What's Included?

Unit Planning

- NGSS and APES Standards document
- Unit Pacing Guide for 50 min classes
- Differentiation ideas for honors students and virtual students ***Digital links for virtual learning found here**
- Honors assignment list

Notes

- Unit PowerPoint (49 slides)
  - Composition & Layers of Atmosphere
  - Weather & Global Winds
  - Biogeochemical Cycles
- Cornell Notes Pages (6 pgs)
- Doodle Notes Pages (3 pgs)
  - Guide to Using Doodle Notes
  - Doodle Note Keys & Examples
- Web-quest (11 pgs) (Can be used as an alternative to notes)

Activities

- Web-quests (11 pgs) *Can be used as an alternative to notes
- Composition of the Atmosphere Lab
- Layers of the Atmosphere Activity
- Coriolis Effect Activity
- Local Weather
- Meteorology Activity
- What's Your Weather?
- Nitrogen Cycle Board Game
- Answer Keys for all activities

*Honors Options

Student Pages

- This folder contains duplicate copies of every student page. They are in order according to the pacing guide for QUICK PHOTOCOPYING if you are using the pacing guide as is.

Extensions

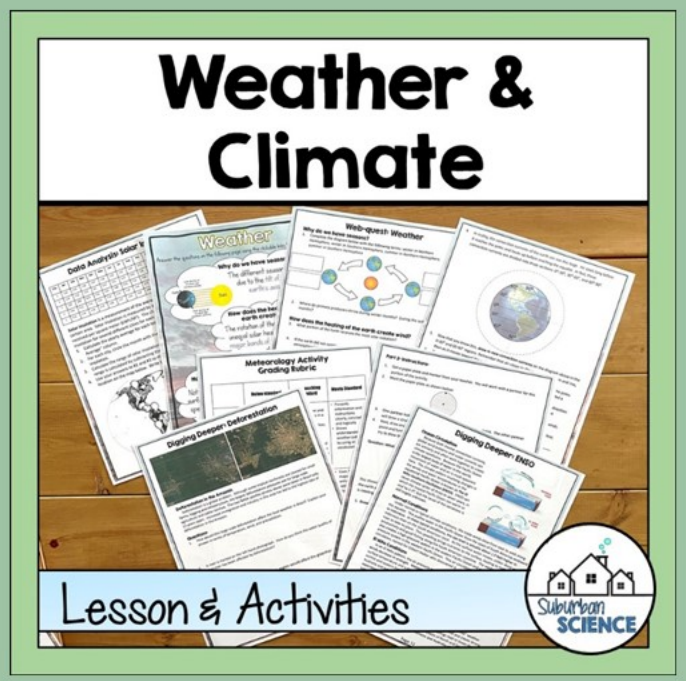
- Digging Deeper: The Ozone Layer
- Data Analysis: Atmospheric Composition
- Math Extension: Atmospheric Pressure*
- Data Analysis: Solar Insolation*
- Digging Deeper: Deforestation
- Digging Deeper: ENSO
- Data Analysis: Carbon Residence Time*
- Digging Deeper: Greenhouse Gases
- Answer Keys for all extension pages

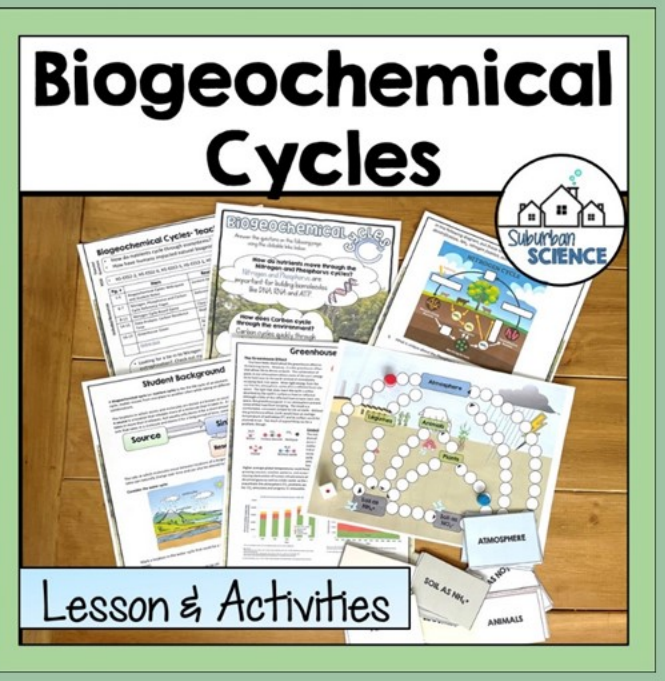
*Honors Options

Review and Assessment

- Online Intro to Atmosphere Quiz through Google Forms
- Editable Task Card Review (24 cards) with answer sheet
- Atmosphere Test (paper)- both Honors and Regular versions with answer sheets

Includes the following individual lessons which were previously available separately in my store:





If you've already purchased any of these individual lessons, please contact me at support@suburbanscience.com for a discount on this unit.

Unit Planning

NGSS and APES Standards Document

If you have specific state standards, contact me by email (support@suburbanscience.com) and I'll help you figure out which ones are covered!

Not included:

Materials Needed

- General classroom use: computers, calculators, rulers, colored pencils, paper, scissors
- Composition of the Atmosphere Lab: birthday candles (at least 5 cm long), shallow pans or culture dishes, metric rulers, test tubes, matches or lighters, food coloring (optional)
- Coriolis Effect Activity: markers, paper plates
- Local Weather Activi
  these), string, paper
- Nitrogen Cycle Game

Included Resources by Folder:

What's Included? Atmosphere Unit

Unit Planning

- NGSS Standards document
- Unit Pacing Guide for 50 min classes
- Differentiation ideas for honors students and virtual students ← *Digital links for virtual learning found here
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Notes

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Extensions

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- Answer Keys for all extension pages

*Honors Options

Review and Assessment

- Intro to Atmosphere Quiz through Google Forms (Make a copy of this file to your Drive. Do NOT assign to students using this link.)
- Editable Task Card Review (24 cards) with answer sheet
- Atmosphere Test (paper)- both Honors and Regular versions with answer sheets

Student Pages

- This folder contains duplicate copies of every student page. They are in order according to the pacing guide for QUICK PHOTOCOPYING if you are using the pacing guide as is.

Not included:

Supplementary Resources

- YouTube: Air Pressure
- Bozeman Science Video: The Atmosphere
- Convection Video
- El Niño and La Niña Demonstration
- ENSO & Jetstream Wheel
- Data Nuggets Activity on Mangrove Growth with Nitrogen & Phosphorus
- Data Nuggets Activity on Nutrients in Arctic Streams
- Bozeman Science Video: Biogeochemical Cycles
- Carbon Cycle Song
- Carbon Cycle Interactive

Atmosphere Unit Guide

Standards:

Topic	NGSS Standard	Description	APES Topics
Biogeochemical Cycles	HS-ESS2-2	Analyze geoscience data to make the claim that one change to Earth's surface can create	1.4: The Carbon
	HS-ES		
	HS-ES		
	HS-ES		
	HS-LS		

*Note: NGSS is a
partners that dev
production of this

Atmosphere Unit Guide

Standards:

Choosing Standards:
Although many states use NGSS, there are some states that do not. I would be glad to help you determine which of your state standards are covered in this unit. You can send me an email at support@suburbanscience.com to find out. Thank you!

The NGSS standards included in this unit are addressed multiple times throughout this course, rather than just once. As the course builds upon itself, the standards will be met with greater depth and detail further into the course.

Topic	NGSS Standard	Description	APES Topics
Intro to Atmosphere	HS-ESS2-2	Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.	4.4: Earth's Atmosphere
	HS-ESS2-4	Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.	9.1: Stratospheric Ozone Depletion
	HS-ESS2-7	Construct an argument based on evidence about the simultaneous coevolution of Earth's systems and life on Earth.	9.2: Reducing Ozone Depletion
Weather & Wind	HS-ESS2-2	Analyze geoscience data to make the claim that one change to Earth's surface can create feedbacks that cause changes to other Earth systems.	4.5: Global Wind Patterns
	HS-ESS2-4	Use a model to describe how variations in the flow of energy into and out of Earth's systems result in changes in climate.	4.7: Solar Radiation and Earth's Seasons
	HS-ESS3-5	Analyze geoscience data and the results from global climate models to make an evidence-based forecast of the current rate of global or regional climate change and associated future impacts to Earth systems.	4.8: Earth's Geography and Climate
	HS-ESS3-6	Use a computational representation to illustrate the relationships among Earth systems and how those relationships are being modified due to human activity.	4.9: El Niño and La Niña

Unit Overview Page
plus
Supplementary Resource Ideas
and **Materials Lists**

Editable Pacing Guides

50 min classes

	Day	Instruct	Assess	Homework
Weather	12	• Show meteorology videos to rest of class. • With remaining time, work on **Digging Deeper: Deforestation**	• Formal assessment of meteorology videos from grading rubric • Informal assessment of understanding from answers to deforestation questions	
Biogeochemical Cycles	13	• Atmosphere PPT (Sections 5 & 6) • **Cornell Notes** (Biogeochemical Cycles: Nitrogen and Biogeochemical Cycles: P (Option 2: Use Biogeochemica PPT & Cornell Notes. Find we Guide" within the "Unit Plann Notes folder.)	• Informal questioning during PPT • Cornell notes summary	Teacher Prep: Print & cut 1 set
	14	• Read, answer, and dis **Game Student Backg** • Groups play Nitrogen **Game Instructions** pe **Comprehension Ques** each student.		
	15	• Finish Nitrogen Cycle • Read, answer, and dis **Greenhouse Gases**.		
Review	16	• Use Doodle notes to s the unit		
	17	• Use **Task Cards** to revie copy **Task Card Answer**		
Assess	18	• Take **Atmosphere Test**		

Coincide with NGSS document in Unit Planning

50 min classes

	Day	Instruct	Assess	Homework
Weather	5	• Atmosphere PPT (Sections 3 & 4) • **Cornell Notes** (Weather and Coriolis Effect) (Option 2: Use Weather web-quest instead of PPT & Cornell Notes. Find web-quest links in "Differentiation Guide" within the "Unit Planning" folder or use PDF from Notes folder.)	• Informal questioning during PPT • Cornell notes summary	
	6	• Students complete **Coriolis Effect Activity** in pairs or groups. Materials: Paper plates, markers, pencils	• Formal or informal assessment of student understanding and participation by checking/grading answers on Coriolis Effect Activity.	
	7	• Read pg 1 of **Digging** a class • ENSO demonstration https://www.youtube.co • Complete **Digging De** activity • **Quick Check: ENSO**		
	9	• Honors: Check homewo • Intro: **What's Your Wea** • Students complete **Loca** individually or in pairs Materials: colored pencils, sm thermometers with holes in th rubber bands		
	10	• Begin **Meteorology Act** weather, creating script		
	11	• Continue working on **M** finishing research and f		

Coincide with NGSS document in Unit Planning Folder

*Bold items m
photocopied.

Atmosphere Pacing Guide

© Suburban Science

50 min classes

	Day	Instruct	Assess	Homework
Intro to Atmosphere	1	• Complete **Composition of the Atmosphere Lab**. Each student (or group) will need one **Student Instructions** Page and one **Results** Page Materials: birthday candle (at least 5 cm long), shallow pan or culture dish, metric ruler, test tube, matches or lighter, calculator, water, food coloring (optional)	• Informal questioning while students work on lab • Discuss answers to % oxygen as a class after all groups are finished. Discuss possible flaws (last question) that were considered.	
	2	• Atmosphere PPT (Section 1) • **Cornell Notes** during PPT (Composition of the Atmosphere) (Option 2: Use Atmosphere web-quest instead of PPT & Cornell Notes. Find web-quest links in "Differentiation Guide" within the "Unit Planning" folder or use PDF from Notes folder.) • Begin **Layers of the Atmosphere Activity.** (Note: If students remember this material well from Earth Science, you can skip this activity and Day 3.)	• Informal questioning during PPT • Cornell notes summary	
	3	• Finish Layers of the Atmosphere Activity from yesterday. • Atmosphere PPT (Section 2) • **Cornell Notes** during PPT (Layers of the Atmosphere)	• Informal check of student accuracy by comparing the Layers of the Atmosphere graph they created to the one in the PPT. Students should be challenged to notice any inaccuracies in their graph. • Cornell notes summary	
	4	• Read and complete **Digging Deeper: The Ozone Layer.** Discuss the importance of the ozone layer as a class. • Take Intro to Atmosphere quiz through Google Forms (find quiz link on START HERE document or Differentiation guide) • Start on homework with remaining time	• Informal check of completion and/or accuracy of answers from Digging Deeper page • Summative assessment through Google Forms quiz	All: **Data Analysis: Atmospheric Composition** Honors: Also complete **Math Extension: Atmospheric Pressure**

Coincide with NGSS document in Unit Planning Folder

*Bold items must be photocopied.

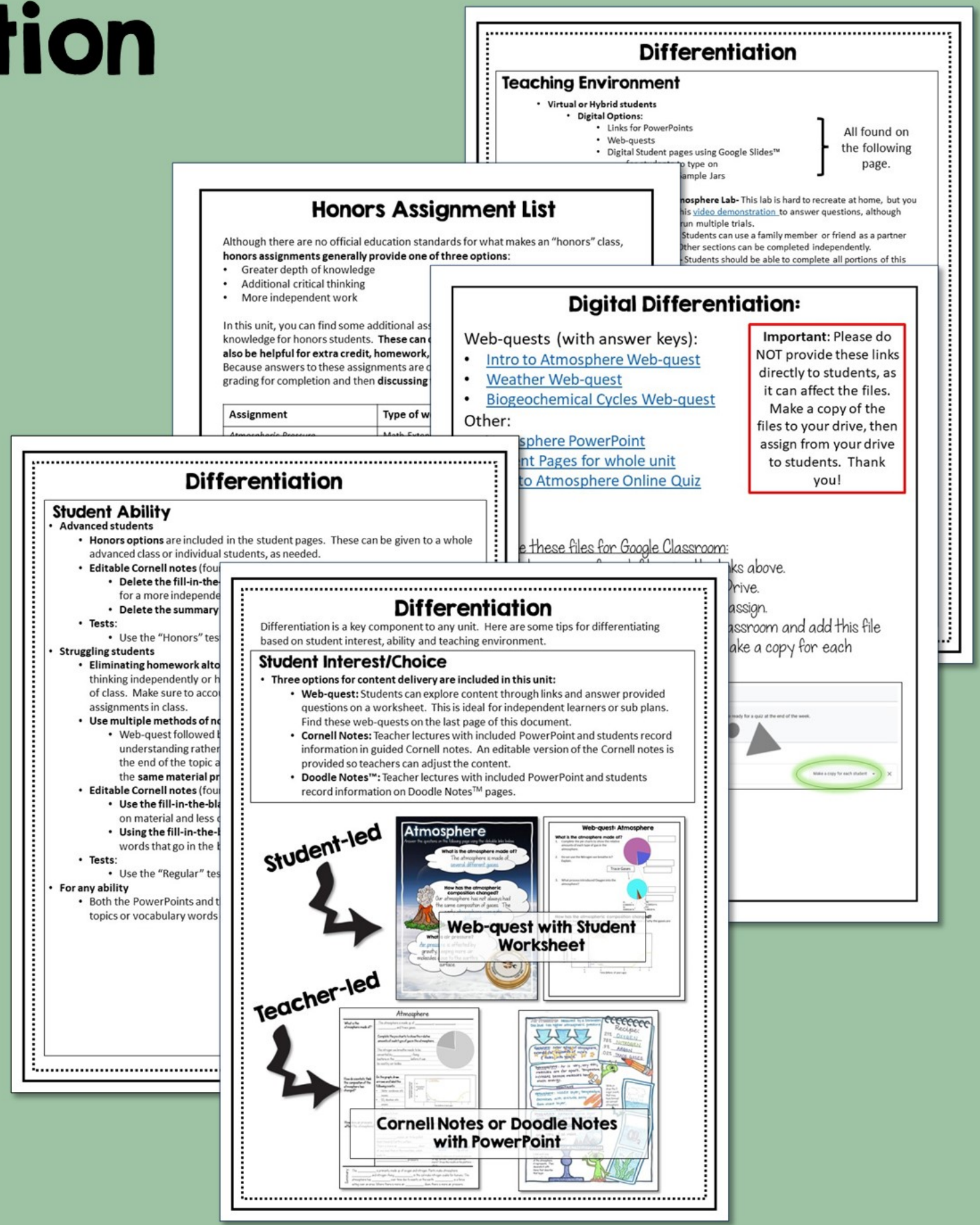
This icon is found on the top right corner of Honors pages for easy identification.

The daily topics coincide with the previous standards document.

Lesson planning is now quick and easy!

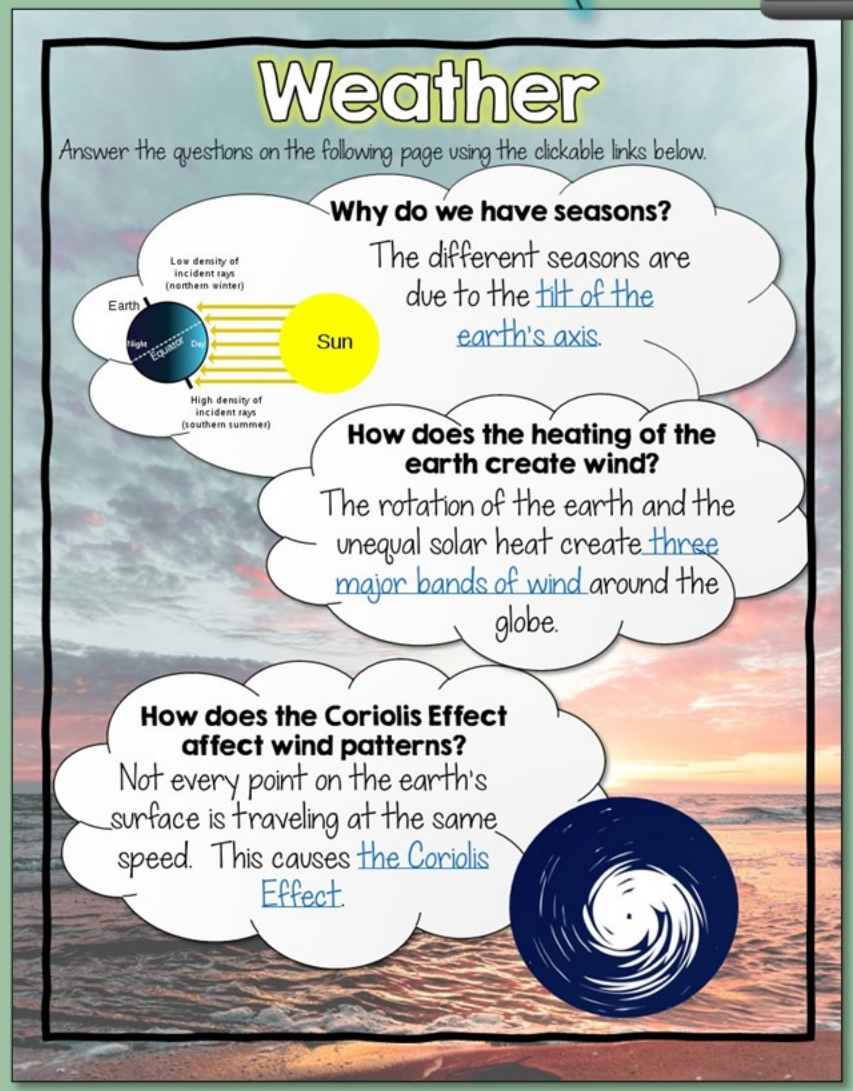
Differentiation Ideas for:

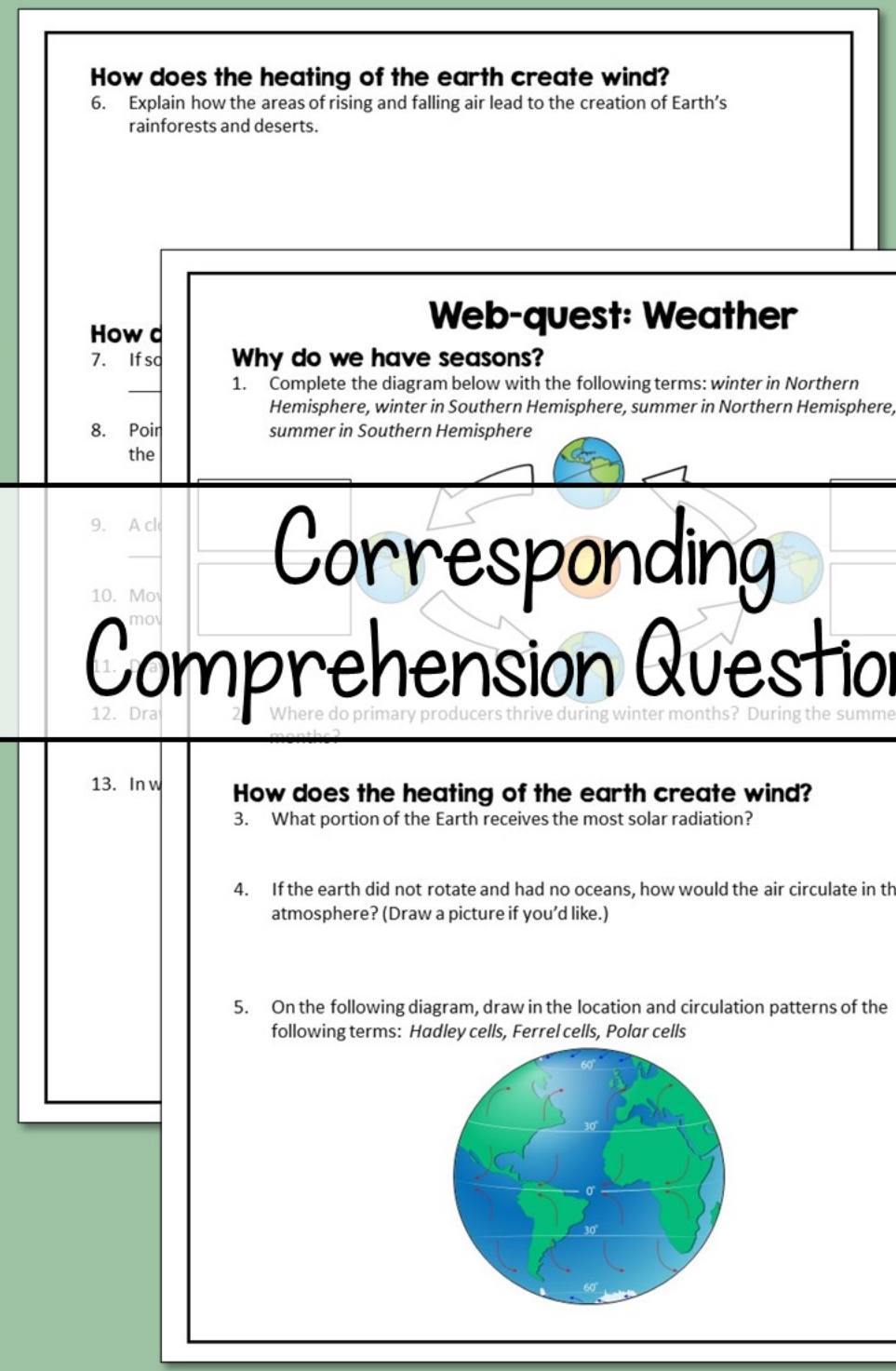
- Student Interest
- Student Ability
- Teaching Pace
- Teaching Environment (Virtual, in-class, or hybrid)



Content Delivery Option I: Student Webquest

Live video links for independent learning on any device!

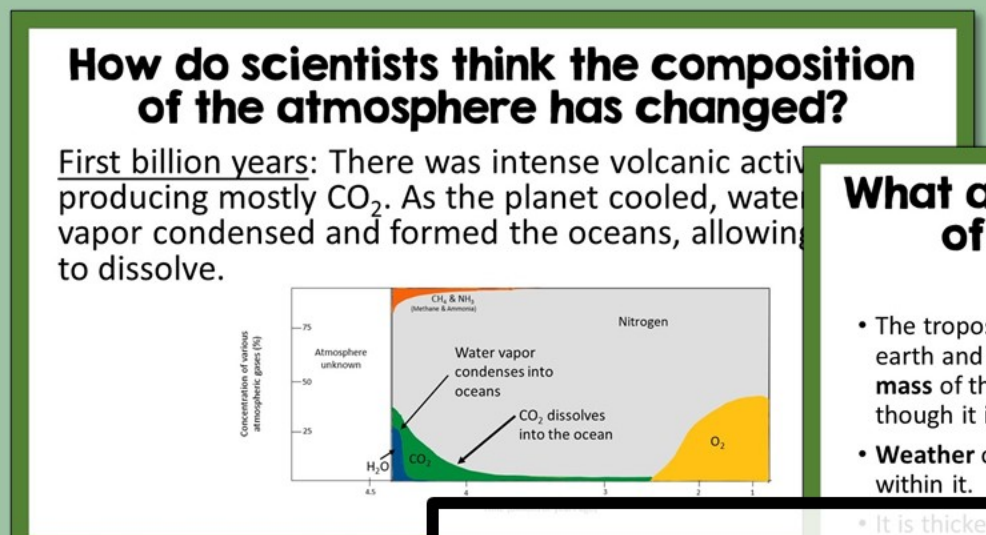


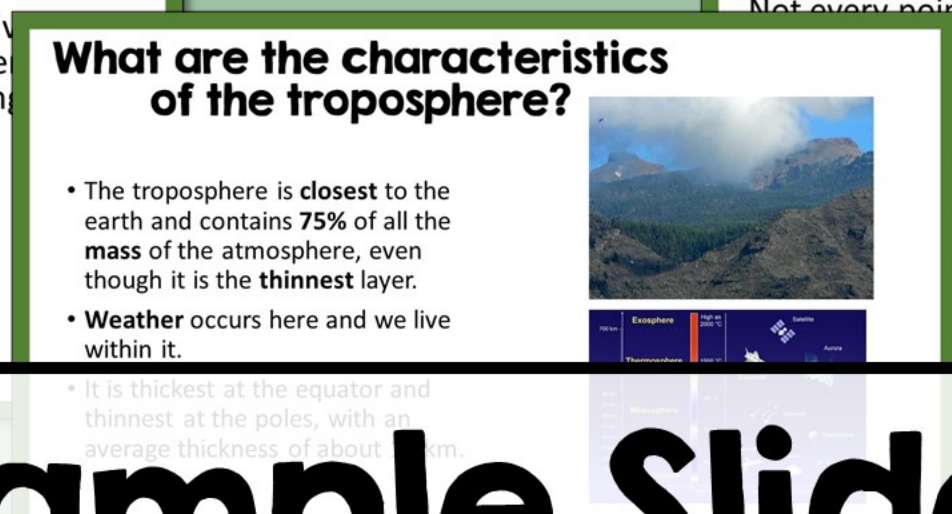


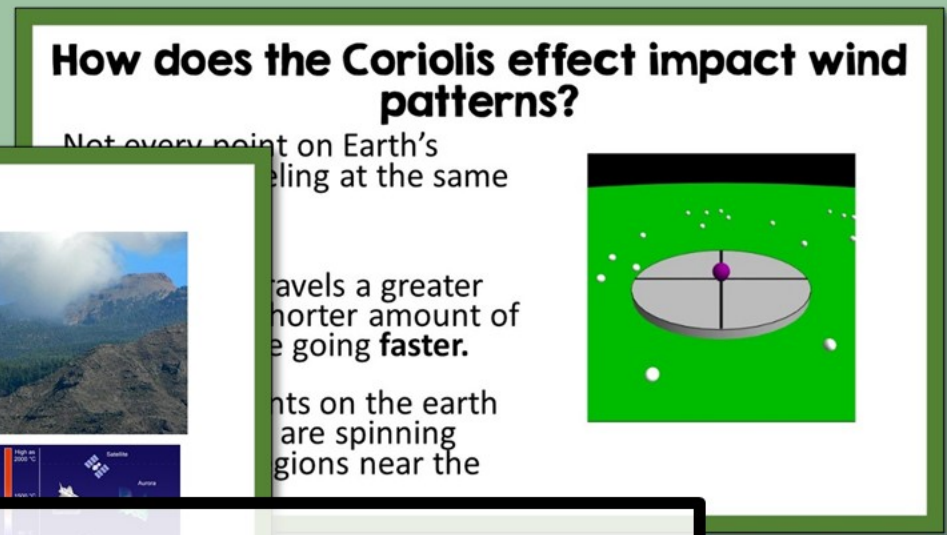
Corresponding Comprehension Questions

Content Delivery Option 2: PowerPoint Presentation

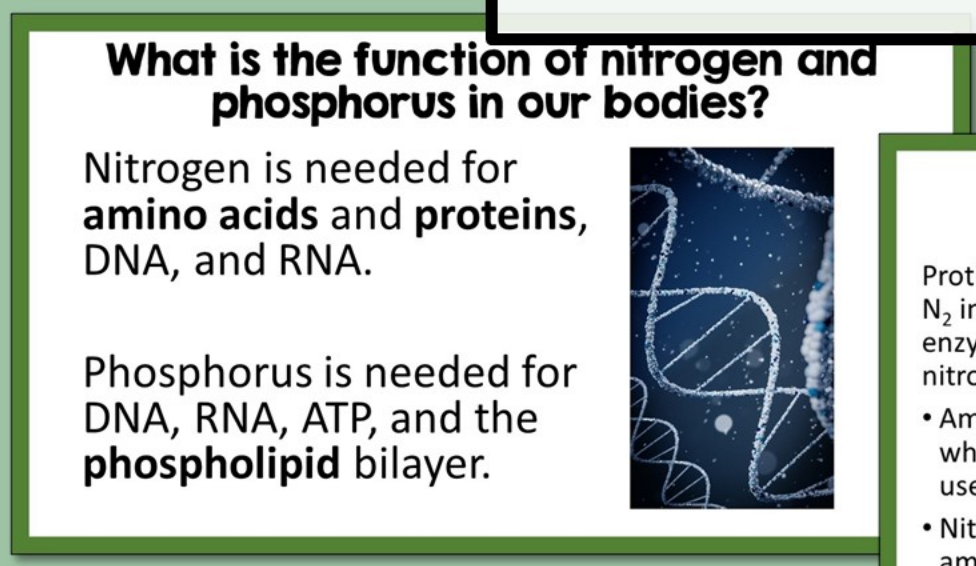
49 **editable**, fully-animated slides

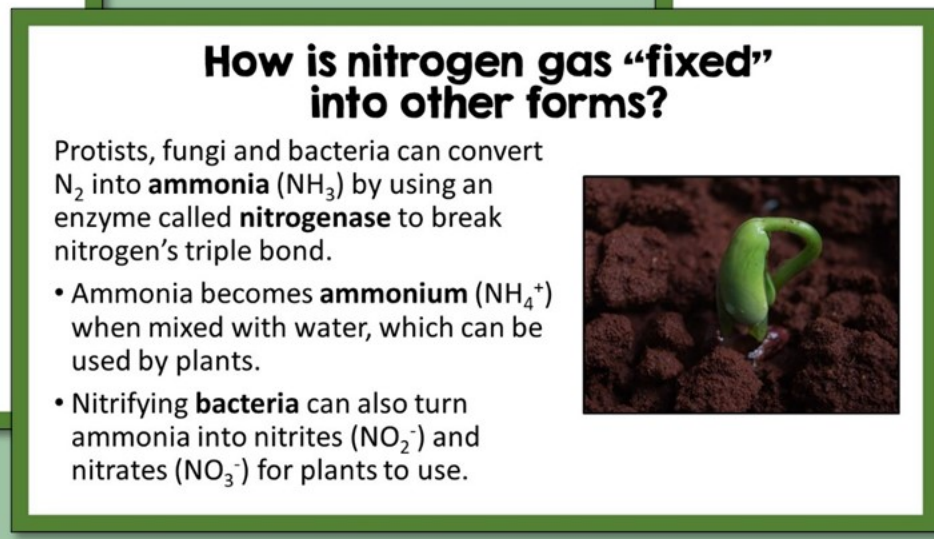


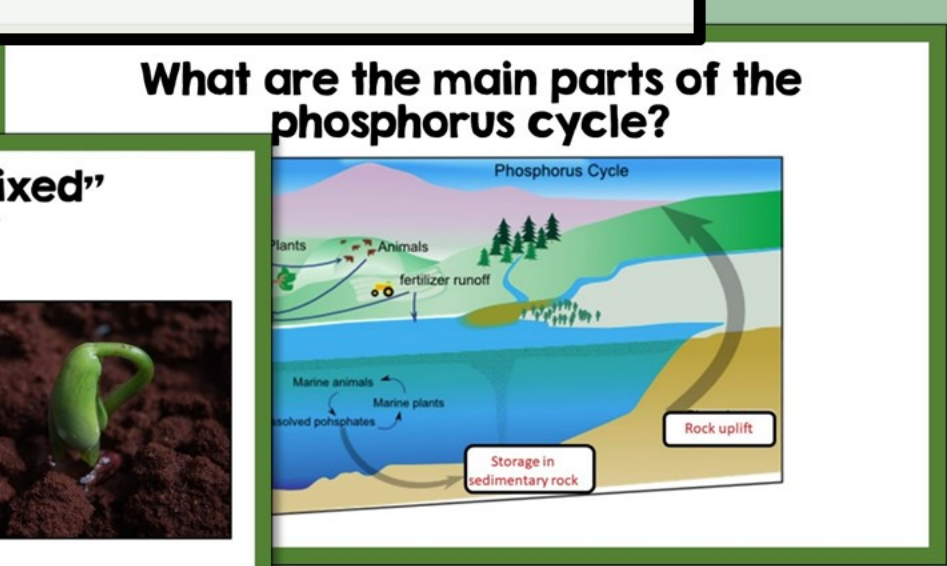




Sample Slides







6 pages of Cornell Notes

Big concept questions

Biogeochemical Cycles: Nitrogen

What is the function of nitrogen and phosphorus in our bodies?
Nitrogen is needed for amino acids and proteins, DNA, and RNA.
Phosphorus is needed for DNA, RNA, ATP, and the phospholipid bilayer.

Why is gaseous nitrogen in the atmosphere difficult to break down?
Gaseous nitrogen has a triple bond that makes it hard to break apart and use.

Sketch a N_2 molecule.

How is nitrogen gas "fixed" into other forms?
Protists, fungi, and bacteria can convert N_2 into ammonia (NH_3) by using an enzyme called nitrogenase to break nitrogen's triple bond.
- Ammonia becomes: ammonium (NH_4^+) when mixed with water, which can be used by plants.
- Nitrifying bacteria can also turn ammonia into nitrites (NO_2^-) and nitrates (NO_3^-) for plants to use.

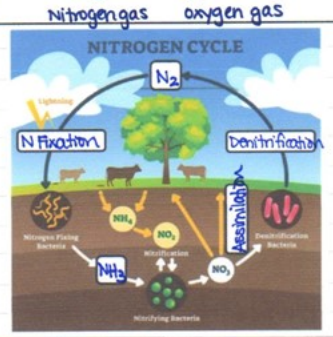
Nitrogen can also be converted into useful forms by lightning and man-made fertilizer products.

What is denitrification?
Denitrification is the process by which nitrate is converted back into nitrogen and oxygen. It is the opposite process from nitrogen fixation.

Write the equation for denitrification below & label each molecule with its chemical name.

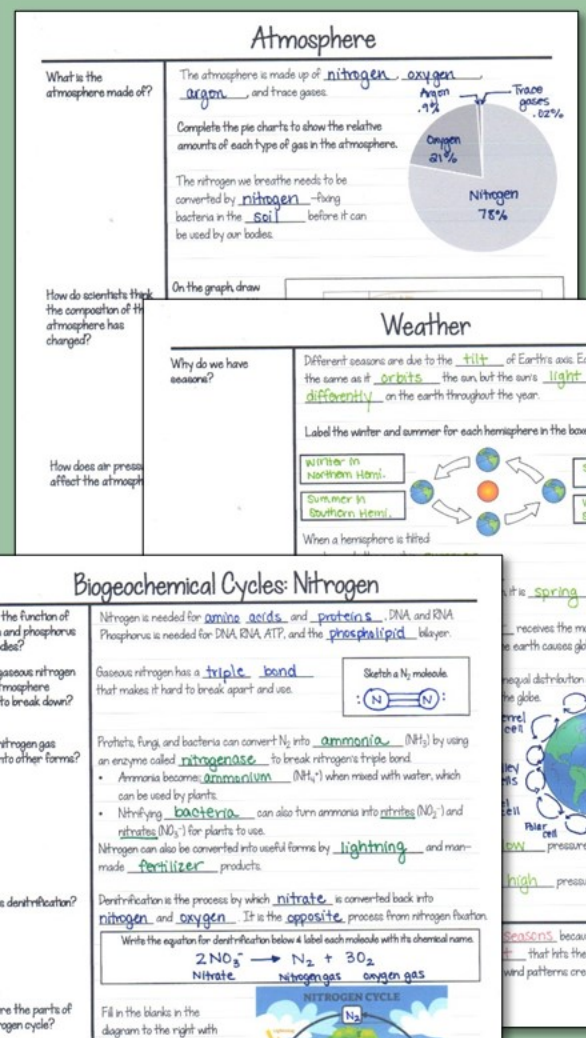
$2NO_3^- \rightarrow N_2 + 3O_2$
Nitrate — Nitrogen gas — oxygen gas

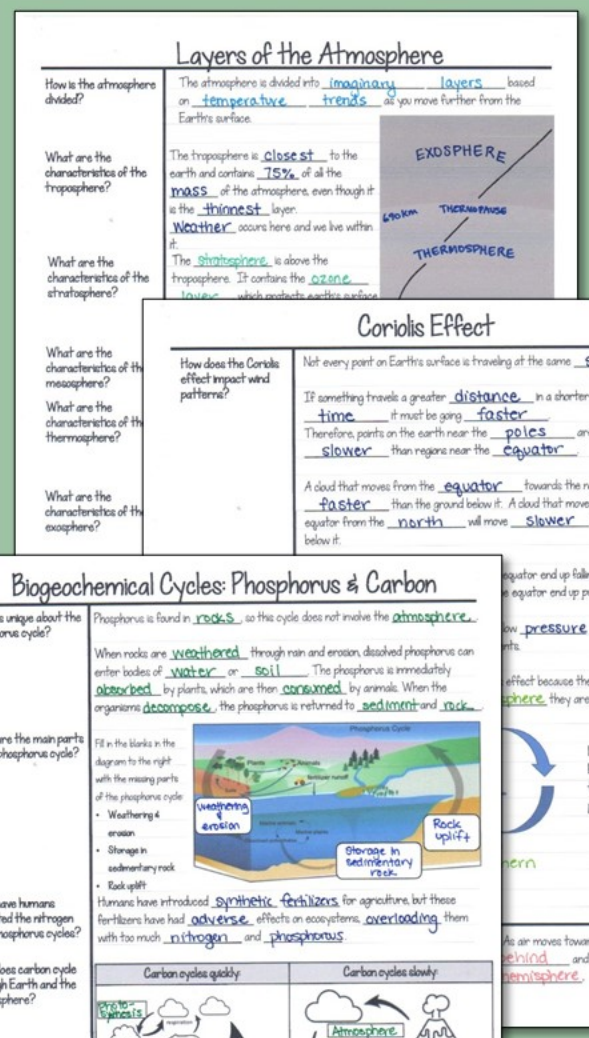
What are the parts of the nitrogen cycle?
Fill in the blanks in the diagram to the right with the missing parts of the nitrogen cycle:
- Denitrification
- NH_3
- Nitrogen fixation
- Assimilation/absorption
- N_2



Summary: Nitrogen is needed by the human body but is inaccessible in its natural form. Various organisms, natural occurrences, and man-made products can fix nitrogen into a form plants can use. Humans are then able to access this nitrogen as they ingest plants for food. Nitrogen continues to cycle through Earth and Earth's atmosphere in the Nitrogen cycle.

Content summary for each page

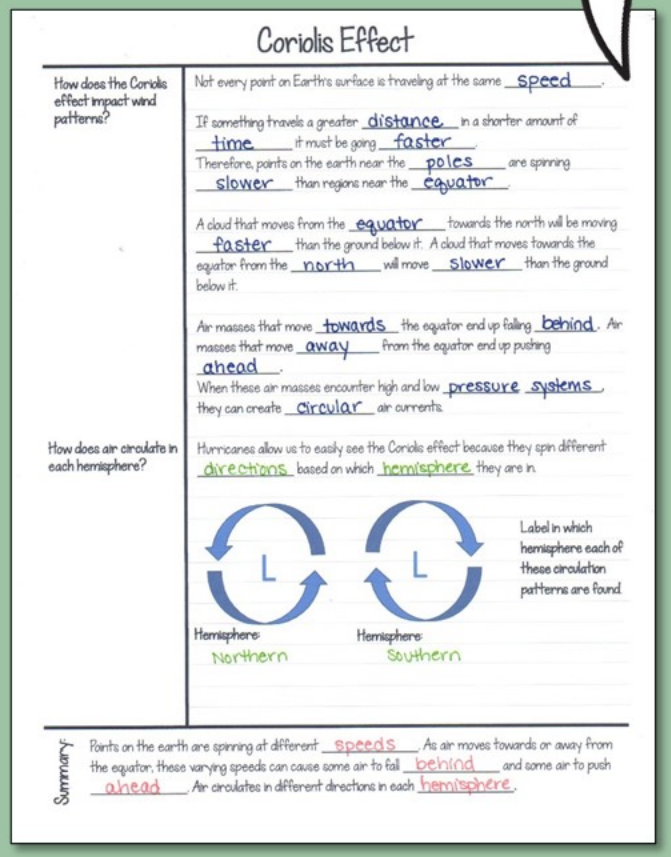




Each page is **editable**.
Add and delete text, questions, and summaries to meet the needs of your students.

Every student page also comes in a digital version on Google Slides

Virtual, hybrid, or absent students can stay right on track!



Coriolis Effect

How does the Coriolis effect impact wind patterns?

Not every point on Earth's surface is traveling at the same speed.

If something travels a greater distance in a shorter amount of time it must be going faster.

Therefore, points on the earth near the poles are spinning slower than regions near the equator.

A cloud that moves from the equator towards the north will be moving faster than the ground below it. A cloud that moves towards the equator from the north will move slower than the ground below it.

Air masses that move towards the equator end up falling behind. Air masses that move away from the equator end up pushing ahead.

When these air masses encounter high and low pressure systems, they can create circular air currents.

How does air circulate in each hemisphere?

Hurricanes allow us to easily see the Coriolis effect because they spin different directions based on which hemisphere they are in.

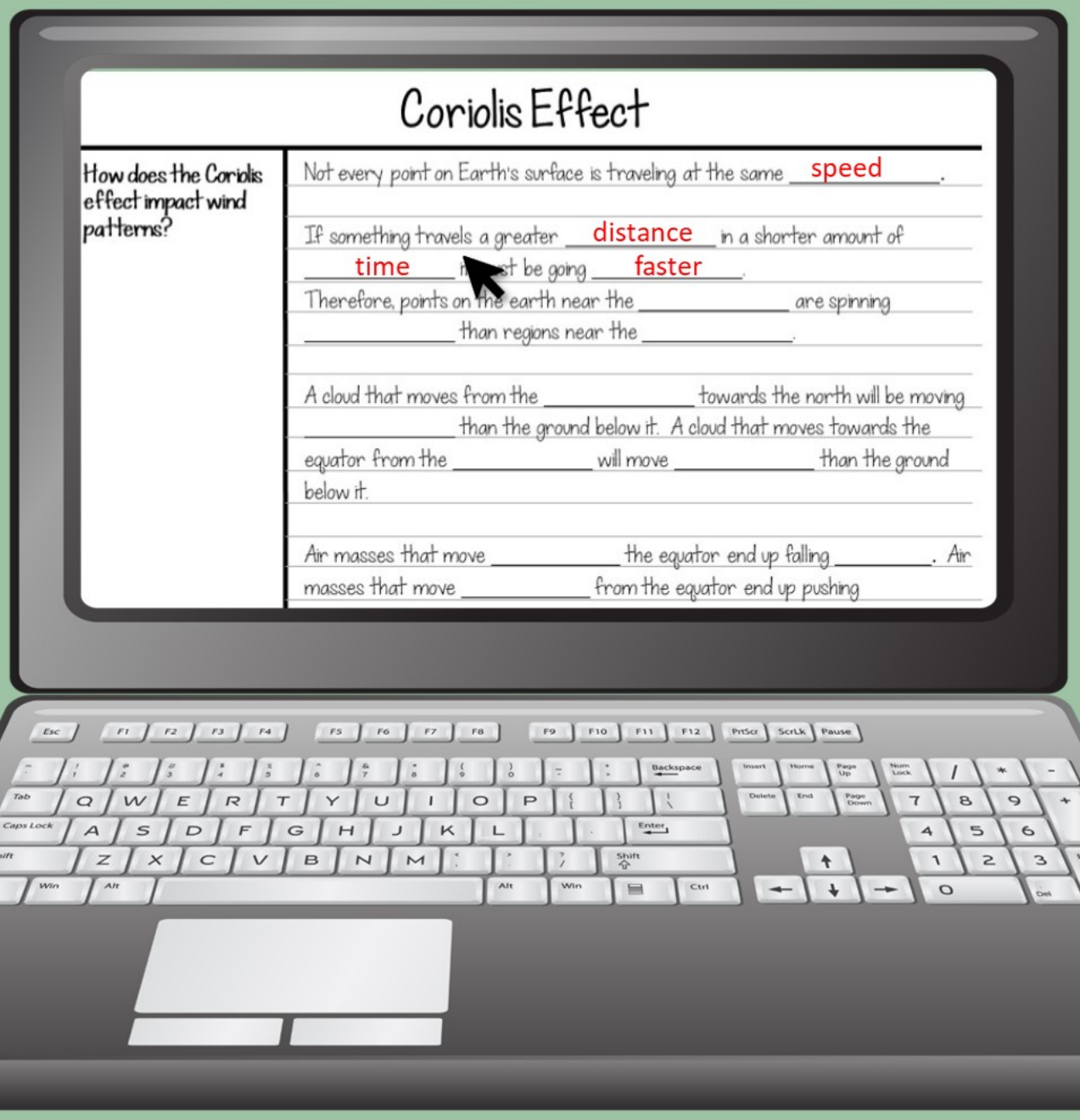
Hemisphere: Northern

Hemisphere: Southern

Label in which hemisphere each of these circulation patterns are found.

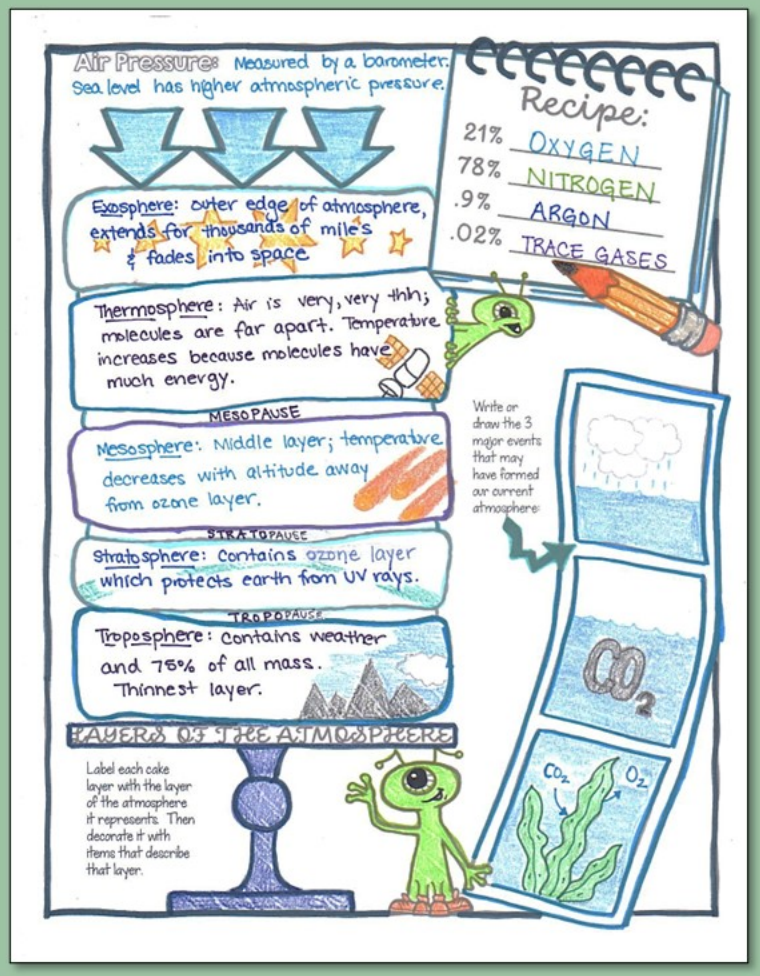
Summary

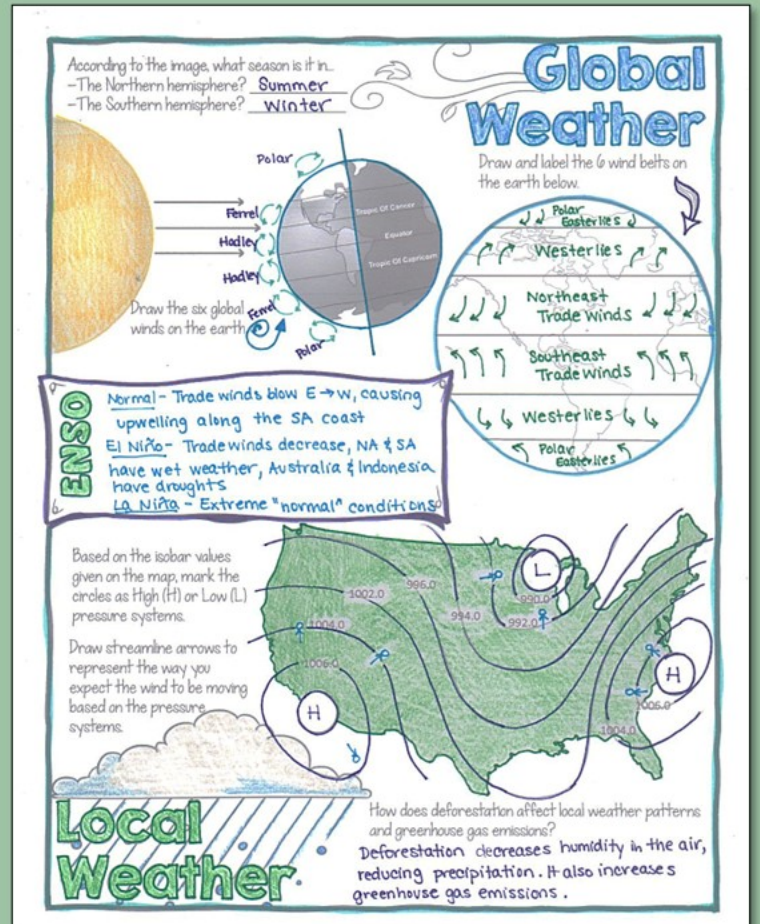
Points on the earth are spinning at different speeds. As air moves towards or away from the equator, these varying speeds can cause some air to fall behind and some air to push ahead. Air circulates in different directions in each hemisphere.

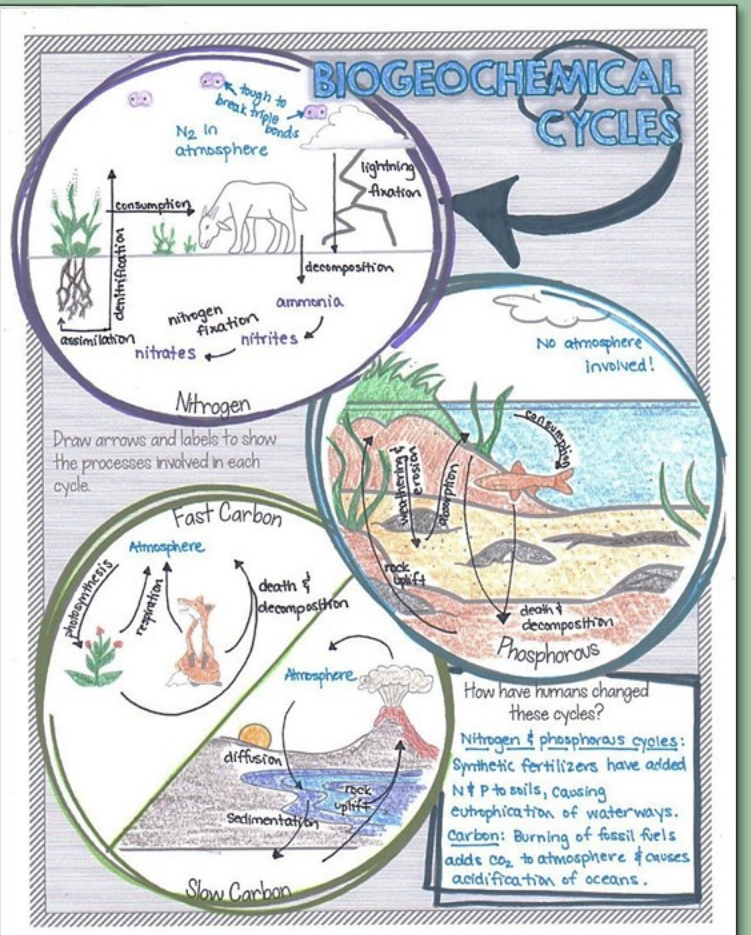


Can be used in Google Classroom, Microsoft OneDrive or many other platforms!

3 page of Doodle Notes for Summarizing & Review





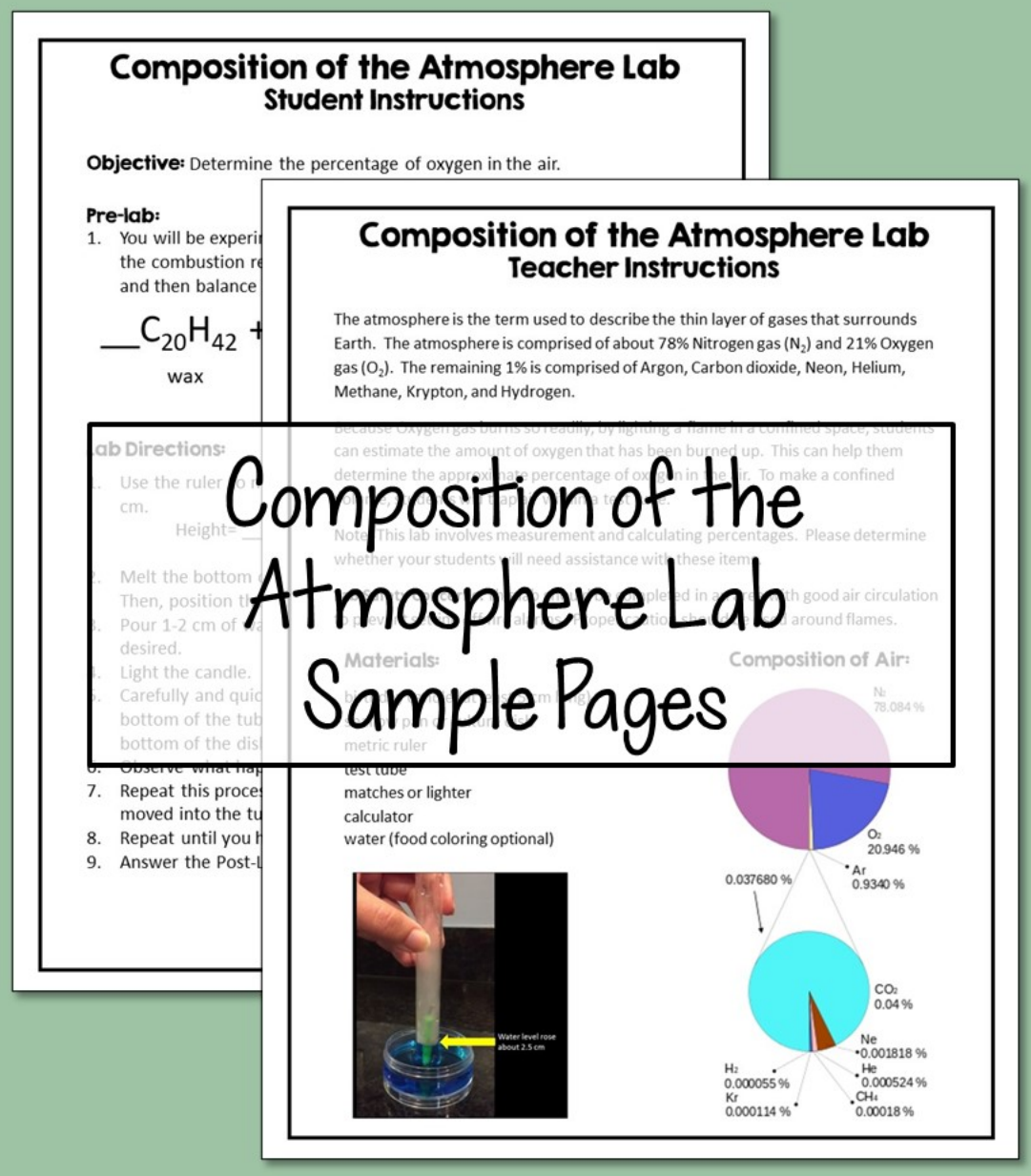


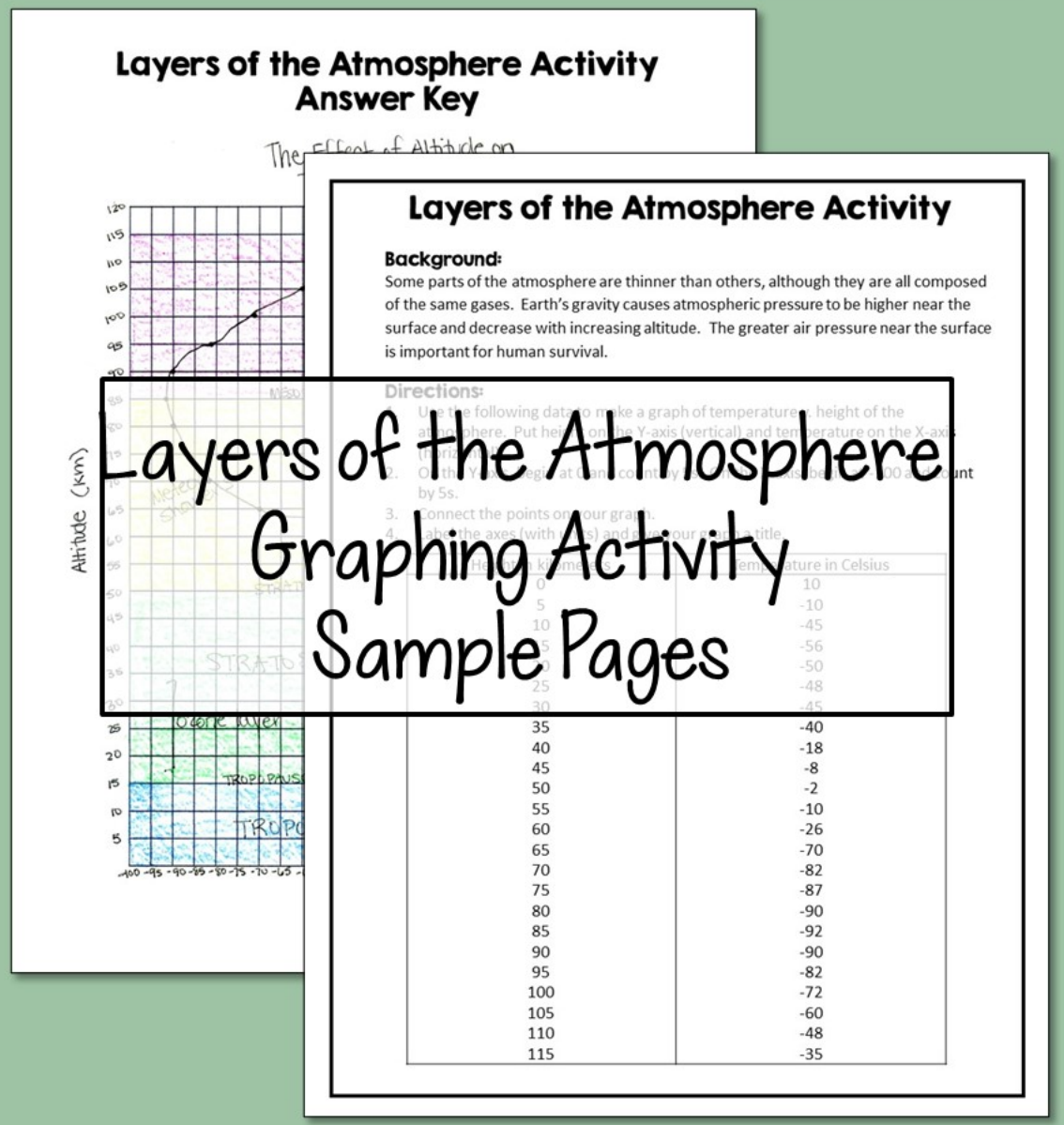
Doodle Notes™ increase student focus and memory- and they're great fun!

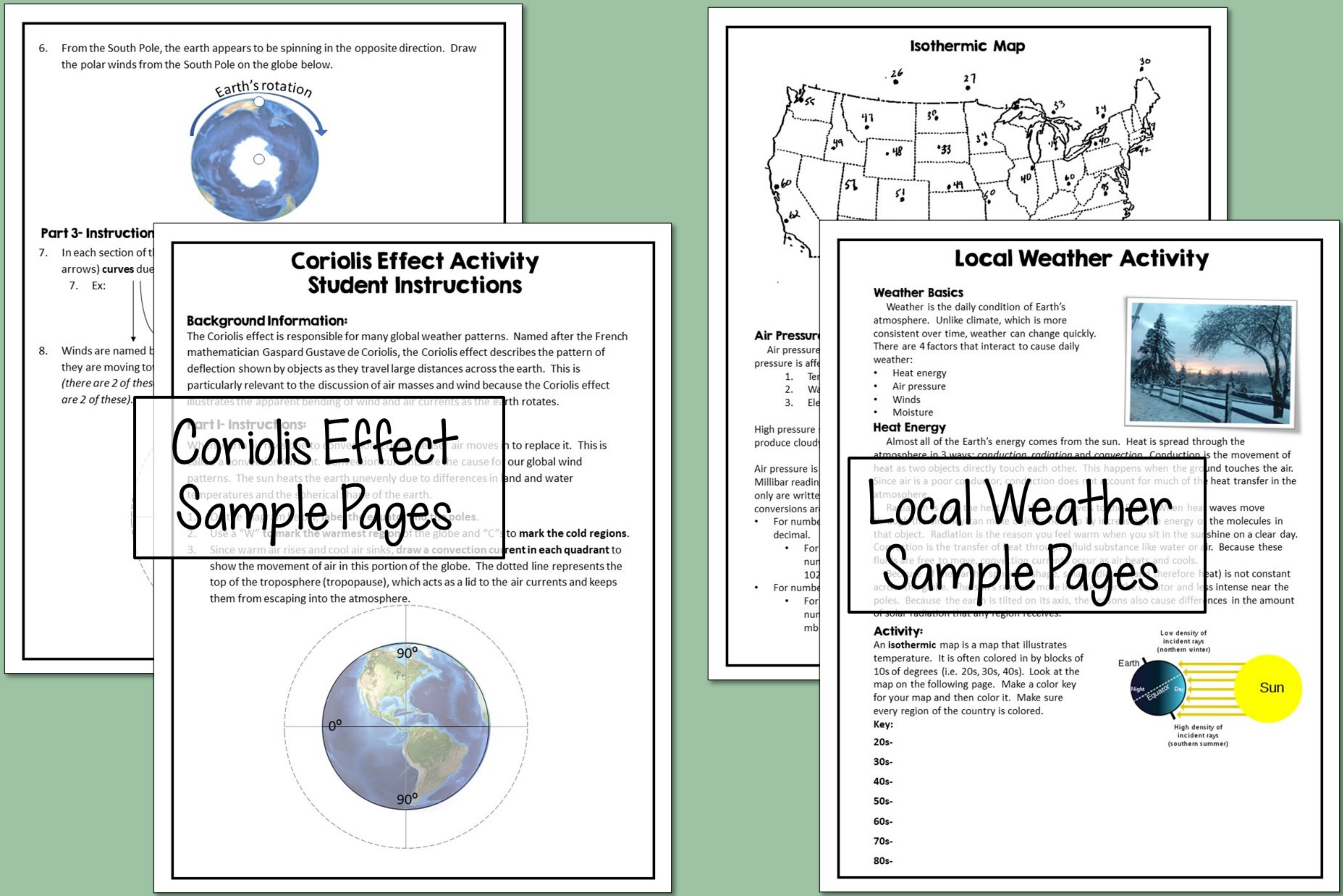
A guide for using them in your classroom is included.

Includes 7 Activities

- Composition of the Atmosphere Lab
- Layers of the Atmosphere Graphing Activity
- Coriolis Effect Activity
- Local Weather
- Meteorology Video Activity
- What's Your Weather?
- Nitrogen Cycle Board Game






Coriolis Effect
Sample Pages
Local Weather
Sample Pages
6. From the South Pole, the earth appears to be spinning in the opposite direction. Draw the polar winds from the South Pole on the globe below.
Earth's rotation
Part 3- Instruction
Coriolis Effect Activity
Student Instructions
Background Information:
The Coriolis effect is responsible for many global weather patterns. Named after the French mathematician Gaspard Gustave de Coriolis, the Coriolis effect describes the pattern of deflection shown by objects as they travel large distances across the earth. This is particularly relevant to the discussion of air masses and wind because the Coriolis effect illustrates the apparent bending of wind and air currents as the earth rotates.
3. Since warm air rises and cool air sinks, draw a convection current in each quadrant to show the movement of air in this portion of the globe. The dotted line represents the top of the troposphere (tropopause), which acts as a lid to the air currents and keeps them from escaping into the atmosphere.
90°
0°
90°
Isothermic Map
Air Pressure
Local Weather Activity
Weather Basics
Weather is the daily condition of Earth's atmosphere. Unlike climate, which is more consistent over time, weather can change quickly. There are 4 factors that interact to cause daily weather:
• Heat energy
• Air pressure
• Winds
• Moisture
Heat Energy
Almost all of the Earth's energy comes from the sun. Heat is spread through the atmosphere in 3 ways: conduction, radiation and convection.
Activity:
An isothermic map is a map that illustrates temperature. It is often colored in by blocks of 10s of degrees (i.e. 20s, 30s, 40s). Look at the map on the following page. Make a color key for your map and then color it. Make sure every region of the country is colored.
Key:
20s-
30s-
40s-
50s-
60s-
70s-
80s-
Low density of incident rays (northern winter)
Earth
Night
Equator
Day
Sun
High density of incident rays (southern summer)

Meteorology Activity Grading Rubric

	Below standard	Approaching Standard	Meets Standard
Explanation of Ideas & Information	• Does not present information and instructions clearly, concisely, or logically • Does not show understanding of	• Presents information and instructions in a way that is sometimes clear, concise, and	• Presents information and instructions clearly, concisely, and logically • Shows
Presentation Aids			
Peer Evaluation from Group Members			

Meteorology Activity Teacher Instructions

Teacher Background:

In this activity, students will use their knowledge of air pressure, heat, wind, and humidity to explain several national weather maps through a meteorology presentation.

Students will work in groups to give a weather report. Although only one group member will need to be on video, the other students should help to research, create a script, and find visual materials. Weather.gov has excellent forecast maps for various types of data. Students may also want to research information on weather fronts, as these are found on many local weather maps.

Peer evaluation is provided. Including peer evaluation in the assessment of the project will help group members to stay on task and contribute to the group.

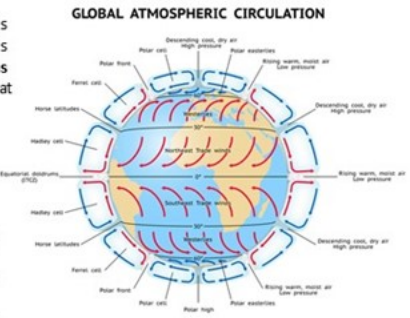
Students may use any presentation or video software to create their weather reports. You may even encourage students to dress professionally for the video. Let the students be creative!

Meteorology Video Activity Sample Pages

What's Your Weather?

Global Weather Patterns

Global temperatures vary with latitude due to the sun's unequal heating of the spherical surface of the earth. This unequal solar radiation creates **global circulation patterns** or cells. Warm, rising air creates areas of low pressure that allow clouds and precipitation to form. Areas of high pressure create dry regions with little precipitation and clear skies. Our local weather, however, is not only dependent on our latitude.



Regional Climate Influences

Although our seasons and global winds are dependent on latitude, there are other geographical features that affect weather patterns. **Elevation** above sea level has an important influence on continental temperatures. At higher elevations there are fewer air molecules to absorb the heat from Earth's surface. In addition, wind velocities are higher in high elevations because friction with the earth's surface is less prevalent.

In addition to elevation, a region's proximity to oceans can affect local weather patterns. Because water holds heat more effectively than land, coastal regions of continents have smaller fluctuations in seasonal air temperatures and more humid air. Terrestrial regions that are further inland experience greater seasonal temperature swings and often have drier air. Mountains can change the moisture levels in the air. As humid air masses meet large mountain ranges, they cool and drop their precipitation along the slope. The air mass becomes much drier on the other side of the range, creating a **rain-shadow effect**.

The last major influence on local weather is the amount of **vegetation** in the area. Some solar radiation is reflected when it reaches the earth's surface. This reflected radiation is known as **albedo**. Regions with little vegetation have a high albedo, while regions with lots of trees and plants absorb more sunlight, reducing albedo and keeping a more consistent temperature. This is easily noted in desert environments which are very hot during the day but quite cold at night because vegetation is not available to moderate the solar radiation. Vegetation can also increase humidity through transpiration and reduce wind speeds, since the presence of large trees can disrupt air flow.

Describe the weather in your local area. Explain your weather patterns based on factors such as latitude, global winds, air pressure, elevation, proximity to oceans, and vegetation.

What's Your Weather? Sample Page

Nitrogen Cycle Game
Game Instructions

Materials/ Set-up:
-Playing piece for each player (coin, plastic chip, etc.)
-Organize cards into piles based on the words on the back of the cards. (Atmosphere, Animals, etc.) Then shuffle each pile. The small print side of each card should be facing down.
-1 die is required for play.

Beginning Play:
-Best for 2-5 players.
-Each player needs a playing piece- coin, plastic marker, etc.
-All playing pieces begin on the word "Atmosphere".
-All players roll the die and player that rolls the highest number goes first.

Continuing play around the board:
The first player selects a card from the "Atmosphere" pile. The directions on the card will determine which path the player will be taking on the board.

The player should move toward that pool (word) by rolling the die and moving that many spaces toward the pool directed by the card. This completes the player's turn and the next player continues by selecting another "Atmosphere" card to determine their direction. Drawn cards should be returned to the bottom of the pile.

When a player reaches a new "nitrogen pool", a card from that pool will be selected to determine the next location.

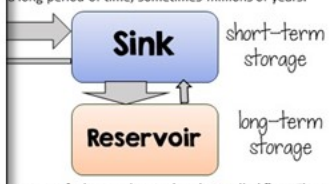
After each turn, players should record their route on the Game Play Tracker page. This allows players to see the processes they are demonstrating as they move through the cycle.

Ending the game:
The game ends when one player has returned to the atmosphere pool 2 more times.

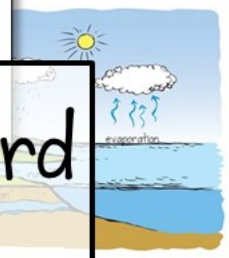
Cycle Game Background

like the life cycle of an element. In a biogeochemical
er often while taking on different forms and molecular

re stored are known as sources, sinks, and reservoirs.
molecule than it takes in. A **sink** is the opposite- it
y stores it for a short amount of time. A **reservoir** is a
a long period of time, sometimes millions of years.



ocations of a biogeochemical cycle is called **flux**. Flux
also be altered by human activity.



n in the water cycle that could be a source, nk, and reservoir (one location for each term).

cycle be altered- either naturally or by human activity?

The cards for game play
as they pass around the
each path.

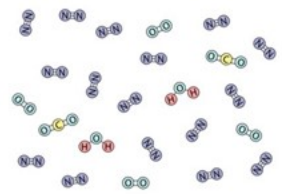
Students should follow the
page w playing the gam

Upon
the Co

For set-up:
The board can be printed in
1. At your local copy store
2. On your printer on any s
board significantly smaller.

Print the game play cards in double-sided formatting and choose "Flip pages on Short Edge". For more durable cards, print on cardstock or laminate.

After game:
Students should understand that living organisms need only small amounts of Nitrogen. Therefore, the majority of Nitrogen atoms are found in the atmosphere at any one time. The atmosphere is known as the largest reservoir for Nitrogen while the residence time for Nitrogen in living organisms is quite short.



Nitrogen Cycle Board Game
Sample Pages

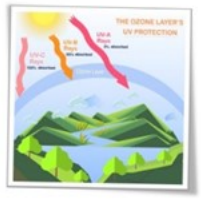
8 Extension Pages

Math skills check!
(great for standardized test prep)

Digging Deeper: The Ozone Layer

The Ozone Layer

Most atmospheric ozone (O_3) is concentrated in a layer near the bottom of the stratosphere. The **ozone layer** is responsible for absorbing ultraviolet radiation from the sun, primarily in the form of UVB. UVB has been linked to many harmful effects on human health including skin cancer and cataracts. Levels of ozone in the atmosphere fluctuate based on natural cycles of sunspots, seasons, and latitude. In the 1970s, however, the levels of ozone were beginning to slowly decrease.

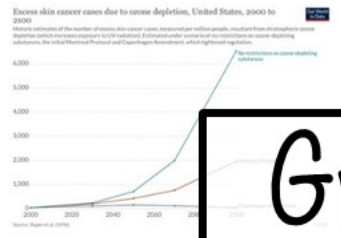


Ozone Depletion

In the 1970s, scientists began to be concerned about the effects of **ozone-depleting substances** (ODS) and their effects on the ozone layer. ODS like chlorofluorocarbons (CFCs), found in some refrigerants and aerosols, release chlorine or bromine when they are exposed to UV light. These molecules can then destroy ozone molecules. ODS were believed to be contributing to the depletion of ozone in the atmosphere.

The Montreal Protocol

The Montreal Protocol, finalized in 1987, is a global agreement to protect the ozone layer by phasing out the production of ODS. It received bipartisan support in the United States and is remarkable because it was the first treaty to achieve universal ratification by all countries in the world. Several amendments have also been ratified since 1987 providing even stricter regulations on ODS. Chlorofluorocarbons have mostly been replaced with hydrofluorocarbons (HFCs), which do not deplete the ozone layer because they are less reactive in the atmosphere. Thankfully, due to these changes, the ozone layer has gradually begun to recover.



Math Extension: Atmospheric Pressure

Conversion Factors:
10 mm = 1 cm
2.54 cm = 1 inch
29.92 inHg = 1 atmosphere
1 mile = 1.6 km

1. Convert 44 mmHg to inHg.

2. Convert 72 inHg into atmospheres.

3. Convert .83 atmospheres into two other units of pressure.

4. The stratosphere extends from 10 km above the ground to 50 km. How many miles thick is the stratosphere?

Data Analysis: Solar Insolation

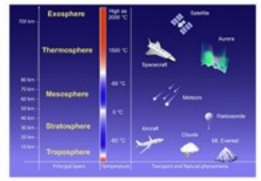
City	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Yearly Average	Range
1	5.26	5.53	5.86	5.97	5.68	5.04	4.62	4.54	4.74	5.13	4.83	4.97		
2	5.65	5.38	5.18	4.6	4.12	4.12	4.29	4.98	5.65	5.5	5.61	5.7		
3	2.01	3.09	4.15	5.12	5.15	4.98	5.53	5.11	4.39	3.35	2.41	1.76		
4	4.44	4.33	4.35	4.46	4.74	5.12	5.36	5.54	5.70	5.62	5.44	4.88		
5	6.35	6.26	5.38	4.19	3.08	2.57	3.03	3.63	4.64	5.45	5.85	6.26		

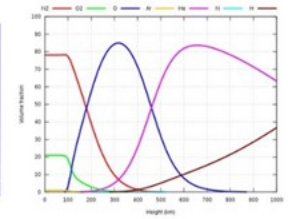
Solar insolation is a measurement of the average daily solar radiation for a certain area. Solar insolation is measured by average daily kilowatt hours received per square meter (kWh/M²). The chart above lists the solar insolation for several different cities for each month.

1. Calculate the yearly average for each location and write it in the "Yearly Average" column.
2. For each city, circle the month with the highest amount of solar insolation.
3. Calculate the range of solar insolation for each city. (Reminder: the range is calculated by subtracting the lowest and highest values.)
4. Use your answers to #2 and #3 to match the city's data to the correct location on the map below. Write the city number in each marker.

Data Analysis: Atmospheric Composition

Use the images to complete the questions below.





1. Which two elements are most common in the exosphere?

2. At which height are there equal amounts of free Oxygen and Helium?

3. You decide to measure the composition of atmospheric gases from a weather balloon. Would the compositions be different than those found on the surface of the earth? Explain.

4. Look at the table below. Explain the correlation between atomic (or molecular) mass and height as seen on the graph.

Element	Atomic Mass
Hydrogen	1.007 amu
Helium	4.0026 amu
Nitrogen	14.0067 amu
Oxygen	15.9994 amu
Argon	39.948 amu

Greater depth of knowledge, scientific literacy, & critical thinking

Digging Deeper: ENSO

Ocean Circulation

Because both involve convection currents, global wind patterns and ocean currents can act similarly and often work together to create climate conditions. Because the Pacific Ocean is the largest body of water in the world, movement of water and air is most apparent here. The climate pattern involving changes in the winds and water temperatures in the equatorial Pacific Ocean is known as **The El Niño-Southern Oscillation (ENSO)**. ENSO can cause climate cycles of three to seven years, in which the tropical Pacific Ocean can warm or cool by 1-3°, but the cause of the variations is still largely unknown.

Normal Conditions

Under normal or typical climate conditions, the trade winds blow from east to west along the equator. This pushes water in the Pacific Ocean from the coast of South America westward to Indonesia. In these typical conditions, the sea-level is actually about 1.5 feet higher in Indonesia than on the South American coast. As the surface water moves, colder deep water rises to take its place. This upwelling brings nutrients to the surface, leading to high productivity and good fishing along the South American coastline. The westward moving air also creates a high-pressure system in the eastern Pacific Ocean and a warm, wet, low-pressure system in the western Pacific Ocean. This air circulation pattern is called Walker circulation, named for Gilbert Walker who discovered it.

El Niño Conditions

In an El Niño pattern, the air pressure patterns weaken or reverse direction and the trade winds decrease in strength. Westerly winds can also increase. The result is a higher ocean surface temperature and a disrupted air circulation pattern. Precipitation tends to fall in the central and eastern Pacific Ocean rather than in the western Pacific Ocean. Countries like Australia and Indonesia have unusually hot and dry weather, while North and South America experience warmer, wetter climate conditions. The fishermen off the coast of South America noticed these unusually warm conditions in the winters of the 1600s and named the phenomenon El Niño for "Christ Child" in Spanish.

La Niña Conditions

La Niña is a cooler weather pattern caused by an unusually strong "normal" weather pattern. In these conditions, the trade winds are stronger than normal and create strong ocean upwellings off the coast of South America. These upwellings lead to lower-than-normal ocean temperatures in the eastern Pacific Ocean. The coasts of North and South America can be extremely dry during these conditions and Indonesia and Australia often receive more rain than usual, which can lead to flooding.

Digging Deeper: Deforestation

Deforestation in the Amazon

Deforestation is a global problem. Although some tropical rainforests are cleared for small farms, logging and infrastructure, the largest deforestation pressures are for large-scale agriculture and cattle ranches. The two NASA satellite photos above were taken in Brazil only 15 years apart. Increased immigration and industry in this area has led to the highest rate of deforestation in the Amazon.

Questions:

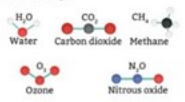
1. How would this large-scale deforestation affect the local weather in Brazil? Explain your answer in terms of temperature, wind, and precipitation.

2. A river is marked on the left-hand photograph. How do you think the water quality of that river has been affected by deforestation?

3. Provide 3 ways the deforestation of this region would affect the greenhouse gas emissions in the local area.

Digging Deeper: Greenhouse Gases

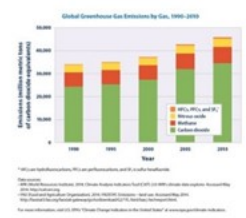
You have likely heard about the greenhouse effect in threatening terms. However, it is the greenhouse effect that allows life to thrive on Earth. The combination of gases in the atmosphere traps some of the heat that is trying to be held near to the earth instead of immediately escaping back into space. When light energy from the sun hits the atmosphere, some of it is reflected back into space. The light that does reach the earth is either absorbed by the earth's surface as heat or reflected. Although a little of the reflected heat escapes back into space, the greenhouse gases in our atmosphere prevent some of that heat from escaping. The result is a comfortable, consistent climate for life on earth. Without the greenhouse effect, Earth would have an average temperature of well below 0°C and its surface would be covered in ice. Too much of a good thing can be a problem, though.

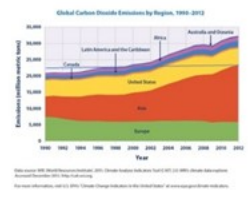


Global Warming

The concentration of greenhouse gases in our atmosphere has risen dramatically over the past several decades. Many greenhouses gases occur naturally in the atmosphere such as carbon dioxide (CO_2), methane (CH_4), water vapor (H_2O) and nitrous oxide (N_2O). Since the Industrial Revolution, however, the burning of fossil fuels and the increase of commercial agriculture have far exceeded the amount of carbon dioxide (CO_2) and methane (CH_4) that is naturally in the atmosphere. If this emission rate continues, the atmosphere may trap too much heat, leading to temperatures that affect life on Earth.

Higher average global temperatures could have many devastating impacts on Earth including changes in agricultural growing seasons, weather patterns, and ocean temperatures. As global ice melts, sea levels may rise several feet causing destruction of human infrastructure and natural ecosystems. In addition, warm water is unable to hold dissolved gases as well as colder water so the oceans will be less effective as a sink for CO_2 molecules. This will only exacerbate the atmospheric CO_2 problems and the heating cycle will continue. Hopefully, with continued regulations for CO_2 emissions and progress in renewable energy sources, our effect on the global atmosphere can be reduced.





Data Analysis: Carbon Residence Time

Carbon Pool	Quantity (Gigatons of Carbon or GtC)	Percentage of Global Carbon stores
Atmosphere	800	
Organic matter in soil	2,300	
Surface ocean	1,000	
Ocean sediments and sedimentary rocks	43,000	
Land plants	550	
Fossil fuels	10,000	

Questions:

1. Calculate the total amount of global Carbon and use that number to determine the percentage of global Carbon found in each pool.

2. Based on the estimated amounts of Carbon provided, which location is the largest reservoir for Carbon?

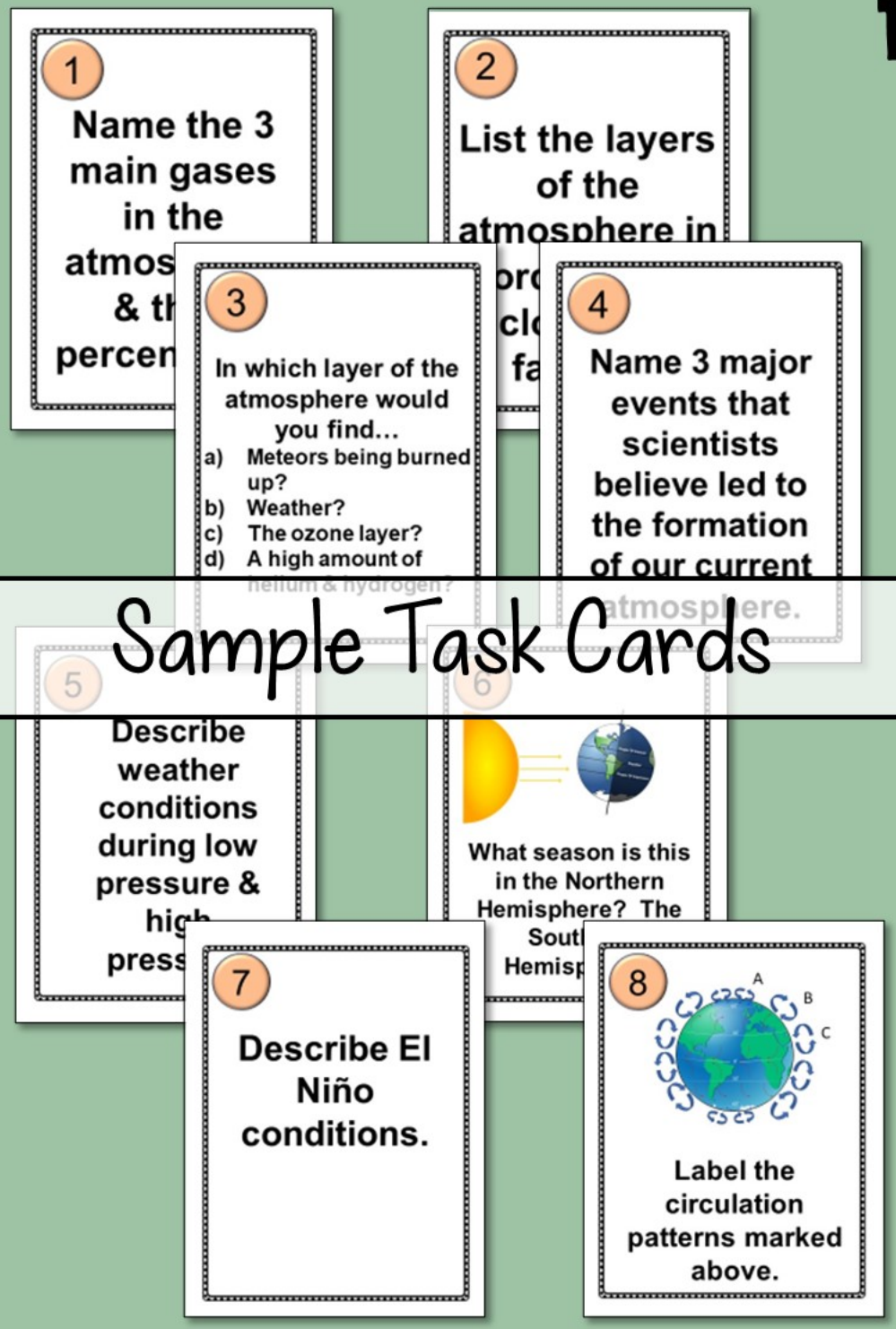
3. In which location does Carbon have the shortest residence time?

4. For the following question, use the equivalent quantities provided below.
   1 gigaton= 1 billion metric tons
   1 metric ton= 1000 kg

   How many kilograms (kg) of Carbon are found in land plants? Use dimensional analysis to solve.

24 Editable Task Cards for Review

Sample Task Cards



Teacher Tips

Using Editable Task Cards

How to set-up:

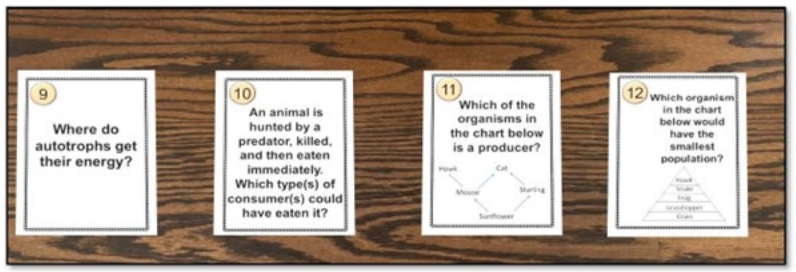
1. Print the cards on cardstock or paper.
2. Cut the pages so that each card is separate. If you'd like to use them in future years, it may be worth laminating them to protect them from student writing and other damage.
3. Place each task card at a seat around the room.
4. Students will rotate to each seat until all cards are finished. Answers are recorded on their "Task Card Answer Sheet" or notebook paper.

*TIP: It is important to set a timer for each station. Usually 1-2 minutes is appropriate. Without a timer, students will get backed up while rotating and chaos will ensue. ☺

Modifications:

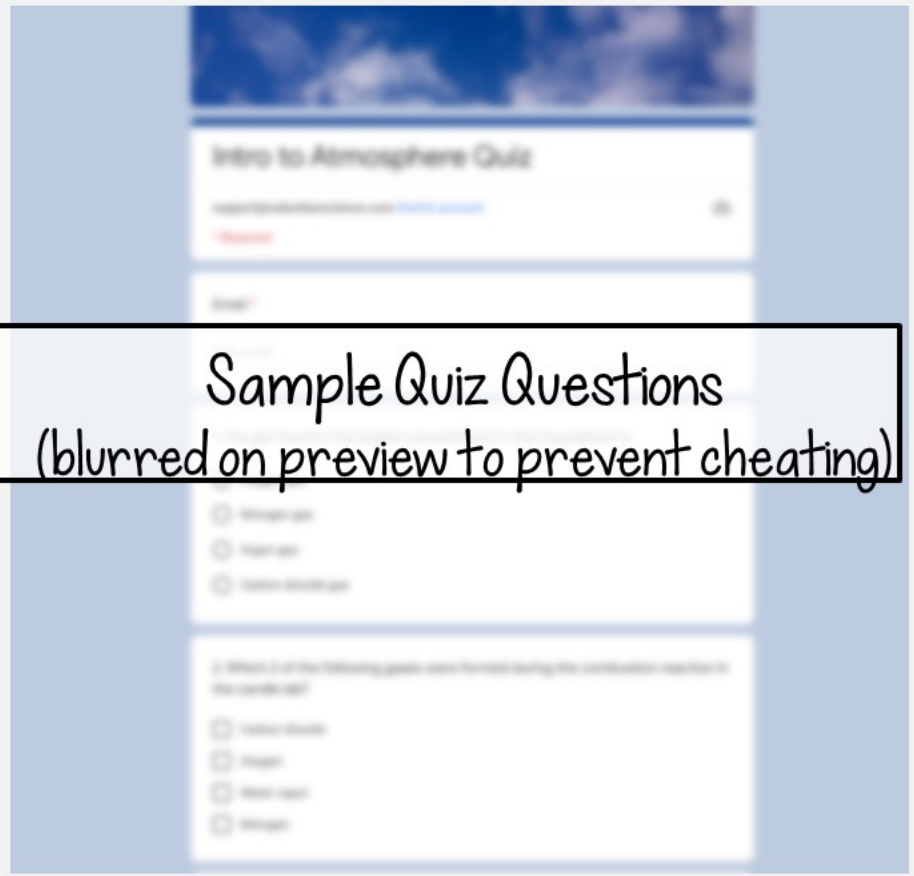
- These task cards are editable so you can change the text on any card.
- There are additional cards at the end of the document for adding questions. Be sure to add the correct number, as well!

- If moving around your room isn't possible, you can have students pass the cards in one direction.
- Other options:
  - Students can use notes or not depending on the level of memorization you expect prior to reviewing.
  - Students can work in pairs, which adds confidence.

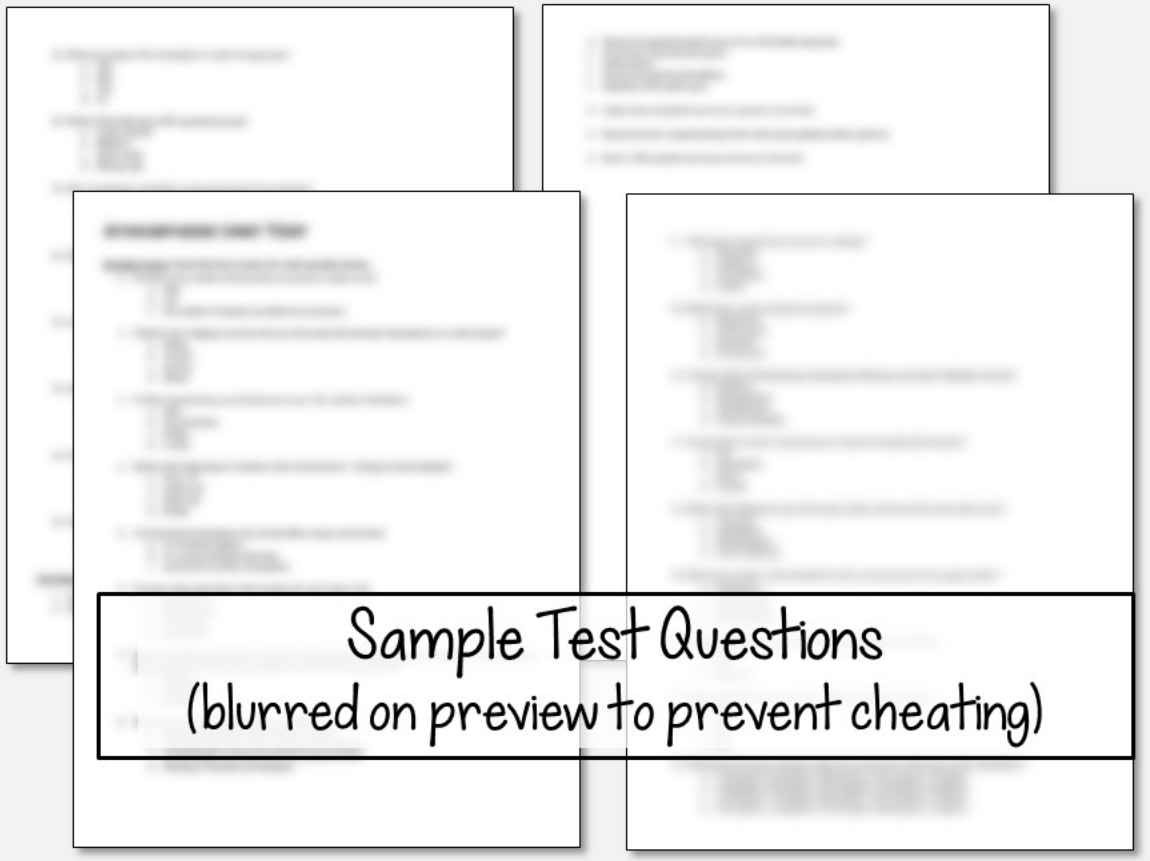


Assessment

Editable Online Quiz through Google Forms



- 8 multi-part questions
- Fully editable
- Answer key included for automatic grading



- 25 multiple-choice questions
- 6 free response questions
- Both Honors & Regular versions included with answer keys

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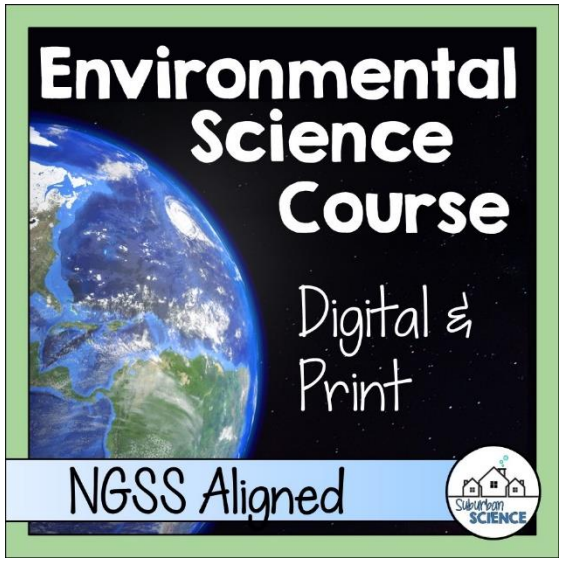

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Sincerely,
Anne from Suburban Science