM) This is when the Full Moon will rise.
6. Place the Full Moon so it is above the letter W. This represents the western horizon where the moon sets.
7. Read the time above the S arrow. (6 AM) This is when the Full Moon will set.

TEKS 8.12 A

Practice Using It

Use your Moon Clock to answer the following questions.

At what time will the New Moon be highest in the sky? _____

At what time will the First Quarter rise? _____

At what time will the Waning Crescent set? _____

Questions:

After testing you Moon clock at home in the Take it Home activity, answer the following questions:

1. How well did your predictions match the actual times?

2. If your predictions did not match the actual times what could account for the differences?

TEKS 8.12 A

Take It Home

1. Use the Internet, newspaper or calendar to determine the phase of the moon for tonight.

2. Use the Moon Clock to determine what time it will rise, be highest in the sky and set.

3. Take the Moon Clock home and determine if your calculations were correct. Depending on the phase you will not be able to witness the rise, high point and setting of the Moon in one night. Choose the event or events that best fit your time schedule.

4. Be sure to take into account whether you are in Daylight Savings Time or Standard Time.

My Predictions and Observations

Tonight's Phase _____

Time you predict it will rise _____

Time is actually rose _____

Time you predict it will be highest in the sky _____

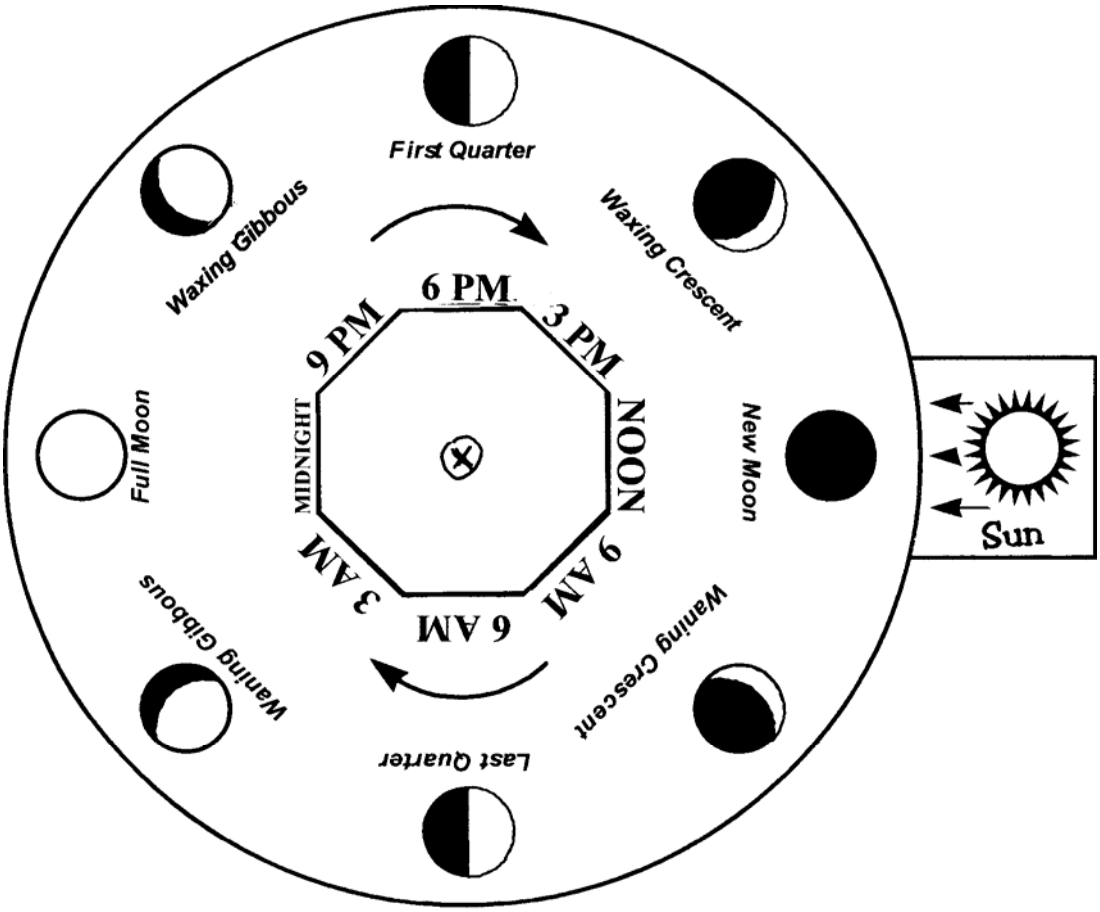
Time it actually was highest in the sky _____

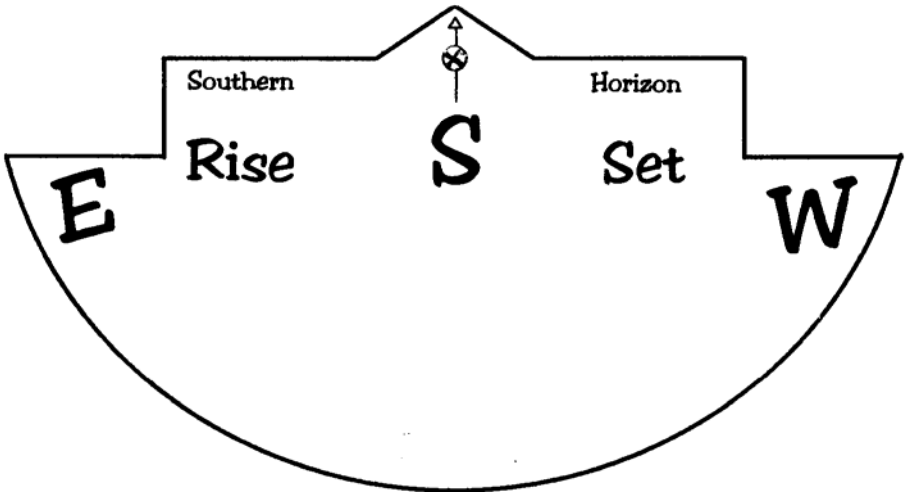
Time you predict it will set _____

Time it actually set _____

TEKS 8.12 A

Moon Clock





TEKS 8.12 A

5 E's

Rock Cycle

Engage

Demonstration: Rocks are *BORING!*

Use real rocks or a video to show the following discrepant facts.

- Rocks are heavy. (Drop a piece of pumice in water.)
- Rocks are dull. (Show the images of the popcorn rock as it grows crystals.)
- Rocks are ugly (Pick up the geode and turn it around so students can see the crystals inside.)
- Rocks never change (Show the Flash movie animation of a piece of coal turning into a diamond.)

Explore

Activity: Which Rock Made This Sand? (see Black-Line Masters)

Class Time: 20 minutes

Objective: The student will be able to observe playground sand under a microscope and predict which rock it came from.

Process Skills:

TEKS 8.4 (A) The student is expected to collect, record and analyze information using tools including microscopes.

TEKS 8.12 A

Materials:

Playground sand and various rock samples including granite
Transparent tape
Microscope slide
Microscope

Students observe playground sand under a microscope and observe the components of granite. Most playground sand is granite-like in composition so the components of sand are mostly quartz (whitish-clear) feldspar (gray–pink) hornblende (black) and mica biotite (shiny, flaky black).

Teacher should have various rocks available for students to compare but must have a piece of granite in the mix.

Explain

By looking closely at rocks, as was done in the Explore activity, evidence of what a rock "use to be" can sometimes be seen. The rock cycle is a very slow change process that cannot even be noticed in a lifetime. Students will gather evidence by looking at rocks to see if they look like any other rocks and then trying to determine how they came to be as they are now.

The Chocolate Rock activity is designed as an analogy to help student relate the rock cycle to something they can understand and control. Terminology begins to play a major role so use the terms often and define them as necessary.

Key Vocabulary

Metamorphic
Sedimentary
Igneous
Sediment
Pressure

TEKS 8.12 A

Elaborate

Elaboration 1

Activity: Chocolate Rocks! (see Black-Line Masters)

Class time: 30 minutes

Objective: The student will be able to predict the events in the rock cycle.

Process Skills:

TEKS 8.3 (C) – The student is expected to represent the natural world using models and identify their limitations.

Materials:

Hot plate
Milk chocolate chips
White chocolate chips
Peanut butter or butterscotch chips
Paper towels
Plastic knives
Aluminum foil
Heavy books

Caution when using the hotplate.

Students cut up (weather) various colors of chocolate chips and subject them to pressure, heat and pressure, melting and cooling to simulate the processes of the rock cycle.

Elaboration 2

Activity: Organizing and Explaining the Rock Cycle (see Black-Line Masters)

Class Time: 1 class period

Objective: The student will be able to diagram and explain the rock cycle.

TEKS 8.12 A

Materials:

Computer with Internet access
Scissors
Glue
Reference materials such as encyclopedia or Internet

Students watch a Rock Cycle movie on the Internet at http://BrainPop.com/science.

Special Note: This website will allow access twice in one day per computer free of charge. To access it more than twice you must subscribe to the website.

Students should relate the movie to the process they simulated with the Chocolate Rocks! Students then work as a team to create a graphic organizer to show the rock cycle in its simplest and more complicated form. Creating the rock cycle in MS Excel is demonstrated in the online module Rock Cycle/Inside the Classroom at http://web2.unt.edu/weblibrary. Students then write explaining what they have learned about the rock cycle.

Evaluate

Assessment tools: Draw Your Own Rock Cycle (see Black-Line Masters)

TEKS 8.12 A

TEKS 8.12 A

WHICH ROCK MADE THIS SAND?

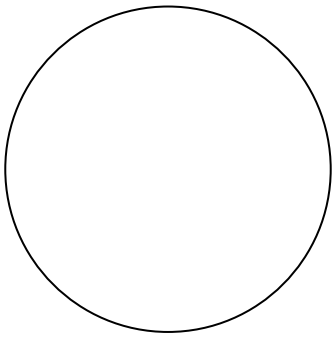
Purpose: To observe playground sand under a microscope and predict which rock it came from.

Materials: microscope, slide, transparent tape, small amount of playground sand, various rocks such as limestone, slate, marble and granite

What to Do:

1. Use a piece of tape to pick up a sample of the sand.
2. Place the tape on the slide.
3. Place the slide under the lowest power of your microscope.
4. Observe the sand particles.
5. Draw and color your observations in the circle.

Observations



Sand Particles

Questions:

1. Describe the color of the sand particles.

2. Are the colors you see under the microscope what you expected? How are they different?

3. Describe the various shapes of the sand particles.

4. Compare your sand with the rocks your teacher has provided. Which would you predict made this sand? Explain your reasoning.

5. What process do you think made the rock into the sand?

TEKS 8.12 A

CHOCOLATE ROCKS!

Purpose: To demonstrate the rock cycle by simulating activities showing the processes of erosion and the formation of sedimentary, metamorphic and igneous rock.

Materials: Hotplate, 10-12 milk chocolate chips (from baking aisle), 3 plastic knives, 10-12 white chocolate chips, sheet of aluminum foil, 10-12 butterscotch or peanut butter chips, heavy books, 3 paper towels

What to Do

Part 1 Weathering and Erosion

1. Pour one color of chips on a paper towel and cut them into little pieces and shavings with the plastic knife. (The smaller the pieces and shavings, the better.)

2. Repeat with the other colors keeping the colors separate until ready to combine them.

3. In the middle of the sheet of aluminum foil pour all of one of the colors of chips.

4. Place another color on top of the first color and then the other color last.

5. Make some observations in the space below.

Observations:

1. Draw and color what you see from the top.

2. Draw and color what you see from the side.

TEKS 8.12 A

Part 2 Making Sedimentary Rock

1. Fold the aluminum foil over your three layers of chips.

2. Place two–three heavy books over the aluminum foil and leave for three minutes.

3. Take off the books and observe the chips.

4. Make some observations in the space below.

Observations:

1. Draw and color what you see from the top.

2. Draw and color what you see from the side.

Part 3 Making Metamorphic Rock

1. Fold the aluminum foil over the chips again.

2. Have one member of the group press very hard on the foil with their hands for 30 seconds.

3. Have another member of the group do the same for another 30 seconds.

4. Continue doing this until all members of the group have done it twice.

5. Unwrap the aluminum foil and observe the chips.

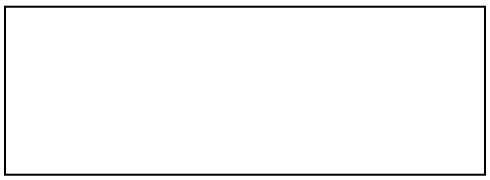
6. Make some observations in the space below.

TEKS 8.12 A

Observations:

1. Draw and color what you see from the top.

2. Draw and color what you see from the side.



Part 4 Making Igneous Rock

Safety Concern: The hot plate will cause burns. Use it carefully.

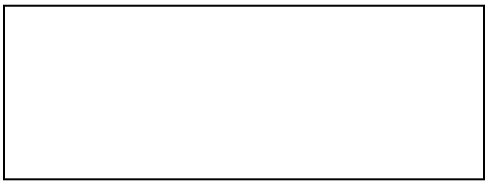
1. Wrap the aluminum foil over the chips again.
2. Take the foil package to a hot plate and lay it on the hot plate for 30-45 seconds.
3. Pick up the package by the sides and return it to your table.
4. Leave the package wrapped for at least 10 minutes
5. Gently unwrap the aluminum foil and observe.
6. Make some observations in the space below.

Observations:

1. Draw and color what you see from the top.

TEKS 8.12 A

2. Draw and color what you see from the side.



Questions:

1. What did your group do to simulate weathering? erosion?

2. What did your group do to make the sedimentary rocks stick together?

3. What did your group do to make the metamorphic rocks stick together?

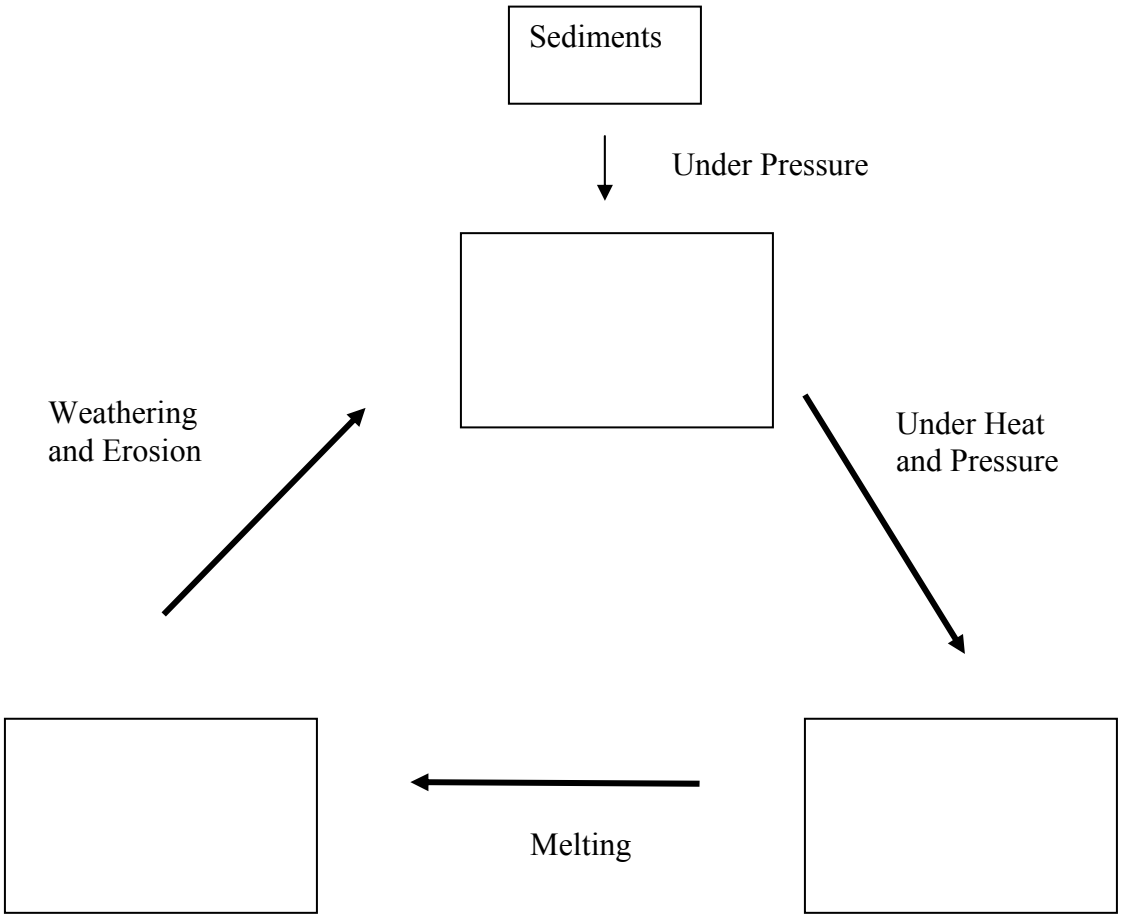
4. What was the difference between what you did to the sedimentary rocks and the metamorphic rocks?

TEKS 8.12 A

5. What did your group do to make the igneous rocks?

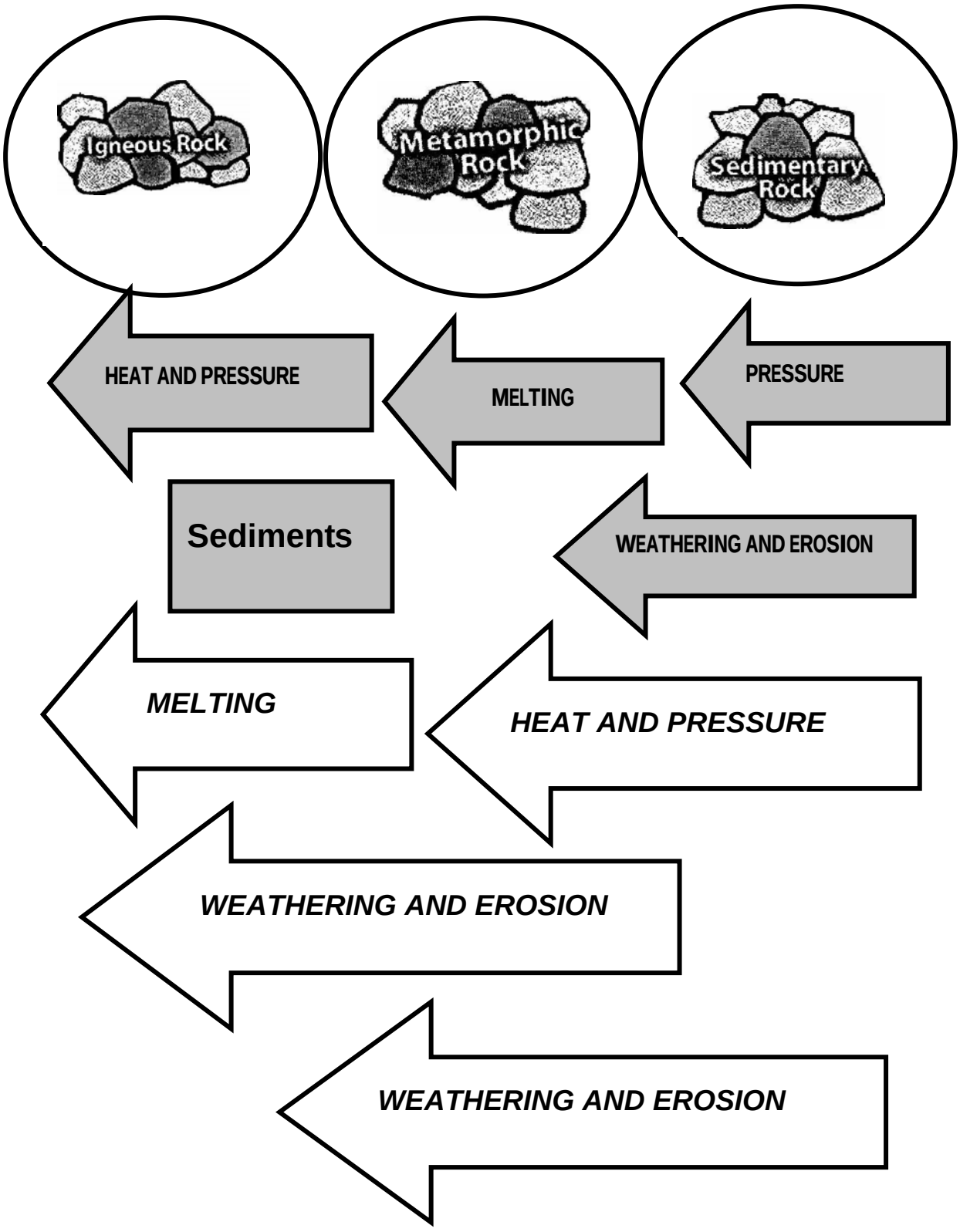
6. What was different between what you did to the metamorphic rocks and the igneous rocks?

7. From what you did in this activity fill in the following flow chart.



TEKS 8.12 A

Rock Cycle Pictures and Arrows



TEKS 8.12 A

ORGANIZING AND EXPLAINING THE ROCK CYCLE

Purpose: To understand more about the rock cycle by making a graphic organizer and writing about it.

Materials: Computer with Internet access, Student Sheet: Rock Cycle Pictures and Arrows (one for every 2 students), glue, scissors

What to Do:

1. Watch The Rock Cycle movie on www.BrainPop.com/science.
2. As you watch the movie relate what you are seeing and hearing to the Chocolate Rocks!
3. With your partner, cut out the pictures and arrows on the Rock Cycle Pictures and Arrows paper.
4. Discuss with your partner how to arrange the pictures and the gray–shaded arrows and boxes to show a simplified version of the Rock Cycle.
5. Place the white arrows on your graphic organizer according to the following questions.
6. When you are satisfied with your placement of the pictures and arrows glue them to a sheet of paper.

TEKS 8.12 A

Questions:

1. Are metamorphic rocks the only rocks that can melt to form igneous rocks?

    To show you understand the answer to this question, place another melting arrow where it should go on your diagram

2. Are igneous rocks the only rocks that can be weathered and eroded?

    To show you understand the answer to this question, place the two weathering and erosions arrows where they should go on your diagram.

3. Are sedimentary rocks the only rocks that can undergo heat and pressure to make metamorphic rocks?

    To show you understand the answer to this question place the heat and pressure arrow where it should go on this diagram.

You and your partner should work together to write three paragraphs.

1. Explain the basic steps of the Rock Cycle.

2. Relate the steps in the Rock Cycle to what you did in the Chocolate Rocks!

3. Explain how the Rock Cycle is more complex than you first thought.

TEKS 8.12 A

DRAW YOUR OWN ROCK CYCLE

Directions: You have learned about the Rock Cycle over the last few lessons. In the space below draw the Rock Cycle. Use the words in the box below. They may be used more than once.

Sedimentary Rock	Metamorphic Rock	Igneous Rock
Sediments	Pressure	
Weathering and Erosion	Heat and Pressure	Melting

TEKS 8.12 A

TEKS 8.12 B

Blow the Man Down!

TAKS Objective 5 – The student will demonstrate an understanding of Earth and Space systems.

Learned Science Concepts:

- Complex interactions occur between matter and energy.
- ➡ **Cycles exist in Earth systems.**
- Characteristics of the universe.
- Natural events and human activity can alter Earth systems.

TEKS Science Concepts 8.12

The student knows that cycles exist in Earth systems. The student is expected to:

(B) relate the role of oceans to climatic changes.

Overview

Students will understand that the ocean temperature and saltiness affects ocean currents. Ocean currents distribute heat energy over the globe and aid in the absorption of carbon dioxide by the ocean waters. The delicate balance of ocean temperature, salinity and currents keeps the Earth's climate consistent enough to sustain life. A major disruption of the balance would have devastating affects on plant and animal life.

Instructional Strategies

Students will discover relationships between water temperature, salinity, gas absorption and currents through hands-on activities where they can manipulate the variables. Students will role play the parts of policy makers and use science facts and predictions to make decisions.

Objectives

1. Students will be able to describe how water temperature and salinity affect ocean currents.
2. Students will be able to explain the effect of temperature and salinity on solubility of gases in ocean water.
3. Students will be able to relate past and present climate to the ocean.
4. Students will use scientific arguments to predict how changes in ocean water temperature and salinity will affect future world climate.

TEKS 8.12 B

For Teacher's Eyes Only

Ocean Circulation

Oceans cover about 71% of the Earth's surface. They play a much larger role than just providing the Earth with water. The oceans have different names, but they all connect to form one big body of water. The composition, temperature and circulation of the ocean's water play major roles in controlling the Earth's climate.

Seawater is a complex, active fluid. It is composed of both organic and inorganic materials including: pure water, dissolved gases, salts and microscopic living organisms. As the ocean waters circulate over the globe, these components distribute and contribute to the maintenance of living systems.

Ocean water circulation is caused by two factors: wind and water density. Differentiated heating of land and water along with latitude heat differences, create wind patterns across the surface of the planet. These winds cause surface currents that circulate the ocean water. Water density is a combined result of water temperature and water salinity and causes thermohaline circulation. The volume of this deep undersea current is 16 times greater than the flow of all the Earth's rivers combined. The continuous deep-sea circulation oxygenates the deep oceans and redistributes heat from the equator to the poles.

Ocean temperature and salinity

Ocean currents transport heat around the globe like a giant conveyer belt. Warm waters from the Gulf of Mexico flow north heating the air. The waters get cooler, saltier, and denser until near Iceland the waters sink and begin traveling southward along the ocean floor. As the water moves south it begins to warm until eventually it is warm enough to rise and the cycle continues.

In the Indian Ocean, the water is too warm to sink. Even though the water is cold in the Northern Pacific, it is not salty enough to sink. It is believed that snow and rains in that part of the country run into the ocean and reduces saltiness. Water temperature is extremely important but not just because of density. Warm water cannot hold as many dissolved gases as colder water. If water warms to the point where the concentration of such dissolved gases as oxygen and carbon dioxide are greatly reduced, there would be a huge impact on plant and animal life.

TEKS 8.12 B

Carbon dioxide

Carbon dioxide easily dissolves in water. This reaction acts to reduce the amount of carbon dioxide in the atmosphere and supplies gases to the ocean plants. Reduction of atmospheric carbon dioxide helps to control the greenhouse effect and thus the warming of the Earth. Less salty seawater also holds higher concentrations of carbon dioxide. There is a delicate balance to maintaining the oceans. If the carbon dioxide levels in the atmosphere increase (as they are at a rapid rate) due to the burning of fossil fuels among other things, the temperature of the planet will increase. Polar icecaps and glaciers will begin melting and reduce the salt concentrations of the cold water in the north. If the water is not dense enough to sink and flow south, then the circulation of water that both increases the absorption of carbon dioxide and helps to distribute heat will not occur. Reduction of absorption of carbon dioxide will result in increased greenhouse effect and the planet will become even warmer.

Though climate changes are usually slow, the rise in Earth's temperature as a result of global warming appears to be significant in the last forty years. Scientists do not agree on what will happen to the climate and the future of the planet. It is unclear whether the ocean will act as a catalyst to speed up the effects or as a control to slow down the catastrophic results.

TEKS 8.12 B

5 E's

Engage

Activity: Engaging the senses

Class Time: 10 minutes

Materials:

A bottle containing fresh cool water
A bottle containing water that has been boiled and cooled
A bottle containing carbonated water (Club soda)
Paper cups for each student

Preparation: Not all water is alike. Let students discover water's ability to dissolve and hold gases through using their sense of taste. The night before this activity, obtain three bottles of water and label them A, B and C or some other nondescript title. One of the bottles should contain carbon dioxide and is commonly known as Club Soda. (Tonic water, Seltzer water, and Perrier contain other things that change taste and should not be used.) Boil the water in one of the bottles and when cooled, return the water to the bottle without agitating the water and leaving as little airspace as possible. Students should label their cups A, B and C to match the bottles. The water can be served room temperature but be careful opening the club soda as to not loose the carbonation.

Procedure: With no explanation, allow students to taste the water from each of the three bottles.

TEKS 8.12 B

Explore

Exploration 1

Activity: How does temperature and saltiness of water cause ocean currents?

Class Time: 1 class period

Objective: Students will be able to describe how water temperature and salinity affect ocean currents.

Process Skills:

TEKS 8.2 (B) Students will collect data by observing and measuring.

Materials:

Clear glass or plastic cup
Large Styrofoam cup that will partially fit into clear glass
Salt
Beaker
Water
Hotplate
Ice
Food coloring
Index card
Stopwatch
Digital camera (optional)

Caution hotplate gets hot!

Classroom Management: This activity can be executed in several different ways depending upon classroom management preferences. It can be done as a whole-class demonstration, as teacher prepared materials for small group or as small group preparation.

Pre-activities: The activity will allow students to test multiple possibilities and determine cause and effect related to water temperature and water saltiness in the ocean. Before doing this activity, students should discuss the different combinations that can be tested. In order for each group to be able to compare results with other groups, some experimental controls must be put into place. Examples of these controls are cold water temperature (maybe 5 degrees Celsius), warm water temperature (maybe 35 degrees

TEKS 8.12 B

Celsius), salt concentration (same amount of salt added to each 10 ml water) and how data are collected (drawings, photograph, time with a stopwatch, etc.)

Procedure:

Groups may test a variety of combinations of their choice. A few examples are:

Warm water on top – Cold water on bottom
Cold water on top – Warm water on bottom
Salty cold water on top – Pure warm water on bottom
Salty warm water on top – Pure warm water on bottom

1. Each group will select the variables for the experiment. Put the liquid selected for the bottom into the clear cup. Fill the cup so that the Styrofoam cup bottom will extend into the contents.
2. Cut a 2 cm. hole in the bottom of the Styrofoam cup and place a piece of paper over the hole.
3. Carefully fill the Styrofoam cup with the second liquid. The contents should be dyed with food coloring so resulting currents, if any, will be visible.
4. Remove the paper in the bottom of the Styrofoam cup without disturbing the liquid.
5. Record the results.

Exploration 2

Activity: You've got gas.

Objective: Students will be able to explain the effect of temperature and salinity on solubility of gases in ocean water.

TEKS 8.12 B

Materials:

Carbonated water (chilled)
Carbonated water (room temperature)
Tap water (room temperature)
Salt
Plastic spoons
Plastic cups

Compare results with pure water and room temperature and cold Club soda (carbonated water). Half fill the cups with the different waters. Add a little salt to each and record results. Make sure the quantities of waters are the same and the same amount of salt is added to each. Add more salt. Continue to add salt to each until nothing more happens. What conclusions can be drawn? Share results as a class.

Explain

Results of the activities show that cold salty water sinks and warm unsalted water rises. The rates that the rising/sinking occurs are important to ocean currents. The saltier the water the faster it sinks. The warmer the water, the faster it rises. Cold water can dissolve more carbon dioxide than warmer water. Salt decreases the solubility of carbon dioxide in water. It is important that the students understand all of the things which affect the distribution of heat energy over the surface of the Earth.

Show a diagram of prevailing winds and discuss how this winds blow across the surface of the oceans and cause waters to move in circulating patterns over the globe. The ocean temperature is warmer in the equatorial regions. As the warm waters are carried north, the water warms the cooler waters of the north. As the water is carried further north, it is cooled and these cooler waters are then circulated as they are carried south where they are again warmed.

Show the NOVA production titled What's up with the weather?

TEKS 8.12 B

Elaborate

Elaboration 1

Research: Climate through the ages.

Class Time: 1 class period

Objective: Students will be able to relate past and present climate to the ocean.

Process Skills:

> TEKS 8.3 (A) – The student is expected to analyze, review and critique scientific explanations, including hypotheses and theories, as to their strengths and weaknesses using scientific evidence and information.

Students investigate climate conditions and changes that have occurred over the centuries. Use all resources available. Determine the role the oceans played.

Elaboration 2

Research: Climate conditions across the globe.

Class Time: 1 class period

Objective: Students will be able to relate past and present climate to the ocean.

Process Skills:

> TEKS 8.2 (C) – The student is expected to organize, analyze, evaluate, make inferences and predict trends from direct and indirect evidence.

As a small group or individual projects, have students choose a country or part of the world. Research weather and climate conditions in the area. Find out about the ocean in that part of the world, such things as water temperature, plant and animal habitation, ocean currents, etc. Have students predict how global warming could change the ocean in their selected part of the world and what would be the resulting climate changes.

Elaboration 3

Role play: Is global warming threatening?

Class Time: 2 class periods

TEKS 8.12 B

Objective: Students will use scientific arguments to predict how changes in ocean water temperature and salinity will affect future world climate.

Process Skills:

TEKS 8.3 (D) – The student is expected to evaluate the impact of research on scientific thought, society and the environment.

Hold a mock congressional committee meeting on global warming. Students can represent various corporations such as power companies or automobile manufacturers, environmental protection agencies, scientists, etc. Students should research and collect information supporting their arguments. Each person or persons representing on of the agencies has an opportunity to present their views to the congressional committee. The committee should then make decisions and write a supporting document clarifying their decision.

Evaluate

Evaluation 1

Ask students to draw a pictorial representation of the oceans and how they affect global climate. The students can emphasize any aspect they want such as prevailing winds and land temperature, alinity and current flow or global warming and water temperature. Let the students be creative and be flexible. Papers should be graded on the correctness of the content, completeness of the cycle illustrated and clarity of the diagram.

Evaluation 2

Ask students to argue the point: maintaining the present conditions of the oceans is important to the survival of the world. Have students choose a scenario where one factor is drastically changed. Students should follow the cycle of results that would occur.

TEKS 8.12 B

TEKS 8.12 C

Lords of the Rings

TAKS Objective 5 – The student will demonstrate an understanding of Earth and Space systems.

Learned Science Concepts:

- Complex interactions occur between matter and energy.
- ➡ **Cycles exist in Earth systems.**
- Characteristics of the universe.
- Natural events and human activity can alter Earth systems.

TEKS Science Concepts 8.12

The student knows that cycles exist in Earth systems. The student is expected to:

(C) predict the results of modifying the Earth's nitrogen, water and carbon cycles.

Overview

Human activities have impacted and in some cases destroyed the delicate balance of energy flow, and chemical cycling of ecosystems. Often, these effects are local as well as global. It is also important to understand the role of water in terms of quantity and quality as potable water is a limited resource and overpopulation urbanization, and inefficient irrigation practices place considerable pressure on our ability to provide the amount of clean water necessary to survival. An overlapping concern is loss of nitrogen in the soil through denitrification, immobilization, leaching, runoff and volatilization. In this TEKS, understanding the role greenhouse gases play with regard to environmental problems will be tied to creating a sustainable planet. Greenhouse gasses include water vapor, methane,

carbon dioxide, chlorofluorocarbons (CFC) and nitrogen oxide (NO). Using this information, students will have the knowledge they need to understand their role in becoming careful guardians of the environment.

Instructional Strategies

A variety of simulations will be used to build knowledge about these cycles. A game similar to Chutes and Ladders will be used to learn the Nitrogen cycle. Online graphic simulations will represent both the water and carbon cycle.

Objectives

1. The student will identify and classify natural and human activities that influence the carbon cycle.

2. After graphing the temperature and carbon dioxide data, the student will use data to predict the results of global warming.

3. The student will predict the results of: denitrification, volatilization, leaching, runoff and immobilization on the nitrogen.

4. The student will summarize the effects of human activity on the water cycle: global warming, water quality and quantity.

TEKS 8.12 C

For Teacher's Eyes Only

Carbon Cycle

Carbon is a very important element for a couple of reasons. The raw materials that make up hair, muscle and skin are carbon based and carbon is the basic unit of all living organisms. Also, carbon bonds store energy allowing living organisms to move, eat, sleep, breath and repair. **So carbon is very important to life on this planet and its versatility in terms of the ability to bond with a number of elements creates a number of complex pathways that are used to recycle carbon throughout the environment.** It is estimated that each carbon molecule has made approximately 30 trips through the carbon cycle over the last four billion years. Now that's a lot of frequent flyer miles!

There are a number of possible ways carbon cycles through the environment. One way involves photosynthesis and cellular respiration. During photosynthesis, plants and algae use CO_2 from the air or water to manufacture glucose ($C_6H_{12}O_6$) to fuel the process of cellular respiration. In cellular respiration, glucose is broken down in a chemical reaction with oxygen releasing carbon dioxide, water and energy. In this way, the photosynthesis and cellular respiration enable the cycling of carbon and oxygen through the environment. Other ways carbon cycles through the environment include:

- Decomposition when CO_2 and CH_4 is released,
- Stored in shells and skeletons of marine animals where it is stored as $CaCO_3$,
- Stored in wood (e.g., trees),
- Released from wood as CO_2 (e.g., burning of wood) and
- Stored in a fossil fuel such as coal and then released as CO_2 during burning.

The table shows natural sources of carbon and sources of carbon due to human activity. **Burning of fossil fuels, respiration and decomposition are the most frequently mentioned methods by which carbon in the form of carbon dioxide enters the atmosphere.** Since photosynthesis by plants is how carbon dioxide is removed from the atmosphere, students should understand how easy it is for an excess of CO_2 to just hang around in the atmosphere creating problems because CO_2 molecules absorb heat. Unlike oxygen (O_2) and atmospheric nitrogen (N_2) atoms which are bound too tightly together to vibrate and absorb heat, a molecule of carbon dioxide is composed of three atoms that are bound loosely together enabling it to vibrate and absorb heat. Another source of carbon is

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methane (CH_4). Methane is the principal ingredient of natural gas and is generated by bacteria in rice paddies, decomposition and ruminant animals such as cattle. Methane absorbs 20-30 times as much radiation as CO_2 making it a more serious greenhouse gas.

Natural Sources of Carbon	Sources of Carbon from Human Activity
• Death of plants and animals • Animal waste • Atmospheric CO_2 • Weathering • Methane gas from cows (and other ruminants) • Aerobic respiration from terrestrial and aquatic life	• Burning wood or forests • *Cars, trucks, planes* • *Burning fossil fuels such as coal, oil and natural gas to produce heat and energy for our homes and businesses*

The carbon cycle is important in terms of the greenhouse effect, which is the warming of the atmosphere caused by carbon dioxide, methane and other gases that absorb infrared radiation slowing its escape from the Earth's surface. Some scientists believe the greenhouse effect can have effect on food production, precipitation (flooding), Polar Ice Cap melting (mixing fresh and salt water upsetting ocean currents), economic loss (catastrophic events), and displacement of species (upsetting ecosystems) and immune system impact (increasing lethal disease). However, skeptics charge that the process by which oceans take up excess carbon dioxide is not well understood and water vapor is the most important greenhouse gas that impacts temperature. The skeptics also indicate that the earth will self-correct, CO_2 is necessary to prevent the planet from cooling down, and CO_2 increases plant growth.

Nitrogen Cycle

Nitrogen (N_2) makes up 79% of the atmosphere where it exists as a gas. There are also trace amounts of NH_3, N_2O, and NO_2 in the atmosphere. Even though atmospheric nitrogen is all around us, it is not in a form that can be utilized by humans who must have nitrogen to carry on life's functions such as making amino acids and proteins (e.g., muscle, hair, enzymes) and nucleic acids (e.g., DNA, RNA). That is, humans cannot use atmospheric nitrogen. Therefore, **it is the nitrogen cycle, which makes possible a different source of nitrogen that humans can use**, and we

TEKS 8.12 C

obtain this source of nitrogen by eating plants and/or the animals that have eaten plants. About 90% of nitrogen is biochemically fixed in the soil by microorganisms. Legumes and other types of plants that form mutualistic symbiotic relationships with nitrogen fixing bacteria (e.g., *Rhizobium*) provide the nitrogen we depend on for our survival.

Generally, **nitrogen is stored in living and dead organic matter, then converted into inorganic forms through the process of decomposition** although a little enters the soil in rainfall or through the effects of lightening. Plants cannot use organic forms of nitrogen, so decomposers such as bacteria and fungi take nitrogen occurring in the form of ammonia (NH_3) and convert it to ammonium salts (NH_4^+), which are highly attracted to negative clay particles in the soil. This process is known as ammonification or mineralization. During the process of immobilization nitrogen is taken up by microbes and immobilized or made largely unavailable to plants. Immobilization occurs when the ratio of C:N is greater than 30. Immobilization is the opposite of mineralization.

Interestingly, nitrogen is often the limiting factor for plant growth. Plants can only take up inorganic nitrogen from the soil solution in solid form as ammonium salts (NH_4^+) or nitrate (NO_3^-). As previously mentioned, since ammonium is a positively charged ion, it is readily absorbed onto the surface of negatively charged clay particles in the soil. When the ammonium is released by the clay particle:

1. It is usually chemically modified by chemotropic bacteria (*Nitrosomonas*) into nitrite (NO_2^-) and

2. Further modified by chemotrophic bacteria (*Nitrobacter*) into nitrate (NO_3^-), which is an extremely soluble solid form of nitrogen that can be used by plants.

Both of these processes are known as *nitrification* and excess ammonium salts will stimulate the process of nitrification. Since nitrate is extremely soluble and negatively charged, it is sometimes lost from the soil (reducing soil fertility) through a process called *leaching* where it moves through the soil and into the groundwater contaminating streams and drinking water. When nitrites are absorbed into the human body, they bind to hemoglobin and reduce oxygen-carrying capacity. In babies, this can lead to "blue baby syndrome" a form of respiratory distress. In the gut, it can also form nitrosamines, which are highly carcinogenic. For this reason, **there are strict government regulations concerning the amount of nitrate that can be present in drinking water.**

When nitrate reaches the oceans, it can be returned to the atmosphere by *denitrification*. The process of denitrification is also common in poorly drained soils (e.g., wetlands) in which nitrate is reduced to nitrogen or

nitrous oxide gas by heterotropic bacteria (e.g., *Pseudomonas, Alkaligenes* and *Bacillus*). The gas escapes into the atmosphere through *volatilization*. Urea fertilizer and manure on the soil surface also form gases that volatilize into the atmosphere. **The processes of denitrification and volatilization account for most of the nitrogen lost to the cycle.**

Nitrogen is also lost from the soil due to *runoff*, which results when soil is saturated with water and can hold not more water. If the soil is void of protective vegetation and has a steep slope, then soil materials will be carried off by excess water. When this occurs, both organic and inorganic nitrogen are carried down to streams, and other water sources causing water pollution and harm to aquatic life. This is different from, *erosion,* which is the result of the soil surface wearing away by running water, ice, or other geological processes.

Human activities that alter the nitrogen cycle include:

- Applying nitrogen fertilizers to crops and lawns increase denitrification.
- leaching of nitrate into groundwater can contaminate human water supply.
- Runoff of nitrogen in streams, rivers and lakes can lead to a population explosion of detrivores that will suffocate aerobic organisms.
- Burning fossil fuel produce nitrogen oxide that takes part in ozone depletion.
- Waste from livestock ranching can runoff and contaminate water systems.
- Sewage treatment facilities dumping dissolved inorganic nitrogen into rivers, lakes and streams can cause algal blooms.
- N_2O and NO are involved in the production of acid rain.
- In the stratosphere, N_2O undergoes photolysis (80% N_2 and 20% NO) destroying the ozone, which protects us from UV rays.

Water Cycle

The water cycle describes the storage and movement of water. Water can be stored as surface water (e.g., ocean, lakes, rivers), soil, glaciers, groundwater and in the atmosphere. There are a number of processes that allow for the movement of water from one storage area to another. Evaporation, condensation, precipitation, runoff, leaching melting, deposition and transpiration are examples of processes that allow water to move from storage area to another.

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Most of the evaporated water found the atmosphere is supplied by the ocean. Ninety-one percent of evaporated water is returned to the ocean via precipitation with the remaining 9% spread out as precipitation over the landmass. The net balance is returned to the ocean through runoff and groundwater flow to the ocean. **This is a never-ending cycle for moving water between the earth and the atmosphere.** About 97% of the earth's water supply is found in the ocean, so it is critical to exercise careful use of the remaining 3%.

Another source of atmospheric water comes from tropical rainforests. The rapid destruction of tropical rainforests reduces the return of water to the atmosphere via the process of transpiration. Destruction of rainforests changes the amount of water vapor in the air, which in turn is likely to alter local and perhaps global weather patterns.

Population increases and industrialization place unnatural demands on our environment and have the potential to affect the quantity and quality of usable water for generations. For example, a rising population can place impossible demands on a water system. Additionally, a rising population results in rising wastes. Urbanization alters the rates of infiltration, evaporation and transpiration. This can result in flooding and the inability to replenish ground water supply given the rate of water use. Additionally, poor agricultural practices waste water during crop irrigation, which further compromises our ability to meet the water demands given the finite nature of the water supply.

Another aspect of the water cycle deals with water quality. As previously mentioned in the discussion of the nitrogen cycle, water may gather contaminates from the soil as runoff or as it percolates into the ground (infiltration) and possibly the groundwater system (i.e., leaching). As chemical and particles in dust, smoke, and smog accompany the movement of water recycling between the land and the air, these contaminates fall back to the earth in the form of precipitation (e.g., acid rain). In turn, this lowered water quality affects the land and water storage areas and disrupts fragile ecosystems. It is also possible to pollute water so thoroughly that as wastewater it must be impounded and not be returned to the water cycle resulting in a loss of potable water.

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Student Misconceptions

☒Misconception

Plants do not breath (respire).

☑Science Concept

Plants use stomata for respiration similar to how animals use lungs or gills.

🛠Rebuild Concept

The instructor may wish to use a microscope to show students actual stomata of plants or show pictures of plant stomata and connect this activity with a debriefing about difference in respiration between plants and animals.

☒Misconception

Rainforests are the principle source of carbon dioxide uptake.

☑Science Concept

Algae in the oceans are responsible for the majority of carbon dioxide uptake from the atmosphere.

🛠Rebuild Concept

Provide students with data showing the use of carbon dioxide by algae and plants.

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☒Misconception

Humans use atmospheric nitrogen (N_2).

☑Science Concept

Humans cannot use N_2 and must obtain nitrogen from plants or animals that eat plants.

🛠Rebuild Concept

Students will participate in the Nitrogen Cycle Game. The student should identify that ingestion of plants is how humans obtain nitrogen.

☒Misconception

There is plenty of water.

☑Science Concept

There is a limited supply of potable water on earth.

🛠Rebuild Concept

Students will participate in the Water Cycle activity. The student should understand the impact of global warming and other human activities on water quantity and quality.

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Student prior knowledge

Students should understand:

TEKS 6.8 (B) explain and illustrate the interactions between matter and energy in the water cycle and in the decay of biomass such as in a compost bin;

TEKS 6.14 (C) describe components of the atmosphere, including oxygen, nitrogen, and water vapor and identify the role of atmospheric movement in weather change;

TEKS 7.5 (A) describe how systems may reach an equilibrium such as when a volcano erupts;

TEKS 7.14 (A) describe and predict the impact of different catastrophic events on the Earth;

TEKS 7.14 (B) analyze effects of regional erosional deposition and weathering; and

TEKS 7.14 (C) make inferences and draw conclusions about effects of human activity on Earth's renewable, non-renewable and inexhaustible resources.

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5 E's

Extreme Carbon Rings

Engage

Show the "Carbon Guy" video clip.

Explore

Use the diagram from the following website to examine the elements of the carbon cycle.

http://www.fsl.noaa.gov/~osborn/cg_32.pdf

Explain

Carbon is a very important element for a couple of reasons. The raw materials that make up hair, muscle and skin are carbon based. Carbon is the basic unit of all living organisms. Also, carbon bonds store energy allowing living organisms to move, eat, sleep, breath and repair. Students should be able to identify natural *sources* of Carbon and identify which are natural and how human activity modifies the Carbon cycle.

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Natural Sources of Carbon	Sources of Carbon from Human Activity
• Death of plants and animals • Animal waste • Atmospheric CO_2 • Weathering • Methane gas from cows (and other ruminants) • Aerobic respiration from terrestrial and aquatic life	• Burning wood or forests • Cars, trucks, planes • Burning fossil fuels such as coal, oil and natural gas to produce heat and energy

TEKS 8.12 C

Elaborate

Use the following information to track information about the relationship between temperature and Carbon Dioxide.

Average Temperature and CO_2 Data (1760-2001)		
Year	**Temperature (° C)**	**CO_2 (ppm)**
1950	13.83	311.26
1960	13.98	316.91
1970	14.05	325.65
1980	14.27	338.67
1990	14.49	354.19
1991	14.44	355.62
1992	14.16	356.36
1993	14.18	357.10
1994	14.31	358.86
1995	14.45	360.90
1996	14.34	362.58
1997	14.38	363.84
1998	14.68	366.58
1999	14.41	368.28
2000	14.39	369.39
2001	14.51	370.88
http://www.earth-policy.org/Indicators/indicator8_data2.htm		

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Use the following questions to debrief students about this activity:

1. What is the temperature trend from 1950 through 2001? *Temperature increases until 1990s and fluctuate during the 1990s.*
2. What is the CO_2 trend from 1950 through 2001? *CO_2 increases.*
3. What is the relationship between temperature and carbon dioxide? *There appears to be a relationship between temperature increases and increases in the level of carbon dioxide.*
4. List at least four sources that might increase the carbon dioxide in the atmosphere. *Answers will vary but may include fossil fuel sources such as oil, gas and coal; deforestation; exhaust from cars, trucks and buses; decomposition; and animal/plant respiration.*
5. The industrial revolution began in 1760. If the amount of CO_2 was 276.72 ppm, what inferences might be made about the relationship between human activity and the amount of carbon dioxide in the atmosphere? *Advances in technology increase the level of carbon dioxide in the atmosphere.*
6. How does photosynthesis by algae (and plants to a lesser degree) affect the amount of carbon dioxide in the atmosphere? *Plants and certain microorganisms utilize carbon dioxide during the process of making carbohydrates If there is too much carbon dioxide to be utilized, then the excess moves to the atmosphere.*
7. List at least three ways to reduce the amount of carbon dioxide in the atmosphere. *Answers will vary but might include decrease dependence on fossil fuels; limit deforestation; increase mass transportation; use alternative energy resources such as solar, water and wind energy.*
8. What are possible replacements for fossil fuels? *Windmills, solar panels, nuclear reactors, hydropower.*
9. Define in your own words what the greenhouse effect is and why we should be concerned about it. *Answers will vary but might include information about the warming effects food production, precipitation, Polar Ice Cap melting, economic loss and displacement of species. The greenhouse effect is the warming of the atmosphere caused by carbon dioxide, methane and other gases that absorb infrared radiation slowing its escape from the Earth's surface.*

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Evaluation

Evaluation 1

Using the carbon cycle handout (see Black-Line Masters), the student will identify and classify at least two natural and two human activities that influence the carbon cycle.

Evaluation 2

After graphing the temperature and carbon dioxide data, the student will use data to predict the results of global warming.

Average Temperature and CO_2 Data (1760-2001)	
Description	**Points**
Appropriate graph type is used	10
Appropriate scale range and interval are used	20
Graph has a title	10
Descriptive labels for variable on the x-axis and responding variable for the y-axis	5
Information is plotted correctly	40
Units are indicated for each axis	5
Key is included	10

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The Fate of the Nitrate

Engage

Students view the nitrogen strike news clip animation

Explore

Game: Nitrogen Game. Adapted from Journal of Natural Resources and Life Science Education, Volume 26, No. 2, 1997 by Jessica G. Davis

Class Time: 30 minutes

Objective: The student will predict the results of denitrification, volatilization, leaching, runoff and immobilization on the nitrogen.

Process Skills:

TEKS 8.3 (C) – The student is expected to represent the natural world using models and identify their limitations.

Materials:

Game board for each 3-6 students
Game token for each player

Overview of the game: Introduce students to the nitrogen cycle using a familiar childhood game, *Chutes and Ladders*. Students begin the game as organic nitrogen and as they move through the game transform to ammonium salts (NH_4^+), nitrate (NO_3^-) in the journey toward crop uptake. As players move around the board, ladders help the players advance on their way to the green zone while chutes represent the loss of nitrogen through leaching, runoff, immobilization, erosion or denitrification and remove the player from the game. If a player is volatilized or denitrified, they end up in the air. If a player is encounters erosion or runoff, they end

TEKS 8.12 C

up in the surface water. If a player is encounters leaching, they end up in the groundwater.

Three to six players select from tokens representing three different types of organic nitrogen: legume nitrogen, crop residue nitrogen and manure nitrogen and use one game board. Each player spins to determine who goes first. The player with the highest number goes first and play proceeds in a clockwise direction. Each player spins and moves the corresponding number of squares across the game board (no diagonal moves are permitted). Two or more players are permitted to land on a square simultaneously. If a player lands at the BASE of a ladder, the player moves up to the top of the ladder. If a player lands at the TOP of a chute, the player slides down the chute to the bottom. The player must roll the exact number on the dice to win. The first player to arrive at Crop Uptake (Square 25) is the winner.

Explain

Use the following questions to debrief the students about the activity.

1. How does nitrogen enter the cycle? *Nitrogen enters the cycle through rain, snow, lightning, air, manure, decay, commercial fertilizer and sludge.*
2. How is nitrogen lost from the soil? *Nitrogen is lost through leaching, runoff, erosion and immobilization.*
3. How is nitrogen returned to the atmosphere? *Nitrogen is returned to the atmosphere through the processes of denitrification and volatilization.*
4. How does nitrogen get into the human body? *Humans obtain nitrogen by eating plants or animals that have eaten plants.*

Elaboration

Use diagrams of the nitrogen cycle or visit the following website to view Figures 1 and/or 2 which show diagrams of the nitrogen cycle. Ask students to compare the diagram to the game. How are they the same? How are they different?

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http://muextension.missouri.edu/explore/envqual/wq0252.htm

Evaluation

After participating in the nitrogen cycle game, the student will predict the results of denitrification, volatilization, leaching, runoff and immobilization on the nitrogen cycle in a 200-word essay.

NITROGEN CYCLE RUBRIC			
40 points	50 points	60 points	70 points
One or two topics (e.g., denitrification, volatilization, leaching, runoff, immobilization) are addressed with at least two sentences about each. Information clearly relates to the main topic. Each topic is at least 40 words long.	Three topics (e.g., denitrification, volatilization, leaching, runoff, immobilization) are addressed with at least two sentences about each. Information clearly relates to the main topic. Each topic is at least 40 words long.	Four topics (e.g., denitrification, volatilization, leaching, runoff, immobilization) are addressed with at least two sentences about each. Information clearly relates to the main topic. Each topic is at least 40 words long.	All topics (e.g., denitrification, volatilization, leaching, runoff, immobilization) are addressed with at least two sentences about each. Information clearly relates to the main topic. Meets word count requirement.
No points	10 points	20 points	30 points
Many grammatical, spelling or punctuation errors.	A few grammatical, spelling or punctuation errors.	Almost no grammatical, spelling or punctuation errors.	No grammatical, spelling or punctuation errors.
TOTAL SCORE:			

TEKS 8.12 C

Extreme Water

Engage

Use the textbook or pictures from the Internet to show students several pictures of the effects of diminished water quantity and quality.

Explore

Visit the Environmental Protection Agency (EPA) website to learn about the water cycle.

http://www.epa.gov/globalwarming/kids/water_cycle_version2.html

Use the animated video clip to answer the following questions.

1. Where is water stored?
2. How does water move from one place to another?
3. What is infiltration?
4. What is runoff?
5. How does global warming affect the water cycle? Include information about the effect of (a) the wet cycle and (b) the dry cycle.

Explain

Debrief students over the following questions related to the EPA water cycle animated video clip.

1. Where is water stored? *Water is stored in oceans, lakes, rivers and groundwater.*

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2. How does water move from one place to another? *Evaporation, transpiration, condensation, precipitation (e.g., rain, snow, ice).*
3. What is infiltration? *Infiltration is water movement between the spaces in the soil.*
4. What is runoff? *Runoff occurs when water flows over the ground instead of sinking into the ground.*
5. How does global warming affect the water cycle? *Global warming intensifies the water cycle because the earth's surface is a little warmer and this increases evaporation.* Include information about the effect of (a) the wet cycle. *When there is too much water, there is more water infiltrating and more runoff. This could cause flooding and negative effects on the plants and animals living in that area.* and (b) the dry cycle *In areas away from a water source more evaporation and transpiration could dry out the soil. This could lead to lowered ground water supply, and have negative effects on the plants and animals living in the area.*

Elaborate

Create a diagram showing the effects of global warming on the water cycle.

TEKS 8.12 C

Evaluate

After completing the Extreme Water activity, the student will summarize the effects of human activity on the water cycle: global warming, water quality and quantity by writing at least 100 words in the science journal and including one diagram.

Water Cycle Rubric			
30 points	40 points	50 points	60 points
One topic (e.g., global warming, water quality, water quantity) is addressed with at least two sentences about each. Information clearly relates to the main topic. Each topic is at least 35 words long.	Two topics (e.g., global warming, water quality, water quantity) are addressed with at least two sentences about each. Information clearly relates to the main topic. Each topic is at least 35 words long.	Three topics (e.g., global warming, water quality, water quantity) are addressed with at least two sentences about each. Information clearly relates to the main topic. Each topic is at least 35 words long.	All topics (e.g., global warming, water quality, water quantity) are addressed with at least two sentences about each. Information clearly relates to the main topic. Meets word count requirement.
4 points	6 points	8 points	10 points
Many grammatical, spelling, or punctuation errors.	A few grammatical, spelling or punctuation errors.	Almost no grammatical, spelling or punctuation errors.	No grammatical, spelling or punctuation errors.
No points	10 points	20 points	30 points
Diagram is not accurate OR does not add to the reader's understanding of the topic.	Diagram is neat and accurate and sometimes adds to the reader's understanding of the topic.	Diagram is accurate and adds to the reader's understanding of the topic.	Diagram is neat, accurate and adds to the reader's understanding of the topic.
TOTAL:			

TEKS 8.12 C

TEKS 8.12 C

TEKS 8.13 A, B, AND C

Dust and Gases

TAKS Objective 5 – The student will demonstrate an understanding of Earth and Space systems.

Learned Science Concepts:

- Complex interactions occur between matter and energy.
- Cycles exist in Earth systems.
- ➡ **Characteristics of the universe.**
- Natural events and human activity can alter Earth systems.

TEKS Science Concepts 8.13

The student knows characteristics of the universe. The student is expected to:

(A) describe characteristics of the universe such as stars and galaxies;

(B) explain the use of light years to describe distances in the universe; and

(C) research and describe historical scientific theories of the origin of the universe.

Overview

Students will understand that distances in space are very large and are measured in light years. Students will understand how information about space is gathered and analyzed. Students will learn how to classify stars and galaxies by their characteristics.

Instructional Strategies

These activities make use of pictures, paper models and charts to find patterns, calculate data and draw conclusions about the universe.

Objectives

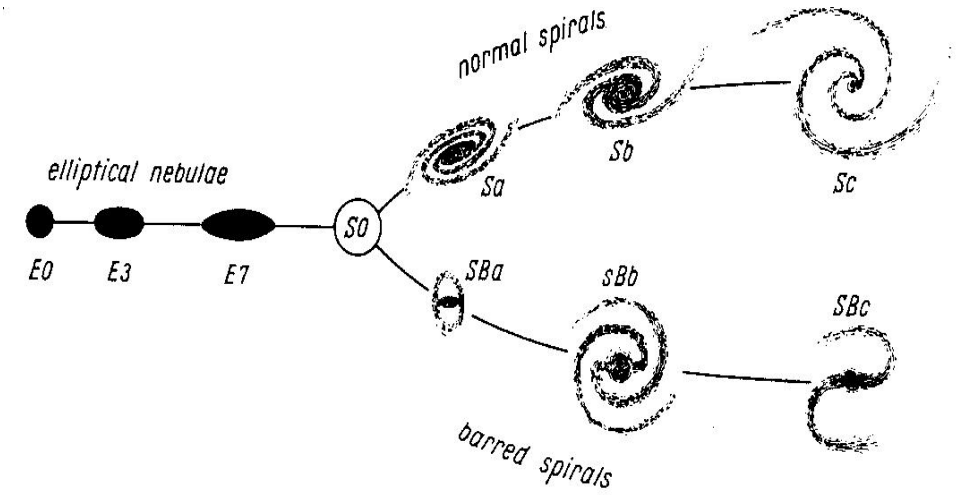
1. The student will be able to describe the distance and size of various objects in space.
2. The student will be able to describe and classify the different shapes of galaxies.
3. The students will be able to describe what the color and brightness of a star can tell about its properties.
4. The student will be able to explain the use of light years to describe the distances in the universe.
5. The student will be able to analyze scientific explanations as to the strengths and weaknesses using scientific evidence and information.

TEKS 8.13 A, B, C

For Teacher's Eyes only

Galaxies

Galaxies are made up of many billions of stars, dust and gas all held together by gravity. Galaxies are scattered throughout the universe. Galaxies are so far away that we can't make out individual stars. They vary greatly in size and shape. Until the 1920s astronomers did not have a classification system for galaxies. An astronomer, Edwin Hubble decided to group the galaxies he could see through a telescope by shape. The three shapes he originally used were elliptical, spiral and barred spiral. He then discovered that he needed a more specialized system of grouping and arranged the main types of galaxies and the sub-types into a chart that has come to be called "The Tuning Fork Diagram."



About 75% of the galaxies we can see are spiral galaxies (about half ordinary spiral and half barred spiral), 20% are elliptical and 5% are irregular galaxies. **Ordinary spiral galaxies are classified by the relative strength of the central bulge and tightness of the spiral arms**. Spirals are divided into Sa, which have a strong bulge and tight indistinct arms, Sb, which are an intermediate type, and Sc, which have a small bulge and loose, well-defined arms. Stars in spiral galaxies tend to be of a medium age but new stars are forming within them. It is believed the Sun lies on the edge of a spiral arm in the Milky Way Galaxy that is thought to be an ordinary spiral galaxy of the Sb class.

TEKS 8.13 A, B, C

Elliptical galaxies show little internal structure, have no disks, arms or dust lanes and their brightest stars are old red stars. They are divided into eight groups from E0 – E7; E0 is the most circular and E7 is the flattest.

Barred Spirals feature a strong central stellar bar with the spiral arms extending out from the ends of the bar. The bar rotates as a unit, which is called solid body rotation.

Irregular galaxies show little evidence of systematic rotation and this category has become a catchall class since many of them defy classification. **Irregular galaxies tend to have many young blue stars.**

The Hubble Space Telescope was named after Edwin Hubble. It has looked far into space and discovered many galaxies. The picture of the Hubble Galaxies in this unit was taken in the area of space near the North Star – Polaris. Before this picture was taken it was thought that area of space was empty. The Hubble is making frequent new discoveries such as these. This telescope is important to astronomers because it is located in space and its images are not distorted and destroyed by the atmosphere. Astronomers can "see" much deeper into space and much dimmer objects than with Earth-based telescopes.

Stars

Stars can be classified by their temperature, color and luminosity. The luminosity of a star is a measure of the total amount of power it gives off into space during nuclear fusion. Other stars are compared to our Sun, which is designated as a luminosity of 1.

Blue stars are the hottest while red stars are the coolest. Smaller stars are white, middle stars are mostly yellow and white but seem to be in all colors; large stars are orange, red and blue. Smaller stars are less luminous than the sun and larger stars are more luminous that the sun.

Space: Time and Distance

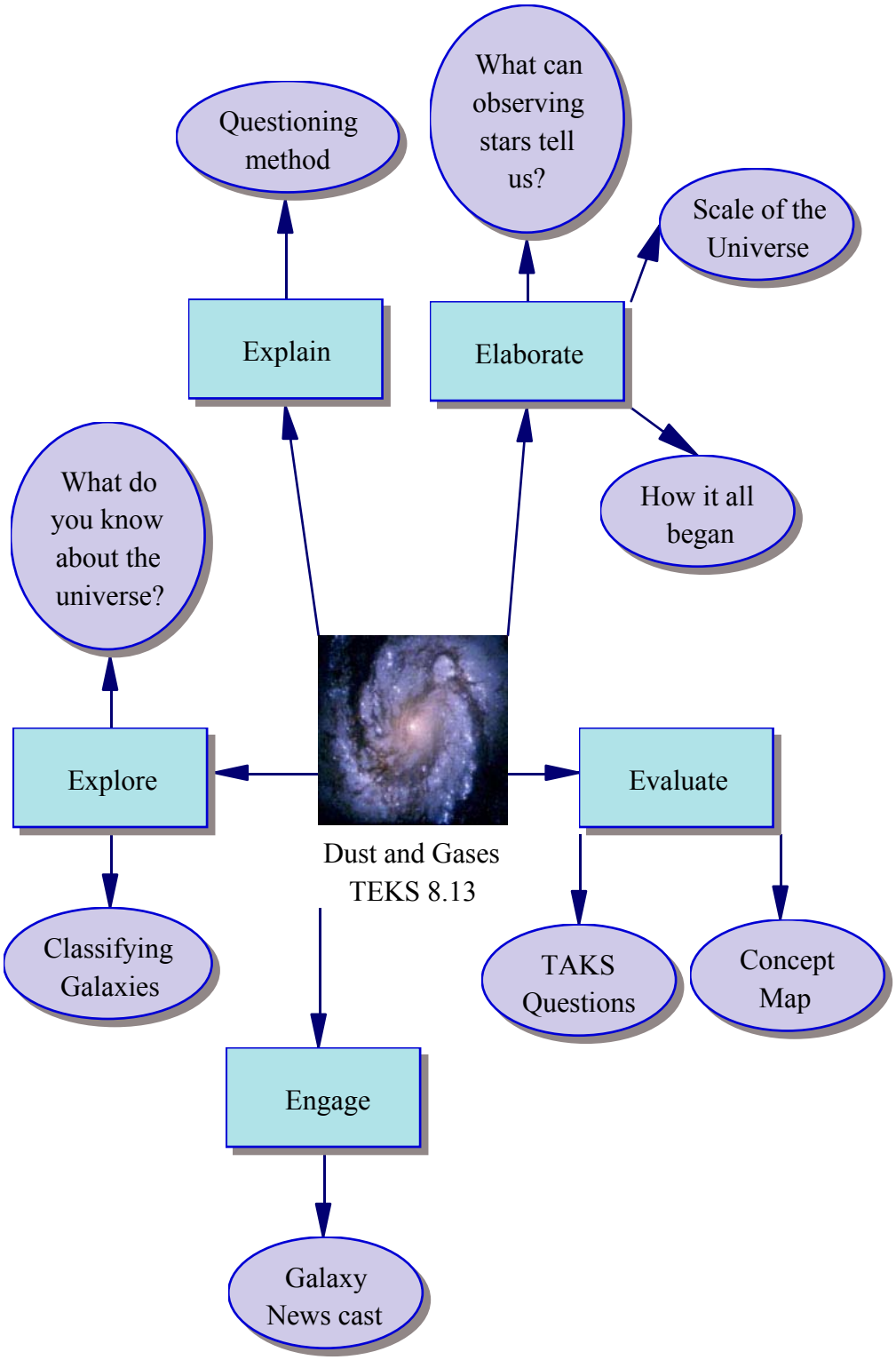
There is so much space even within galaxies that normal distance measurements are meaningless or ineloquent. **Scientists use a distance measurement in space that is expressed at the distance light will travel in the course of a year – a light year.** Light travels at a speed of about 300,000 kilometers per second. In a year's time, light can travel nine and a half trillion kilometers (9,500,000,000,000). It takes over four years for the light from Alpha Centauri, our nearest star, to reach the Earth.

When you look into the night sky, you are looking into the history of the universe. The sunlight that shines on us left the Sun 8.5 minutes ago. The sunlight that reaches Jupiter left the sun 35 minutes ago. When you look up into the sky and see Sirius, the light has been traveling 8.4 years

just to get to you. That star could have blown up 5 years ago and we would not know it for 3.4 more years. So you are not seeing the stars as they are today but as they were hence you are looking at history when you observe starlight.

TEKS 8.13 A, B, C

Lesson Layout



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Student Misconceptions

☒ Misconception

The Moon is located out among the stars.

☑ Scientific Concept

The Moon is as far from the stars as is the Earth. When on the Moon, the stars appear just as they would on Earth.

🛠 Rebuild Concept

Give a comparison. For example, if the Moon were one inch away from your nose, the nearest star outside the solar system would be a thousand times further than the Moon.

☒ Misconception

Light years are a measurement of time.

☑ Science Concept

Actually, light years measure distance. A light year is the distance light travels in a year. At 186,000 miles per second, it travels an extremely great distance in a year.

🛠 Rebuild Concept

Compare measurement units for distance. One would not use a ruler to measure something as small as an atom or as large as the distance between two cities. In the same way, a kilometer is fine for measuring the distance to the moon, but far too small to measure the distance to a galaxy.

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☒ Misconception

Stars are white points of light in the sky.

☑ Science Concept

Stars are giant spheres of burning gases. Depending upon size and temperature, they can give off different colors of light.

🗝 Rebuild Concept

Look at the stars through a telescope. The different colors are visible on a good dark night. Yellow, red and bluish colored stars can be seen.

Student Prior Knowledge

TEKS 6.5A Students identify and describe a system that results from the combination of two or more systems such as in the solar system.

TEKS 7.13A Students identify and illustrate how the tilt of the Earth on its axis as it rotates and revolves around the Sun causes changes in seasons and the length of the day.

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5 E's

Engage

Show the Xtreem science news cast featuring Cole Ission reporting when galaxies collide.

Explore

Exploration 1

Activity: What Do You Know About the Universe?

Class Time: 15 minutes

Objective: The student will be able to describe the distance and size of various objects in space.

Process Skills:

TEKS 8.2 (E) – The student is expected to construct graphs, tables, maps and charts using tools including computers to organize, examine and evaluate data.

Materials:

Student Sheets copied (see Black-Line Masters)

Students predict how big and how far eight objects in space are by looking at a set of Space Object Cards provided by the teacher. The teacher then provides the following information about the actual size and distance. (NOTE: A color copy of this picture sheet can be found on the CD that

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accompanies this project. Teachers can print, cut apart and laminate a class set of the color copy to use with every class)

Distance from Earth Ranking	Object	Distance in kilometers*
1	Hubble Space Telescope	560
2	International Space Station	1200
3	Moon	380 thousand
4	Sun	150 million
5	Jupiter	620 million
6	Monoceros Nebula	1000 trillion
7	Andromeda Galaxy	19 trillion million
8	Hubble Galaxies	300 trillion trillion

* Kilometers are used as the unit of measure here to illustrate just how big and how far the objects are. The concept of light years is addressed in a later lesson.

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Distance from Earth Ranking	Object	Size
1	Hubble Space Telescope	12 meters
2	International Space Station	90 meters
3	Moon	3200 kilometers in diameter
4	Jupiter	140,000 kilometers in diameter
5	Sun	1.4 million kilometers in diameter
6	Andromeda Galaxy y	960 million kilometers across
7	Monoceros Nebula	160 trillion kilometers
8	Hubble Galaxies	1,600 trillion kilometers

Exploration 2

Activity: Classifying Galaxies

Class Time: 15 minutes

Objective: The student will be able to describe and classify the different shapes of galaxies.

Materials:

Classifying Galaxies (see Black-Line Masters)

Students learn about the classification system for galaxies created by Edwin Hubble and then classify eight different pictures of galaxies.

Note: Students should understand that there has never been a picture taken of the Milky Way Galaxy and is only from evidence (location of stars, cluster and gases) that astronomers believe that the Milky Way Galaxy is a spiral galaxy. Photos of other spiral galaxies are often used as models of

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what the Milky Way Galaxy would look like from far away outside the galaxy.

Answers

- **M81: Type Sb spiral**
- **NGC2997: Type Sc spiral**
- **M95: Type SBa barred spiral**
- **NGC1365: Type SBb barred spiral**
- **Leo I: Type E3 (dwarf) elliptical**
- **M110: Type E6 elliptical**
- **Small Magellanic Cloud: Irregular type**
- **NGC4486 Type E0 elliptical:**

Explain

Use questions to get students to think about how scientists measure such large distances and sizes. Don't look for correct answers; look rather at how the students think about the questions. Example questions:

1. How far into space have humans traveled? *To the Moon.*

2. If we haven't been beyond the Moon, how do we know how far things are? *We don't know. We think they are certain distances because of motion, size and other things we can measure and find patterns.*

3. Why do we think we exist in a spiral galaxy? *The Milky Way is a long ribbon formation filled with stars. From our perspective this appears to be the arm of a spiral.*

4. How do we know the temperatures of the stars? *Scientists do spectral analyses that provide information about the outer gases of the star.*

5. How do we know the distances of the stars? *By relative sizes and brightness. If all red giants are about the same size and brightness, scientists can compare a red giant that is smaller and dimmer than another red giant and conclude that it is farther away. By specific measurements, a value can be calculated.*

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Elaborate

Elaboration 1

Activity: What Can Observing Stars Tell Us? (see Black-Line Masters)

Objective: The students will be able to describe what the color and brightness of a star can tell about its properties.

Students cut out and classify two sheets of stars according to temperature, color and luminosity.

Elaboration 2

Activity: Scale of the Universe (see Black-Line Masters)

Objective: The student will be able to explain the use of light years to describe the distances in the universe.

Students predict how long it would take to travel to various destinations then learn the real time. Student use calculators to find out how far in miles several objects are discovering the numbers are too large to fit into the calculator leading them to an understanding of why astronomers need and use a different measuring unit – the light year.

Elaboration 3

Research: How it all began

Class Time: 1 class period

Objective: The student will be able to analyze scientific explanations as to the strengths and weaknesses using scientific evidence and information

Process Skills:

> TEKS 8.3 (A) – The student is expected to analyze, review and critique scientific explanations, including hypothesis and theories, to their strengths and weaknesses using scientific evidence and information.

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Assign students a research project for homework that answers the question: What are the historical scientific theories concerning the origin of the universe?

Evaluate

TAKS questions:

1. Rank the following objects by size from smallest to largest:
    a. Moon, Jupiter, Hubble Space Telescope, Andromeda Galaxy
    b. Jupiter, Moon, Hubble Space Telescope, Andromeda Galaxy
    c. Andromeda Galaxy, Jupiter, Moon, Hubble Space Telescope
    d. *Hubble Space Telescope, Moon, Jupiter, Andromeda Galaxy

2. Rank the following objects by distance from the Earth from closest to farthest:
    a. Sun, Jupiter, International Space Station, Hubble Galaxies
    b. Hubble Galaxies, Sun, Jupiter, International Space Station
    c. *International Space Station, Sun, Jupiter, Hubble Galaxies
    d. Jupiter, Sun, Hubble Galaxies, International Space Station

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3. A star's color is related to its _____.

    a. Distance from Earth

    b. *Temperature

    c. Luminosity

    d. Name

4. The unit of measurement used by astronomers to express distance in space in the_____.

    a. *light year

    b. Miles

    c. Kilometers

    d. Year

5. Galaxies are classified by their _____

    a. Color

    b. *Shape

    c. Brightness

    d. Size

Assessment tools: Concept Map

Students fill in missing words on a concept map.

ESL modification: Give a word list to help with spelling and word recognition.

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WHAT DO YOU KNOW ABOUT THE UNIVERSE?

Purpose: To explore what you know about objects in space and to find out how big and how far away these objects really are.

Materials: One set of Space Object Cards per pair of students

Part 1 How Big Are Objects In Space?

What to Do:

1. Look at the Space object cards.
2. Thinking about what you and your partner know from experience, put the objects in order by actual size.
3. Put the objects in order from smallest to largest.
4. Write the names of the objects in the chart below.
5. Write the actual size in the chart as your teacher tells you.
6. Examine the sizes given and place the real size ranking in the chart.

Observations:

MY RANKING	NAME OF OBJECT	ACTUAL SIZE	REAL RANKING
1			
2			
3			
4			
5			
6			
7			
8			

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Part 2 How Far Away Are Objects in Space?

What To Do:

1. Again, look at the Space object cards.

2. Thinking about what you and your partner know from experience, put the objects in order by how far the object is from earth.

3. Put the objects in order from closest to farthest.

4. Write the names of the objects in the chart on the next page.

5. Write the actual distance in the chart as your teacher tells you.

6. Examine the distances given and place the real distance ranking in the chart.

Observations:

MY RANKING	NAME OF OBJECT	ACTUAL DISTANCE	REAL RANKING
1			
2			
3			
4			
5			
6			
7			
8			

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Questions:

1. Why do you think it was difficult to determine size and distance?

2. What surprised you in the size rankings?

3. What surprised you in the distance rankings?

4. Many people think that the Hubble Space telescope is farther away than the moon. What did you and your partner think?

5. The picture of the Hubble Galaxies was taken by the Hubble Space telescope. Until that telescope was placed in orbit scientists thought that area of the sky was empty. What does this information make you think about?

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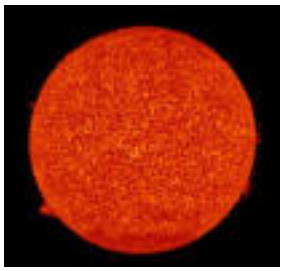
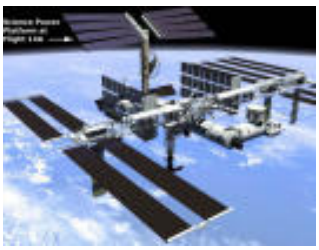
SPACE OBJECT CARDS

Hubble Telescope 	**Andromeda Galaxy** 
Jupiter 	**Monoceros Nebula** 
The Sun 	**The Moon** 
Hubble Galaxies 	**International Space Station** 

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SCALE OF THE UNIVERSE

Purpose: To learn about the vast distances of space and why we use light years as a form of measurement.

Materials: Transparency of How Fast Can We Get There? calculators

Part 1

What to Do:

1. Discuss with your partner and guess how long you think it would take to travel to the following destinations. Put your guess in the top half of the box and the real time underneath it.

Destination	Jet (960 km/hour)	Rocket (40,000 km/hour)	Sunbeam (300,000 km/second)
Moon			
Sun			
Jupiter			
Alpha Centauri (the nearest star to our Sun)			

2. Observe the information your teacher presents and compare your guesses with the real information.

Questions:

1. Where your guesses close to the real time?

2. What surprised you about the real time it takes to travel to the various destinations?

The time it takes light to go from one place to another in space is a convenient way of comparing distances. When astronomers measure distance they do so in light seconds, light minutes and light years.

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Part 2

What to Do:

1. Use the following information and a calculator to determine how many miles from the Sun each of the following objects are.

Measurement	kilometers
light-second	300,000
light-minute	18,000,000
light-year	10,000,000,000,000

A. Earth is 500 light seconds from the Sun. How many kilometers apart are they?

B. Jupiter is 43.3 light minutes from the Sun. How many kilometers apart are they?

C. Alpha Centauri is 4.2 light years from the Sun. How many kilometers apart are they?

Questions:

1. Does a regular calculator have enough spaces to calculate the miles to Alpha Centauri?

2. Look at the slide How Fast Can We Get There? again. All of the sunbeam times are really light-seconds, light minutes or light years. Set up the equation to determine the number of kilometers to the center of the Milky Way.

3. Why do astronomers use the unit of light years as a measurement of distance rather than miles or kilometers?

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HOW FAST CAN WE GET THERE?

Destination	Jet (960 km/h)	Rocket (40,000 km/h)	Sunbeam (300,000 km per second)
Moon	16.5 days	9.4 hours	1.2 seconds
Sun	17 years, 8 months	4 months	8.5 minutes
Jupiter	74 years, 3 months	1 year, 9 months	35 minutes
Alpha Centauri (nearest star)	4.8 million years	114,155 years	4.2 years
Monocerus Nebula	---	---	109 years
Center of the Milky Way	---	---	38,000 years
Andromeda Galaxy	---	---	2.2 million years
Hubble Galaxies	---	---	400 million years

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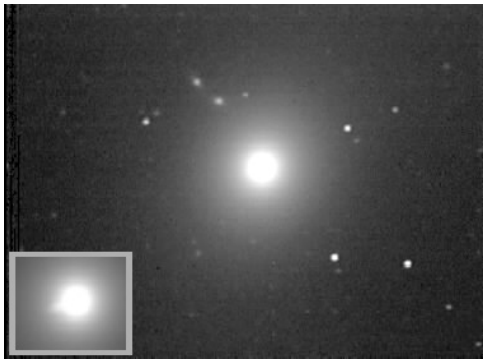
Classifying Galaxies

M 81 Type:

M110 Type:



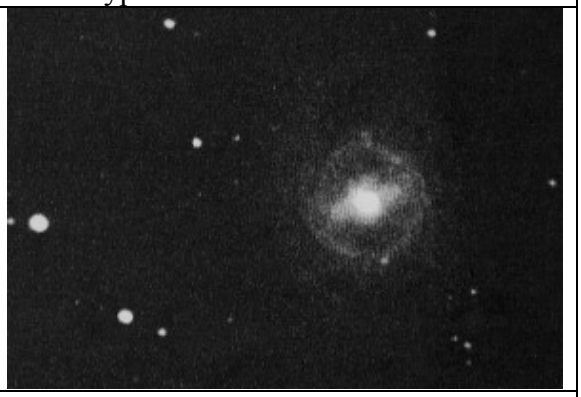
NGC4486 Type:

Small Magellanic Cloud Type:

NGC1365 Type:

Leo I Type:

NGC2997 Type:



M95 Type:

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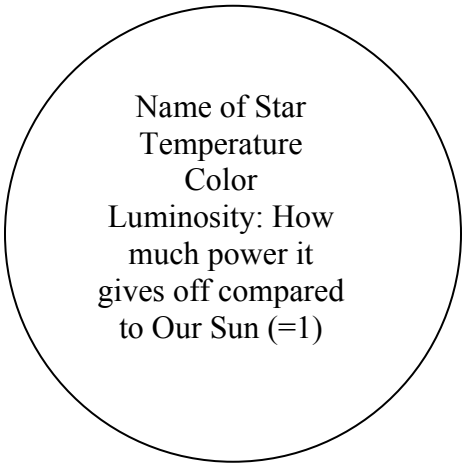
WHAT CAN OBSERVING STARS TELL US?

Purpose: To discover what the color and brightness of stars can tell us about their properties.

Materials: Scissors, 1 set of star sheets for each set of partners

What to Do:



1. Cut out the stars from the star sheets.
2. Observe the information on each star and compare it to the graphic on this paper.
3. Classify the stars according to color and look for any patterns that emerge.
4. Classify the stars according to size (small, medium and large) and look for any patterns that emerge.
5. Classify the stars according to temperature and look for any patterns that emerge.
6. Classify the stars according to luminosity and look for any patterns that emerge.

Questions:

1. What pattern did you see when you classified the stars by color?

2. What pattern did you see when you classified the stars by size?

3. What pattern did you see when you classified the stars by temperature?

4. What pattern did you see when you classified the stars by luminosity?

5. What can we say about small stars?

6. What can we say about medium stars?

7. What can we say about large stars?

8. Why do you think the bigger stars are more luminous?

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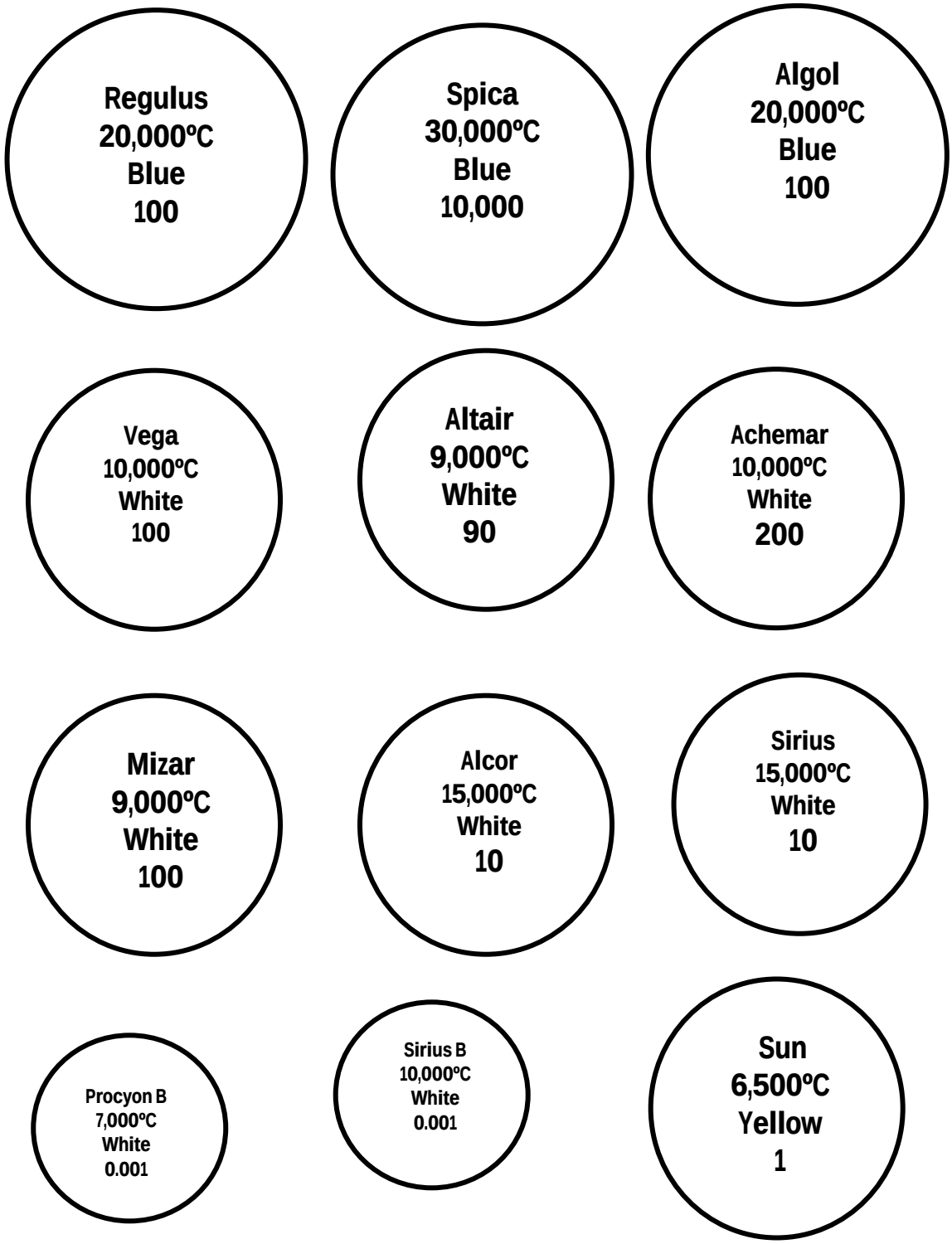
STAR CHART



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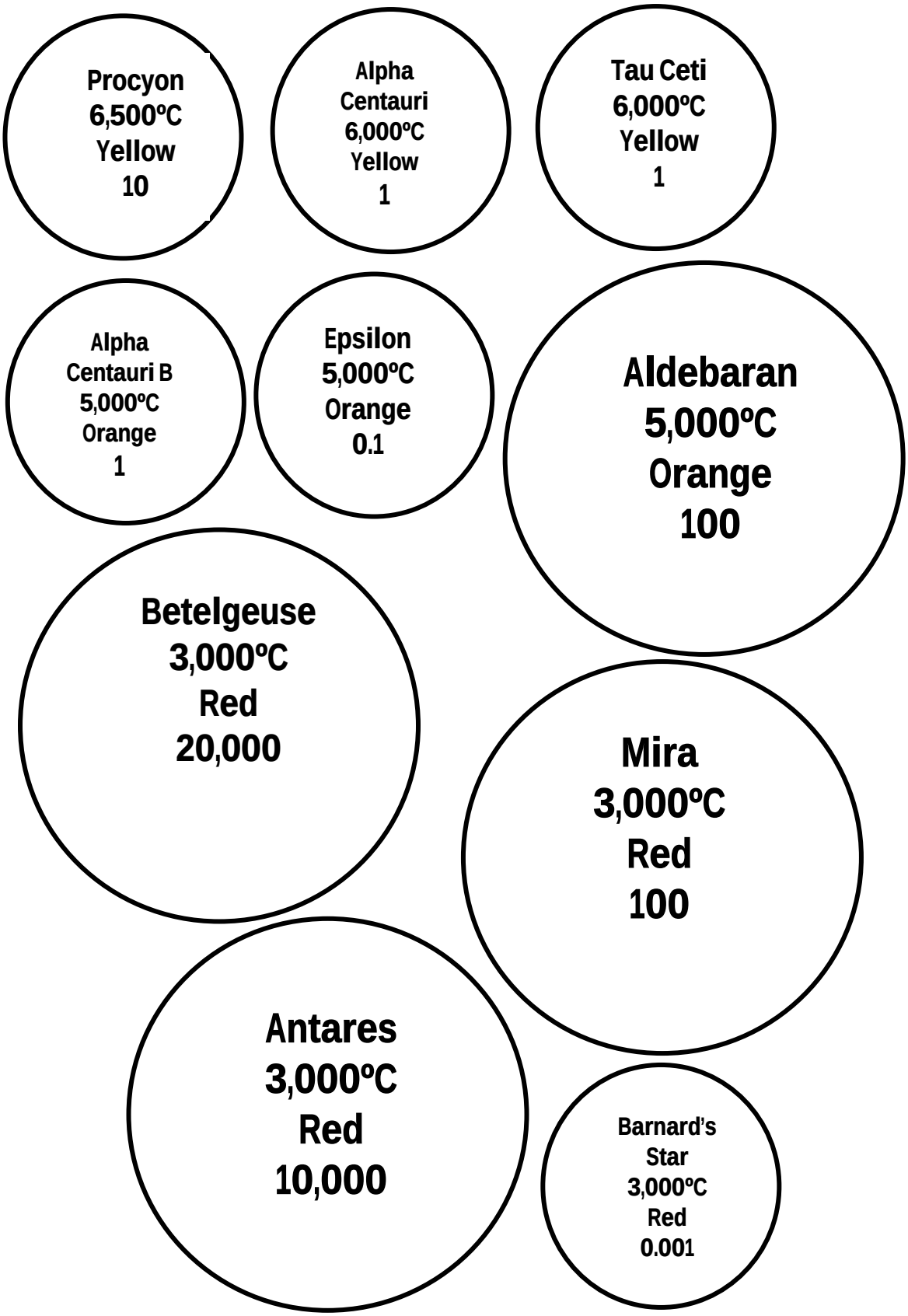
Procyon
6,500ºC
Yellow
10
Alpha
Centauri
6,000ºC
Yellow
1
Tau Ceti
6,000ºC
Yellow
1
Alpha
Centauri B
5,000ºC
Orange
1
Epsilon
5,000ºC
Orange
0.1
Aldebaran
5,000ºC
Orange
100
Betelgeuse
3,000ºC
Red
20,000
Mira
3,000ºC
Red
100
Antares
3,000ºC
Red
10,000
Barnard's
Star
3,000ºC
Red
0.001

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World Altering Events

TAKS Objective 5 – The student will demonstrate an understanding of Earth and Space systems.

Learned Science Concepts:

- Complex interactions occur between matter and energy.
- Cycles exist in Earth systems.
- Characteristics of the universe.
- ➡ **Natural events and human activity can alter Earth systems.**

TEKS Science Concepts 8.14

The student knows that natural events and human activity can alter Earth systems. The student is expected to:

(A) predict land features resulting from gradual changes such as mountain building, beach erosion, land subsidence and [continental drift]; **

**TAKS will assess students' understanding of plate tectonics. The theory of plate tectonics is the most current and accepted theory of plate movement.

(B) analyze how natural or human events may have contributed to the extinction of some species; and

(C) describe how human activities have modified soil, water, and air quality.

Overview

It is important for students to understand the natural and human events that contribute to the changing environment we live in. For example, land can subside from ground water over-pumping and declining water tables. This can cause irrigation ditches, canals and water wells used in agricultural areas to collapse threatening plant and animals that rely on these water systems. In urban areas, subsidence can affect bridges, highways, electric lines, waterlines, sewer pipes and gas pipes, which are everywhere. As you can see, gradual changes in land features have considerable economic impact and interrupt our everyday life.

In addition to natural events, human activity has modified our soil, water and air quality in a number of ways. Pollution of these resources threatens the way we live, and it is important for everyone to understand how to take care of these resources if we are to maintain a sustainable planet. Presently, there are ongoing human activities that interfere with the ability of certain organisms to survive, and organisms are becoming extinct at an alarming rate. Habitat destruction is still the number one cause of species extinction. However, alien species are an increasing threat to biodiversity.

Certain resources like coal, oil and gas are limited and unless new discoveries are made, these limited resources will run out in a few decades. For example, current estimates indicate we have about a 40-year supply of oil, a 62-year supply of gas and a 262-year supply of coal. Given our increasing dependence on oil and natural gas and the environmental air pollution problems associated with fossil fuel, it may be that we need cleaner, cheaper and more efficient ways to produce the energy we need if we are to continue our current level of energy use.

Instructional Strategies

The learner will investigate the effect of changes in environmental conditions (e.g. salt, CO_2, overpopulation) using plants. A guided inquiry instructional strategy is employed.

A simulation instructional strategy is used to explore extinction of an endangered species of amphibian, the Golden Coqui frog of Puerto Rico. The learner compares the results of three graphs which depict stable, declining and growing populations.

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The Internet is employed to conduct a WebQuest which examines various environmental and economic perspectives regarding the building of a road in a remote area.

Lesson Objectives

1. After completing the TerrAqua ecocolumn group activity, the learner will describe the effect of excess salt on terrestrial and aquatic plant life scoring at least 70 points on the rubric.

2. After completing the TerrAqua ecocolumn group activity examining salt infiltration, the learner will record at least five journal entries about the investigation. A pass/fail grade will be given.

3. Working a group, the learner will complete the acid precipitation group investigation and present group findings. A minimum score of 80 on the presentation rubric is required.

4. After researching a stakeholder position, each group of learners will present and defend their position on building a bridge, road and lodge in Taman Negra. A team score of at least 21/30 is required.

5. After viewing the video, the learner will create a book jacket to demonstrate understanding of natural and human activities that alter earth's systems. A minimum score of 70 Points on the rubric is required.

6. After completing *The Golden Coqui Extinction Dice Game.* The learner will participate in a class discussion by providing at least two meaningful interactions during the class debriefing session.

7. Given information about extinct species in Texas, the learner will conduct web research to determine the cause of extinction for at least three animals. The information will be recorded in the science journal.

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For Teacher's Eyes Only

Mechanisms for Loss of Biodiversity

Habitat loss:

Habitat loss occurs when a species looses food, water and/or the shelter they need to survive. ***Habitat fragmentation*** refers to the building of roads, trails, pipelines and electric power lines that carve up natural habitat into fragments too small for larger animals to meet their needs for survival. For example, in the last few decades many famous Texas ranches have been splintered into small pieces in order to accommodate urban sprawl or to provide a weekend escape from urban life. These new landowners view land for its scenic and recreational value and know little about maintaining the delicate ecological balance in these areas. With these new landowners comes more of everything. There are more roads, more power lines, more waterlines, dirt bikes, ATVs and more people. Using land in this way, places pressure on species that are dependent on having many acres of grassland in order to survive. Habitat fragmentation degrades our wildlife habitats and at the same time places pressure on limited water resources. For example, the Northern Bobwhite Quail has declined almost 70% in the last twenty years because of the loss of grassland habitat. In the area east of Interstate 35 the "bobwhite" call of the quail is almost gone. Other birds such as the Eastern Meadowlark and Loggerhead Shrike are in peril. Additionally, small mammals and reptiles such as the horned lizard and box turtles are disappearing. At the same time, our need to conserve and protect precious water resources from pollution continues to be threatened by this practice. Closely associated with habitat fragmentation is ***habitat alienation,*** which occurs when the habitat is still present, but some animals won't use it because of its proximity to human activity. Loss of habitat is the #1 cause of extinction.

Introduced species:

An introduced species is one that is not native to a particular ecosystem and is likely to cause economic or environmental harm or harm to human health. They are also referred to as exotic, non-native or non-indigenous species. Since introduced species have no natural predators and crowd out native species, some biologists believe that introduced species will replace habitat loss as the #1 cause of extinction.

Sometimes non-native species are introduced deliberately. For example, the large-mouth bass is an introduced species specifically for sport fishing. The nutria (the largest rodent in Texas) is used for its fur and sterile grass

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carp (triploid) are used to control the growth of undesirable aquatic vegetation.

However, there are a number of ways that an introduced species may arrive accidentally. They can stow away on imported fruits and vegetables. This is how the Mediterranean fruit fly came to Texas. They can hitchhike on cars, trains, boats and planes. The Asian Long Horned beetle and wood-boring wasp came in on shipping containers or packing materials. African Killer Bees escaped from the lab where they were contained and have spread into Texas and red fire ants were originally from South America.

Invasive species cost Texans in loss of biodiversity. In Texas the economic costs of invasive species is high in that it negatively impacts agriculture, ranching, mariculture, fishing, tourism and real estate. The following website contains information about loss of biodiversity in Texas. http://fireant.tamu.edu/antfacts/pdf/texas1.pdf

Pollution of soil, water, and atmosphere

Pollution is the spoiling of land, air or water by artificial waster produces. Pollution can be a nuisance, and a threat to health or ecosystems. The land can become polluted in a number of ways. For example, roads, electric transmission towers, strip mining and quarrying can ruin the landscape. Crops are sprayed with pesticides, which poison insects, small animals and birds. Dumping of waste products from mines and industry can also release poisons into the environment. In turn, pesticides or other waste products may run off into rivers and reservoirs that supply drinking water for human consumption.

In the early 1970s, DDT, which was a widely used pesticide, was shown to be a biological magnification agent. That is when a small organism at the start of a food chain consumed DDT and was later eaten by other organisms up the food chain, the level of DDT continued to increase to the point where certain species such as cormorants, bald eagles and pelicans were threatened with extinction because of the levels of DDT in their bodies.

Another source of water pollution is untreated sewage dumped directly into waterways. Since oxygen is consumed in the breakdown of sewage, other organisms living in the water died due to lack of oxygen. A similar problem occurs when fertilizers such as nitrates and phosphates was washed into the water system. The fertilizer causes the water plants to multiply using up the oxygen in the water.

In the 1950s the industrial waste, acetaldehyde was pumped into Minamata Bay near Japan. Through the natural food chain, the poison

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built up in fish and shellfish and eaten by the people. Families who relied on the fish and shellfish became ill and many died. In Texas, industrial dumping in Galveston Bay almost wiped out the shrimping industry in the 1980s. Another source of water pollution is the release of heated water resulting from factory processes. This is called thermal pollution, which is hazardous to small plants and animals living in lakes and rivers.

Non-biodegradable substances such as oil and other pollutants are highly dangerous to aquatic wildlife. The Mediterranean Sea is the most polluted sea in the world due to floating oil and other garbage. The Mediterranean Sea is not safe for humans to swim in. Another example of oil pollution is the Exxon Valdez oil spill, which is one of the most publicized and tragic disasters in history. As late as 2001 over 50% of the sites were still contaminated with oil that was spilled in 1989.

Air pollution can result from either natural causes such as volcanic explosions and dust storms or human activities such as automobiles, planes and industrial factories that produce waste in the form of smoke, soot and other gases. Often, the particles of moisture in the air contain sulfur dioxide, which corrodes stonework and metals. It also contributes to human health problems in that it can cause cancer by diminishing the protective ozone layer in the upper atmosphere and increase the frequency of respiratory problems. Furthermore, excess sulfur dioxide and carbon dioxide contribute to the potential for world climate change. For more information about air, water and land pollution in Texas visit the following websites from the Environmental Defense and Texas Center for Policy Studies:

http://www.texasep.org/html/air/air_1nfa_poll.html
http://www.texasep.org/html/wql/wql_2sfc.html
http://www.texasep.org/html/wst/wst.html
http://www.texasep.org/html/pes/pes.html

Exploitation of Plant and Animal Species

In 400 A.D. fossil evidence suggests there were 98 species of endemic birds present in the Hawaiian Islands when the islands were colonized by Polynesians. Before the first Europeans arrived in 1778, about 50 of these species were extinct. Scientists believe these extinctions were the result of clearing tracts of forest for agriculture, natural and human predation and introduced species. After the first humans arrived in New Zealand around 1000 A.D., the introduction of animals such as the domestic dog and Polynesian rat, as well as the deforestation by fire and extensive hunting of large birds led to the extinction of 13 species of large flightless birds (Moas) as well as 16 other endemic species of birds. Other exploited species include The Auk and passenger pigeon, which are extinct, as well

as Lebanon cedar, the Peruvian anchovy, Sumatran and Javan rhinos all which have been driven to the edge of extinction.

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Misconceptions

Common Misconceptions about soil, water and air pollution

☒ Misconception

Oxygen in the water exists in the form of an oxygen atom.

☑ Science Concept

Oxygen in the water exists in the form of an oxygen atom in water (H_2O) rather than dissolved 0_2 in water.

🛠Rebuild Concept

Provide students with experiences to explore dissolved oxygen in water and how depleted oxygen supplies can jeopardize aquatic life.

☒ Misconception

Global warming may or may not be a problem.

☑ Science Concept

Incremental changes of less than 1°C can cause serious consequences to an aquatic system. Students do not fully understand the implications of using fossil fuels and how present practices and laws negatively impact our environment in terms of air, water and soil pollution.

🛠Rebuild Concept

Provide experiences to acquaint students with the importance of the carbon cycle. Allow students to engage in concrete learning involving the manipulation of environmental conditions and the effects on the environment (e.g., acid rain, excess CO_2).

TEKS 8.14 A, B, C

☒ Misconception

Resources are abundant.

☑ Science Concept

Without careful guardianship of renewable resources, these resources can become unusable to life on earth for many years.

🛠Rebuild Concept

Provide students with experiences that investigate the negative impact of human activity on the environment.

Common misconceptions about extinction

☒ Misconception

Living organisms can be brought back from the edge of extinction if humans intervene.

☑ Science Concept

Often, there is not a large enough gene pool to support saving a particular organism even if money were of no concern. Also, this loss of diversity can seriously jeopardize a food web via the creation of new niches that upset the delicate balance of nature.

🛠Rebuild Concept

Provide students with information about extinct, endangered and threatened species. Provide examples of recent species extinction in the U.S. and how this extinction came about (e.g., Passenger pigeon, Ivory-billed woodpecker).

TEKS 8.14 A, B, C

☒ Misconception

The rainforest is the major source of oxygen for the environment.

☑ Science Concept

Aquatic plants in the ocean are the major source of oxygen for the environment.

🛠Rebuild Concept

Ocean pollution can have serious consequences with regard to aquatic plant life. Provide students with data about oxygen production of terrestrial and aquatic plants.

Student Prior Knowledge

Knowledge from TEKS 7.14 should include prior knowledge about the TEKS 14 (A) impact of different catastrophic events on the Earth such as glaciation, asteroid/comet impacts, landslides, floods and volcanic activity. Additionally, the student should already be able to analyze the effects of regional erosional deposition and weathering on the earth's surface [TEKS 14 (B)]. Finally, TEKS 14 (C) specifies the student should be able to make inferences and draw conclusions about effects of human activity on Earth's renewable (e.g., plant and animal, oxygen, water), non-renewable (e.g., oil, natural gas, coal, minerals) and inexhaustible resources (e.g., sunlight, wind).

TEKS 8.14 A, B, C

TEKS 8.14 A, B, C

5 E's

ENGAGE

Show the Lorax Video to introduce the effect of human activity on the environment.

EXPLORE

Download the learning activity from the following website:

http://www.fastplants.org/pdf/ecology/fromaboveandbelow.pdf

TerrAqua columns may be prepared in advance or students prepare columns according to instructions for TerrAqua in blackline master's section. Students complete the learning activity and complete lab report.

Materials:

Per student or group: 20-30 fast plants; sterile soil; 1-2 aquatic plants such as Elodea; Peters solution; 2 clear plastic liter soda bottles; algae; pond bottom; lab grade NaCl, pickling or kosher salt;

Per class: Dissolve 20 grams of salt in two liters of distilled water. Dissolve 1 Tablespoon of 20/20/20 Peter's solution in one gallon of distilled water, Fast Plant lighting system.

	50 ml 20/20/20 Peters solution	100 ml salt solution
# of Days	4	3
	7	6
	14	9

TEKS 8.14 A, B, C

EXPLAIN

Salt is introduced into an ecosystem in a variety of ways. In some areas salt used to deice roads in the winter runs off in to the soil. Overhead watering systems that are commonly used in agriculture cause a buildup of salt during evaporation, which leaves salt molecules behind on the soil. In this series of lessons, the student examines the effect of salt on terrestrial and aquatic plant life introduced through soil and through water.

1. Why is salt not added during the plant germination phase of the experiment? *Salt greatly reduces germination of seeds.*
2. What is the purpose of the control TerrAqua ecocolumn? *A control allows the experimenter to attribute the results of plant grow to the experimental variable, salt. Without the control, it is possible that variable other than salt might affect plant growth and this would not be shown with only an experimental setup.*
3. Describe how salt from the aquarium travels into the soil. *When salt water is rained on the fast plants, it percolates through the soil and eventually drops through the holes in the cap down into the aquarium.*
4. Why is salt water added on three subsequent occasions? *Salt is added three times in order to maintain salt in both soil and water throughout the experiment and to make the experimental results more dramatic.*
5. How does salt affect terrestrial plant life? *Answers will vary, but should include reduces plant growth, flowering and fruit production.* Aquatic plant life? *Answers will vary, but should include reduces or destroys algae.*
6. Why is fertilizer added to the terrestrial plants? *The fertilizer contains Phosphorus, nitrogen and potassium, which increase plant growth. When nitrogen is limited, plant leaves yellow, plants are undersized and bear little or no fruit. Limited phosphorus can cause leaves and fruit to drop prematurely. Lack of phosphorus also affects the structure and acid content of the fruit. A lack of potassium causes a drop in photosynthesis critical to building proteins.*
7. How does fertilizer affect aquatic plants? *Fertilizer can cause overgrowth of algae in aquatic systems depleting the water of dissolved oxygen. When dissolved oxygen levels drop, organisms living in the aquatic ecosystem will die.*

TEKS 8.14 A, B, C

ELABORATE

First Elaboration

Salt infiltration may also be modeled using the TerrAqua columns. Prepare columns as in Explore activity except add a capillary wick such as pellon that begins at the top of the soil supporting the fast plants and runs through the bottle cap to end at the bottom of the aquarium. In Texas coastal areas, extensive pumping of ground water aquifers can cause the infiltration of salt from the ocean into the soil and the aquifers. Be sure the students do not sprinkle salt water on the fast plants, but rather add the salt solution only to the aquarium. Students answer the following questions.

1. Describe how salt from water is able to contaminate soil. *The salt moves up the pellon through capillary action and subsequently infiltrates the soil.*

2. How does salt affect terrestrial plant life? *Answers will vary, but should include reduces plant growth, flowering and fruit production.* Aquatic plant life? *Answers will vary, but should include reduces or destroys algae.*

Second Elaboration:

As the human population continues to grow on this planet, there is an increased competition for limited resources required for survival. Uncontrolled overpopulation crowds out other species and leads to extinction of species unable to complete for limited resources. Some researchers believe we can't always assume that technology will allow the human population to continue expanding. There are factors such as water, space, food, disease, shelter and natural disasters that limit populations. In the next learning activity, we will examine the effect of overpopulation using Wisconsin Fast Plants. Students will complete the learning activity available from the following website:
http://www.fastplants.org/pdf/ecology/populationexplosion.pdf

TEKS 8.14 A, B, C

Third Elaboration:

Materials

#158745 acid rain kit from Carolina biological supply

Carolina fast plant growing system (e.g., lighting water reservoir, mats, pots, soil, seeds).

Rainwater has a pH of 5.6 and any form of precipitation with a pH of less than 5.6 is called acid rain. The burning of fossil fuels such as coal, gas and oil causes acid rain. When fossil fuels are burned they release sulfur which combines with oxygen in the air forming sulfur dioxide. When the sulfur dioxide combines with water, sulfuric acid is formed creating acid rain. Additionally, nitrogen in the air reacts with burned fossil fuels to form nitrogen oxide. When nitrogen oxide combines with water, nitric acid is formed which is yet another form of acid rain. The effect of acid rain is damaging on terrestrial and aquatic life sensitive to pH changes. In this experiment the student will investigate the effect of sulfuric acid and nitric acid on plant growth.

Fourth Elaboration:

Investigate the effects of excess carbon dioxide on plant growth. Download the learning activity from the following website:

http://www.fastplants.org/newsletters/fpnotes_1993.pdf

Fifth Elaboration:

Use the webquest from the following website to engage in an issue investigation to explore the impact of human activity on the rainforest.

http://www.geocities.com/Athens/Sparta/7374/intro.htm

TEKS 8.14 A, B, C

EVALUATE

After completing the TerrAqua ecocolumn group activity, the learner will describe the effect of excess salt on terrestrial and aquatic plant life scoring at least 70 points on the rubric.

Check Sheet for Independent Investigations TerrAqua Ecocolumn Salt Learning Activity		Present √	Point Value
I.	Stating a problem to investigate Problem phrased as a research question If…then hypothesis statement		5
II.	Develop a procedure to compare the effect of salt on terrestrial and aquatic plants including a control setup. All steps in sequential order and reproducible Multiple trials indicated Materials are appropriate and described		15
III.	Gathering quantitative data for plant growth and qualitative data about the phenotypic effects of salt terrestrial and aquatic plants. Data organized in table or chart Data has a title Labels for manipulated and responding variables Units are stated Multiple trials, totals and averages are included		15
IV.	Graphing data for plant growth Appropriate graph type used Appropriate scale, range and interval are used Graph has a title Descriptive label for variable on the x-axis and responding variable for the y-axis Graphed data matches data collected Units indicated for each axis		20
V.	Data analysis Results from graph clearly stated Inferences made about results		20
VI.	Conclusion Conclusions based on results and inferences Hypothesis is restated Hypothesis is accepted or rejected		25

After completing the TerrAqua ecocolumn group activity examining salt infiltration, the student will record at least five journal entries about the investigation. A pass/fail grade will be given.

TEKS 8.14 A, B, C

Working a group, the student will complete the acid precipitation group investigation and present group findings. A score of 80 on the presentation rubric is required.

Acid Precipitation Investigation				
0-14	15-17	18-19	20	
Often mumbles, cannot be understood OR mispronounces more than three words.	Speaks clearly and distinctly most (>70%) of the time. Mispronounces no more than one word.	Speaks clearly and distinctly all (95%-100%) the time, but mispronounces one word.	Speaks clearly and distinctly all (95%-100%) the time and mispronounces no words.	
0-24	25-39	40-49	50	
Uses no drawing, pictures, table, graph or other prop during the presentation.	Uses at least two of the following: drawing, picture, table, graph or other prop during the presentation.	Uses three of the following: drawing, picture, table, graph or other prop during the presentation.	Uses all of the following: drawing, picture, table, graph or other prop during the presentation.	
0-19	20-23	24-29	30	
Does not seem to understand the topic very well.	Shows a good understanding of most parts of the topic.	Shows a good understanding of the topic.	Shows a full understanding of the topic.	
TOTAL POINTS				

This rubric was created using information from the following website:
http://rubistar.4teachers.org/index.php

TEKS 8.14 A, B, C

After researching a stakeholder position, each group of learners will present and defend their position on building a bridge, road and lodge in Taman Negra. A team score of at least 21/30 is required.

WebQuest – Taman Negra		
0	7	10
Every point was not supported.	Most major points were adequately supported with relevant facts, statistics and/or examples.	Every major point was well supported with several relevant facts, statistics and/or examples.
Counter-arguments were not accurate and/or relevant	Most counter-arguments were accurate, relevant and strong.	All counter-arguments were accurate, relevant and strong.
One or more members of the team had a presentation style that did not keep the attention of the audience.	Team generally used gestures, eye contact, tone of voice and a level of enthusiasm in a way that kept the attention of the audience.	Team consistently used gestures, eye contact, tone of voice and a level of enthusiasm in a way that kept the attention of the audience.
TOTAL POINTS		

This rubric was created using information from the following website:
http://rubistar.4teachers.org/index.php

TEKS 8.14 A, B, C

After viewing the video, the learner will create a book jacket to demonstrate understanding of natural and human activities that alter earth's systems. A minimum score of 70 Points on the rubric is required.

The Effect of Natural and Human Activity on Earth's Systems			
Revise and resubmit	70-79 Points	80-89 Points	90-100 Points
Messy and hard to read. It looks like the student threw it together at the last minute.	The book jacket is fairly readable but some parts are of poor quality. It looks like the student ran out of time or took shortcuts to finish.	The book jacket has almost no distracting errors, corrections or erasures and is easily read. It appears the student worked hard on it.	The book jacket has no distracting errors, corrections or erasures and is easily read. It appears the student spent a lot of effort.
Information has little or nothing to do with the natural and human activities that alter earth's systems.	Information clearly relates to natural and human activities that alter earth's systems, but only two examples are provided for each area (total of four).	Information clearly relates to natural and human activities that alter earth's systems. At least three examples for each area are provided (total of six).	Information clearly relates to natural and human activities that alter earth's systems. At least four examples for each area are provided (total of eight).
Illustrations were drawn and/or colored carelessly.	Illustrations were drawn and colored neatly, but some were too large or too small.	Illustrations were drawn and colored neatly and were a good size.	Illustrations were creative, drawn and colored neatly and were a good size.
Author's name AND/OR bibliography is missing.	Includes the author's name and a biography that includes some personal facts about the author.	Includes the author's name and a biography that includes some personal facts and the name of at least one other book written by the author.	Includes a small photograph or drawing of the author, the author's name and a biography that includes some personal facts and the name of at least one other book written by the author.
Diagrams and illustrations are not accurate OR do not add to the reader's understanding of the topic.	Diagrams and illustrations are neat and accurate and sometimes add to the reader's understanding of the topic.	Diagrams and illustrations are accurate and add to the reader's understanding of the topic.	Diagrams and illustrations are neat, accurate and add to the reader's understanding of the topic.

This rubric was created using information from the following website:
http://rubistar.4teachers.org/index.php

TEKS 8.14 A, B, C

The Golden Coqui Extinction Dice Game

Engage

Ask students to respond to the following statement:

> 99.9% of all species that have ever lived extinct. Many of them perished in five mass extinctions. According to the American Museum of Natural History and the Louis Harris survey research firm, seven out of ten biologists believe we are in the mist of a sixth mass extinction.

Explore

Students experiment with "The Golden Coqui Extinction Dice Game." Rules for the game are in the Black Line Masters at the end of this section.

Explain

Debrief the students using the following questions.

1. Why are all the graphs not identical? *Answers will vary, but students should include variables such as birthrate, death rate, and environment causes.*

2. How do the three lines on the graph compare? *The lines will most likely be different. Why are they different? There is an increasing probability that the death rate or birth rate will change the rate of extinction. When the death rate is higher, extinction is more likely. When the birthrate is higher, the population is more likely to continue to exist.*

TEKS 8.14 A, B, C

3. Under what circumstance might an increased birthrate have a negative outcome? *Overpopulation can increase competition for limited resources resulting in starvation and spread of disease.*

4. What are ways that citizens can become active in the protection of biodiversity? *Students can become involved in the protection of biodiversity by writing letters, talking to politicians, and funding organizations that actively work to protect species.*

5. What causes a population to grow? *When resources necessary to survival are present (e.g., water, food, shelter) then a population will usually increase in number. When the number of births exceeds the number of deaths there is population growth.*

6. What causes a population decline? *Environmental factors can place pressure on a species and cause it to decline. When the number of deaths exceeds the number of births there is a population decline.*

7. What makes a population stay the same? *The number of births and deaths are highly similar. This kind of population will appear as a wavy line on a graph.*

8. Does the size of the population matter? *Yes.* Why or why not? *If a population is too small, then it may not be possible to reproduce sufficient numbers of offspring. In a small population, inbreeding results in decreasing numbers of healthy individuals and the population is genetically similar. The world cheetah population is so genetically similar that it is possible to graft the skin of one cheetah to another without rejection. Presently, there are about 12,000 cheetahs worldwide.*

Elaborate

Students may explore extinct species in Texas using information from the following website: http://www.texasep.org/html/wld/wld_3pna_ext.html or by using the information contained in the teacher notebook.

TEKS 8.14 A, B, C

Evaluation

After completing the learning experience, "The Golden Coqui Extinction Dice Game." The learner will participate in a class discussion by providing at least two meaningful interactions during the class debriefing session.

NOTE: the teacher will want to use a class roll checklist for purposes of recording student participation during the debriefing session.

TEKS 8.14 A, B, C

TEKS 8.14 A, B, C

Check Sheet for Independent Investigations TerrAqua Ecocolumn Salt Learning Activity		**Present √**	**Point Value**
I.	Stating a problem to investigate Problem phrased as a research question If…then hypothesis statement		5
II.	Develop a procedure to compare the effect of salt on terrestrial and aquatic plants including a control setup. All steps in sequential order and reproducible Multiple trials indicated Materials are appropriate and described		15
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IV.	Graphing data for plant growth Appropriate graph type used Appropriate scale, range and interval are used Graph has a title Descriptive label for variable on the x-axis and responding variable for the y-axis Graphed data matches data collected Units indicated for each axis		20
V.	Data analysis Results from graph clearly stated Inferences made about results		20
VI.	Conclusion Conclusions based on results and inferences Hypothesis is restated Hypothesis is accepted or rejected		25

TEKS 8.14 A, B, C

Acid Precipitation Investigation				
0-14	15-17	18-19	20	
Often mumbles, cannot be understood OR mispronounces more than three words.	Speaks clearly and distinctly most (>70%) of the time. Mispronounces no more than one word.	Speaks clearly and distinctly all (95%-100%) the time, but mispronounces one word.	Speaks clearly and distinctly all (95%-100%) the time and mispronounces no words.	
0-24	25-39	40-49	50	
Uses no drawing, pictures, table, graph or other prop during the presentation.	Uses at least two of the following: drawing, picture, table, graph or other prop during the presentation.	Uses three of the following: drawing, picture, table, graph or other prop during the presentation.	Uses all of the following: drawing, picture, table, graph or other prop during the presentation.	
0-19	20-23	24-29	30	
Does not seem to understand the topic very well.	Shows a good understanding of most parts of the topic.	Shows a good understanding of the topic.	Shows a full understanding of the topic.	
TOTAL POINTS				

TEKS 8.14 A, B, C

WebQuest – Taman Negra		
0	7	10
Every point was not supported.	Most major points were adequately supported with relevant facts, statistics and/or examples.	Every major point was well supported with several relevant facts, statistics and/or examples.
Counter-arguments were not accurate and/or relevant	Most counter-arguments were accurate, relevant and strong.	All counter-arguments were accurate, relevant and strong.
One or more members of the team had a presentation style that did not keep the attention of the audience.	Team generally used gestures, eye contact, tone of voice and a level of enthusiasm in a way that kept the attention of the audience.	Team consistently used gestures, eye contact, tone of voice and a level of enthusiasm in a way that kept the attention of the audience.
TOTAL POINTS		

TEKS 8.14 A, B, C

The Effect of Natural and Human Activity on Earth's Systems			
Revise and resubmit	70-79 Points	80-89 Points	90-100 Points
Messy and hard to read. It looks like the student threw it together at the last minute.	The book jacket is fairly readable but some parts are of poor quality. It looks like the student ran out of time or took shortcuts to finish.	The book jacket has almost no distracting errors, corrections or erasures and is easily read. It appears the student worked hard on it.	The book jacket has no distracting errors, corrections or erasures and is easily read. It appears the student spent a lot of effort.
Information has little or nothing to do with the natural and human activities that alter earth's systems.	Information clearly relates to natural and human activities that alter earth's systems, but only two examples are provided for each area (total of four).	Information clearly relates to natural and human activities that alter earth's systems. At least three examples for each area are provided (total of six).	Information clearly relates to natural and human activities that alter earth's systems. At least four examples for each area are provided (total of eight).
Illustrations were drawn and/or colored carelessly.	Illustrations were drawn and colored neatly, but some were too large or too small.	Illustrations were drawn and colored neatly and were a good size.	Illustrations were creative, drawn and colored neatly and were a good size.
Author's name AND/OR bibliography is missing.	Includes the author's name and a biography that includes some personal facts about the author.	Includes the author's name and a biography that includes some personal facts and the name of at least one other book written by the author.	Includes a small photograph or drawing of the author, the author's name and a biography that includes some personal facts and the name of at least one other book written by the author.
Diagrams and illustrations are not accurate OR do not add to the reader's understanding of the topic.	Diagrams and illustrations are neat and accurate and sometimes add to the reader's understanding of the topic.	Diagrams and illustrations are accurate and add to the reader's understanding of the topic.	Diagrams and illustrations are neat, accurate and add to the reader's understanding of the topic.

TEKS 8.14 A, B, C

THE GOLDEN COQUI EXTINCTION DICE GAME

The Golden Coqui (Eleutheroactylus jasperi) is one of the most legendary symbols of Puerto Rico. Its name is highly appropriate and you would know if you were near one from the sound it makes, "co key." The Coqui frog is very small measuring only ¼ to one inch in length and can jump many feet in a single leap. The color ranges from cream to deep brown, an adaptation to help the Coqui blend into its environment to avoid predation. The El Yunque rainforest in Puerto Rico is one of the favorite hangouts of the Coqui frog. There are a number of legends about the Coqui and it plays a part in Puerto Rican folklore. One legend tells that the Coqui was once a bird and lost its wings. It later acquired the ability to climb trees. Another legend describes Coqui as a disobedient child that was turned into a frog as punishment as its sound resembles a child whistling (U.S. Forest Service).

In this learning experience, you will investigate environmental pressures that can lead to the extinction of a species such as the Golden Coqui frog. Some of these pressures include:

- Habitat destruction due to environmental pollution or natural causes
- Predation from man, natural and introduced species
- Lack of food or water
- Illegal poaching

The game begins with 15 Coqui frogs living in the rainforest. Each partner will roll one die. Based on the results of both dice, the Coqui frog population will increase, decrease, or stay the same. Use the information in the KEY to determine what each roll of the dice will stand for. For example, if a combination of 7 is rolled with the dice, then one of the Coqui frogs dies because an exotic species was introduced into its habitat. After each roll of the dice, record the number of Coqui frogs living in the El Yunque Rainforest in Table 1. Use Graph 1 to show the population change over 20 years. Engage in learning experience using the KEY below to interpret the dice roll. Record the results in Table 1 and Graph 1. Use a blue map pencil to draw the line.

TEKS 8.14 A, B, C

KEY

2 = Reproduce one offspring

3 = Continue living

4 = Die from habitat destruction by environmental pollution/natural disaster

5 = Die from habitat destruction by environmental pollution/natural disaster

6 = Die from a natural predator

7 = Die from an exotic or introduced animal species

8 = Die from starvation from a competition and/or lack of food or water

9 = Die in a poacher's home aquarium

10 = Continue living

11 = Continue living

12 = Reproduce one offspring

TEKS 8.14 A, B, C

Engage in the learning experience a 2nd time EXCEPT use the following key. Record the results in Table 1 and Graph 1. Use a red map pencil to draw the line.

KEY

2 = Die from a natural predator Reproduces one offspring

3 = Die from habitat destruction by environmental pollution/natural disaster

4 = Reproduce one offspring

5 = Continue living

6 = Continue living

7 = Continue living

8 = Continue living

9 = Continue living

10 = Reproduce one offspring

11 = Die from an exotic or introduced animal species

12 = Die from starvation from a competition and/or lack of food or water

TEKS 8.14 A, B, C

Engage in the learning experience a 3rd time EXCEPT use the following key. Record the results in Table 1 and Graph 1. Use a green map pencil to draw the line.

KEY

2 = Die from a natural predator Reproduces one offspring

3 = Die from habitat destruction by environmental pollution/natural disaster

4 = Continue living

5 = Reproduce one offspring

6 = Reproduce one offspring

7 = Reproduce one offspring

8 = Reproduce one offspring

9 = Reproduce one offspring

10 = Continue living

11 = Die from an exotic or introduced animal species

12 = Die from starvation from a competition and/or lack of food or water

TEKS 8.14 A, B, C

	YEARS (1 Dice Roll = 1 Year)																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
Game 1																				
Game 2																				
Game 3																				

Table 1

After completing the activity, answer the following questions:

1. Why are all the graphs not identical?

2. How do the three lines on the graph compare? Why are they different?

3. Under what circumstance might an increased birthrate have a negative outcome?

4. What are ways that citizens can become active in the protection of biodiversity?

5. What causes a population to grow?

6. What causes a population decline?

TEKS 8.14 A, B, C

7. What makes a population stay the same?

8. Does the size of the population matter? Why or why not?

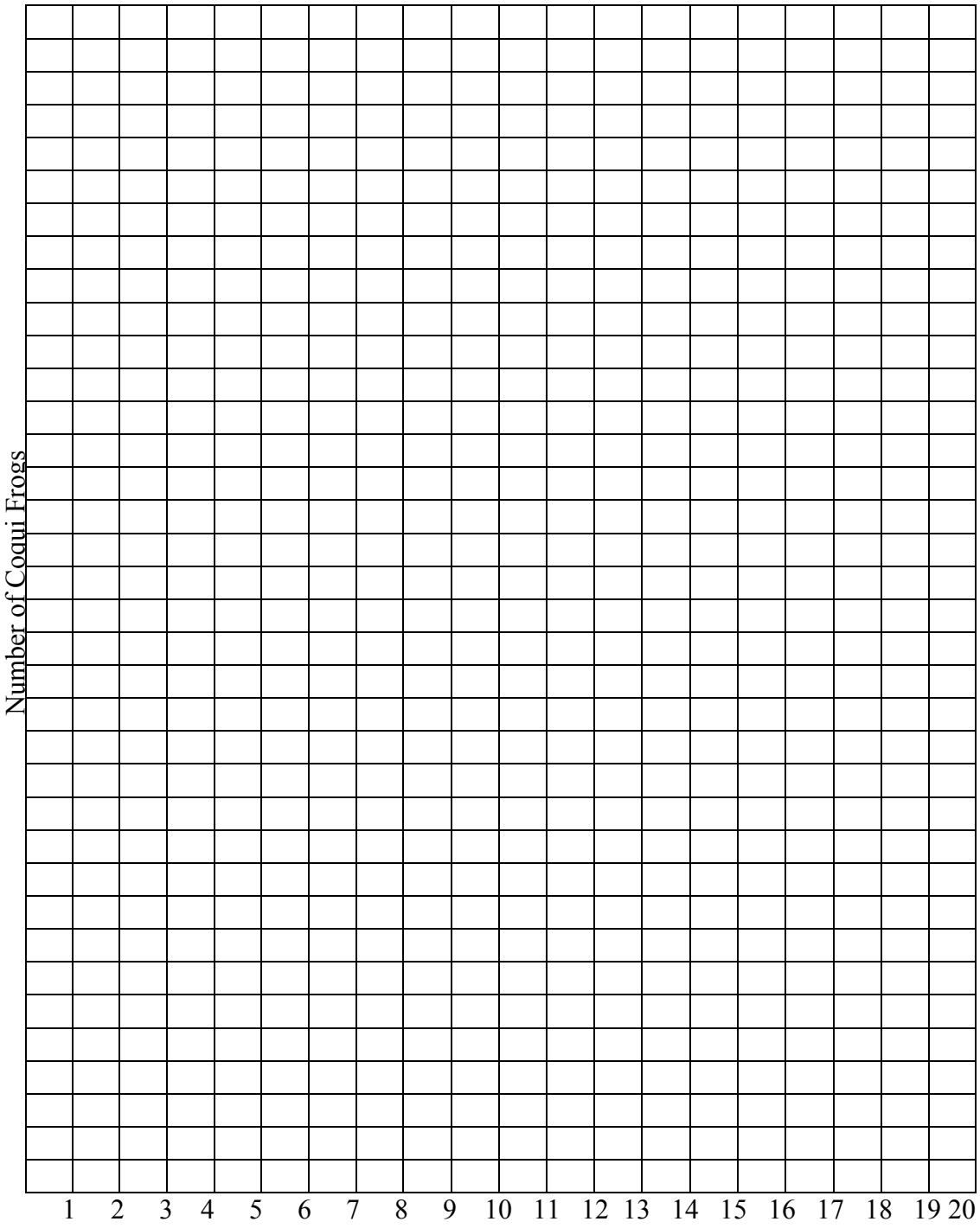
9. Associate the probability of rolling the dice with the outcome of the simulation (i.e., What is the probability of rolling a 2,3,4,5,6,7,8,9,10,11,12?).

Dice roll	# of Combinations	Probability
2	(1,1)	1/36
3	(1,2) (2,1)	2/36
4	(1,4) (4,1) (2,2) (2,2)	4/36
5		
6		
7		
8		
9		
10		
11		
12		

The Golden Coqui Extinction Dice Game was adapted from a student activity on *Newton's Apple,* the PBS science program for children. The segment (Show Number 1509, copyright 1997, Twin Cities Public Television).

TEKS 8.14 A, B, C

The Relationship Between Environmental Pressures and Extinction



KEY
Blue – stabilizing population
Red – increasing population
Green – decreasing population

TEKS 8.14 A, B, C