Name _____

Date _____

Episode 10: SLOW CARBON CYCLE

Directions: Define these vocabulary words as you watch STEM with Cog, Episode 10: The Slow Carbon Cycle.

Part I. Vocabulary Words

- Calcium carbonate [1:58]
- Biogenic calcium carbonate [2:24]
- Lithification [4:36]
- Cement [5:43]
- Chemical weathering [8:14]

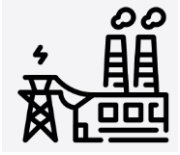
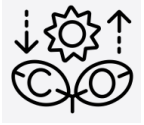
Part II. Answer after viewing the video.

What role does CO_2 play in making calcium carbonate seashells?	How is CO_2 released from limestone?
How can oil and gas form in the ocean bed?	How does limestone move?

Name _____

Take a deeper dive after viewing the video:

Part III. Draw icons in the columns below to represent sources that move carbon into our air and sinks that remove carbon from our air. Think about examples of burning fossil fuels, fires, photosynthesis, volcanoes, food webs, etc. (https://thenounproject.com/s can help you envision icons.) One example from the noun project is given for each column.

Carbon sources: Draw icons that show how carbon or CO_2 moves into our air.	**Carbon sinks:** Draw icons that show how carbon or CO_2 move out of our air.
 Power Plant	 Photo-synthesis

Part IV. Think Big:

- Circle the icons you've drawn that move carbon quickly, within decades or fewer years (the fast carbon cycle).
- Box icons that move carbon over millions of years (the slow carbon cycle).
- Write N by natural processes, H next to human activities, or N/H if the process is both natural and human.

Look at the results. What is one conclusion you can draw from this activity? Answers will vary.

Part V. Why is it a problem when human activities push carbon from the slow carbon cycle into the quick carbon cycle?

Answer Key

Name _____

Date _____

Episode 10: SLOW CARBON CYCLE

Directions: Define these vocabulary words as you watch STEM with Cog, Episode 10: The Slow Carbon Cycle.

Part I. Vocabulary Words

- Calcium carbonate [1:58] is a compound made of calcium and carbonate, $CaCO_3$, and can be found rock like chalk or limestone. It is the major component in shells of snails, clams, conchs, foraminifera and coccolithophore, as well as stony corals formations, sea urchin exoskeleton and sea star endoskeleton.

- Biogenic calcium carbonate [2:24] is calcium carbonate formed by animals that extract calcium ions and carbonate ions from water (or the bloodstream), then form the calcium carbonate into seashells, skeletons, eggshells, etc.

- Lithification [4:36] is the process by which loose material is turned into rock. Lithic is Greek for rock.

- Cement [5:43] is the most common building material today.
  [Note to teacher: gravel and sand are added to cement to make concrete. Ask students where they've seen cement or concrete used. Possible answers: buildings, bridges, skate parks, reservoirs to hold water as in wastewater treatment facilities, etc.]

- Chemical weathering [8:14] is a process that causes erosion or disintegration of rocks, for example, when CO_2 in air reacts with rain to form carbonic acid that can break down limestone, releasing CO_2.

Part II. Answer after viewing the video.

What role does CO_2 play in making calcium carbonate seashells? CO_2 absorbed in water can form carbonate ions. Some marine life can extract calcium ions and carbonate ions to make their shells.	How is CO_2 released from limestone? • Heat from volcanoes • Heat to make cement • Chemical weathering (water forms carbonic acid and dissolves limestone)
How do oil and gas form in the ocean bed? The soft bodies of plankton mostly, but other marine life too, are buried under the sediment that forms rock.	How does limestone move? Limestone mostly moves on tectonic plates. A small amount is scraped from coral reefs by parrot fish. It travels through fish guts, and becomes sand.

Name _____

Take a deeper dive after viewing the video:

Part III. Draw icons that represent processes that move carbon into our air (sources) and out of our air (sinks). Think about examples of burning fossil fuels, fires, volcanoes, photosynthesis, food webs, etc. (https://thenounproject.com/s can help you envision icons.)

Carbon sources: Draw icons that show how carbon or CO_2 moves into our air.	**Carbon sinks:** Draw icons that show how carbon or CO_2 move out of our air or store it.
Answers will vary • Breathing – N/H • Wood fires N/H • Burning gas in cars H • Burning jet fuel H • Volcano eruption N • Chemical Weathering N • Burning Coal to make electricity H • Burning fossil fuels for electricity H • Making Cement H • Decomposition N And more	Answers will vary • Photosynthesis in plants N • Photosynthesis in plankton N • CO_2 Absorption in ocean water N • Calcium Carbonate formation N • Absorption in food webs N • **Fossil Fuel formation** N • Limestone formation N

Part IV. See circles and boxes above.

- Circle all of the icons that move carbon quickly, within decades or fewer years.
- Box icons that move carbon over millions of years (the slow carbon cycle).
- Write N by natural processes, H next to human activities, or N/H if natural and human.

Look at the results. What is one conclusion you can draw from this activity? Answers will vary. Humans are good at releasing carbon, but not so good (yet) at capturing carbon. The slow carbon cycle runs naturally. I want to know more because this activity does not tell us quantities of CO_2 produced, so we can't compare amounts of CO_2 released or stored.

Part V. Why is it a problem when human activities push carbon from the slow carbon cycle into the quick carbon cycle? When we add ancient carbon, carbon that has been trapped and unavailable to our quick carbon cycle for hundreds of millions of years, we increase the levels of greenhouse gases in our atmosphere that trap heat. Land and oceans ocean

TEACHER RESOURCES

NGSS Standards:

MS-PS1-1 Develop models of molecules (e.g. calcium carbonate).
MS-PS1-2 Interpret properties of products to determine if chemical reaction occurred.
MS-LS2-1 Affects of resource availability on populations (shell-building in ocean with increased pH levels)
MS-LS2-3 Cycling of matter among living and nonliving (carbonates -> mollusks -> limestone)
MS-LS2-4 Evidence of change causing population effects (ocean acidification /shell building)
MS-ESS2-1 Cycling of Earth's materials and energy (lithification of shells)
MS-ESS3-4 Increased human population and consumption affects systems (ocean acidification)

Experiment resources:
Find the calcium carbonate precipitate experiment at:
https://www.acs.org/middleschoolchemistry/lessonplans/chapter6/lesson3.html

Description: This worksheet goes along with the Cog's Episode 10 video about the Slow Carbon Cycle [9:48] It can be used by teachers or their substitutes (given the answer key) to fill in learning and check for understanding.
STEM with Cog's Episode 10: The Slow Carbon Cycle.
https://www.youtube.com/watch?v=s7izmCCqWu0
The first page asks literal questions that can help students understand the material covered in the video. The second page helps students connect the information to their own lives and evaluate or infer meaning by pondering the importance of the information. Pages can be used separately or print front-to-back to make a 2-page worksheet.

Directions:

Before viewing the video, hand out a worksheet to each student if being done individually or a worksheet to each group of 2-4 students if they're working in groups.

Part I. Students can define the vocabulary words as you watch the video. The timestep next to each word alerts you to where the word is used. Stop the video and replay as many times as needed. If students need help, give them the definitions from the answer key.

Part II. Ask students to answer each question. It may help to show them final sketchnote, page 7 of this document or [9:20] in the video. If time permits, share student answers. Ask students to jot down any new information they've gathered from others.

Part III. To warm them up, ask students to ponder the examples given in the directions. Which of them are carbon sources that release carbon and which are carbon sinks that trap carbon:

- burning fossil fuels (source)
- fires (source)
- photosynthesis (sink)
- volcanoes (source)
- food webs (sink – carbon captured by photosynthesis and passed along)

Get a few ideas of what they might draw for each of these bullet points.

Give students 3 minutes to draw icons of carbon sources and sinks. The website https://thenounproject.com/s is a great place to get ideas for drawing icons if students have access to tablets or computers. It's okay for reluctant students to use words instead, but encourage them to expand their learning by trying to draw some. Stick figures are fine. After 3 minutes, ask students to share their ideas, so others can add icons to their worksheet.

Part IV. Think Big: (Think-Pair-Share) Give them 1-2 minutes to **Think** and circle or box icons. Remind students to listen respectfully, conclusions will vary. Then assign each student to a **Pair**. Ask the pair to **Share** their work. Remind students to listen respectfully and ask questions if they have any. If time allows bring everyone back together and share conclusions.

Part V: Ask students to write their answer or write what they feel they need to know more about in order to answer. Where might they find that information?

WATCH RELATED COG VIDEOS ABOUT THE CARBON CYCLE:

The fast carbon cycle:

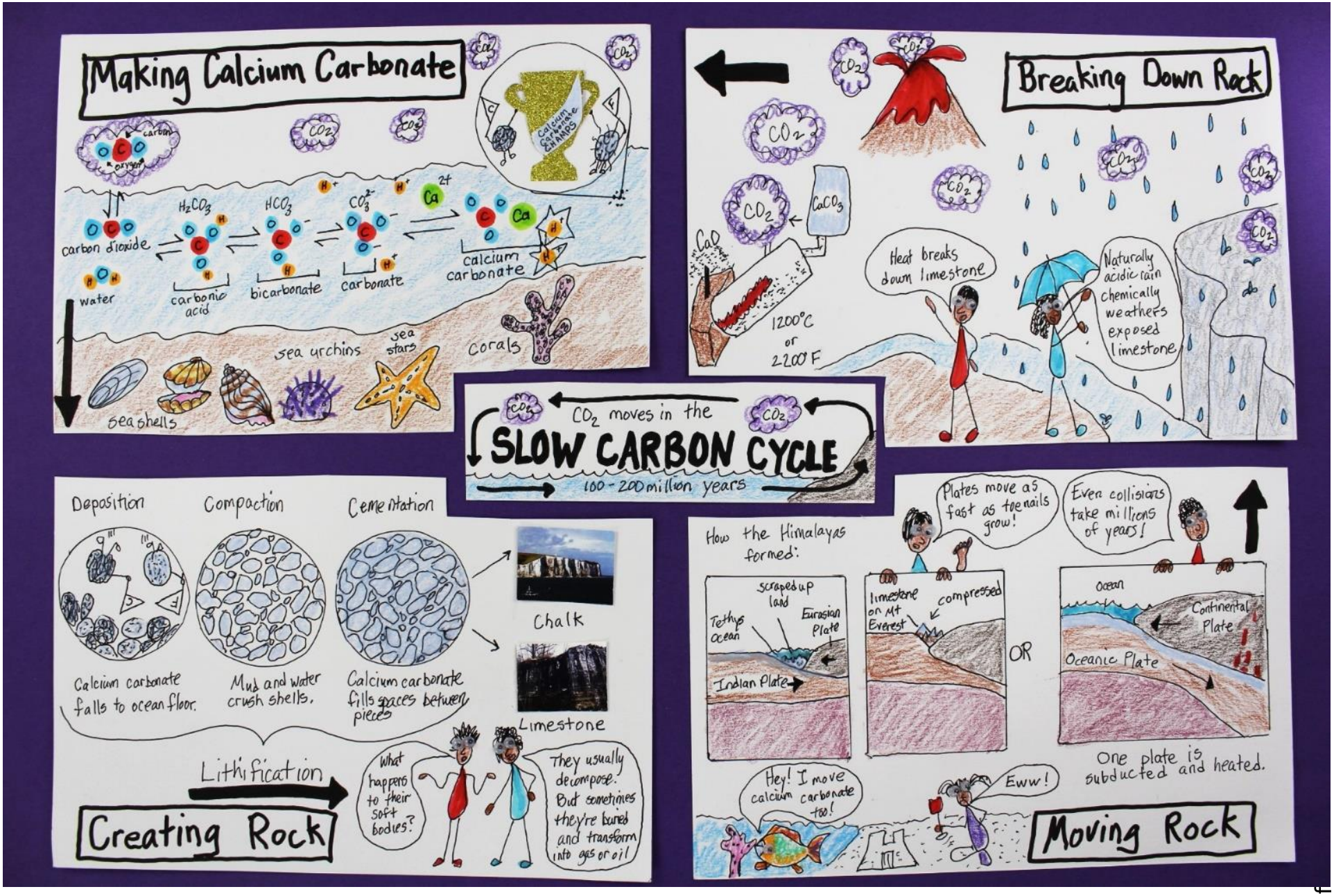
- Episode 2: Gas Exchange (How food is broken down, releasing CO_2 and water.)
- Episode 3: Campfires (How plants burn, releasing CO_2 and water.)
- Episode 8: Photosynthesis (How plants turn CO_2 and water into food.)
- Episode 9: Oceans (How carbon moves through a food web or pyramid.)

The slow carbon cycle:

- Episode 7: Volcanoes (How volcanoes form and release CO_2)
- Episode 10: The Slow Carbon Cycle (How CO_2 absorbed into oceans from atmosphere is incorporated into shells, falls as sediment, lithifies into rock, and releases CO_2 as it is heated (volcanoes or cement production) or chemically eroded.

Moving fossil fuels from slow carbon cycle into fast carbon cycle:

- Episode 4: Coal-fired Power Plants (How coal forms and is burned as a CO_2-generating heat source to create steam that turns a turbine and generator to produce electricity.)
- Episode 5: Crude Oil Fuels (How petroleum or crude oils form, are refined, and burned as a CO_2-generating fuel for cars and jets.)
- Episode 6: Natural Gas and Methane (How natural gas, which is mostly methane, forms and is burned as a CO_2-producing heat source. Includes fracking explanation.)


Making Calcium Carbonate
carbon
oxygen
carbon dioxide
water
carbonic acid
bicarbonate
carbonate
calcium carbonate
sea urchins
sea stars
corals
sea shells
Breaking Down Rock
Heat breaks down limestone
Naturally acidic rain chemically weathers exposed limestone
1200°C or 2200°F
CO2 moves in the
SLOW CARBON CYCLE
100-200 million years
Deposition
Compaction
Cementation
Calcium carbonate falls to ocean floor.
Mud and water crush shells.
Calcium carbonate fills spaces between pieces
Chalk
Limestone
Lithification
Creating Rock
What happens to their soft bodies?
They usually decompose. But sometimes they're buried and transform into gas or oil
How the Himalayas formed:
Plates move as fast as toenails grow!
Even collisions take millions of years!
scraped up land
Tethys ocean
Eurasian Plate
Indian Plate
limestone on Mt Everest
compressed
OR
ocean
Continental Plate
Oceanic Plate
One plate is subducted and heated.
Hey! I move calcium carbonate too!
Eww!
Moving Rock