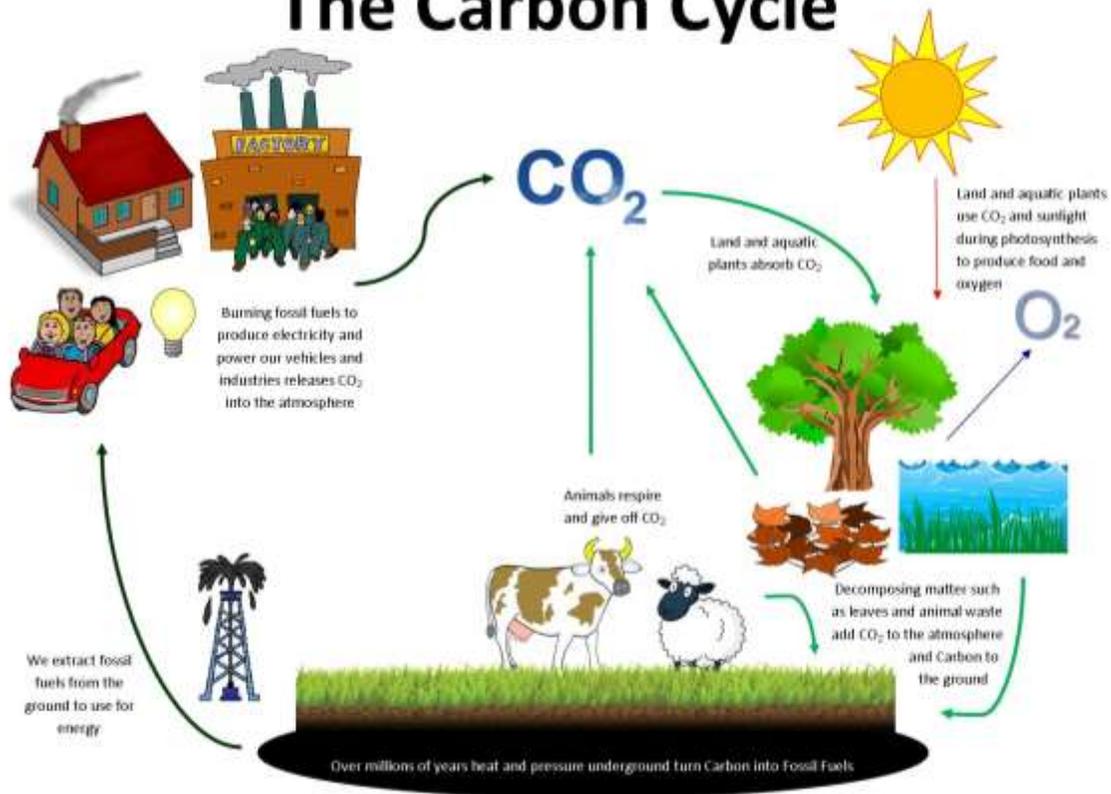


Supplement A

The Carbon Cycle



Carbon is one of the most common elements found on Earth and is the main ingredient of every plant and animal (even humans). Over time, carbon moves between many places and forms—this movement is known as the Carbon Cycle. The Carbon Cycle is made up of sources and sinks. **Sources** are things that add carbon to the atmosphere. **Sinks** are things that remove carbon from the atmosphere.

Explain the carbon cycle using the steps below; for each step ask a student to place the corresponding pieces and arrows on the board:

1. In the atmosphere, carbon reacts with oxygen to form a gas known as carbon dioxide (CO₂).
2. Land and aquatic plants absorb CO₂ and sunlight to photosynthesize and produce oxygen—this makes plants a carbon **sink**.
3. Animals and humans need oxygen to breathe. As animals and humans breathe, or respire, they give off CO₂—this makes human and animal respiration a carbon **source**.
4. As plants, animals, and other organic matter die, they decompose. During decomposition, carbon is released into the atmosphere (**source**) and carbon enters the ground beneath the land and oceans (**sink**).
5. After millions of years, heat and pressure turn the underground carbon into fossil fuels. Since the 1800s, humans have been extracting fossil fuels from deep underground on a large scale.
6. We burn these fossil fuels in order to power our buildings, vehicles, and factories; which releases the carbon that has been trapped underground for millions of years into the atmosphere. Through the burning of fossil fuels, humans have created a new **source** of carbon into the atmosphere.

Supplement A continued

Carbon Cycle Discussion Questions and Information

a. What happened in the natural cycle (lighter arrows on the right)?

- The level of carbon dioxide in the atmosphere was stable because the sources (that add carbon to the atmosphere) and sinks (that remove carbon from the atmosphere) were in balance.

b. What happened when humans began extracting and burning the fossil fuels for energy (darker arrows on the left)?

- The level of carbon dioxide in the atmosphere increased because the sources and sinks became unbalanced—carbon was added to the atmosphere from burning fossil fuels (source) much faster than any natural sinks could remove it.

c. Why is this increase important and how does it relate to humans and climate change?

- Carbon Dioxide (the gaseous form carbon takes when it reacts with oxygen in the atmosphere) is one of the **Greenhouse Gasses**, meaning that it holds heat and traps it in the atmosphere, like a greenhouse. Greenhouse gasses exist naturally in the atmosphere and are important for keeping Earth warm enough for organisms to live.
- When humans burn fossil fuels (source) and remove natural sinks such as forests and wetlands, carbon dioxide is added to the atmosphere faster than it can be removed.
- This results in an overload of carbon dioxide in the atmosphere, and because carbon dioxide is a heat-trapping greenhouse gas, this increase causes the atmosphere to warm up.
- The atmosphere's temperature cycles between warm and cool naturally over time, which is what creates periods like Ice Ages. The recent increase in carbon and other greenhouse gasses, however, has caused the atmosphere to warm and change much more quickly and significantly than has ever been observed in history.

d. Do you know any effects of climate change?

- Higher temperatures overall
- Increased droughts in dry areas and floods in wet areas
- More extreme, changing, and unpredictable weather patterns
- Ice, snowpack, and glacier melt in the arctic regions
- Warmer ocean temperatures
- Sea level rise
- Ocean acidification

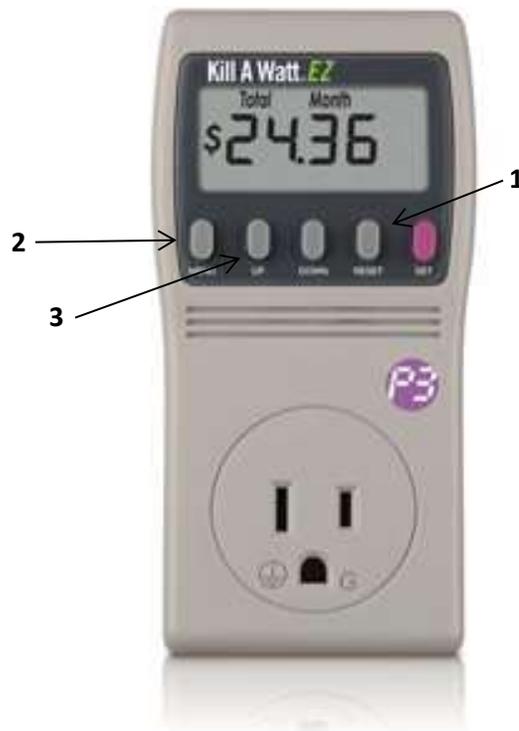
e. Is there anything you can do to help?

- Reduce your **Carbon Footprint** (the amount of carbon released into the atmosphere as a result of an individual's activities)

Sources: U.S. Environmental Protection Agency (EPA), 2015; U.S. National Aeronautics and Space Administration (NASA), 2015

Supplement B

1. Plug Kill A Watt meter into any outlet.
2. Connect appliance to be tested directly into plug on meter.
3. Reset meter by holding down RESET button (1) until “rEST” appears on screen.
4. Press MENU button (2) repeatedly until “Volt” is displayed on screen.
5. Press UP button (3) repeatedly until “Watt” is displayed on screen. This is the correct unit of measurement students will be taking.
6. Reset meter before testing each appliance.



Supplement C

Lots of Watts!



Item Tested	Watts Used	
	On	Off

Which item uses the most energy?

Which item uses the least energy?

How can I help to reduce my carbon footprint at home?

Supplement D

Vocabulary

Oxygen- The life supporting component of air.

Carbon Dioxide- gas produced by burning carbon and respiration.

Carbon Cycle – the process and movement of carbon as it is recycled and reused throughout the biosphere (the total of all ecosystems)

Carbon Footprint – the amount of carbon released into the atmosphere as the result of an individual's activities

Watt – a unit of power that expresses the rate at which electric energy is being used

Kilowatt – 1000 watts of electrical power

Photosynthesis – the process of plants using energy from sunlight, carbon dioxide and water to produce energy

Atmosphere – the mass of air surrounding the earth; it is held in place by gravity and protects Earth's organisms from severe weather and radiation from the sun, and keeps us warm

Fossil Fuels – natural fuels, such as coal, oil, and natural gas, that produce excess carbon dioxide into the atmosphere when burned; these fuels are considered non-renewable because they take millions of years to form through heat and pressure underground.

Greenhouse Gas– a gas that traps heat in the atmosphere; major greenhouse gasses include water vapor, ozone, carbon dioxide, methane, and nitrous oxide.

Renewable Energy – any natural source of energy, that is not depleted when used (ex. Solar, wind, water)

Non-Renewable Energy- any natural resource from the earth that exists in limited supply and cannot be replaced if it is used up (ex. Oil, natural gas).

Vampire Energy- the electric power consumed by an appliance while it is switched off or in stand-by mode but still plugged in.

Supplement E

Carbon is not released for those who...:

- Carpool or use public transportation
 - a. Carpooling or riding a bus or train saves gas and produces less carbon pollution. Fewer cars on the road means less CO₂ released into the atmosphere.
- Ride a bike
 - a. Bikes don't produce any CO₂ into the atmosphere, and its great exercise!
- Buy local food
 - a. Buying from local farmers' markets and/or growing your own food saves all the carbon that is produced in transporting food over long distances, and saves resources that are used in big factories.
- Recycle at home
 - a. Recycling means less plastic, paper, cardboard, glass, etc. going into landfills. This leaves more open space for trees to grow and help clean the atmosphere, and less CO₂ being produced from the decomposing waste in landfills.
- Hang your clothes to dry
 - a. Using a clothesline not only saves your clothes, but also saves the energy a dryer would need to dry them. Hanging your clothes to dry doesn't generate any CO₂.
- Compost
 - a. Composting prevents many kinds of food waste from ending up in landfills, and also produces nutrient-rich soil.
- Plant trees
- Use solar panels
- Turn off lights/TV
- Unplug chargers, etc.