

THE CARBON CYCLE

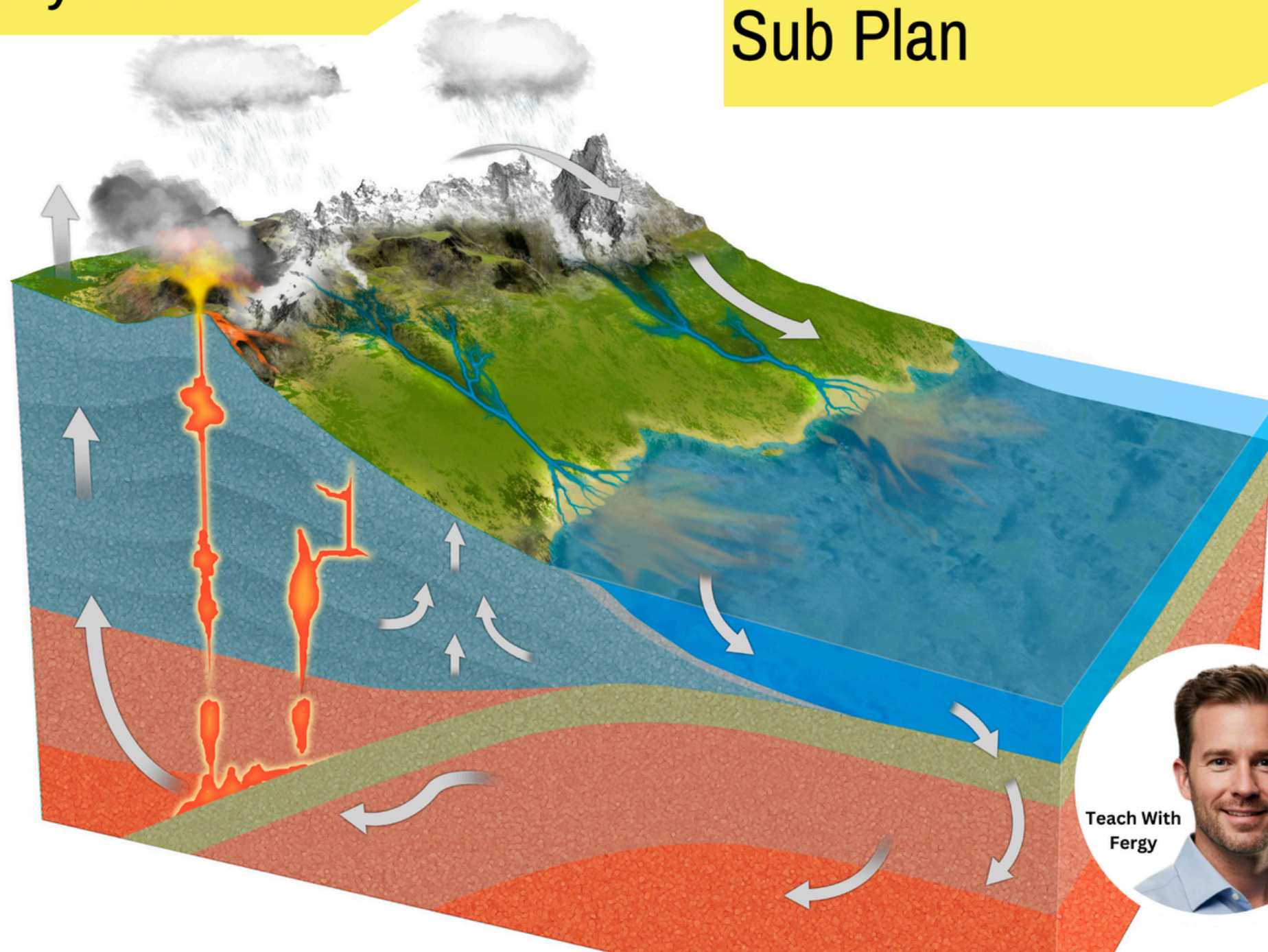
PROCESSES, HUMAN IMPACTS, & SOLUTIONS

GRADE 8 AND UP READING

Improve students'
literacy skills

Science Applicability

Sub Plan



Reading Comment

“Extremely satisfied - Great resource to work on student reading comprehension and it tied into the topic I was teaching. My students have been struggling with reading and I've been incorporating more reading into my lessons. Thank you for the resource.”

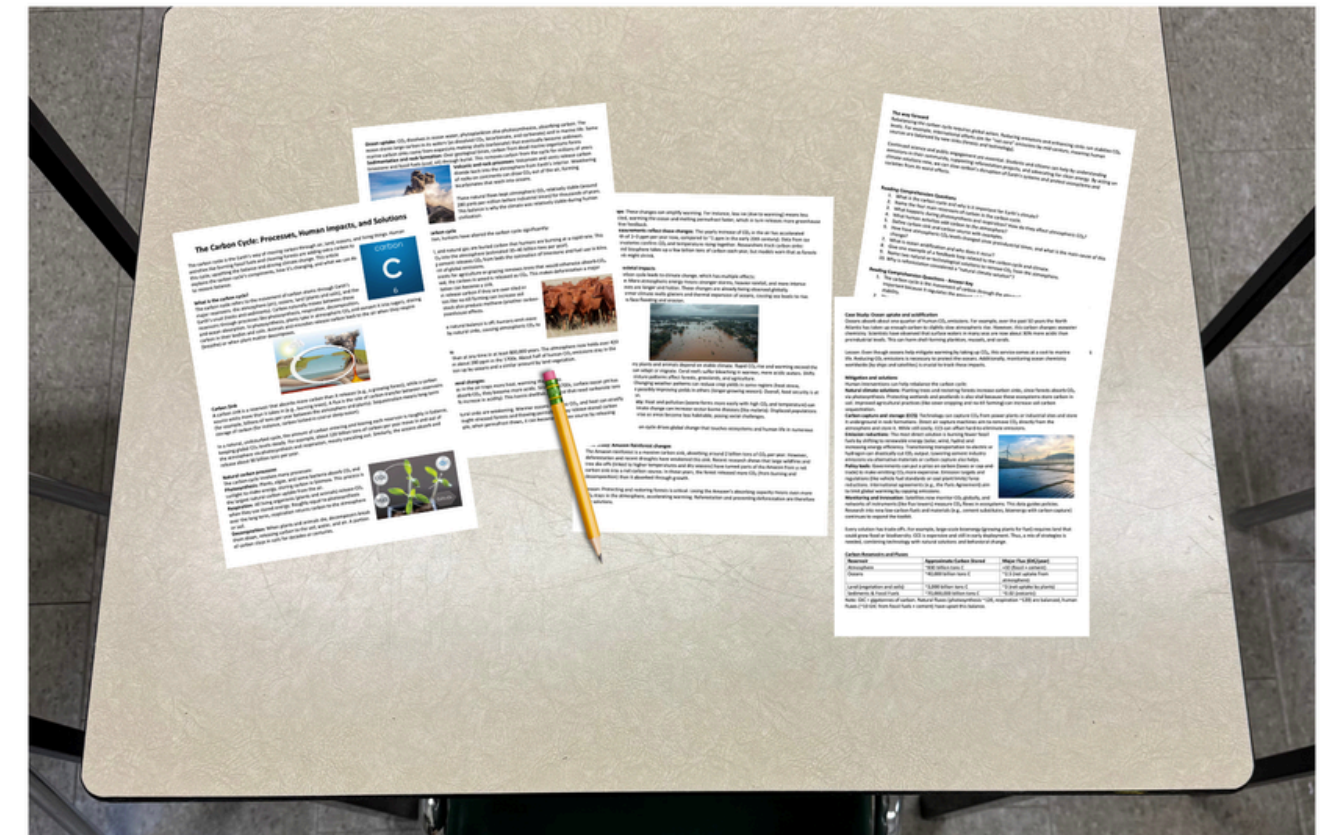
SCROLL
to take a look inside!

THE PROBLEMS YOU FACE

- Limited time to teach scientific literacy and strengthen students' reading and analysis skills.
- Need meaningful extension activities to engage fast-moving learners.
- Difficulty creating effective last-minute sub plans that still support student learning.

CLASSROOM READY

- Questions and Answer Key
- **No Prep, Ready-to-Use:** Print or assign digitally with Google Docs, Microsoft Word, and PDF formats for flexible classroom use
- **Includes Varied Question Types:** Knowledge, thinking, connecting, application, and open-ended questions.



What Will Your Students Learn?

READING COMPREHENSION ARTICLE & QUESTION BUNDLE

Article with
Comprehension
Questions

Grade 8 and Up

Print & Digital

- What Is the Carbon Cycle?
- Carbon Reservoirs and Carbon Fluxes
- Photosynthesis and Respiration
- Decomposition and Ocean Uptake
- Carbon Sinks and Carbon Sources
- Sedimentation, Fossil Fuels, and Long-Term Carbon Storage
- Human Impacts on the Carbon Cycle
- Fossil Fuel Burning and Cement Production
- Deforestation and Land-Use Change
- Rising Atmospheric CO₂ Levels
- Ocean Acidification
- Feedback Loops and Climate Change
- Ecological and Societal Impacts
- Case Studies (Amazon Rainforest and Ocean Uptake)
- Natural Climate Solutions and Carbon Capture
- Net-Zero and Climate Mitigation Strategies

Reading Comprehension Questions

1. What is the carbon cycle and why is it important for Earth's climate?
2. Name the four main reservoirs of carbon in the carbon cycle.
3. What happens during photosynthesis and respiration? How do they affect atmospheric CO₂ levels?
4. What human activities add carbon to the atmosphere?
5. Define a carbon sink and carbon source with examples.
6. How has the carbon cycle changed since preindustrial times, and what is the impact?

The Carbon Cycle: Processes, Human Impacts, and Solutions

The carbon cycle is the Earth's way of moving carbon through air, land, oceans, and living things. Human activities like burning fossil fuels and clearing forests are adding extra carbon to this cycle, upsetting the balance and driving climate change. This article explains the carbon cycle's components, how it's changing, and what we can do to restore balance.

What is the carbon cycle?

The carbon cycle refers to the movement of carbon atoms through Earth's major reservoirs: the atmosphere (air), oceans, land (plants and soils), and Earth's crust (rocks and sediments). Carbon naturally moves between these reservoirs through processes like photosynthesis, respiration, decomposition, and ocean absorption. In photosynthesis, plants take in atmospheric CO₂ and convert it into sugars, storing carbon in their bodies and soils. Animals and microbes release carbon back to the air when they respire (breathe) or when plant matter decomposes.



Carbon Sink

A carbon sink is a reservoir that absorbs more carbon than it releases (e.g., a growing forest), while a carbon source emits more than it takes in (e.g., burning trees). A flux is the rate of carbon transfer between reservoirs (for example, billions of tons per year between the atmosphere and plants). Sequestration means long-term storage of carbon (for instance, carbon locked in coal or deep ocean).

In a natural, undisturbed cycle, the amount of carbon entering and leaving each reservoir is roughly in balance, keeping global CO₂ levels steady. For example, about 120 billion tons of carbon per year move in and out of the atmosphere via photosynthesis and respiration, mostly canceling out. Similarly, the oceans absorb and release about 90 billion tons per year.

Natural carbon processes

The carbon cycle involves several natural processes:

Photosynthesis: Plants and other organisms take in CO₂ from the atmosphere and use it to produce glucose and oxygen.

Respiration: Plants and animals release CO₂ back into the atmosphere.

Decomposition: When plants and animals die, their bodies are broken down by decomposers, releasing CO₂ back into the atmosphere.

Ocean Uptake: The oceans absorb CO₂ from the atmosphere, which is then used by marine organisms.

Fossil Fuel Combustion: Burning fossil fuels releases CO₂ that has been stored underground for millions of years.

Land-Use Change: Deforestation and other land-use changes can reduce the amount of carbon stored in plants and soils.

Carbon Capture: New technologies are being developed to capture CO₂ from industrial processes and store it underground.

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Your Reading

The Carbon Cycle: Processes, Human Impacts, and Solutions

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Carbon Sink

A carbon sink is a reservoir that absorbs more carbon than it releases (e.g., a growing forest). A source emits more than it takes in (e.g., burning trees). A flux is the rate of carbon transfer (for example, billions of tons per year between the atmosphere and plants). Sequestration is the storage of carbon (for instance, carbon locked in coal or deep ocean).

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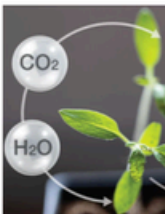
Natural carbon processes

The carbon cycle involves many processes:

Photosynthesis: Plants, algae, and some bacteria absorb CO₂ and sunlight to make energy, storing carbon in biomass. This process is the largest natural carbon uptake from the air.

Respiration: All living organisms (plants and animals) release CO₂ when they use stored energy. Roughly equal to photosynthesis over the long term, respiration returns carbon to the atmosphere or soil.

Decomposition: When plants and animals die, decomposers break them down, releasing carbon to the soil, water, and air. A portion of carbon stays in soils for decades or centuries.



Ocean uptake: CO₂ dissolves in ocean water; phytoplankton also photosynthesize, absorbing carbon. The ocean stores large carbon in its waters (as dissolved CO₂, bicarbonate, and carbonate) and in marine life. Some marine carbon sinks come from organisms making shells (carbonate) that eventually become sediment.

Sedimentation and rock formation: Over geological times, carbon from dead marine organisms forms limestone and fossil fuels (coal, oil) through burial. This removes carbon from the cycle for millions of years.



Volcanic and rock processes: Volcanoes and vents release carbon dioxide back into the atmosphere from Earth's interior. Weathering of rocks on continents can draw CO₂ out of the air, forming bicarbonates that wash into oceans.

These natural flows kept atmospheric CO₂ relatively stable (around 280 parts per million before industrial times) for thousands of years. This balance is why the climate was relatively stable during human civilization.

Human influences on the carbon cycle

Since the Industrial Revolution, humans have altered the carbon cycle significantly:

Fossil fuel burning: Coal, oil, and natural gas are buried carbon that humans are burning at a rapid rate. This releases large amounts of CO₂ into the atmosphere (estimated 35–40 billion tons per year).

Cement production: Making cement releases CO₂ from both the calcination of limestone and fuel use in kilns. It accounts for several percent of global emissions.

Land-use change: Clearing forests for agriculture or grazing removes trees that would otherwise absorb CO₂. When forests are cut or burned, the carbon in wood is released as CO₂. This makes deforestation a major carbon source, while reforestation can become a sink.

Agriculture: Farming soils can release carbon if they are over-tilled or over-farmed, although practices like no-till farming can increase soil carbon. Rice paddies and livestock also produce methane (another carbon-containing gas) that adds to greenhouse effects.



Because of these activities, the natural balance is off: humans emit more carbon than can be absorbed by natural sinks, causing atmospheric CO₂ to rise.

Current changes and feedbacks

Carbon levels today are higher than at any time in at least 800,000 years. The atmosphere now holds over 420 parts per million of CO₂, up from about 280 ppm in the 1700s. About half of human CO₂ emissions stay in the air, while roughly 25–30% is taken up by oceans and a similar amount by land vegetation.

This extra carbon is causing several changes:

Rising CO₂: More greenhouse gas in the air traps more heat, warming the climate.

Ocean acidification: As oceans absorb CO₂, they become more acidic. Since the 1700s, surface ocean pH has dropped by about 0.1 unit (a 30% increase in acidity). This harms shellfish and coral that need carbonate ions to build their shells.

Reduced carbon sinks: Some natural sinks are weakening. Warmer oceans hold less CO₂, and heat can stratify ocean layers, slowing uptake. Drought-stressed forests and thawing permafrost may release stored carbon instead of absorbing it. For example, when permafrost thaws, it can become a carbon source by releasing methane and CO₂.

Feedback loops: These changes can amplify warming. For instance, less sunlight reflected warms the ocean and melting permafrost faster, which releases more CO₂.

Ice sheets reflect these changes: The yearly increase is about 3 ppm per year now, compared to ~1 ppm in the 1950s. Data confirms CO₂ and temperature rising together. Ice sheets take up a few billion tons of carbon each year, but this is shrinking.

Impacts

Climate change leads to climate change, which has multiple impacts. More atmospheric energy means stronger storms, higher sea levels, and longer and hotter. These changes are already affecting ecosystems and human societies.



Many plants and animals depend on stable climate. Some can adapt or migrate. Coral reefs suffer bleaching. Changing weather patterns affect forests, grasslands, and agriculture. Droughts can reduce crop yields, while heavy rains can cause flooding and erosion.

Human health: Heat and pollution (ozone forms more easily) can cause health problems. Climate change can increase vector-borne diseases. Sea level rise can displace communities.

Human activities drive global change that touches every part of our lives.

Deforestation changes

Deforestation is a massive carbon sink, absorbing around 2 billion tons of CO₂ per year. Recent droughts have weakened this sink. Recent fires (higher temperatures and dry seasons) have turned forests into carbon sources. In those years, the forest released more carbon than it absorbed through growth.

Restoring forests is critical. Losing the Amazon's rainforest, accelerating warming. Reforestation and protecting forests can help.

Case Study: Ocean uptake and acidification

Oceans absorb about one quarter of human CO₂ emissions. For example, over the past 50 years, the Atlantic has taken up enough carbon to slightly slow atmospheric rise. However, this carbon uptake has changed ocean chemistry. Scientists have observed that surface waters in many seas are now about 30% more acidic than preindustrial levels. This can harm shell-forming plankton, mussels, and corals.

Lesson: Even though oceans help mitigate warming by taking up CO₂, this service comes at a cost. Reducing CO₂ emissions is necessary to protect the oceans. Additionally, monitoring ocean acidification worldwide (by ships and satellites) is crucial to track these impacts.

Mitigation and solutions

Human interventions can help rebalance the carbon cycle:

Natural climate solutions: Planting trees and restoring forests increase carbon sinks, since forests take up CO₂ via photosynthesis. Protecting wetlands and peatlands is also vital because these ecosystems store carbon. Improved agricultural practices (like cover cropping and no-till farming) can increase soil carbon sequestration.

Carbon capture and storage (CCS): Technology can capture CO₂ from power plants or industrial processes and store it underground in rock formations. Direct air capture machines aim to remove CO₂ directly from the atmosphere and store it. While still costly, CCS can offset hard-to-eliminate emissions.

Emission reductions: The most direct solution is burning fewer fossil fuels by shifting to renewable energy (solar, wind, hydro) and increasing energy efficiency. Transitioning transportation to electric or hydrogen can drastically cut CO₂ output. Lowering cement industry emissions via alternative materials or carbon capture also helps.

Policy tools: Governments can put a price on carbon (taxes or cap-and-trade) to make emitting CO₂ more expensive. Emission targets and regulations (like vehicle fuel standards or coal plant limits) force reductions. International agreements (e.g., the Paris Agreement) aim to limit global warming by capping emissions.

Monitoring and innovation: Satellites now monitor CO₂ globally, and networks of instruments (like flux towers) measure CO₂ flows in ecosystems. This data guides policy. Research into new low-carbon fuels and materials (e.g., cement substitutes, bioenergy with carbon capture) continues to expand the toolkit.

Every solution has trade-offs. For example, large-scale bioenergy (growing plants for fuel) could grow food or biodiversity. CCS is expensive and still in early deployment. Thus, a mix of solutions, combining technology with natural solutions and behavior change, is needed.

Carbon Reservoirs and Fluxes

Reservoir	Approximate Carbon Stored	Major Flux (GtC/y)
Atmosphere	~830 billion tons C	+10 (fossil + cement)
Oceans	~40,000 billion tons C	~2.5 (net uptake from atmosphere)
Land (vegetation and soils)	~3,000 billion tons C	~3 (net uptake by vegetation)
Sediments & Fossil Fuels	~70,000,000 billion tons C	~0.02 (volcanic)

Note: GtC = gigatonnes of carbon. Natural fluxes (photosynthesis ~120, respiration ~120) are balanced. Human fluxes (~10 GtC from fossil fuels + cement) have upset this balance.

The way forward

Rebalancing the carbon cycle requires global action. Reducing emissions and enhancing sinks can stabilize CO₂ levels. For example, international efforts aim for "net-zero" emissions by mid-century, meaning human emissions are balanced by new sinks (forests and technology).

Continued science and public engagement are essential. Students and citizens can help by understanding climate change, reducing emissions in their community, supporting reforestation projects, and advocating for clean energy. By acting on climate solutions now, we can slow carbon's disruption of Earth's systems and protect ecosystems and societies from its worst effects.

Reading Comprehension Questions

- What is the carbon cycle and why is it important for Earth's climate?
- Name the four main reservoirs of carbon in the carbon cycle.
- What happens during photosynthesis and respiration? How do they affect atmospheric CO₂?
- What human activities add carbon to the atmosphere?
- Define carbon sink and carbon source with examples.
- How have atmospheric CO₂ levels changed since preindustrial times, and what is the main cause of this change?
- What is ocean acidification and why does it occur?
- Give one example of a feedback loop related to the carbon cycle and climate.
- Name two natural or technological solutions to remove CO₂ from the atmosphere.
- Why is reforestation considered a "natural climate solution"?

Reading Comprehension Questions - Answer Key

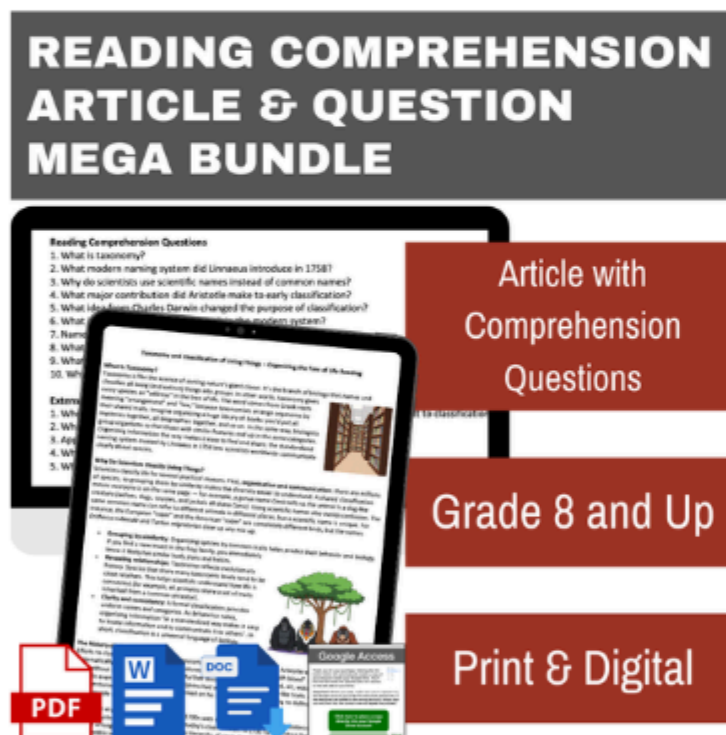
- The carbon cycle is the movement of carbon through the atmosphere, oceans, land, and rocks. It is important because it regulates the amount of CO₂, which affects Earth's temperature and climate stability.
- The atmosphere (air), oceans, land (plants and soil), and sediments/fossil fuels (Earth's crust).
- Photosynthesis (by plants and algae) uses CO₂ from the air to make food, reducing atmospheric CO₂. Respiration (in animals and plants) breaks down food for energy and releases CO₂ back into the air. Together they balance each other normally.
- Burning fossil fuels (coal, oil, gas), cement production, and deforestation (cutting or burning forests) all release CO₂ into the atmosphere.
- A carbon sink absorbs more carbon than it releases (e.g., a growing forest). A carbon source releases more than it absorbs (e.g., a coal power plant).
- CO₂ levels have risen from about 280 ppm to over 420 ppm today. This increase is mainly caused by human emissions from fossil fuel burning and land-use changes.
- Ocean acidification is the process of seawater becoming more acidic (lower pH) as it absorbs excess CO₂ from the atmosphere. When CO₂ dissolves in water, it forms carbonic acid, which lowers the pH.
- One example is the ice-albedo feedback: warming melts ice, reducing Earth's reflectivity so it absorbs more sunlight, causing further warming and more melting. (Another is permafrost thaw releasing methane, causing more warming.)
- Two solutions are reforestation (nature-based, plants absorb CO₂) and carbon capture and storage (technology that traps CO₂ from air or power plants and stores it underground).
- Reforestation plants trees that capture CO₂ via photosynthesis, storing it in wood and soil. This removes CO₂ from the atmosphere, helping offset emissions.

Comprehension and Extension Questions with Answer Key



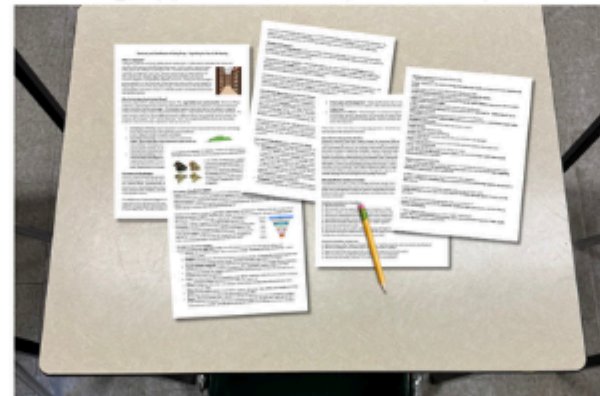
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★★★★★ Extremely satisfied - It is a good supplemental activity either for review and at the same time introducing some concept. I also use this for sub plan. It is well presented, organized and interesting.

★★★★★ Extremely satisfied - This a great resource. I used this for a sub plan. It was fun and engaging for my students.

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