Unit 5: Cycling in Earth's Systems

Standard(s):

Standard ESS.3.5 Develop and use a quantitative **model** to describe the cycling of carbon among Earth's systems. Emphasize each of Earth's systems (hydrosphere, atmosphere, lithosphere, and biosphere) and how the movement of carbon from one system to another can result in changes to the system(s). Examples could include more carbon absorbed in the oceans leading to ocean acidification or more carbon present in the atmosphere leading to a stronger greenhouse effect. (LS2.B, ESS2.D, ESS3.D)

Standard ESS.4.4 Evaluate **design solutions** for a major global or local environmental problem based on one of Earth's systems. *Define the problem, identify criteria and constraints, analyze available data on proposed solutions, and determine an optimal solution*. Examples of major global or local problems could include water pollution or availability, air pollution, deforestation, or energy production. (ESS3.C, ETS1.A, ETS1.B, ETS1.C)

Science and Engineering Practices	Disciplinary Core Ideas	Crosscutting Concepts
Developing and Using Models Students develop physical, conceptual, and other models to represent relationships, explain mechanisms, and predict outcomes. **Designing Solutions** Students design solutions to problems using observations that are consistent with current evidence and scientific principles.	**LS2.B Cycles of Matter and Energy Transfer in Ecosystems** **ESS2.D Weather and Climate** **ESS3.C Human Impacts on Earth Systems** **ESS3.D Global Climate Change**	**Systems and System Models** Students use models to explain the parameters and relationships that describe complex systems.

Big Ideas:

- The carbon cycle provides an example of matter cycling and energy flow in Earth systems. Photosynthesis, digestion of plant matter, respiration, and decomposition are important components of the carbon cycle, in which carbon is exchanged between the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes.

- Certain gases in the atmosphere (water vapor, carbon dioxide, methane, and nitrous oxides), which absorb and retain energy that radiates from Earth's surface, essentially insulate the planet. Without this phenomenon, Earth's surface would be too cold to be habitable. However, changes in the atmosphere, such as increases in carbon dioxide, can make regions of Earth too hot to be habitable by many species.

- The sustainability of human societies and of the biodiversity that supports them requires responsible management of natural resources not only to reduce existing adverse impacts but also to prevent such impacts to the extent possible.

Preceding Grade Bands:	Target Grade Bands:	Following Grade Bands:
● The atoms that make up the organisms in an ecosystem are cycled repeatedly between the living and nonliving parts of the ecosystem. ● Greenhouse gasses in the atmosphere absorb and retain the energy radiated from land and ocean surfaces, thereby regulating Earth's average surface temperature and keeping it habitable. ● Typically, as human populations and per-capita consumption of natural resources increase, so do the negative impacts on Earth unless the activities and technologies involved are engineered otherwise. ● Human activities, such as the release of greenhouse gases from burning fossil fuels, are major factors in the current rise in Earth's mean surface temperature (global warming).	● Photosynthesis and cellular respiration are important components of the carbon cycle, in which carbon is exchanged between the biosphere, atmosphere, oceans, and geosphere through chemical, physical, geological, and biological processes. ● The outcomes predicted by global climate models strongly depend on the amounts of human-generated greenhouse gases added to the atmosphere each year and by the ways in which these gases are absorbed by the ocean and the biosphere. ● Scientists and engineers can make major contributions—for example, by developing technologies that produce less pollution and waste and that preclude ecosystem degradation. When the source of an environmental problem is understood and international agreement can be reached, human activities can be regulated to mitigate global impacts (e.g., acid rain and the ozone hole near Antarctica). ● Through computer simulations and other studies, important discoveries are still being made about how the ocean, the atmosphere, and the biosphere interact and are modified in response to human activities, as well as to changes in human activities. Thus science and engineering will be essential both to understanding the possible impacts of global climate change and to informing decisions about how to slow its rate and consequences—for humanity as well as for the rest of the planet.	

Proficiency Scale:

4 Advanced	3 Proficient	2 Approaching Proficiency	1 Beginning Proficiency
I can: Use current evidence and scientific principles to **develop a model** showing how carbon cycles through earth's systems (geosphere, atmosphere, hydrosphere, and biosphere). AND Use current evidence and scientific principles to evaluate **solutions to a problem** involving earth's systems. AND Respectfully critique and revise the solution of others by providing supporting or refuting data.	**I can:** Use current evidence and scientific principles to **develop a model** showing how carbon cycles through earth's systems (geosphere, atmosphere, hydrosphere, and biosphere). AND Use current evidence and scientific principles to evaluate **solutions to a problem** involving earth's systems.	**I can:** **Develop a model** showing how carbon cycles through earth's systems (geosphere, atmosphere, hydrosphere, and biosphere). AND Use evidence to evaluate **solutions to a problem** involving earth's systems.	**I can:** **Develop a model** showing carbon moving through one of earth's systems. AND Choose **a solution to a problem** involving earth's systems.

Anchoring Phenomenon:
Carbon Phenomenon - Slide presentation for larger, in color viewing.
Carbon - Student sheet

Essential Question:

How does carbon cycle through Earth's systems?

Learning Goals:

Students will be able to:

- **5A:** Create a model showing how carbon cycles through earth's systems (lithosphere, atmosphere, hydrosphere, and atmosphere).
- **5B:** Evaluate and justify solutions to a problem involving earth's systems.

	Learning Opportunities	Formative Assessments
Engage	Carbon - Student sheet 1. What do you notice? 2. Draw an initial model that shows your thinking about how carbon cycles through Earth's systems. 3. Students share models with one another and discuss the evidence they used to justify their models. 4. What questions do you have?	**Suggested for this activity:** **Options:** ● Student answers to questions ● Student Discussions ● Exit Ticket
Learning Goal 5A: Create a model showing how carbon cycles through Earth's systems (lithosphere, atmosphere, hydrosphere, and atmosphere).		
Explore	The goal of these activities is for students to collect evidence they can use to answer the question: **How does carbon move through Earth's systems?** The Carbon Cycle Game teachers_notes_carbon_cycle.docx student_handout_carbon_cycle (1).docx reservoir_cards.doc Climate Change and Global Warming - Website for Climate Change Webquest Climate Change Webquest.docx Optional: Carbon Cycle Gizmo Explore Climate Change This relates back to the Engage; you could use it as a teacher-led demo/discussion or create your own activity. Ocean Acidification Demo	**Suggested for this activity:** **Options:** ● Student answers to questions ● Student Discussions ● Exit Ticket
Explain	1. Discuss evidence from the investigation(s). **How does carbon move through Earth's systems?**	**Suggested for this activity:** **Options:**

	2. Use one of the following resources. **What evidence do you find in the resource (text, video, etc.) that helps to explain how carbon moves through Earth's systems?** Teacher Resource/Student Reading earthobservatory.nasa.gov-The Carbon Cycle.pdf 3D video of carbon What are the greenhouse gas changes since the Industrial Revolution? 3. CER summary that answers the question: **How does carbon move through Earth's systems?** 4. Revisit student questions from engage a. What questions did we answer? b. Do we have any new questions? 5. Revisit phenomena and revise initial models based on evidence gathered and scientific principles learned.	• Revised Models • CER Paragraph • Student Discussions • Demonstrate a skill • Student answers to Questions • Quiz • Exit Tickets

Learning Goal 5B: Evaluate and justify solutions to a problem involving earth's systems.		
Elaborate	Earth's Systems- Teacher Earth's Systems-Student Critique and Revision Video: Working Together - Earth's Systems & Interactions Connections in the Earth System | Center for Science Education	
Evaluate	Please complete this **SURVEY** to request access to the summative assessments for the JSD High School Science Exemplar Units.	