

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.

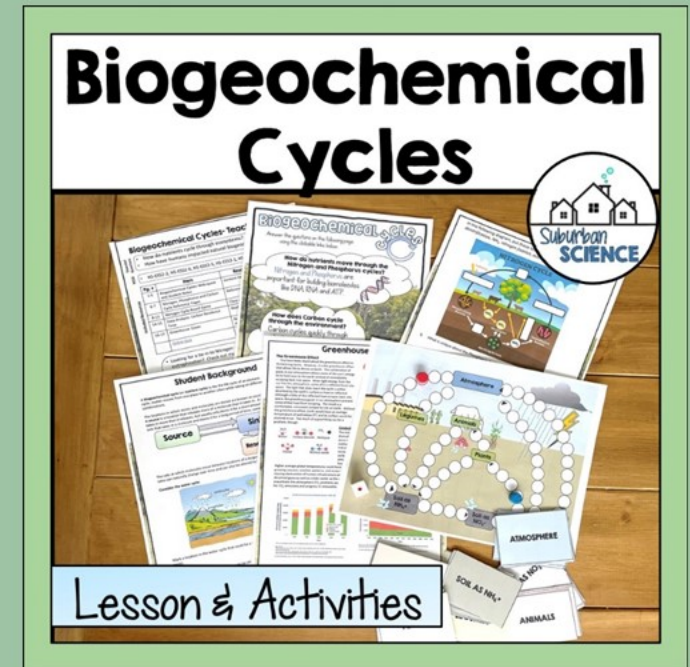
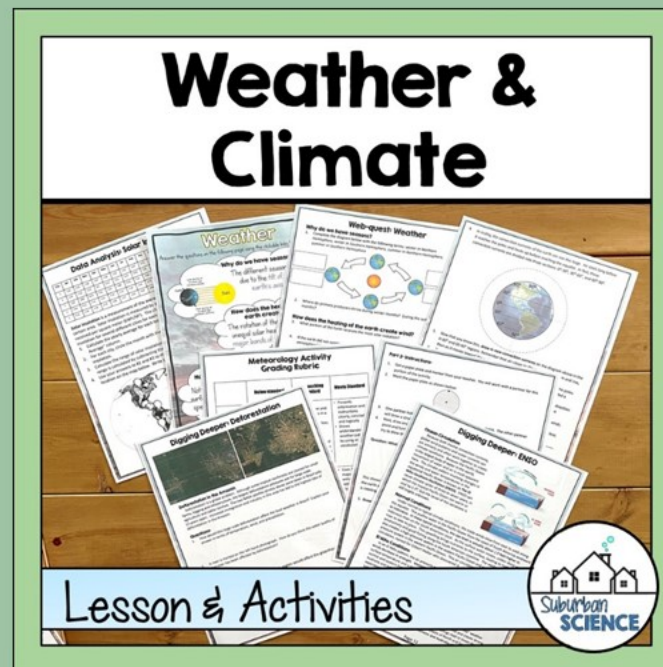
Extensions

- 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 Activity: [these](#), string, paper
- Nitrogen Cycle Game

What's Included? **Atmosphere Unit**

Included Resources by Folder:

Unit Planning

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- Unit Pacing Guide for 50 min classes
- Differentiation ideas for honors students and virtual students
- Honors assignment list

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- Answer Keys for all activities

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
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Student Pages

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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](#)

***Digital links for virtual learning found here**

Extensions

- Digging Deeper: The Ozone Layer
- Data Analysis: Atmospheric Composition
- Math Extension: Atmospheric Pressure*
- Data Analysis: Solar Insolation*
- Digging Deeper: Deforestation
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- Data Analysis: Carbon Residence Time*
- Digging Deeper: Greenhouse Gases
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*Honors Options

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		

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

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

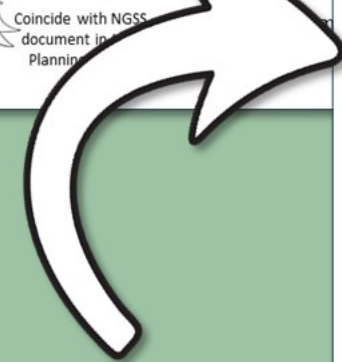
Unit Overview Page
plus
Supplementary Resource Ideas
and Materials Lists

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Editable Pacing Guides

50 min classes

	Day	Instruct	Assess	Homework
Weather	12	<ul style="list-style-type: none"> Show meteorology videos to rest of class. With remaining time, work on Digging Deeper: Deforestation 	<ul style="list-style-type: none"> Formal assessment of meteorology videos from grading rubric Informal assessment of understanding from answers to deforestation questions 	
Biogeochemical Cycles	13	<ul style="list-style-type: none"> Atmosphere PPT (Sections 5 & 6) Cornell Notes (Biogeochemical Cycles: Nitrogen and Biogeochemical Cycles: Phosphorus) <p>(Option 2: Use Biogeochemical Cycles PPT & Cornell Notes. Find web-quest links in "Differentiation Guide" within the "Unit Planning Notes" folder.)</p>	<ul style="list-style-type: none"> Informal questioning during PPT Cornell notes summary 	Teacher Prep: Print & cut 1 set of cards
	14	<ul style="list-style-type: none"> Read, answer, and discuss Game Student Background Groups play Nitrogen Cycle Game Instructions per student. 		
	15	<ul style="list-style-type: none"> Finish Nitrogen Cycle Read, answer, and discuss Greenhouse Gases. 		
Review	16	Use Doodle notes to review the unit		
	17	Use Task Cards to review. Copy Task Card Answer Key		
Assess	18	Take Atmosphere Test		



50 min classes

	Day	Instruct	Assess	Homework
Weather	5	<ul style="list-style-type: none"> Atmosphere PPT (Sections 3 & 4) Cornell Notes (Weather and Coriolis Effect) <p>(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.)</p>	<ul style="list-style-type: none"> Informal questioning during PPT Cornell notes summary 	
	6	<ul style="list-style-type: none"> Students complete Coriolis Effect Activity in pairs or groups. <p>Materials: Paper plates, markers, pencils</p>	<ul style="list-style-type: none"> Formal or informal assessment of student understanding and participation by checking/grading answers on Coriolis Effect Activity. 	
	7	<ul style="list-style-type: none"> Read pg 1 of Digging Deeper a class ENSO demonstration https://www.youtube.com/watch?v=... Complete Digging Deeper activity Quick Check: ENSO 		
	9	<ul style="list-style-type: none"> Honors: Check homework Intro: What's Your Weather? Students complete Local Weather individually or in pairs <p>Materials: colored pencils, small thermometers with holes in the rubber bands</p>		
	10	Begin Meteorology Activity weather, creating script		
	11	Continue working on Meteorology finishing research and		

Coincide with NGSS document in Unit Planning Folder

***Bold items must be photocopied.**

50 min classes

Atmosphere Pacing Guide

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	Day	Instruct	Assess	Homework
Intro to Atmosphere	1	<ul style="list-style-type: none"> Complete Composition of the Atmosphere Lab. Each student (or group) will need one Student Instructions Page and one Results Page <p>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)</p>	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> Atmosphere PPT (Section 1) Cornell Notes during PPT (Composition of the Atmosphere) <p>(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.)</p> <ul style="list-style-type: none"> Begin Layers of the Atmosphere Activity. (Note: If students remember this material well from Earth Science, you can skip this activity and Day 3.) 	<ul style="list-style-type: none"> Informal questioning during PPT Cornell notes summary 	
	3	<ul style="list-style-type: none"> Finish Layers of the Atmosphere Activity from yesterday. Atmosphere PPT (Section 2) Cornell Notes during PPT (Layers of the Atmosphere) 	<ul style="list-style-type: none"> 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	<ul style="list-style-type: none"> 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 	<ul style="list-style-type: none"> 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)

Differentiation

Teaching Environment

- Virtual or Hybrid students
- Digital Options:
 - Links for PowerPoints
 - Web-quests
 - Digital Student pages using Google Slides™

All found on the following page.

Atmosphere Lab- This lab is hard to recreate at home, but you can use this [video demonstration](#) to answer questions, although you may need to run multiple trials. Students can use a family member or friend as a partner. Other sections can be completed independently. Students should be able to complete all portions of this lab.

Honors Assignment List

Although there are no official education standards for what makes an "honors" class, honors assignments generally provide one of three options:

- Greater depth of knowledge
- Additional critical thinking
- More independent work

In this unit, you can find some additional assignments that provide knowledge for honors students. These can also be helpful for extra credit, homework, or enrichment. Because answers to these assignments are due at the end of the unit, grading for completion and then discussing.

Assignment	Type of work
Atmospheric Processes	Math Extension

Digital Differentiation:

Web-quests (with answer keys):

- [Intro to Atmosphere Web-quest](#)
- [Weather Web-quest](#)
- [Biogeochemical Cycles Web-quest](#)

Other:

- [Atmosphere PowerPoint](#)
- [Print Pages for whole unit](#)
- [Intro to Atmosphere Online Quiz](#)

Use these files for Google Classroom:

Important: Please do NOT provide these links directly to students, as it can affect the files. Make a copy of the files to your drive, then assign from your drive to students. Thank you!

Differentiation

Student Ability

- Advanced students
 - Honors options are included in the student pages. These can be given to a whole advanced class or individual students, as needed.
 - Editable Cornell notes (four pages)
 - Delete the fill-in-the-blank for a more independent assignment.
 - Delete the summary.
 - Tests:
 - Use the "Honors" tests.
- Struggling students
 - Eliminating homework allows for independent thinking or help from a teacher or parent. Make sure to accommodate assignments in class.
 - Use multiple methods of note-taking
 - Web-quest followed by a summary at the end of the topic and the same material provided.
 - Editable Cornell notes (four pages)
 - Use the fill-in-the-blank on material and less on words that go in the blank.
 - Using the fill-in-the-blank words that go in the blank.
 - Tests:
 - Use the "Regular" tests.
- For any ability
 - Both the PowerPoints and the student pages on topics or vocabulary words.

Differentiation

Differentiation is a key component to any unit. Here are some tips for differentiating based on student interest, ability and teaching environment.

Student Interest/Choice

- Three options for content delivery are included in this unit:
 - Web-quest:** Students can explore content through links and answer provided questions on a worksheet. This is ideal for independent learners or sub plans. Find these web-quests on the last page of this document.
 - Cornell Notes:** Teacher lectures with included PowerPoint and students record information in guided Cornell notes. An editable version of the Cornell notes is provided so teachers can adjust the content.
 - Doodle Notes™:** Teacher lectures with included PowerPoint and students record information on Doodle Notes™ pages.

Student-led

Teacher-led

Web-quest with Student Worksheet

Cornell Notes or Doodle Notes with PowerPoint

Use the files above. Drive. assign. Classroom and add this file. Make a copy for each.

Content Delivery Option I: Student Webquest

Live video
links for
independent
learning on
any device!



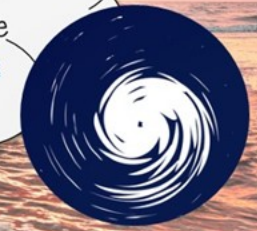
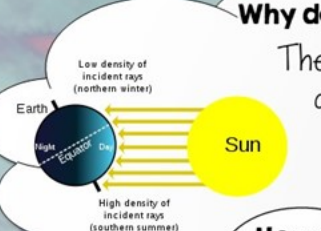
Weather

Answer the questions on the following page using the clickable links below.

Why do we have seasons?
The different seasons are due to the tilt of the earth's axis.

How does the heating of the earth create wind?
The rotation of the earth and the unequal solar heat create three major bands of wind around the globe.

How does the Coriolis Effect affect wind patterns?
Not every point on the earth's surface is traveling at the same speed. This causes the Coriolis Effect.



How does the heating of the earth create wind?

6. Explain how the areas of rising and falling air lead to the creation of Earth's rainforests and deserts.

Web-quest: Weather

Why do we have seasons?

1. Complete the diagram below with the following terms: *winter in Northern Hemisphere, winter in Southern Hemisphere, summer in Northern Hemisphere, summer in Southern Hemisphere*

How does the heating of the earth create wind?

7. If so

8. Point the

9. A cl

10. Mov

11. J

12. Dr

13. In w

How does the heating of the earth create wind?

3. What portion of the Earth receives the most solar radiation?
4. If the earth did not rotate and had no oceans, how would the air circulate in the atmosphere? (Draw a picture if you'd like.)
5. On the following diagram, draw in the location and circulation patterns of the following terms: *Hadley cells, Ferrel cells, Polar cells*



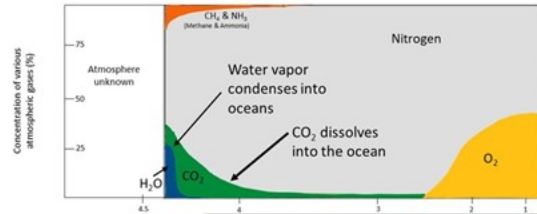
Corresponding Comprehension Questions

Content Delivery Option 2: PowerPoint Presentation

49 editable, fully-animated slides

How do scientists think the composition of the atmosphere has changed?

First billion years: There was intense volcanic activity producing mostly CO_2 . As the planet cooled, water vapor condensed and formed the oceans, allowing CO_2 to dissolve.



What are the characteristics of the troposphere?

- The troposphere is **closest** to the earth and contains **75%** of all the **mass** of the atmosphere, even though it is the **thinnest** layer.
- **Weather** occurs here and we live within it.
- It is **thickest** at the equator and **thinnest** at the poles, with an average thickness of about 10 km.

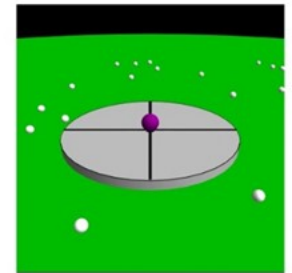


How does the Coriolis effect impact wind patterns?

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

Points on the earth are spinning at different rates. Points closer to the equator travel a greater distance in a shorter amount of time, going faster.

Points further from the equator travel a shorter distance in the same amount of time, going slower.



Sample Slides

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.



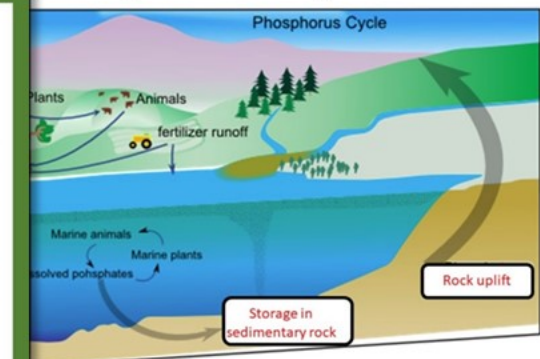
How is nitrogen gas “fixed” into other forms?

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.



What are the main parts of the phosphorus cycle?



Big

concept
questions

6 pages of Cornell Notes

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 N₂ molecule.



How is nitrogen gas "fixed" into other forms?

Protists, fungi, and bacteria can convert N₂ into ammonia (NH₃) by using an enzyme called nitrigenase to break nitrogen's triple bond.

- Ammonia becomes ammonium (NH₄⁺) when mixed with water, which can be used by plants.
- Nitrifying bacteria can also turn ammonia into nitrites (NO₂⁻) and nitrates (NO₃⁻) 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.

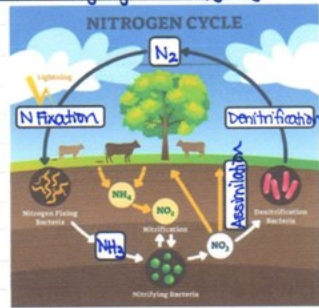
Write the equation for denitrification below & label each molecule with its chemical name.



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
- NH₃
- Nitrogen fixation
- Assimilation/absorption
- N₂



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.

Atmosphere

What is the atmosphere made of?

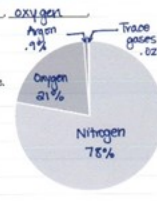
The atmosphere is made up of nitrogen, oxygen, argon, and trace gases.

Complete the pie charts to show the relative amounts of each type of gas in the atmosphere.

The nitrogen we breathe needs to be converted by nitrigen-fixing bacteria in the soil before it can be used by our bodies.

How do scientists think the composition of the atmosphere has changed?

On the graph, draw



Weather

Why do we have seasons?

Different seasons are due to the tilt of Earth's axis. Earth's tilt remains the same as it orbits the sun, but the sun's light shines differently on the earth throughout the year.

Label the winter and summer for each hemisphere in the boxes below.



How does air pressure affect the atmosphere?

Biogeochemical Cycles: Nitrogen

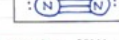
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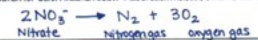
- Ammonia becomes ammonium (NH₄⁺) when mixed with water, which can be used by plants.
- Nitrifying bacteria can also turn ammonia into nitrites (NO₂⁻) and nitrates (NO₃⁻) for plants to use.

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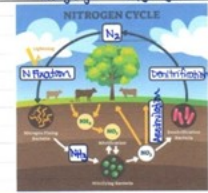
Denitrification is the process by which nitrate is converted back into nitrogen and oxygen. It is the opposite process from nitrogen fixation.

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



What are the parts of the nitrogen cycle?

- Denitrification
- NH₃
- Nitrogen fixation
- Assimilation/absorption
- N₂



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.

Layers of the Atmosphere

How is the atmosphere divided?

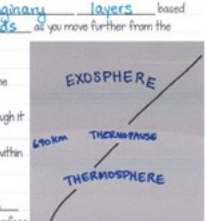
The atmosphere is divided into imaginary layers based on temperature trends as you move further from the Earth's surface.

What are the characteristics of the troposphere?

The troposphere is closest to the earth and contains 75% of all the mass of the atmosphere, even though it is the thinnest layer. Weather occurs here and we live within it.

What are the characteristics of the stratosphere?

The stratosphere is above the troposphere. It contains the ozone layer, which protects earth's surface.



What are the characteristics of the mesosphere?

How does the Coriolis effect impact wind patterns?

Not every part 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, parts on the earth near the poles are spinning slower than regions near the equator.

What are the characteristics of the exosphere?

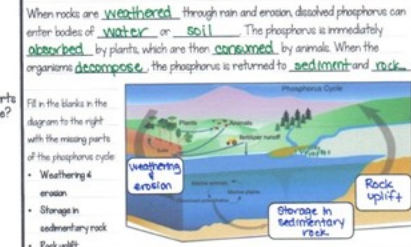
A cloud that moves from the equator towards the north will be moving faster than the ground below it. A cloud that moves towards the equator from the north will move slower than the ground below it.

Biogeochemical Cycles: Phosphorus & Carbon

What is unique about the phosphorus cycle?

Phosphorus is found in rocks, so this cycle does not involve the atmosphere.

What are the main parts of the phosphorus cycle?



How have humans affected the nitrogen and phosphorus cycles?

Humans have introduced synthetic fertilizers for agriculture, but these fertilizers have had adverse effects on ecosystems, overloading them with too much nitrogen and phosphorus.

How does carbon cycle through Earth and the atmosphere?



How have humans altered the carbon cycle?

Humans have accelerated the addition of carbon dioxide to the atmosphere through the burning of fossil fuels. Carbon dissolved in the ocean causes the ocean to be more acidic, threatening ocean life.

Summary

Phosphorus does not cycle through the atmosphere, but weathering causes it to enter water or soil. It is then consumed by animals that return it to the ground when they decompose. The carbon cycle happens both quickly and slowly as carbon travels through the earth and Earth's atmosphere. Humans have negatively impacted both of these cycles, threatening ecosystems.



Each page is **editable**.

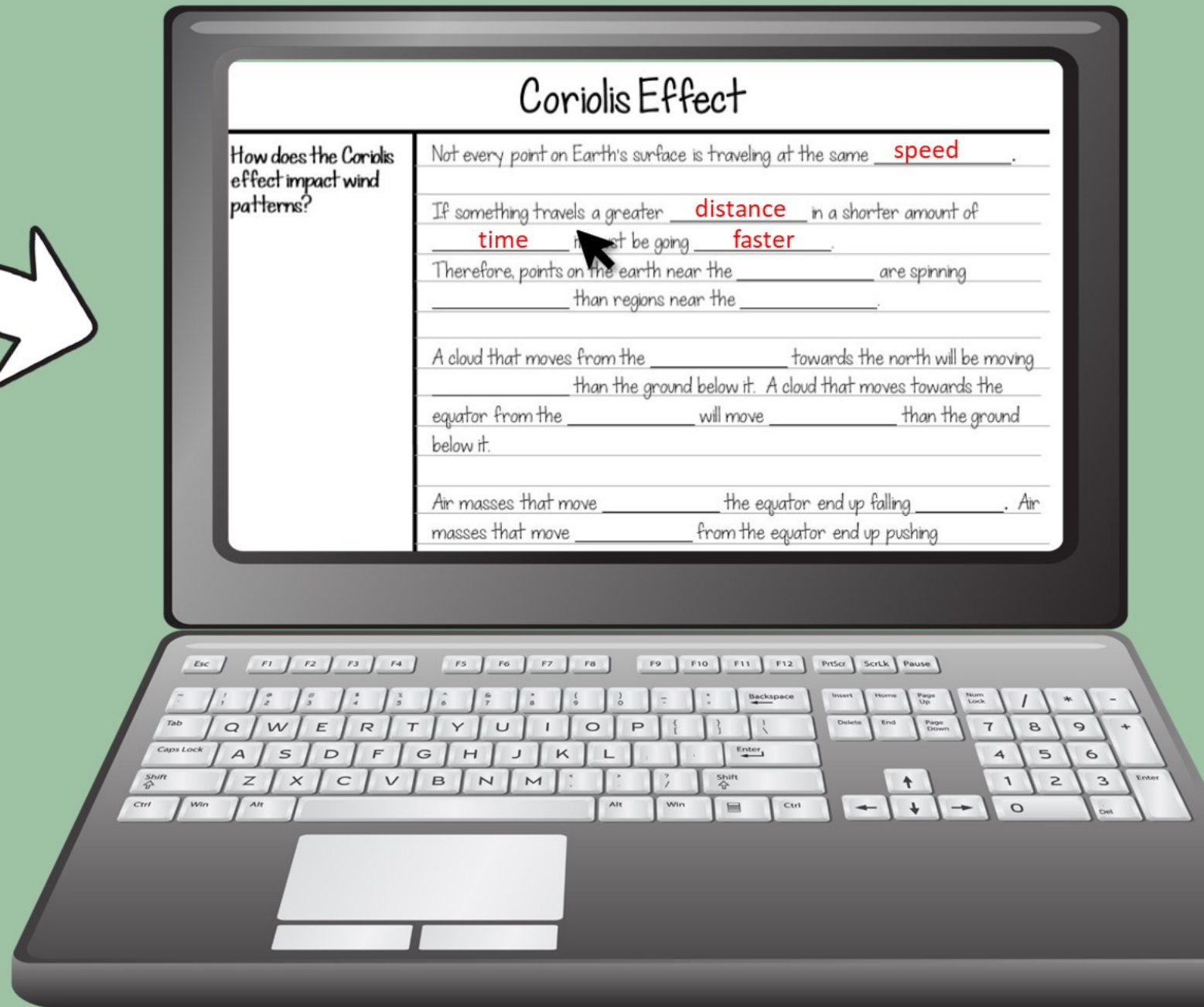
Add and delete text, questions, and summaries to meet the needs of your students.

Content
summary for
each page

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

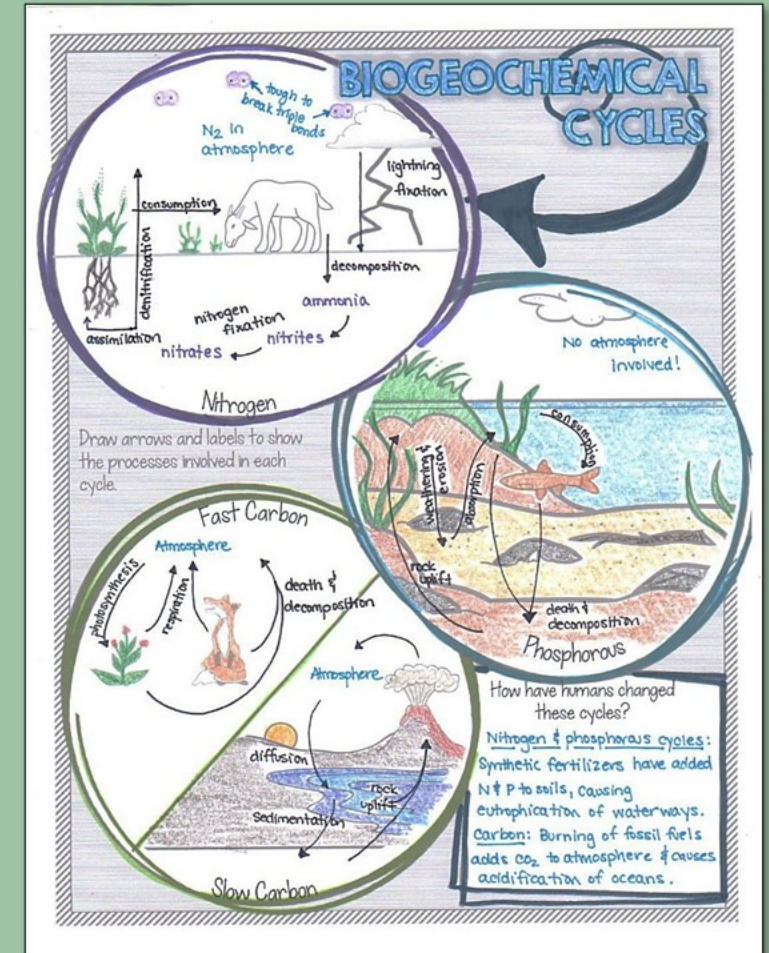
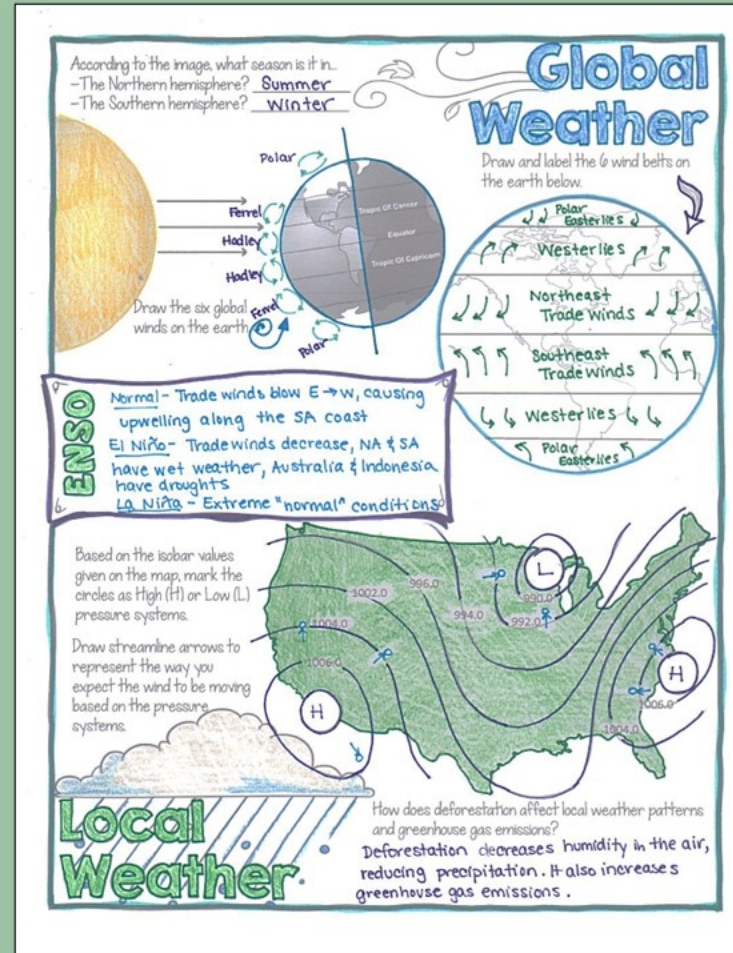
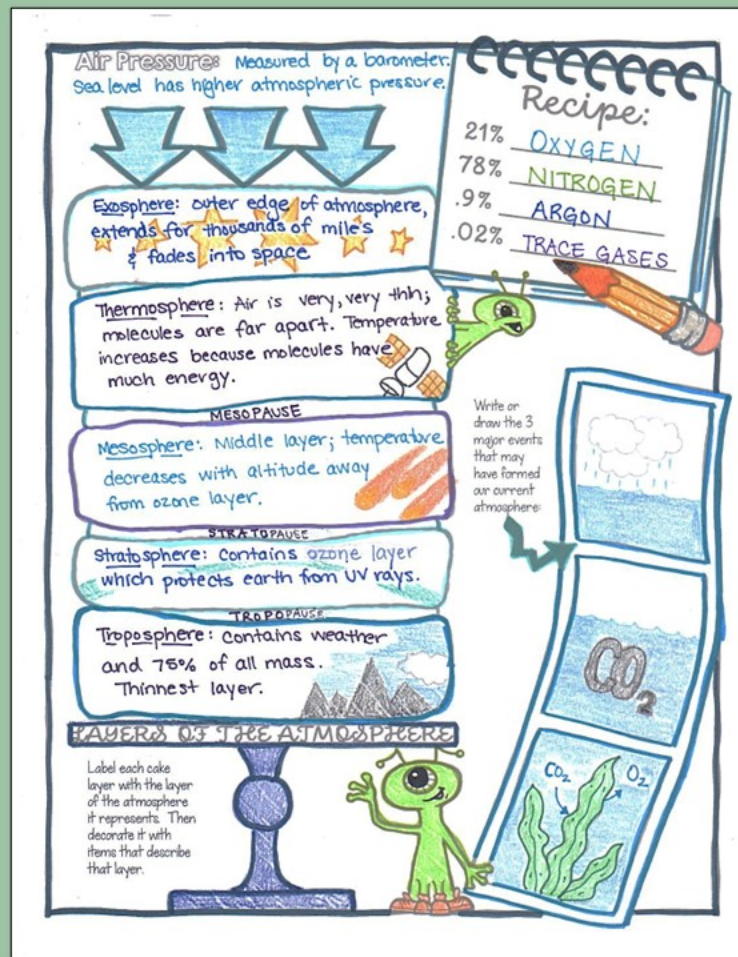
Virtual, hybrid, or
absent students
can stay right on
track!

Coriolis Effect	
How does the Coriolis effect impact wind patterns?	<p>Not every point on Earth's surface is traveling at the same <u>speed</u>.</p> <p>If something travels a greater <u>distance</u> in a shorter amount of <u>time</u> it must be going <u>faster</u>.</p> <p>Therefore, points on the earth near the <u>poles</u> are spinning <u>slower</u> than regions near the <u>equator</u>.</p> <p>A cloud that moves from the <u>equator</u> towards the north will be moving <u>faster</u> than the ground below it. A cloud that moves towards the equator from the <u>north</u> will move <u>slower</u> than the ground below it.</p> <p>Air masses that move <u>towards</u> the equator end up falling <u>behind</u>. Air masses that move <u>away</u> from the equator end up pushing <u>ahead</u>.</p> <p>When these air masses encounter high and low <u>pressure systems</u>, they can create <u>circular</u> air currents.</p>
How does air circulate in each hemisphere?	<p>Hurricanes allow us to easily see the Coriolis effect because they spin different <u>directions</u> based on which <u>hemisphere</u> they are in.</p> <div><div><p>Hemisphere: <u>Northern</u></p></div><div><p>Hemisphere: <u>Southern</u></p></div><p>Label in which hemisphere each of these circulation patterns are found.</p></div>
Summary	<p>Points on the earth are spinning at different <u>speeds</u>. As air moves towards or away from the equator, these varying speeds can cause some air to fall <u>behind</u> and some air to push <u>ahead</u>. Air circulates in different directions in each <u>hemisphere</u>.</p>



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

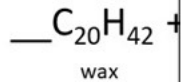
- Composition of the Atmosphere Lab
- Layers of the Atmosphere Graphing Activity
- Coriolis Effect Activity
- Local Weather
- Meteorology Video Activity
- What's Your Weather?
- Nitrogen Cycle Board Game

Composition of the Atmosphere Lab Student Instructions

Objective: Determine the percentage of oxygen in the air.

Pre-lab:

1. You will be exper...



Lab Directions:

1. Use the ruler...
2. Melt the bottom...
3. Then, position t...
4. Pour 1-2 cm of ...
5. Light the candle.
6. Carefully and quic...
7. Repeat this proces...
8. Repeat until you h...
9. Answer the Post-l...

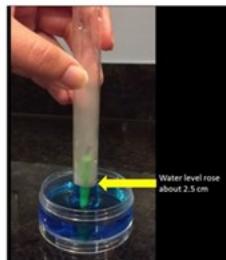
Composition of the Atmosphere Lab Teacher Instructions

The atmosphere is the term used to describe the thin layer of gases that surrounds Earth. The atmosphere is comprised of about 78% Nitrogen gas (N_2) and 21% Oxygen gas (O_2). The remaining 1% is comprised of Argon, Carbon dioxide, Neon, Helium, Methane, Krypton, and Hydrogen.

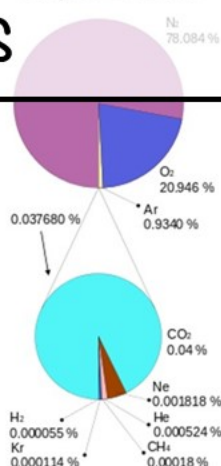
because oxygen gas burns so readily, by lighting a flame in a confined space, students can estimate the amount of oxygen that has been burned up. This can help them determine the approximate percentage of oxygen in the air. To make a confined space, use a test tube and a stopper. Note: This lab involves measurement and calculating percentages. Please determine whether your students will need assistance with these items.

Materials:

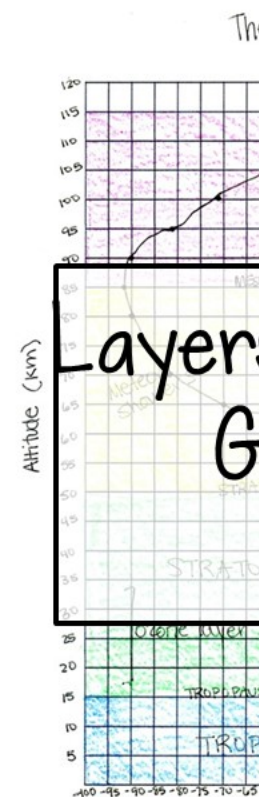
test tube
matches or lighter
calculator
water (food coloring optional)



Composition of Air:



Layers of the Atmosphere Activity Answer Key



Layers of the Atmosphere Activity

Background:

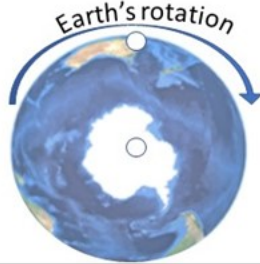
Some parts of the atmosphere are thinner than others, although they are all composed of the same gases. Earth's gravity causes atmospheric pressure to be higher near the surface and decrease with increasing altitude. The greater air pressure near the surface is important for human survival.

Directions:

Use the following data to make a graph of temperature vs. height of the atmosphere. Put height on the Y-axis (vertical) and temperature on the X-axis (horizontal). The Y-axis should range from 0 to 115 km in increments of 5. The X-axis should range from -100 to 100 in increments of 5.

Altitude (km)	Temperature in Celsius
0	15
5	-1
10	-17
15	-33
20	-49
25	-65
30	-81
35	-97
40	-113
45	-129
50	-145
55	-161
60	-177
65	-193
70	-209
75	-225
80	-241
85	-257
90	-273
95	-289
100	-305
105	-321
110	-337
115	-353

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.



Part 3- Instruction

7. In each section of the map, draw arrows that show the direction of the wind (the arrows) curves due to the Coriolis effect.
7. Ex:

8. Winds are named by the direction they are moving toward (there are 2 of these).

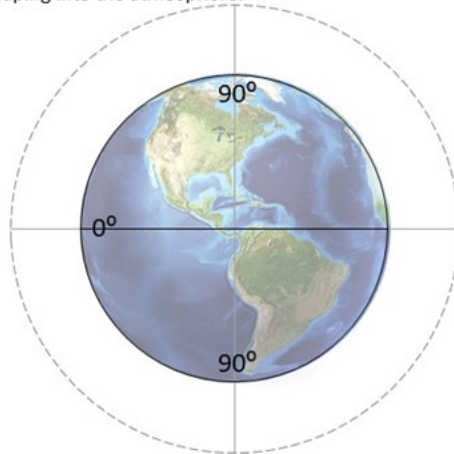
Coriolis Effect Activity Student Instructions

Background Information:

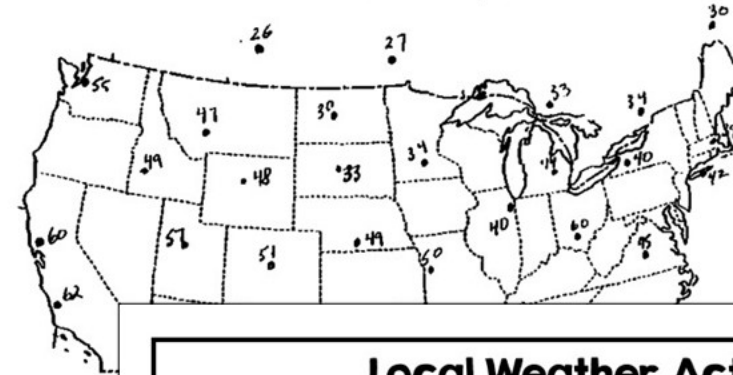
The Coriolis effect is responsible for many global weather patterns. Named after the French mathematician Gaspard Gustave de Coriolis, the Coriolis effect describes the pattern of deflection shown by objects as they travel large distances across the earth. This is particularly relevant to the discussion of air masses and wind because the Coriolis effect illustrates the apparent bending of wind and air currents as the earth rotates.

Coriolis Effect Sample Pages

- When air moves from high to low pressure, it is deflected to the right in the Northern Hemisphere and to the left in the Southern Hemisphere. This is due to the Coriolis effect. The cause of the Coriolis effect is the rotation of the earth. The sun heats the earth unevenly due to differences in latitude and the spherical shape of the earth. This causes air to move from warm to cold areas. Use a "W" to mark the warmest region of the globe and "C" to mark the cold regions. 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.



Isothermic Map



Air Pressure

Air pressure is the force exerted by the weight of the air above a given point.

1. Temperature
2. Wind
3. Humidity

High pressure areas are associated with clear, dry weather.

Air pressure is measured in millibars (mb).

Only one millibar is written on the map.

- For numbers 10 to 9, add a decimal.
- For numbers 100 to 999, add a decimal and a zero.
- For numbers 1000 to 9999, add a decimal and two zeros.
- For numbers 10000 to 99999, add a decimal and three zeros.

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. Conduction is the movement of heat as two objects directly touch each other. This happens when the ground touches the air. Since air is a poor conductor, convection does not account for much of the heat transfer in the atmosphere.

Radiation is the transfer of heat through electromagnetic waves. When heat waves move through the air, they can make the air molecules move faster, creating more energy in that object. Radiation is the reason you feel warm when you sit in the sunshine on a clear day. Convection is the transfer of heat through fluid substance like water or air. Because these fluids are free to move, convection currents occur as air heats and cools.

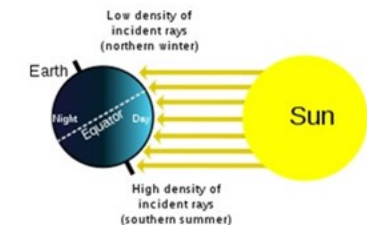
Because the sun's rays are more intense near the equator (where heat is not constant across the globe), the temperature is higher near the equator and less intense near the poles. Because the earth is tilted on its axis, the seasons also cause differences in the amount of solar radiation that any region receives.

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-



Meteorology Activity Grading Rubric

	Below standard	Approaching Standard	Meets Standard
Explanation of Ideas & Information	<ul style="list-style-type: none"> Does not present information and instructions clearly, concisely, or logically Does not show understanding of 	<ul style="list-style-type: none"> Presents information and instructions in a way that is sometimes clear, concise, and 	<ul style="list-style-type: none"> Presents information and instructions clearly, concisely, and logically Shows
Presentation Aids	<ul style="list-style-type: none"> Does not use Does not use 		
Peer Evaluation from Group Members	<ul style="list-style-type: none"> Does not use Does not use 		

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.

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

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

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

Meteorology Video Activity Sample Pages

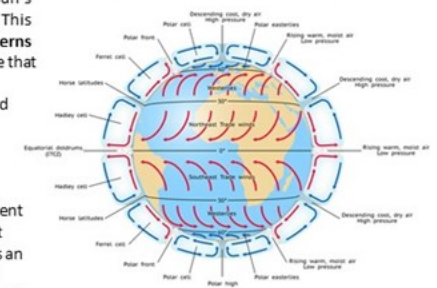


What's Your Weather?

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.

GLOBAL ATMOSPHERIC CIRCULATION



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 trees can disrupt air flow. Think about the weather in your local region in your neighborhood. What patterns does your climate have? 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.

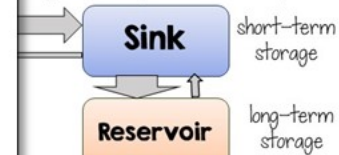
After each turn, players should record their route on the Game Play Tracker page. This allows players to see the processes they are demonstrating as they move through the cycle.

Ending the game:

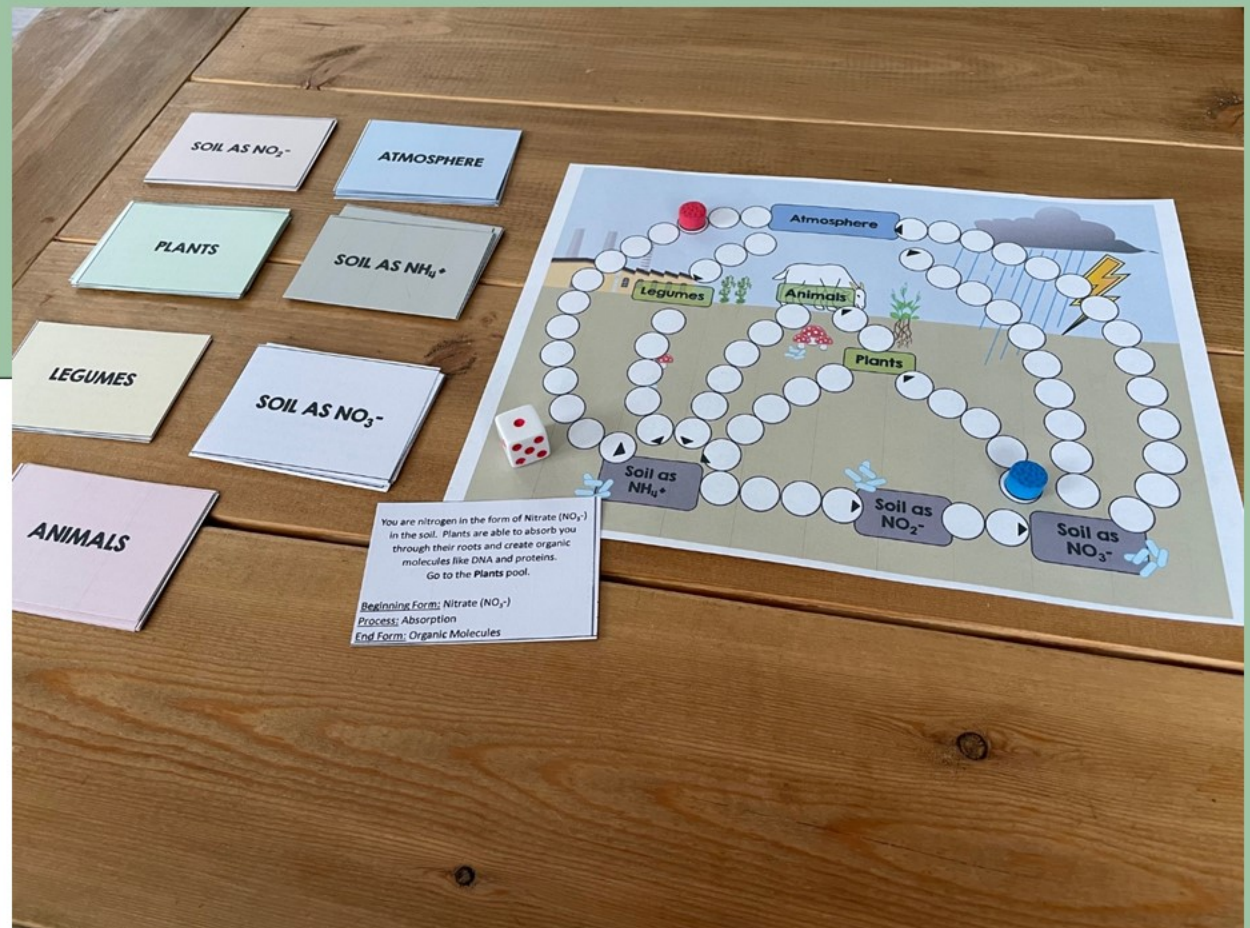
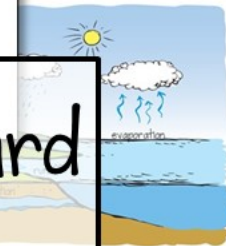
The game ends when one player has returned to the atmosphere pool 2 more times.

Cycle Game Background

Like the life cycle of an element. In a biogeochemical cycle, matter is often taken on different forms and molecular forms. Matter is stored in sources, sinks, and reservoirs. A **sink** is the opposite- it stores it for a short amount of time. A **reservoir** is a long period of time, sometimes millions of years.



Locations of a biogeochemical cycle is called **flux**. Flux can be altered by human activity.



Nitrogen Cycle Board Game Sample Pages

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

Students should follow the page while playing the game.

Upon completion of the game, the cards should be returned to the bottom of the pile.

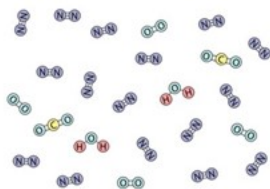
For set-up:

1. At your local copy store.
2. On your printer on any size 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.



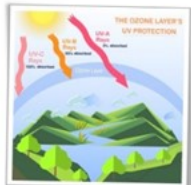
8 Extension Pages

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.

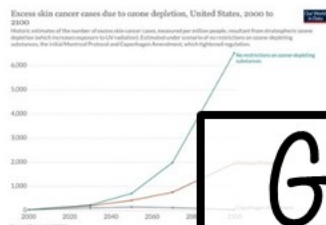


Ozone Depletion

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

- Convert 44 mmHg to inHg.
- Convert 72 inHg into atmospheres.
- Convert .83 atmospheres into two other units of pressure.
- 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	5.53	4.83	4.97		
2	5.65	5.58	5.58	4.6	4.12	4.23	4.96	5.65	5.5	5.61	5.7			
3	2.03	3.09	4.15	5.12	5.15	4.96	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	5.36	4.19	3.08	2.57	3.03	3.63	4.64	5.45	5.65	6.26		

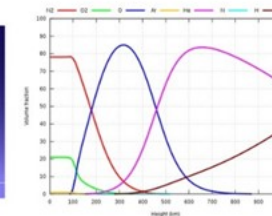
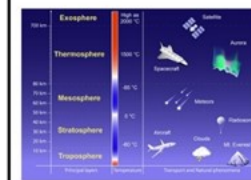
Solar insolation is a measurement of the average daily solar radiation for a certain area. Solar insolation is measured by average daily kilowatt hours received per square meter (kWh/M^2). The chart above lists the solar insolation for several different cities for each month.

- Calculate the yearly average for each location and write it in the "Yearly Average" column.
- For each city, circle the month with the highest amount of solar insolation.
- Calculate the range of solar insolation for each city. (Reminder: the range is calculated by subtracting the lowest and highest values.)
- 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.



- Which two elements are most common in the exosphere?
- At which height are there equal amounts of free Oxygen and Helium?
- 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.
- 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.



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.

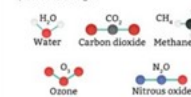
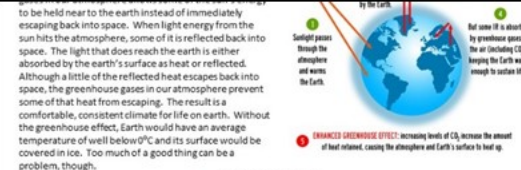
Questions:

- How would this large-scale deforestation affect the local weather in Brazil? Explain your answer in terms of temperature, wind, and precipitation.
- A river is marked on the left-hand photograph. How do you think the water quality of that river has been affected by deforestation?
- Provide 3 ways the deforestation of this region would affect the greenhouse gas emissions in the local area.



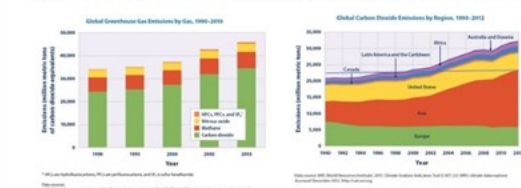
Digging Deeper: Global Warming

You have likely heard about the greenhouse effect in threatening terms. However, it is the greenhouse effect that allows life to flourish on Earth. The greenhouse effect is 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 greenhouse 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:

- Calculate the total amount of global Carbon and use that number to determine the percentage of global Carbon found in each pool.
- Based on the estimated amounts of Carbon provided, which location is the largest reservoir for Carbon?
- In which location does Carbon have the shortest residence time?
- 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

1 Name the 3 main gases in the atmosphere & their percentages.

2 List the layers of the atmosphere in order from closest to farthest from Earth's surface.

3 In which layer of the atmosphere would you find...
a) Meteors being burned up?
b) Weather?
c) The ozone layer?
d) A high amount of helium & hydrogen?

4 Name 3 major events that scientists believe led to the formation of our current atmosphere.

Sample Task Cards

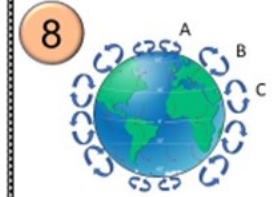
5 Describe weather conditions during low pressure & high pressure.

6 What season is this in the Northern Hemisphere? The Southern Hemisphere?



7 Describe El Niño conditions.

8 Label the circulation patterns marked above.



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.

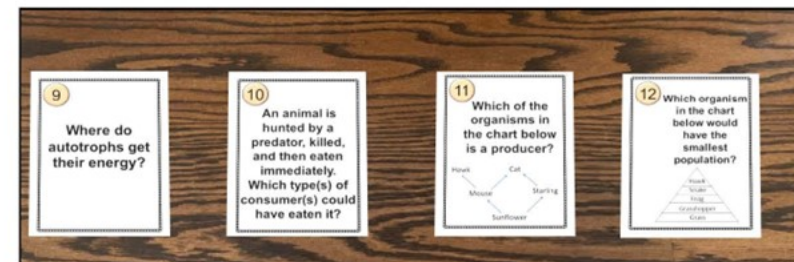
4. Students will rotate to each seat until all cards are finished. Answers are recorded on their "Task Card Answer Sheet" or notebook page.

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

Teacher Tips

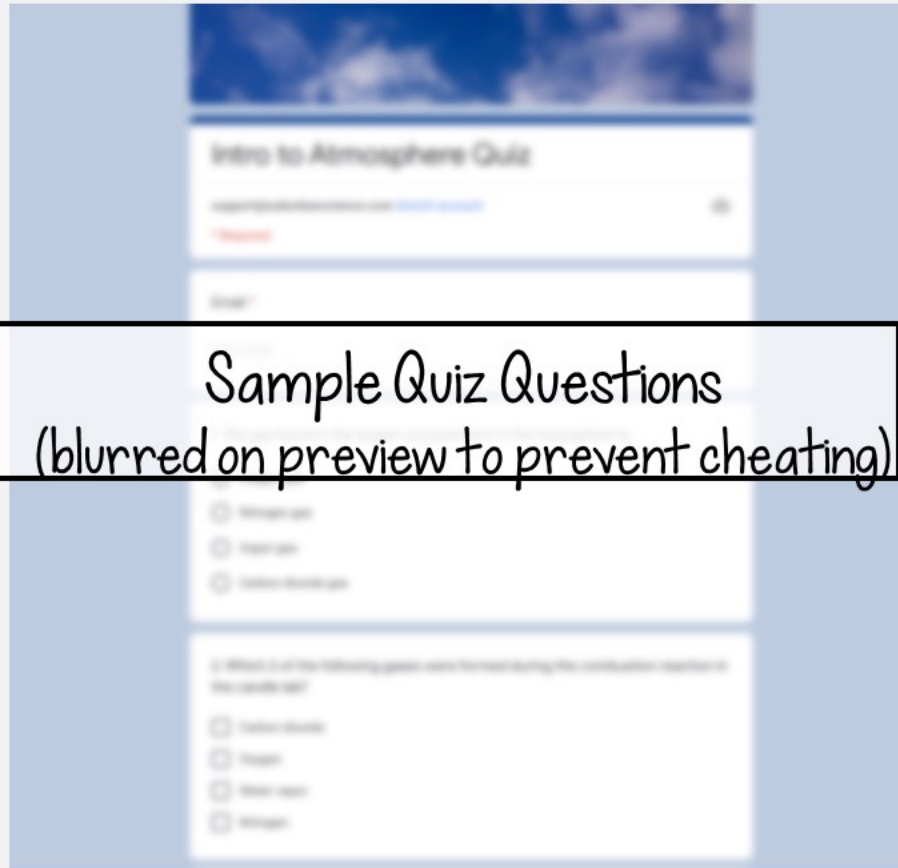
Modifications:

- 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.

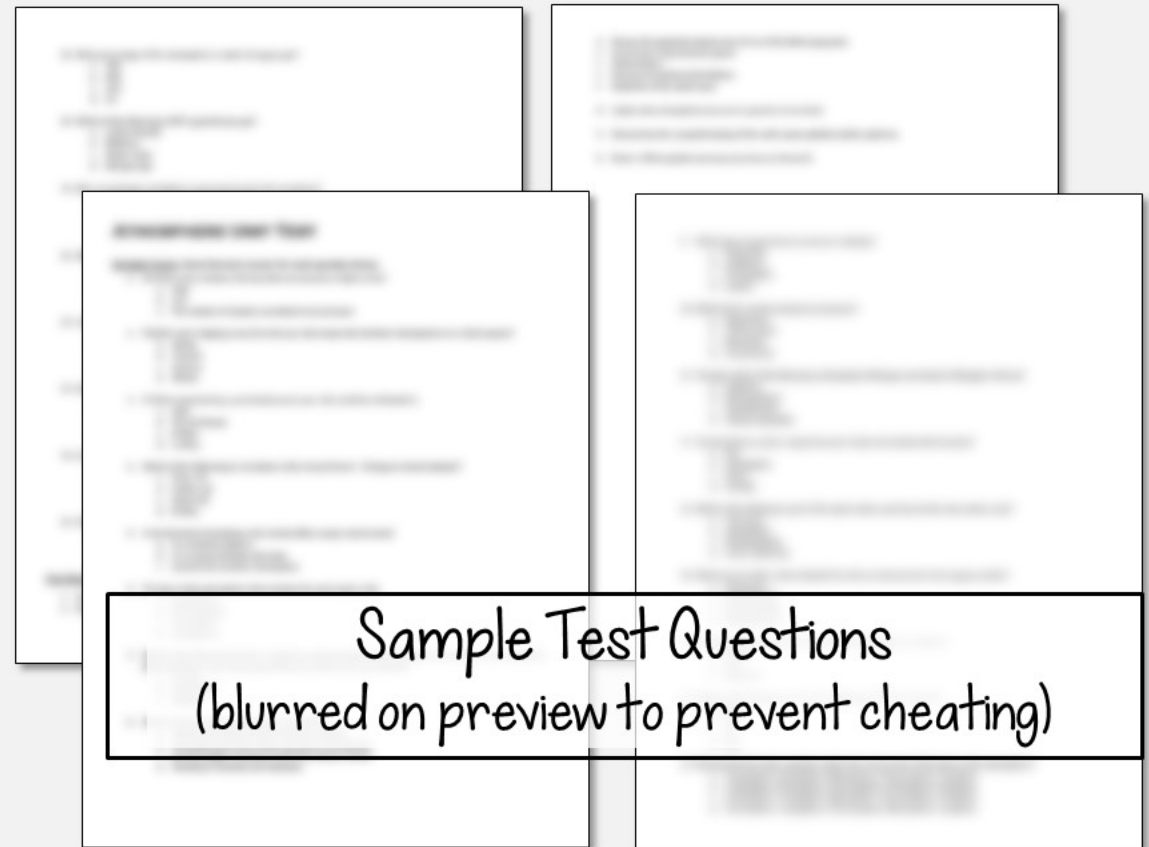


Assessment

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

I'd love to hear from you!

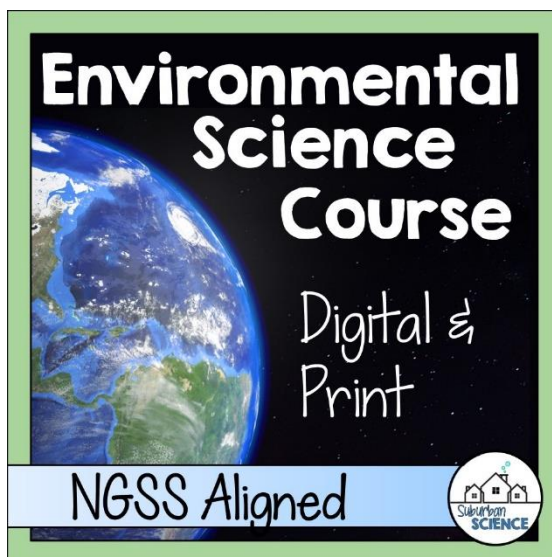
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Sincerely,
Anne from Suburban Science

