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Name _____

Date _____

Episode 7: VOLCANOES, CO₂, AND CEMENT

Part I. Vocabulary Words: Review the given definitions. Define the remaining vocabulary words as you watch Cog's [Episode 7: Volcanoes and CO₂](https://youtu.be/9rKx5cziiPY). <https://youtu.be/9rKx5cziiPY>

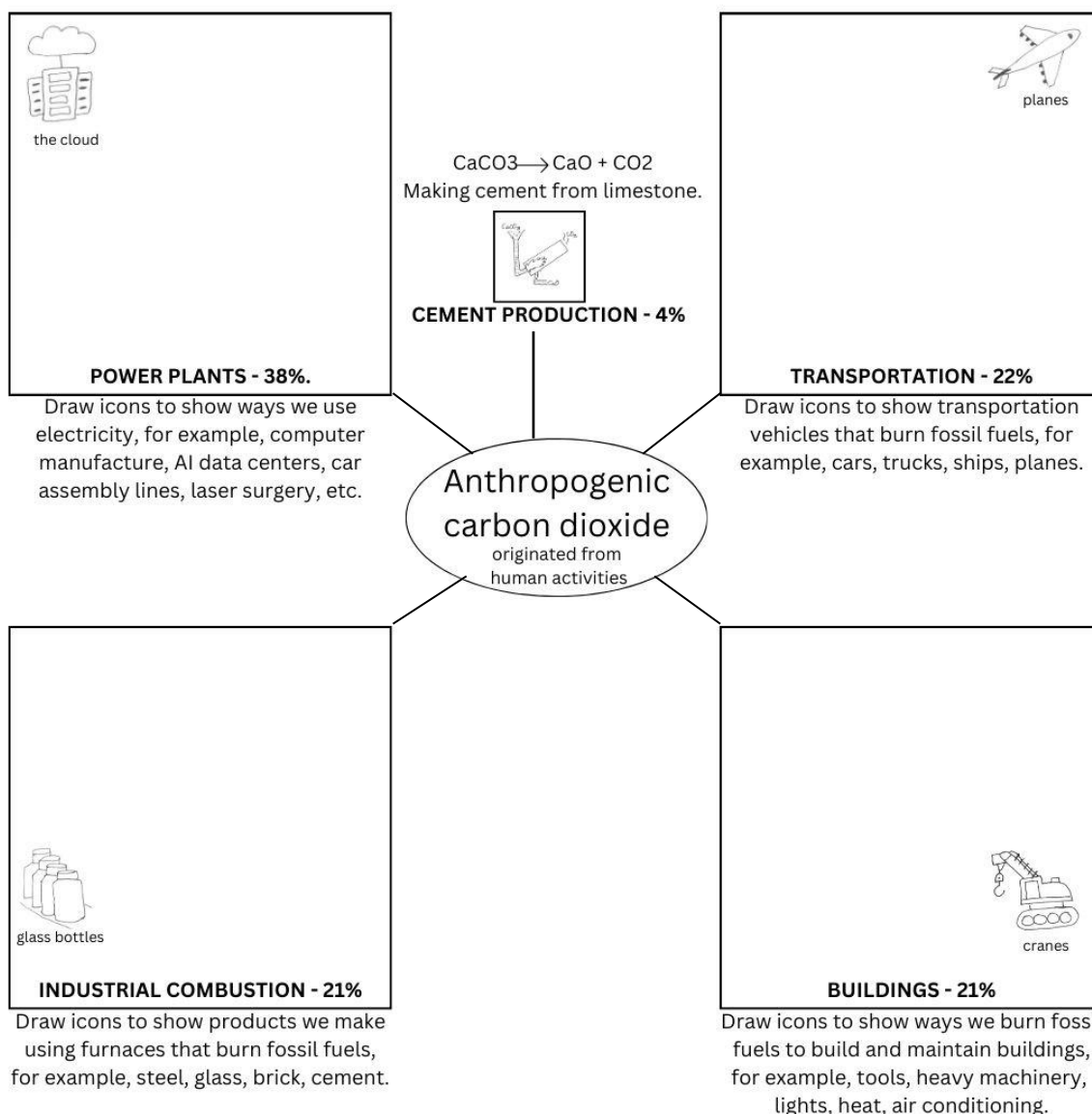
- **Pressure** [1:00] is a steady force upon an area. High pressure is exerted by lots of gas molecules in a container. The same container with few gas molecules has low pressure.
- **Magma** [2:10] is molten or hot, liquified rock trapped underground. When magma flows to Earth's surface, it is called lava.
- **Tectonic plates** [2:52] are pieces of Earth's rigid outer layer. About a dozen large plates and several small plates float on a soft layer of molten rock.
- **Divergent plates** [3:00]
- **Hotspots** [3:15]
- **Subducting plates** [3:23]
- **Anthropogenic CO₂** [5:50]
- **Calcium oxide** [6:40]
- **Cement** [6:40] is about 67% powdered limestone or CaCO₃. Add water, sand, and gravel to make concrete, the most common building material on Earth today.

Part II. Answer after viewing the video.

Why does a can of soda explode when you open it after shaking it?	Why are CO ₂ and water gases released when a volcano erupts?
What are the four major human activities that release the most anthropogenic CO ₂ ? 1. 2. 3. 4.	Why does making cement release so much anthropogenic CO ₂ ?

Take a deeper dive after viewing the video:

Part III. Anthropogenic carbon dioxide is released when we burn fossil fuels. Draw as many icons as you can that illustrate reasons we burn fossil fuels. Visit <https://thenounproject.com> to help you envision icons if you have access to a computer.



Part IV. Think Big: We produce a lot of anthropogenic CO_2 ! Every year we release about 100 times more CO_2 than volcanoes. Volcanoes also spew ash and aerosols into the atmosphere that temporarily “shade” the Earth and cool it. When Mt. Tambora erupted it caused “the year without summer.” If climate change causes too much heat, we could geoengineer clouds of aerosols to “shade” the Earth and cool it. Is this a good idea? Explain.



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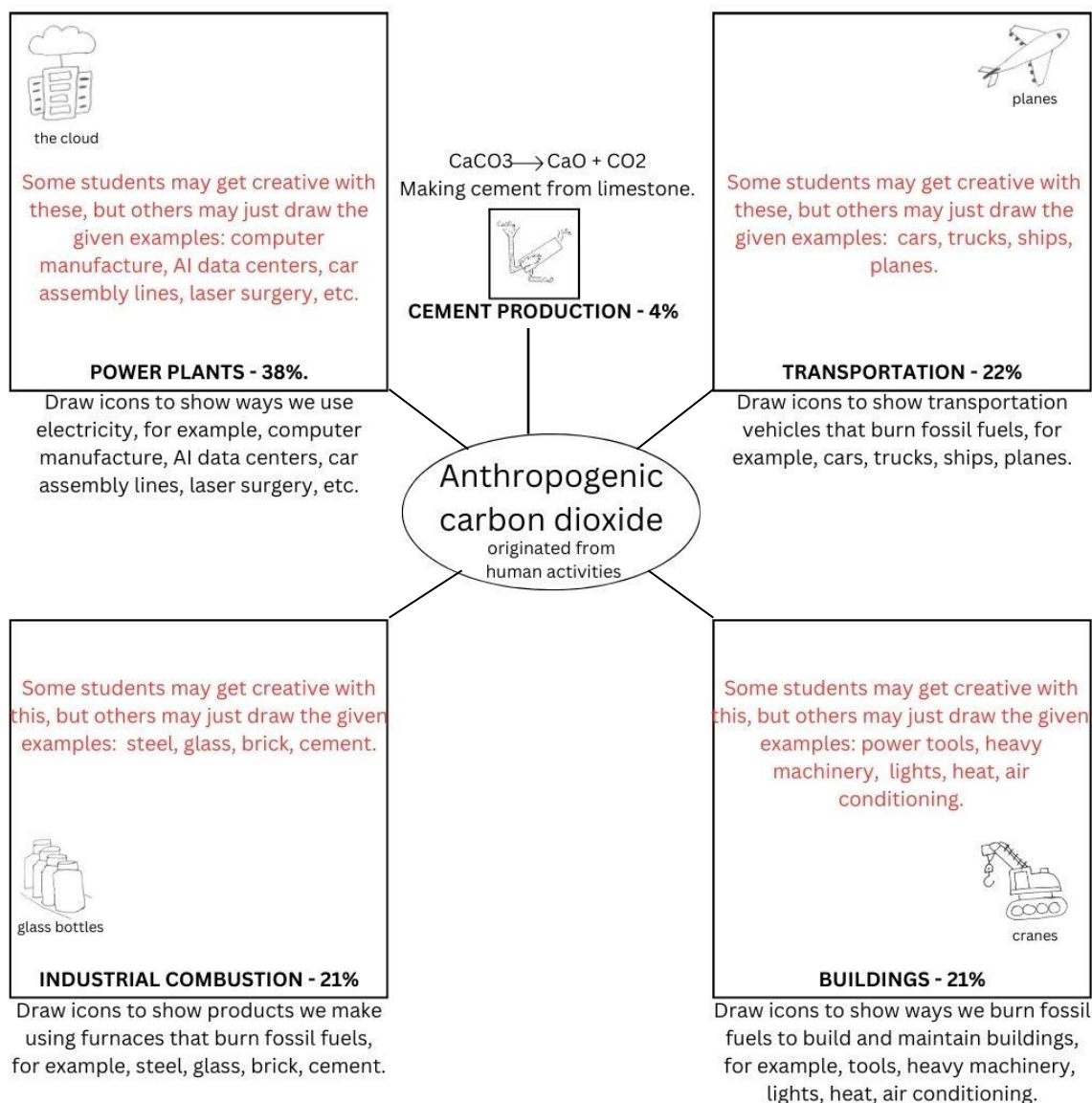
- **Pressure** [1:00] is a steady force upon an area. High pressure is exerted by lots of gas molecules in a container. The same container with few gas molecules has low pressure. **Magma** [2:10] is molten or hot, liquified rock trapped underground. When magma flows to Earth's surface, it is called lava.
- **Tectonic plates** [2:52] are pieces of Earth's rigid outer layer. About a dozen large plates and several small plates float on a soft layer of molten rock.
- **Divergent plates** [3:00] **move away from each other exposing magma.**
- **Hotspots** [3:15] **are places where unusually hot magma pierces the tectonic plate. Thin, runny magma oozes out.**
- **Subducting plates** [3:23] **happen where 2 plates collide and one is pushed under the other. Often the oceanic plate is pushed under continental plate.**
- **Anthropogenic CO₂** [5:50] **is carbon dioxide produced by human activities.**
- **Calcium oxide** [6:50] **is the primary ingredient of limestone, a rock. The chemical formula for limestone is CaCO₃.**
- **Cement** [6:40] is about 67% powdered limestone or CaCO₃. Add water, sand, and gravel to make concrete, the most common building material on Earth today.

Part II. Answer after viewing the video.

Why does a can of soda explode when you open it after shaking it? Shaking the can gives it more energy, giving some of the gas enough energy to escape from the liquid. Pressure in the can rises. When you open it, you release the pressure. Gas wooshes out.	Why are CO ₂ and water gases released when a volcano erupts? CO₂ gas and water gas lower the mantle's melting point, forming magma blobs that rise. Higher up the pressure is lower, so the gases escape, creating enough pressure to erupt.
What are the four major human activities that release the most anthropogenic CO ₂ ? 1. Power Plants 2. Transportation 3. Industry 4. Buildings	What are 2 reasons that making cement releases so much anthropogenic CO ₂ ? 1. CaCO₃ is heated until CO₂ is released as gas, leaving behind CaO powder. 2. To heat the CaCO₃ to such high temperatures, we burn fossil fuels that release CO₂ when burned.

Take a deeper dive after viewing the video:

Part III. Anthropogenic carbon dioxide is released when we burn fossil fuels. Draw as many icons as you can that illustrate reasons we burn fossil fuels. Visit <https://thenounproject.com> to help you envision icons if you have access to a computer.



Part IV. Think Big: We produce a lot of anthropogenic CO_2 ! Every year we release about 100 times more CO_2 than volcanoes. Volcanoes also spew ash and aerosols into the atmosphere that temporarily “shade” the Earth and cool it. When Mt. Tambora erupted it caused “the year without summer.” If climate change causes too much heat, we could geoengineer clouds of aerosols to “shade” the Earth and cool it. Is this a good idea? Explain. Answers will vary. The student must choose whether we should pursue this and then justify why or why not. Reasons to proceed would be that life on Earth was in danger and people weren’t taking necessary action to protect it. Reasons not to proceed include that we can’t be sure how the aerosols would travel in the atmosphere, covering which areas or for how long. Also, it’s only a temporary solution, so we’d have to keep producing these clouds of aerosols. Unintended consequences are a danger with a project like this. If time allows, use Think-Pair-Share to begin a discussion.

TEACHER RESOURCES

NGSS Standards:

[MS-PS1-2](#) Substances like CaCO_3 (limestone) being heated to produce CaO for cement.

[MS-PS1-3](#) Synthetic materials come from a natural resource (cement from limestone).

[MS-ESS2-2](#) Geoscience processes cause volcanic eruptions, changing Earth's surface.

[MS-ESS3-4](#) Increases in human population and consumption impact Earth's systems.

[MS-ESS3-5](#) Clarify evidence of factors causing rise in global temperatures.

Experiment resources:

[Find directions for the experiment](#) with gases being released from carbonated liquids at [7faa47_c5334c22c74c4e43b3a54b93587ee0a1.pdf \(filesusr.com\)](https://filesusr.com/7faa47_c5334c22c74c4e43b3a54b93587ee0a1.pdf)

Description: This worksheet goes along with the Cog's Episode 7 video about volcanoes and carbon dioxide [8:37]. It can be used by teachers or their substitutes (given the answer key) to guide learning, check for understanding, and interpret significance of the information in

[Episode 7: CARBON FROM VOLCANOES](#)

<https://youtu.be/9rKx5cziiPY>

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. Some vocabulary words have been defined and should be discussed before viewing the video. The remaining vocab words can be defined as you watch the video. The timestamp 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 the final sketchnote, page 7 of this document or [8:02] in the video. If time permits, share student answers. Ask students to jot down any new information they've gathered from the discussion.

Part III. To warm them up, ask the class to brainstorm some human activities that burn fossil fuel, like driving a car, or turning on the air conditioner. After you have about 5 ideas, decide whether they belong in the category of Power Plants, Transportation, Industrial Combustion, or Buildings. If it could go into two categories put it in the category where the fossil fuel is actually burned. Building lights would go in Power Plants. Now give students 3-5 minutes to draw icons for anthropogenic CO_2 production. The website <https://thenounproject.com> 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 thinking by trying to draw. Stick figures are fine. When the time is up, ask students to share their ideas, so others can add icons to their worksheet.

Part IV. Think Big: (Think-Pair-Share) Give students 1-2 minutes to **Think** about whether or not we should geoengineer clouds of aerosols to shade Earth. If time allows, 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. Bring the class back together and begin a class discussion about when (if ever) they think it would be time to start geoengineering aerosol clouds.

WATCH RELATED COG VIDEOS ABOUT THE CARBON CYCLE:

The fast carbon cycle:

- [Episode 2: Cellular Respiration & the Fast Carbon Cycle](#) (Food becomes CO₂ and H₂O.)
- [Episode 3: Campfires](#) (How plants burn, releasing CO₂ and water.)
- [Episode 8: Photosynthesis](#) (How plants turn CO₂ and water into food.)
- [Episode 9: Oceans](#) (How carbon moves through a food web or pyramid.)

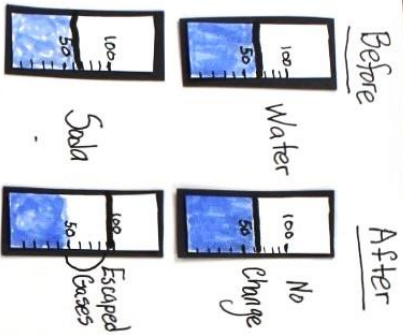
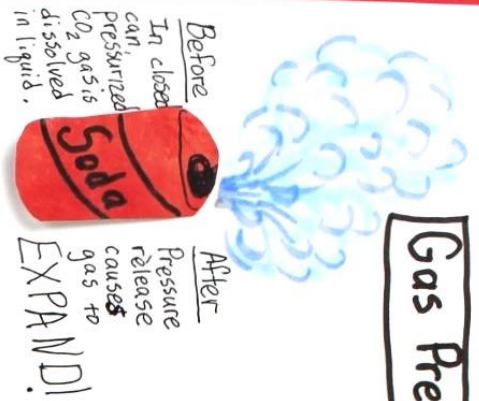
The slow carbon cycle:

- [Episode 7: Volcanoes and CO₂](#) (How volcanoes form and release CO₂.)
- [Episode 10: The Slow Carbon Cycle](#) (How CO₂ is absorbed into oceans from atmosphere, incorporated into shells, falls as sediment, lithifies into rock, which can release CO₂ when heated (volcanoes or cement production) or chemically eroded.)

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

- [Episode 1: Carbon Dioxide: A Greenhouse Gas](#) (Intro to climate change.)
- [Episode 4: Coal-Fired Power Plants](#) (How coal forms and is burned as a CO₂-generating heat source to create steam that turns a turbine and generator to produce electricity.)
- [Episode 5: Crude Oil Fuels](#) (How crude oils (petroleum) form, are refined, and burned as transportation fuels that release excess CO₂ into the atmosphere.)
- [Episode 6: Natural Gas and Methane](#) (How natural gas, which is mostly methane, forms and is burned to produce heat, also releasing excess CO₂. Includes fracking info.)

Gas Pressure and Volume



There is about 150 ml of CO_2 in 160 ml of Soda.

Volcanic Gas



① Gases dissolve in mantle lowering its melting pt, forming magma blobs.

- ④ Kapow!
- ③ Gas pressure ↑.
- ② Magma blobs rise because gases make them less dense.

VOLCANOES

CO_2 comes from

CO_2 production

CO_2 production	
Power plants	38%
Transportation	22%
Industrial Combustion	21%
Buildings	9%
Other	10%
Anthropogenic CO_2	37.5%
Volcanic CO_2	0.375%

$$\frac{\text{Anthropogenic } \text{CO}_2}{\text{Volcanic } \text{CO}_2} \approx \frac{37.5\%}{0.375\%} = 100$$



CO_2 from Volcanoes



We produced 100 times more CO_2 than volcanoes.

CO_2 from Cement

1.7 qt CO_2 from cement
0.375 qt CO_2 from volcanoes
= 4.5 times more CO_2 from cement

100 lbs or 45 kg Lime stone CaCO_3 calcium carbonate
1 ft or 30 cm
1 ft or 30 cm

45 lbs or 20 kg carbon dioxide CO_2

55 lbs or 25 kg calcium oxide

Don't forget the fossil fuel world!

which is 17% of cement

1200°C or 650°F