Monday	Tuesday	Wednesday	Thursday	Friday
4/27 Do Lesson 1 Collecting Carbon Activity in assignment #2.	4/28 Revise your paragraph that you wrote for part 5 of assignment #1. Call Dr. Libeu and leave a voicemail of you reading your paragraph.	4/29 **Assignment #3** Do part 1, Start reading and annotating "Why worry about CO_2?"	4/30 **Assignment #3** Finish reading and annotating " The Earth's Radiation Budget" Finish Part 2	5/1 **Assignment #3** Do Part 3: Solve the Puzzle
5/4 **Finish Assignment #3:** Do Part 4: Explain why Venus is hotter than Earth. *Make sure you draw an excellent cartoon or spend some time working on your paragraph.*	5/5 **Assignment #4** Part 1 Read and annotate the article about the carbon cycle.	5/6 **Assignment #4** Finish reading and annotating part 1 and answer the questions	5/7 **Assignment #4** Do part 2: Solve the puzzle	5/8 **Packet #1 Due** **Assignment #4** Part 3: Complete the organizer.

All students are responsible for completing the work following the assignment schedule. The teacher instructions for obtaining and submitting your work online are different for each teacher, so please make sure that you are following the directions for your teacher. If you are returning written work, you must drop it off at the school by the collection dates established by the district to receive credit. All online work must be submitted by the collection date as well for students to get credit. All online work may be submitted early to your teacher upon completion of article and workbook.

If you need help or have question

<u>**Office Hours:**</u> Weekdays 10:30 -11:30am. Zoom tutorials for each lesson will be announced on Schoology and will start at 11:30am. If you are joining the tutorial, the expectation is that you will have completed any reading assignments before 11:30am so that you can participate in the discussion. For individual help: call (209)565-0124 between 2 pm and 3 pm, email cplibeu@tusd.net or message through Schoology. I will be answering emails and messages later in the afternoon.
<u>**Remind**</u>**:** I will be sending out zoom invites and other class information using remind. To sign up text @4e2k4kg to the number 81010

To obtain work online: Assignments with downloaded fillable pdfs are posted on Schoology

Online Submission of work instructions: Turn in your completed work to Schoology. There are individual assignments for each day. You can turn in either a completed pdf or a photo of your work. For multiple pages, it is easiest to make a video if you are not filling in the pdfs. Your name must be clearly written in ink on each page for the work to be accepted. ***Please do not email me files.***

To obtain printed packets: Pick up at school following the directions on the district website.

Submission of written work from printed packets: Drop off at school following the directions on the district website or take a photo/video and upload it to Schoology.

Why worry about CO_2?

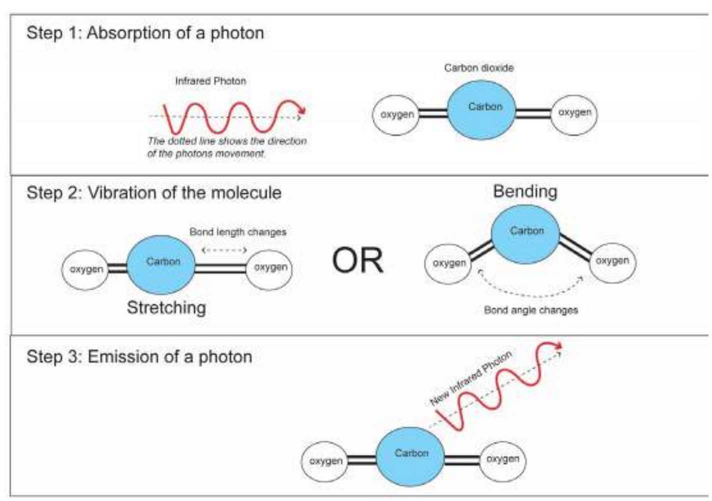
There are lots of gases in the atmosphere. The atmosphere is 70% nitrogen gas (N_2) and 20% oxygen gas (O_2), but only 0.04% is carbon dioxide (CO_2) . Why is such a tiny amount of carbon dioxide (CO_2) so important to the temperature of the planet? What physical properties does CO_2 have that N_2 and O_2 do not?

Absorption of Photons

The difference between the gasses has to do with how molecules respond when exposed to radiation. All radiation like ultraviolet light, visible light, and infrared radiation can be thought of as a stream of tiny packets of energy (photons). Infrared photons have the lowest energy. Visible light photons are in the middle. Ultraviolet light photons have the highest energy. No matter their energy content, all photons can affect electrical processes. For example, when the activity of the sun dramatically increases (a solar flare), the sensitive electrical systems in satellites are affected and suddenly your cell phone does not work as well. This property of photons means that they can interact with the electrons in a molecule and cause them to move. Movement of electrons weakens some bonds and strengthens others which allows the atoms inside the molecule to move. When the energy of the photon is transferred into the movement of the electrons, the photon disappears. When this happens, we say that the photon has been absorbed. We watched this phenomenon in class. Remember when Dr. Libeu used the laser pointers and colored water to show that food coloring absorbs some colors of light and not others.

Bending and Stretching

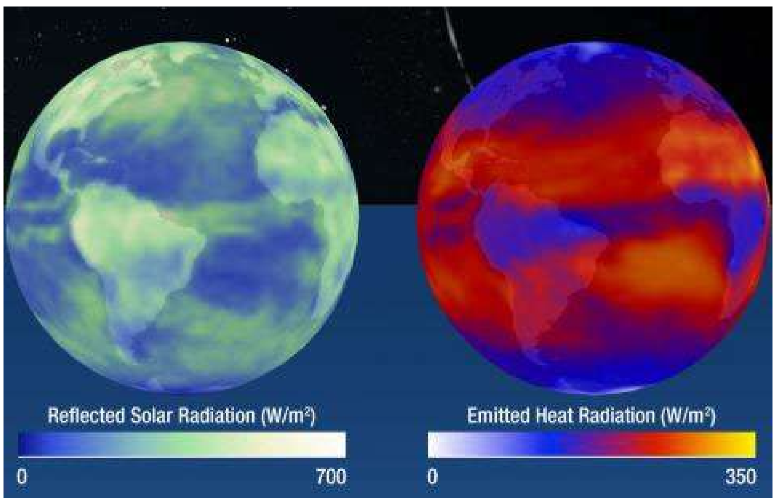
To understand why some molecules are greenhouse gases, one must understand what happens after the photon has been absorbed. After absorbing a photon, a molecule vibrates as all of atoms move in different directions. There are two main types of movements: stretching and bending. Stretching happens when the bonds expand and contract. Bending happens when the atoms move so that the angle between them changes. If you want to see an animation of the vibrations in carbon dioxide after it absorbs a photon check out https://scied.ucar.edu/carbon-dioxide-absorbs-and-re-emits-infrared-radiation.



Greenhouse gases absorb and then emit infrared photons. This process redirects infrared photons that would escape from earth back towards the planet.

Which photons will be absorbed?

For each molecule, only photons with enough energy to cause stretching or bending motions will be absorbed. All other photons will simply pass by the molecule. This effect is why for example, red food coloring does not absorb red light, but does absorb green and blue light. Green and blue photons have more energy that red photons. The energy of red photons is not high enough to cause bending or stretching motions in red dye molecules. Only green and blue photons can be absorbed. The red photons are ignored by the dye molecules. An important difference between CO_2 and N_2 or O_2 is that CO_2 has three atoms. N_2 and O_2 only have two atoms. They can only do stretching motions and stretching bonds takes a lot of energy. This is because the two atoms are the same. The electronegativity of each atom in the bond is equal. Both atoms equally resist losing their share of electrons, so it takes more energy to change the bond length in diatomic gasses then for a bond between atoms that have different electronegativities. In addition, because of the extra atom, CO_2 can bend. For most molecules, bending motions take much less energy, so CO_2 can absorb the lower energy infrared photons while O_2 and N_2 do not. It is a general rule that diatomic molecules do not absorb infrared photons.



The energy budget is the difference between the incoming solar radiation and the outgoing radiation. The temperature of the planet is determined by how much energy is retained near the Earth's surface.

This picture shows satellite measurements of the two parts of the outgoing radiation. The reflected solar radiation image on the left is mostly higher energy photons like ultraviolet and visible light. The emitted heat radiation counts the infrared photons leaving the planet. Heat radiation is another name for infrared radiation. Heat radiation is different than heat. Heat is the amount of energy contained in a substance that determines its temperature. However, because infrared radiation is given off when objects cool, the temperature of an object and the amount of infrared radiation coming from it are related. NASA uses images like these to measure how much energy is leaving the planet at any one time and calculate the global temperature.

Infrared photons heat things up.

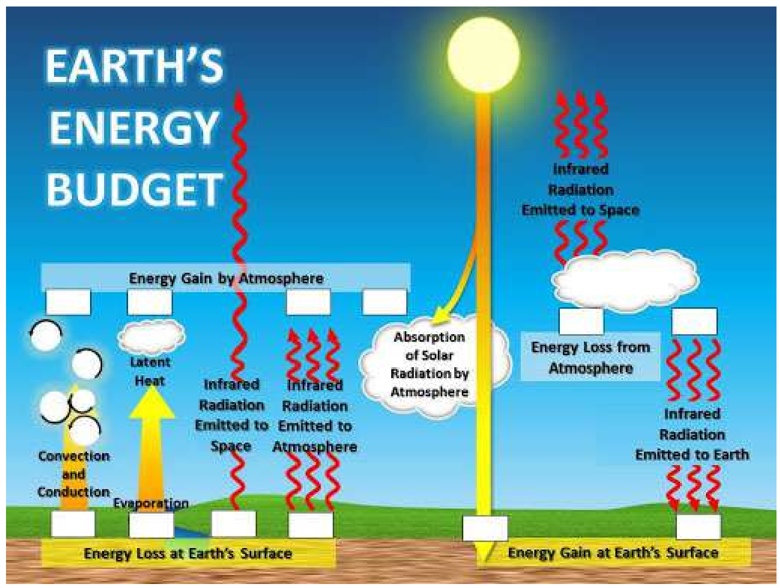
Although all molecules absorb photons. Greenhouse gases absorb infrared photons. About 50% of solar energy arriving at the earth is in the form of infrared photons. Infrared photons are the most effective photons at transferring energy to substances which is stored as heat. Heat lamps for example work by emitting infrared photons which transfer some of their energy to molecules in the air. All the energy goes into increasing the molecules motion and the temperature raises. In this case, the energy is not just moving electrons, but the entire molecule!

Changing the direction of an infrared photon gives it a second chance to heat something up.

Many people become confused by the fact that carbon dioxide molecules absorb infrared photons. They think because carbon dioxide absorbs infrared photons, it also absorbs heat. This misconception happens when people do not understand the difference between heat and photons. They are two different types of energies. Heat is an energy that is contained within a substance and is related to the motion of its molecules. Photons are particles of light that contain energy. For example, if you leave metal out in the sun, it will warm up because the metal absorbs some of the energy from the sun's radiation. In this example, the metal absorbs infrared photons and turns them into heat energy that is stored in the metal. Because of this misconception some people argue that increasing carbon dioxide in the air should decrease the temperature of the planet. Therefore, global warming cannot be related to carbon dioxide.

How can absorption of infrared photons make something hotter?

Greenhouse gas molecules can only hold the absorbed energy from the photons for a tiny fraction of a second. Eventually a new photon, is released so the absorbed energy reappears. It was never lost; it was just temporarily stored in a different form. However, the absorption and emission process can change the direction of travel of the infrared photons. Greenhouse gases can redirect infrared photons that were originally traveling away from the earth into space back towards the earth. You can almost think of them as making a mirror for infrared photons. The effect of greenhouse gases is like using aluminum foil to surround the area heated by a heat lamp. The foil reflects the radiation back so that more infrared photons are retained within the area affected by the lamp.



The concentration of greenhouse gases in the atmosphere is high enough that relatively few infrared photons escape from Earth's atmosphere back into space on their first try, instead they are redirected over and over. This effectively increases the amount of time that infrared photons spend near the surface of the Earth and increase the probability that their energy will be converted heat energy.

Carbon Dioxide is Not the only Greenhouse Gas

Any molecule with more than two atoms that vibrates can absorb infrared radiation. Carbon dioxide is not the only greenhouse gas in the atmosphere. Water (H_2O), methane (CH_4), dinitrogen oxide (N_2O) and ozone (O_3) are natural infrared absorbers found in the atmosphere and all of them play a role in determining how much infrared radiation is prevented from escaping the inner atmosphere. These molecules vary at how effective they are at absorbing and remitting infrared photons. For example, methane is thirty times more effective than carbon dioxide. However, the amount of methane in the atmosphere is less than 5% that of carbon dioxide. Halogenated molecules like trichlorofluoromethane (CCl_3F) and dichlorodifluoromethane (CCl_2F_2) are more the 20,0000 times more effective. Fortunately, these man-made molecules are very rare. Water is the most abundant greenhouse gas in the atmosphere, but it is ten times less effective than carbon dioxide at redirecting infrared photons. However, carbon dioxide is the champion. Carbon dioxide captures and retains nearly half the infrared radiation reflected from the earth's surface.

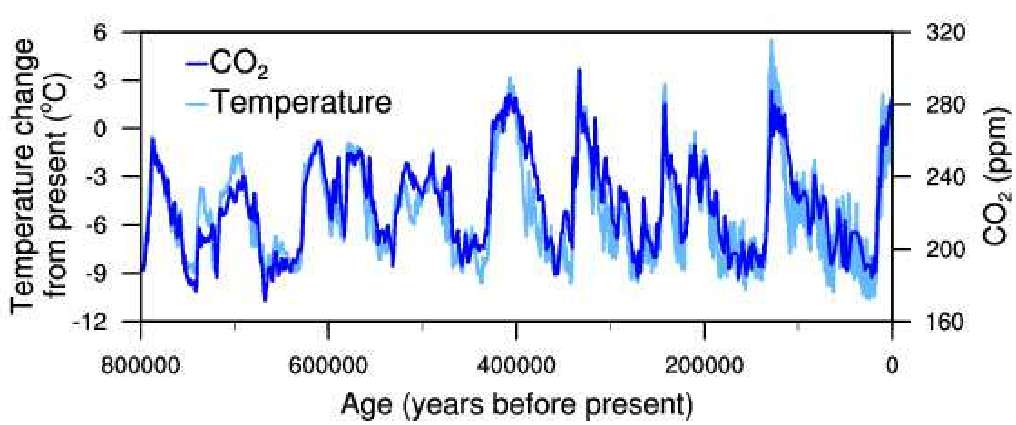
The Amount of Carbon Dioxide in the Atmosphere Correlates with Global Temperature.

Unlike water, whose abundance in the atmosphere is relatively stable. The concentrations of carbon dioxide and methane have been slowly increasing in the atmosphere over the last two hundred years due to human activity. In the atmosphere, carbon dioxide does not typically react with other molecules. As a result, carbon dioxide generated on the surface spreads throughout the atmosphere forming a stable layer. The layer is more concentrated near the surface and less concentrated as the altitude increases.

The famous chemist Svante Arrhenius first proposed that the concentration of carbon dioxide in the atmosphere played a role in setting the temperature of the earth in 1896. At the time, scientists were trying to explain why the ice ages happened. The greenhouse effect was at first controversial but over the last 124 years, scientists have collected data in many very clever ways to show that the temperature of the planet and the amount of carbon dioxide in the atmosphere are related.

The data shows that changes in the carbon cycle affect the global temperature. The carbon cycle is a model of how carbon moves between the atmosphere, the ocean, and the lithosphere (rocks). The ocean and the lithosphere are called sinks because they are locations where more carbon is absorbed than released. The carbon in sinks is stored in very stable forms over long periods of time. Chemical processes release carbon mostly in the form of carbon dioxide and methane from these places into the atmosphere. By measuring the concentrations of carbon dioxide and methane in the atmosphere, scientists can estimate how much the balance between that release and absorption changes over time.

It turns out that changes in the concentrations of carbon dioxide and methane predict changes in the global temperature. Less carbon in the atmosphere means an ice age is coming. More carbon in the atmosphere means a tropical period is coming. Although it is hard to believe, we live in a time when the world is relatively cool. However, that is rapidly changing as more carbon accumulates in the atmosphere. Want to know more about the connection between global temperature and carbon dioxide, watch the Nova Episode Polar Extremes or checkout the website below.



Temperature change (light blue) and carbon dioxide change (dark blue) measured from the EPICA Dome C ice core in Antarctica (Jouzel et al. 2007; Lüthi et al. 2008).

Copied from https://www.ncdc.noaa.gov/global-warming/temperature-change.

Why worry about CO_2 ?

Do part 1 before you read the article!

Part 1: What do you know about the greenhouse effect?

Many people have heard of "the greenhouse effect." But what does that mean? Select all the statements you think apply to the greenhouse effect.

- ☐ 1. The greenhouse effect is related to increasing global temperatures
- ☐ 2. The greenhouse effect supports why we should stop building greenhouses.
- ☐ 3. The greenhouse effect is about the thinning of the ozone layer.
- ☐ 4. The greenhouse effect contributes to increased skin cancer.
- ☐ 5. The greenhouse effect is caused by using spray cans and air conditioners.
- ☐ 6. The greenhouse effect is the same thing as global warming.
- ☐ 7. The greenhouse effect reduces the amount of oxygen in the atmosphere.
- ☐ 8. The greenhouse effect is the main cause of hurricanes.
- ☐ 9. The greenhouse effect can contribute to a change in weather patterns.
- ☐ 10. The greenhouse effect can be reduced by using unleaded gasoline.
- ☐ 11. The greenhouse effect is related to increased use of fossil fuels.
- ☐ 12. The greenhouse effect is one of the causes of acid rain.
- ☐ 13. The greenhouse effect is related to human activities.
- ☐ 14. The greenhouse effect can be controlled by keeping beaches clean.

Explain your thinking. Describe what you know about the greenhouse effect (25 words).

A statement is about the greenhouse effect when it is talking about.......

or

I know that the greenhouse effect is caused by......

Do Parts 2-4 after you read the article "Why worry about CO_2 ?"!

Part 2: Read the article "Why worry about CO_2" and answer the following questions after you read the article.

During your first reading you should annotate the text using the instructions in your planner.

Box words you don't know.
Circle key terms, relevent names, dates places.
Put a ? mark by anything that is you have a question about or that is confusing.
Put an ! mark next to interesting or surprising information.
Highlight the author's claims/arguments/points and supporting evidence

Online TIP: If you are working in adobe acrobat reader on your phone, tap the pencil icon and will open a menu that will allow you to highlight and draw on the document.

1. List key terms from the article that you didn't know before and explain their meaning in your own words.
   Key term 1:
   Key term 2:
   Key term 3:

2. List two things that surprised you when you read the article
   Surprise 1:
   Surprise 2:

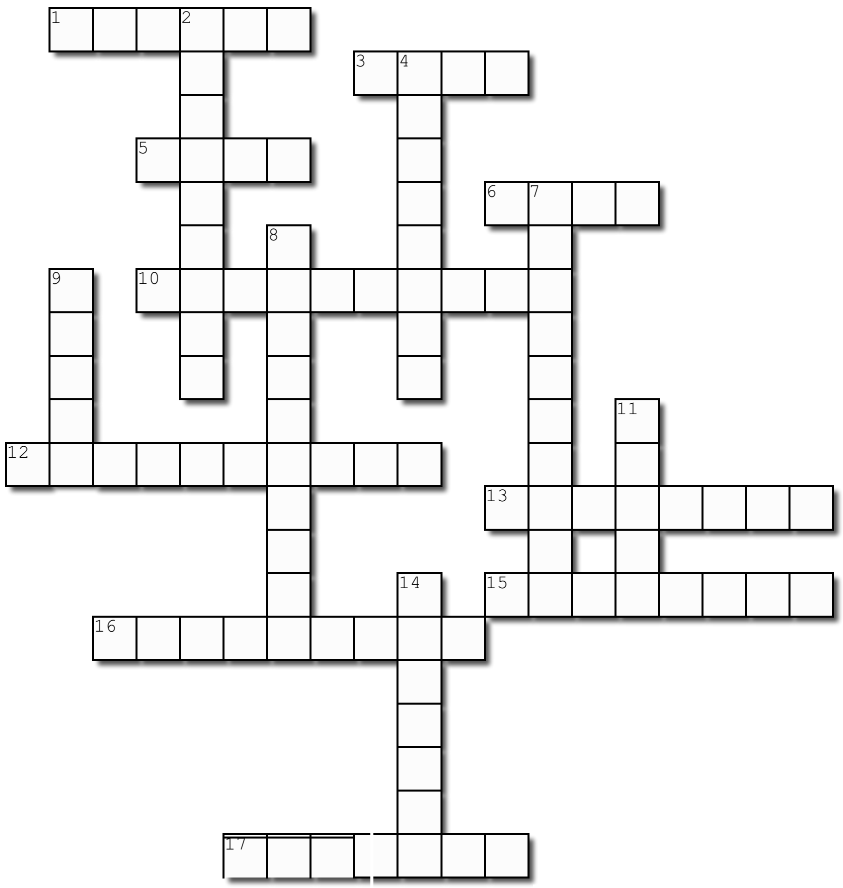
3. List one interesting fact that you learned when you read the article.

4. Connect the information in the article to topics that we studied this year. (at least 25 words)
   Explain how our studies of chemistry this year helped you understand the content of the article?
   Hint: We studied covalent bonding, structure of molecules, naming of molecules, absorption and emission of photons.

Name: ____________ **Period:** __3__ **Teacher:** _____Libeu_________

Part 3: Read the article "Why worry about CO_2 ?" a second time and complete the crossword puzzle below using the clues below and information from article.

Word Bank: *absorption, bending, diatomic, emission, greenhouse, half, halogen, heat, infrared, radiation, react, reflected, sink, stretching, thirty, vibrations, water*



Across

1. Methane is ________ times more effective at absorbing IR than carbon dioxide.
3. Energy stored in substances that determines it's temperature

5. A location at which more carbon dioxide is absorbed than released
6. Carbon dioxide captures and retains nearly __________ of the reflected radiation from the earth's surface

10. Bending, stretching or wiggling motions caused by changes in bond lengths

12. A motion in a carbon dioxide molecule caused by absorbing infrared photons.

13. Many gases that do not absorb infrared radiation are ______.

15. Photons that are efficient are warming objects.
16. Solar energy that is not absorbed by the earth's atmosphere is __________ radiation
17. Adding a _________ atom like fluorine or chlorine to a gas increases it's effectiveness to absorb radiation

Down

2. A stream of photons.
4. When light energy is released from a molecule

7. When light energy is used to move electrons within a molecule
8. Gases that absorb infrared photons are called _________ gases
9. Carbon dioxide does not typically __________ with other molecules in the atmosphere

11. The most abundant greenhouse gas in the atmosphere **14.** A vibration in a carbon dioxide molecule caused by absorbing an infrared photon.

Part 4:

1. Use the table above and the at least five of the vocabulary words from the crossword puzzle to explain why the average temperature of the planet Venus is 467°C, while the average temperature of the Earth is 14.6°C. . You may either draw a cartoon or write a short paragraph (50 words).

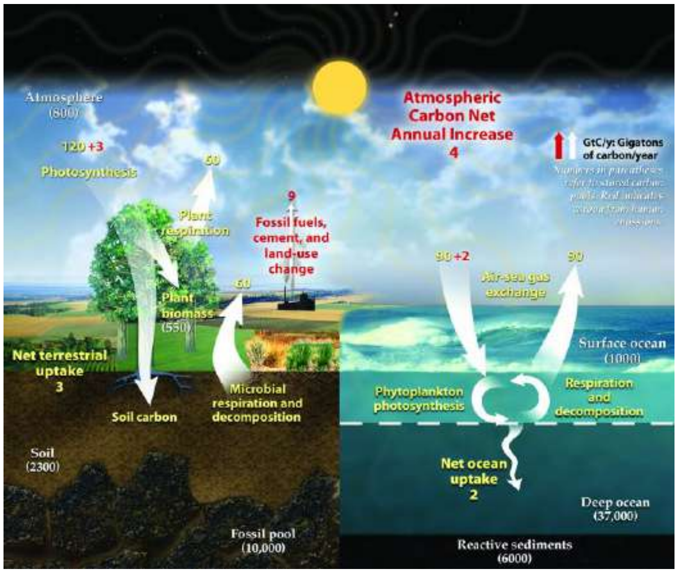
Atmospheric Composition

Gas	Earth (%)	Venus (%)
N_2	78	3.5
Ar	0.9	trace
O_2	21	trace
CO_2	.04	96.5

Write your explanation here.

2. Now that you know more about the greenhouse effect, what are your thoughts about global warming? You can either leave me a voicemail at (209) 565-0124 or you can participate in the online discussion on Schoology. You should make at least one comment yourself and respond to two other people. You must make at least one comment before you can see what everyone else has said. Its OK to make more comments and replies, but remember to be respectful.

The Carbon Cycle



The white arrows show the movement of carbon between the atmosphere, the land and the ocean. The numbers are estimates of the amount of carbon that each process moves in gigatons. A gigaton is one billion metric tons or 1,000,000,000,000 (10^{12}) kilograms.

Carbon is the foundation of all life on Earth and is required to form complex molecules like proteins and DNA. This element is also found in our atmosphere in the form of carbon dioxide (CO_2). Carbon helps to regulate the Earth's temperature. Carbon makes all life possible. Carbon is a key ingredient in our food. Carbon provides a major source of the energy to fuel our global economy.

The carbon cycle describes the process in which carbon atoms continually travel from the atmosphere to the Earth and then back into the atmosphere. Since our planet and its atmosphere form a closed environment, the amount of carbon in this system does not change. Carbon is constantly moving from one place to another through chemical processes.

On Earth, most carbon is stored in rocks and sediments, while the rest is located in the ocean, atmosphere, and in living organisms. These are the reservoirs, or sinks, through which carbon cycles.

Carbon is released back into the atmosphere when organisms die, volcanoes erupt, fires blaze, fossil fuels are burned, and through a variety of other mechanisms.

In the case of the ocean, carbon is continually exchanged between the ocean's surface waters and the atmosphere or is stored for very long periods of time in the ocean depths.

Some chemical processes like photosynthesis and metabolism cause carbon to make the round trip from the atmosphere and back in only tens to hundreds of years. These mechanisms are part of the fast part of the carbon cycle. Other mechanisms like chemical weathering and the rock cycle take millennia to move carbon from a sink like the mud at the bottom of the ocean back to the atmosphere. These mechanisms are part of the slow part of the carbon cycle.

The total amount of carbon in the atmosphere is determined by the balance of processes that remove carbon from the atmosphere and processes that return carbon to the atmosphere.

Humans play a major role in the carbon cycle through activities such as the burning of fossil fuels or land development. As a result, the amount of carbon dioxide in the atmosphere is rapidly rising; it is already considerably greater than at any time in the last 800,000 years.

To learn more about the carbon cycle, read about the eight chemical processes that transform carbon from one form to another and allow it to move between different sinks or between a sink and the atmosphere.

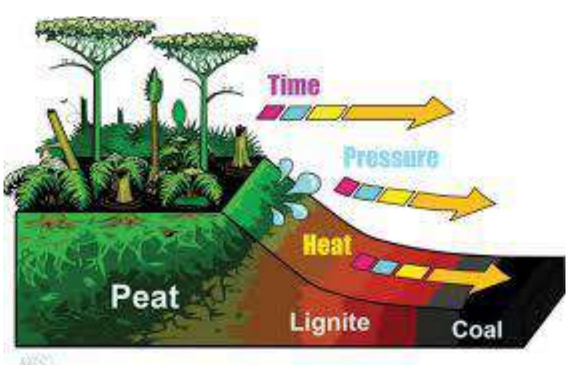
Adapted from "The carbon cycle" https://oceanservice.noaa.gov/facts/carbon-cycle.html

Carbonization

Carbonization is the process that creates hydrocarbons from organic molecules in the buried remains of organisms. These hydrocarbons are found in nature primarily as coal, oil and natural gas.

For carbonization to happen, the organic material must be deeply buried. The environment deep in the earth is hot. The weight of the rock and soil above also pushes down creating enormous pressure. Exposure to both high temperature and pressure causes a series of chemical reactions, that remove nitrogen, oxygen and sulfur from the organic molecules and leaves the carbon and hydrogen behind. The final result are molecules made of almost entirely carbon and hydrogen - hydrocarbons. The final size and shape of the hydrocarbons is determined by the amount of heat and pressure. Varying the heat and pressure produces different products such as natural gases (molecules with 1-4 carbons), liquid oils (molecules with 5-100s of carbons) or solid rocks (coals). Twenty percent of all carbon-containing rock on earth is a type of coal and was created by carbonization. The most common type of natural gas created is methane which has only 1 carbon. Most methane created by carbonization is trapped in pockets of rocks deep within the earth.

Natural carbonization is a slow process. For example, the carbonization process that converts peat forests into coal takes millions of years. The slowness of the process is why natural gas, oil and coal are called fossil fuels. Carbonization is part of the slow carbon cycle.



Decomposition

Decomposition is the process by which living organisms break down dead organisms. All living organisms contain large complex organic molecules made of carbon, hydrogen, oxygen, nitrogen and sulfur. When organisms die, bacteria and fungi use biological catalysts (enzymes) to break down the large molecules into smaller molecules. Catalysts are substances that help chemical reactions to happen at lower temperatures. Most chemical reactions used by living organisms require catalysts because they happen at low temperatures (0-40°C) .

The bacteria and fungi use some of the smaller molecules created by decomposition for food. Other molecules are released into the environment. Some molecules such as carbon dioxide (CO_2) and methane (CH_4) go into the atmosphere, but larger carbon-containing molecules stay in the soil or water. Decomposition is major source of the green-house gas methane in the atmosphere.

Decomposition is a rapid process. Depending on the activity of the bacteria and fungi and the size of the decomposing organism, decomposition may be complete in days to years. For example, mold which is a fungi can completely break down an orange within weeks. Decomposition is part of the fast carbon cycle.

Combustion

Combustion is a chemical reaction in which a molecule combines with oxygen and releases heat. An example of a combustion reaction would be burning natural gas (methane) or wood to heat a home. Another example would be the chemical reaction which converts gasoline into energy used to move a car. Combustion reactions involving fossil fuels are used to generate about 63% of the electricity in the US.

If the combustion reaction is efficient then all the carbon-containing product may be carbon dioxide (CO_2). However inefficient combustion can release carbon monoxide (CO) or VOCs into the air. VOCs are gases with more than two carbons so they are larger than carbon monoxide or carbon dioxide. VOCs are the molecules that leave the black residue from smoke. They are a major source of air pollution in US cities. Most VOCs in the US are produced by poorly maintained car and truck engines.

Combustion is an extremely fast reaction so it can be part of the fast carbon cycle. However, when combustion releases carbon into the environment from fossil fuels it also affects the slow carbon cycle. Therefore, combustion can connect the fast and the slow carbon cycle.

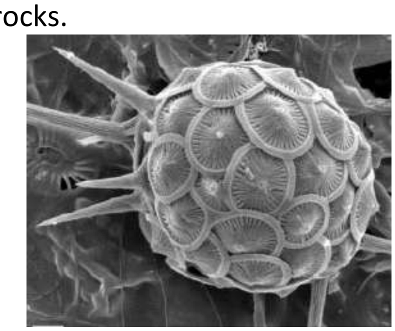
Mineralization

Mineralization is a chemical process that starts when positive and negative ions combine to form salts. When the salt is deposited in biological tissue or deep in the earth, it is called a mineral. Although most people think of rocks when they hear the term mineral, many carbon-containing minerals were created because of organisms' need for skeletons.

Many types of biological organisms can remove the carbonate ion (CO_3^{-2}) from water or convert carbon dioxide into a carbonate ion. The carbonate ion is then combined with a calcium ion to form calcium carbonate ($CaCO_3$). Human skeletons are about 4% carbonate by mass.

However, the champion organisms for the most carbonate used in skeletons are the humble coccolithophores. a type of phytoplankton. These microscopic organisms win the prize for the most carbon removed from the environment because of their sheer number. They live at the surface of the ocean and create elaborate calcium carbonate skeletons less than 0.1 mm in diameter. Most coccolithophores are also photosynthetic, so they can store carbon using two different processes.

Eighty percent of all carbon-containing rocks found on earth are composed of skeletons or shells of living organisms that harvest calcium carbonate from the ocean. Mineralization is a process that links the fast and the slow carbon cycles since it connects the carbon in organisms with the carbon found in rocks.



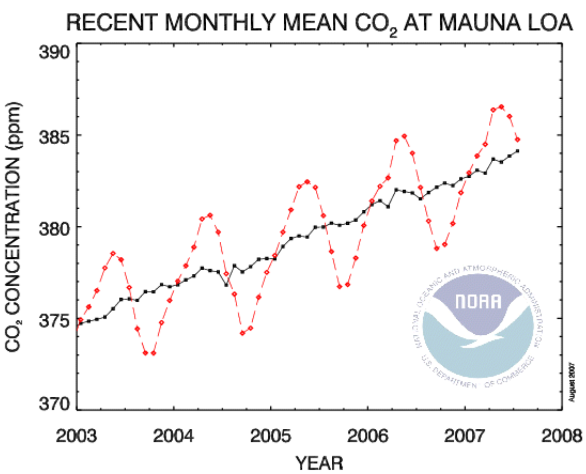
Skeleton of a coccolithophore

Photosynthesis

Photosynthesis is the process that plants, algae and some bacteria use to convert carbon dioxide from the air into sugar. Although organisms burn some of the glucose that they make for fuel using the process of metabolism, much of the sugar is converted into large carbon-containing molecules and stored.

Most people think of land plants when they think about photosynthesis. Much of the photosynthetic activity on Earth is performed by organisms living in the water. Slightly less than half of all carbon that was removed from the atmosphere and stored in the bodies of biological organisms came from the activity of photosynthetic organisms in the ocean.

Photosynthesis is part of the fast carbon cycle. Photosynthetic organisms pull enough carbon dioxide out of the atmosphere that scientists can measure seasonal changes in the carbon dioxide concentrations.



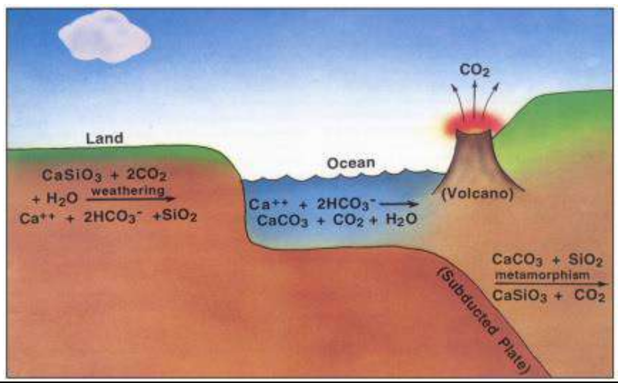
CO_2 in the atmosphere at Mauna Loa observatory. The graph starts at January of 2003 and ends at December 2007. The highest carbon dioxide concentrations occur at the beginning of spring. The lowest concentrations are at the beginning of fall.

Chemical Weathering

Chemical weathering is a process that occurs when water dissolves rocks and minerals and releases ions. Chemical weathering is part of the slow carbon cycle. Carbonate-containing rocks such as limestone or marble can be dissolved by acidic water. This chemical reaction releases carbonate ions into the environment. These carbonate ions can be transported by rivers and streams to the ocean. Release of the carbonate into the ocean completes a cycle started millions of years before since the carbonate in limestone and marble was originally stored in the skeletons of ancient coccolithophores.

Carbonate in water and carbon dioxide in the atmosphere are also connected through a chemical reaction. Depending on the relative amounts, carbon can be released into the air from the ocean as carbon dioxide or absorbed into the ocean becoming the carbonate ion. Until the last two hundred years, these processes were balanced. However, now more carbon dioxide is absorbed than released. The extra carbon is stored as the bicarbonate ion (HCO_3^-) and is responsible for the slow increase in the acidity of the oceans during the last two centuries.

Heat and pressure within the earth can also release carbonate from rocks and convert it to carbon dioxide. Volcanos release a significant amount of carbon dioxide into the atmosphere. This release is part of the slow carbon cycle. Previous very slow increases in carbon dioxide concentrations over thousands of years are thought to be caused by periods of high volcanic activity.



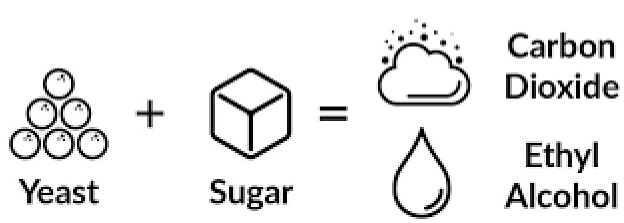
Metabolism/Respiration/ Fermentation

Metabolism are the chemical process that convert food into carbon dioxide, water and energy. Respiration is the part of metabolism that creates the carbon dioxide. Metabolism is part of the fast carbon cycle. These chemical reactions are necessary for life for all living organisms. For example, although plants absorb carbon dioxide for photosynthesis during the day, they are also constantly releasing carbon dioxide. Plants store carbon when the amount of carbon dioxide used in photosynthesis is more than the amount that is released because of metabolism.

Fermentation is a type of metabolism. It is best known as the metabolic process used to create alcoholic drinks like wine and beer from plant material. However, humans are also using fermentation to make ethyl alcohol and other small carbon-containing molecules like methane to the replace hydrocarbons derived from fossil fuels. Ethyl alcohol (CH_3OH) burns more efficiently and is less likely to create toxic gases like carbon monoxide and VOCs than gasoline. However, a burning alcohol produces only about half the energy as gasoline. Using mixtures of gasoline and alcohol as a transportation fuel have resulted in only small reductions in VOCs since more fuel must be burned to propel the vehicle.

Some have proposed that a better use for the products of fermentation might be as replacements for the hydrocarbons used to manufacture plastics and other carbon-rich products. The advantage of using fermentation to make these molecules is that very little extra energy is required for the process in comparison to the energy needed to create hydrocarbons suitable for manufacturing from oil.

Both fermentation and metabolism are part of the fast carbon cycle.



Polymerization

Polymerization is a chemical reaction that creates bonds between small molecules to create giant molecules. The plastic used in water bottles for example is called polyethylene. Each polyethylene molecule is thousands of ethylene molecules (CH_2CH_2) connected through the carbon to form a long chain.

Plastic is so popular that making plastic takes approximately 10% of the world's oil use each year. Although most plastics do not decompose, making plastic and tossing it in a landfill does not effectively remove carbon from the environment. Unlike photosynthesis which uses light energy, making plastic uses electrical energy. Energy is needed to break apart the large hydrocarbon molecules in oil to make smaller molecules suitable for polymerization. In addition, the polymerization reaction requires high temperatures and pressure. About 8% of the energy consumed each year in the US is used to make plastic. More carbon is released in the form of carbon dioxide creating the energy needed to make plastic than is stored in the plastic molecules in the final product. Recycling plastic uses less energy than making new plastic. One way to reduce the carbon released by manufacturing plastic products would be to use recycled plastic instead of new plastic.

The polymerization reaction connects the fast and the slow carbon cycles because both oil and combustion are used to make plastics.

Do Parts 1-3 after you read the article "The Carbon Cycle "!

Part 1: Read the article "The Carbon Cycle" and answer the following questions after you read the article.

During your first reading you should annotate the text using the instructions in your planner.

Box words you don't know.
Circle key terms, relevent names, dates places.
Put a ? mark by anything that is you have a question about or that is confusing.
Put an ! mark next to interesting or surprising information.
Highlight the author's claims/arguments/points and supporting evidence

Online TIP: If you are working in adobe acrobat reader on your phone, tap the pencil icon and will open a menu that will allow you to highlight and draw on the document.

1. List key terms from the article that you didn't know before and explain their meaning in your own words.
   Key term 1:
   Key term 2:
   Key term 3:

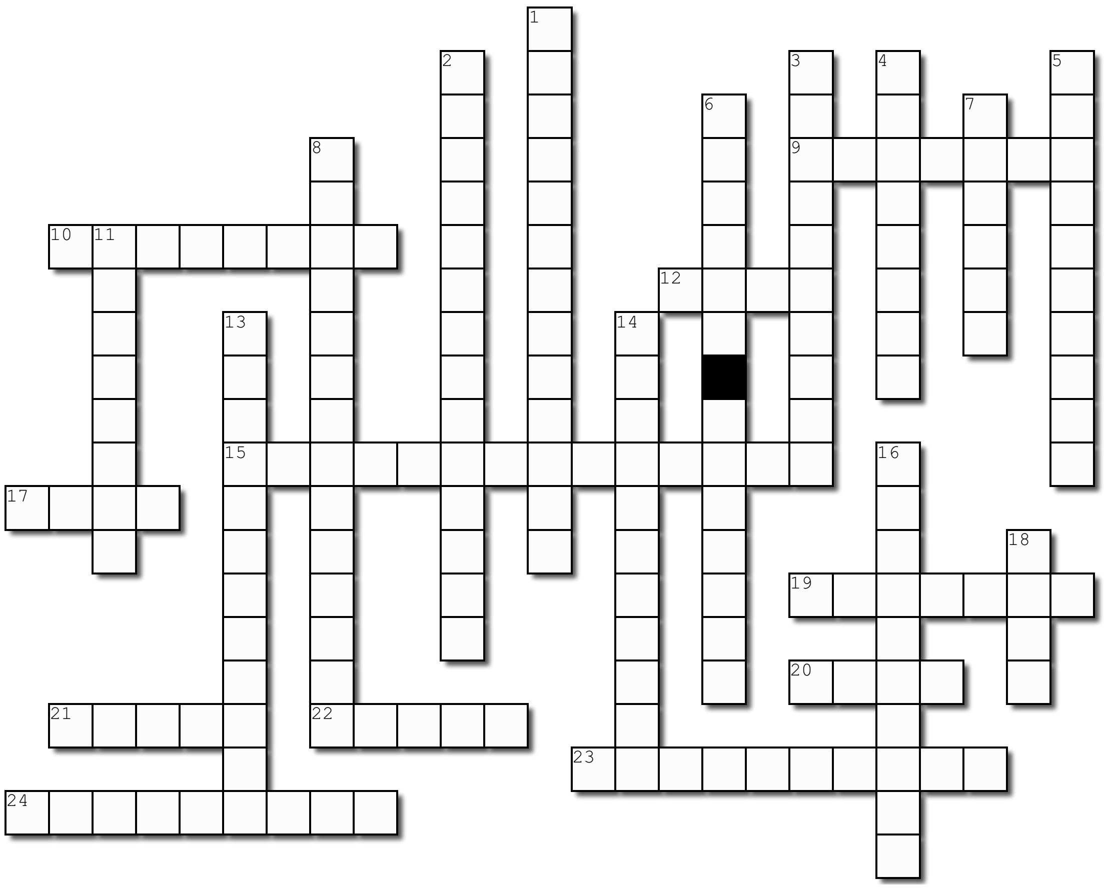
2. List two things that surprised you when you read the article
   Surprise 1:
   Surprise 2:

3. List one interesting fact that you learned when you read the article.

4. Connect the information in the article to your life. (at least 25 words)
   Which of the eight chemical processes do you think is most important for youc life?
   Make sure you explain your reasoning.
   I think that ___________ is most important because ____________.

Part 2:

<u>Directions: Read the article "The Carbon Cycle" and use the information in the reading and the clues below to solve the puzzle.</u>



Wordbank

carbonate | solar | plastic | fast | polymerization | marble | slow | weathering | mineralization | fermentation | bicarbonate | electrical | decomposition | combustion | metabolism | methane | sink | photosynthesis | fungi | organism | catalyst | VOCS | carbon dioxide | volcanos

Across

9. A product of carbonization and decomposition
10. Geological features that release carbon dioxide
12. pollutants created by inefficient combustion
15. The process that organisms use to make calcium carbonate skeletons.
17. The part of the carbon cycle in which carbon can move from one place or form to another in less hundreds of years
19. A product of polymerization
20. The part of the carbon cycle in which carbon can moves from one place or form to another in more than hundreds of years.
21. mushrooms and mold are members of this family
22. energy from the sun harvested by plants and other photosynthetic organisms.
23. A process that releases carbonate ions from carbon-containing rocks
24. The most common carbon-containing polyatomic ion

Down

1. The process by which living organisms break down dead organisms.
2. A chemical reaction that connects many small molecules in one giant molecules
3. A chemical reaction in which a molecule combines with oxygen and releases energy in the form of heat.
4. A substance that allows reactions to happen at low temperatures
5. energy created combustion to power factories and cities
6. Most of the carbon in the atmosphere is in this gas
7. A carbon-containing rock composed of the skeletons of coccolithophores
8. A process that uses solar energy to make sugars from carbon dioxide
11. A living thing
13. A metabolic process that can be used to make fuel.
14. The polyatomic ion in which excess carbon is stored in the ocean,
16. The process that organisms use to convert food into carbon dioxide and water.
18. A place or substance that can absorb carbon from the atmosphere.

Part 3: Carbon Cycle Organizer

Directions

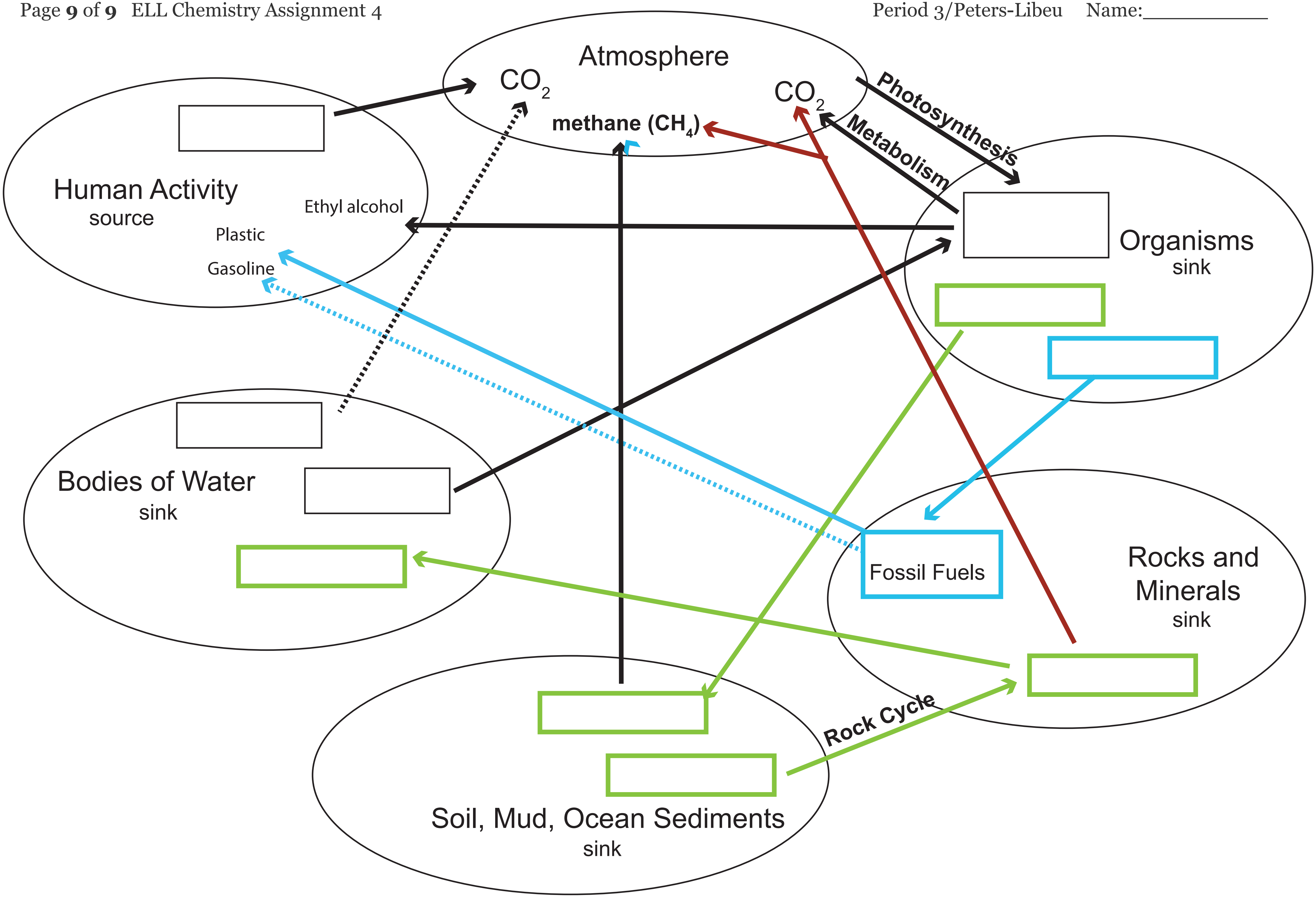
1. The bubbles represent different places that carbon can be found on earth. Use the information in the reading to fill in as many carbon-containing molecules as you can find that would be found in the bubbles representing each carbon sink or source. If you don't know the name of the molecule, you can use a description of the material that it would be found in.

For example, for the carbon in organisms, you could write organic molecules, sugar, plant material, meat.........

2. The arrows indicate chemical processes that move carbon from one sink to another or from a sink to the atmosphere. Each of solid arrows corresponds to one of the chemical processes in the reading. Chose the correct process for each arrow.

Word Bank: Weathering, Combustion, Mineralization, Photosynthesis, Metabolism, Fermentation, Respiration, Carbonization

The dotted lines indicate arrows that were not named in the reading.


Atmosphere
CO_2
CO_2
methane (CH_4)
Photosynthesis
Metabolism
Human Activity
source
Ethyl alcohol
Plastic
Gasoline
Organisms
sink
Bodies of Water
sink
Fossil Fuels
Rocks and Minerals
sink
Rock Cycle
Soil, Mud, Ocean Sediments
sink