

Earth's Interconnected Systems



Superhero Norms:

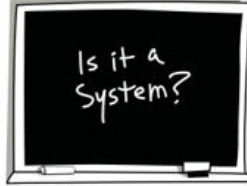
We will all work to:

- Be respectful and open-minded
- Contribute
- Ask questions!
- Silence cell phones- take calls and texts outside



Is It a System?

Various things are listed below. Put an X in front of the things that can be thought of as a system.



- | | | |
|---------------------------------------|---|--|
| <input type="checkbox"/> aquarium | <input type="checkbox"/> digestion | <input type="checkbox"/> cell phone |
| <input type="checkbox"/> pile of sand | <input type="checkbox"/> food web | <input type="checkbox"/> $A + B = C$ |
| <input type="checkbox"/> Earth | <input type="checkbox"/> hurricane | <input type="checkbox"/> electrical circuit |
| <input type="checkbox"/> grasshopper | <input type="checkbox"/> graph | <input type="checkbox"/> water cycle |
| <input type="checkbox"/> volcano | <input type="checkbox"/> seed | <input type="checkbox"/> human body |
| <input type="checkbox"/> soil | <input type="checkbox"/> bicycle | <input type="checkbox"/> $\text{Density} = \text{Mass} \div \text{Volume}$ |
| <input type="checkbox"/> ocean | <input type="checkbox"/> Earth and its Moon | <input type="checkbox"/> box of nails |

Explain your thinking. How did you decide whether something is considered to be

DIVIDING THE ENVIRONMENT

BIOTIC FACTORS

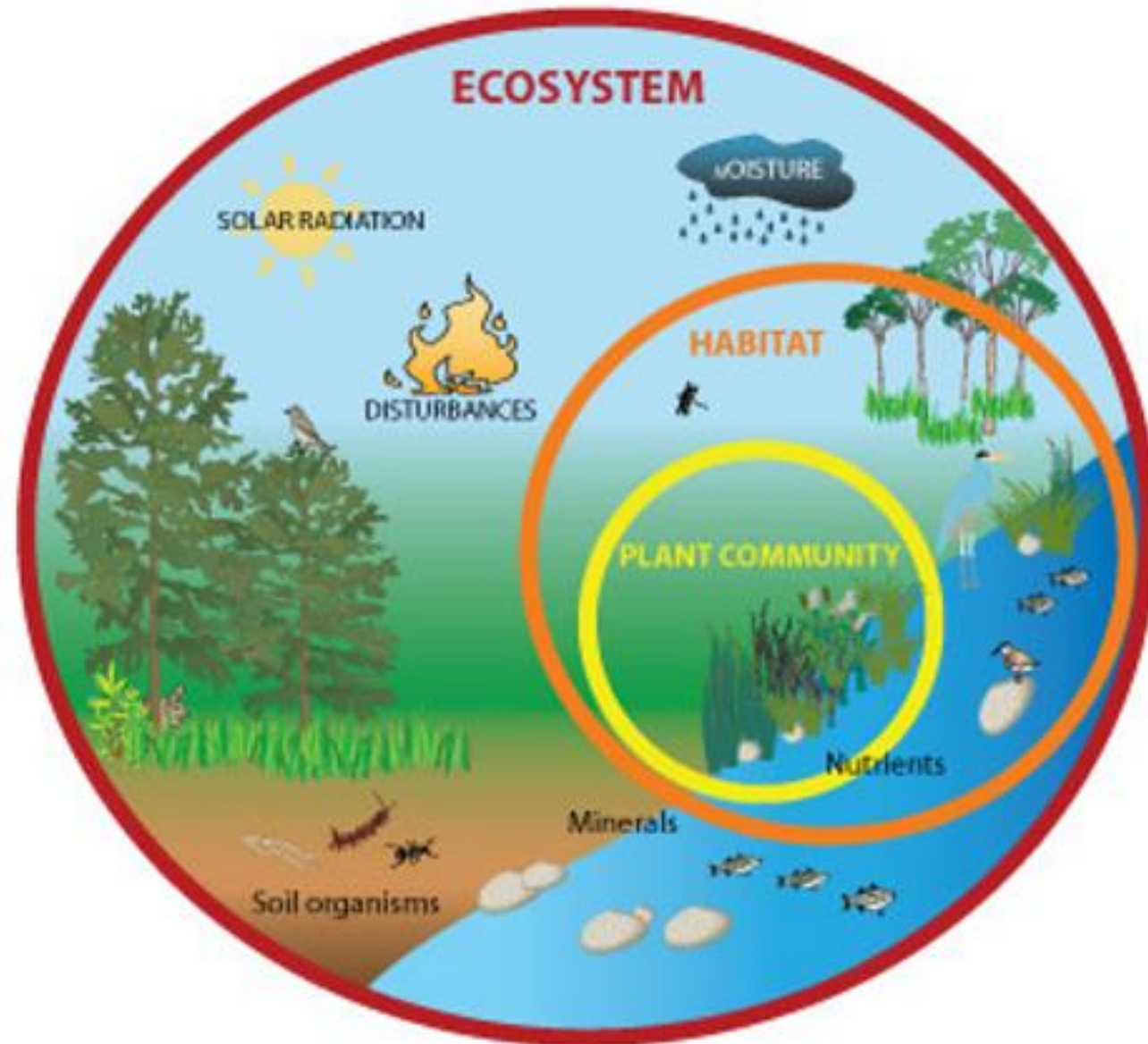
people,
animals,
plants

ABIOTIC FACTORS

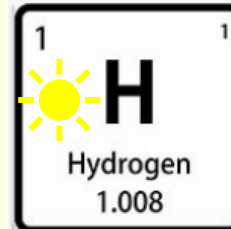
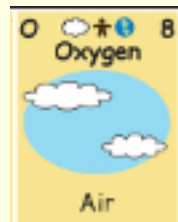
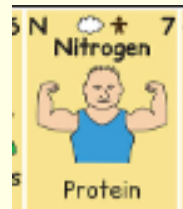
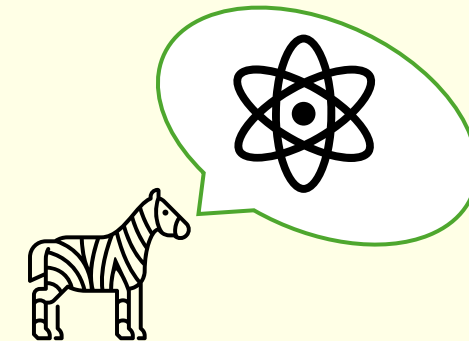
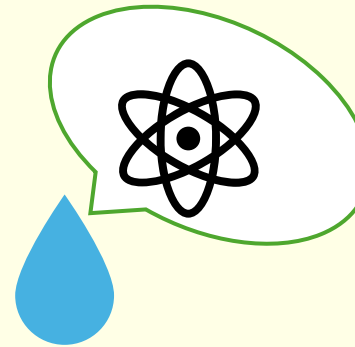
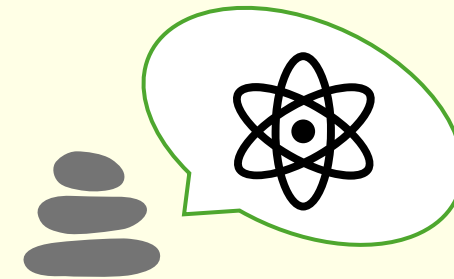
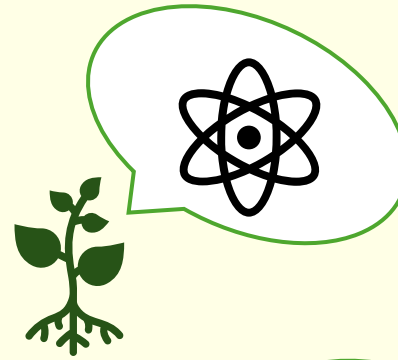
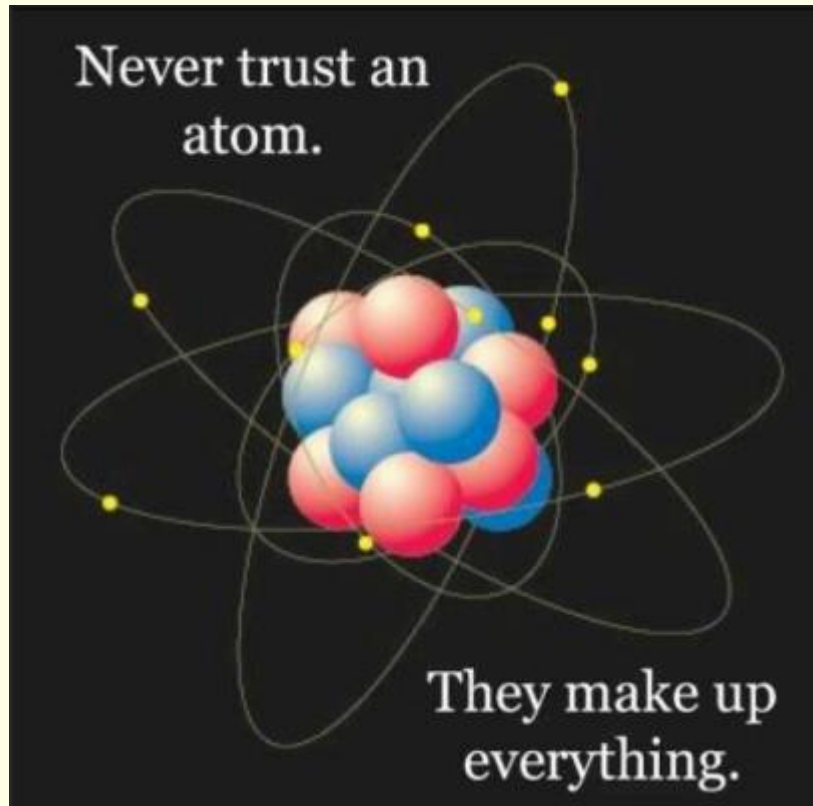
rocks, water,
air, wind
temperature,
light

- Removing part of a system causes a change in the whole system.
- A system is a collection of things (including processes) that have some influence on one another and the whole.
- Systems can be:
 - Manufactured objects (cell phone, thermometer, circuit, bicycle)
 - Life forms (grasshopper, human body, cell, seed)
 - Combinations of living and nonliving things (food-web, aquarium, ocean, soil, Earth)
 - Physical bodies (water cycle, hurricane, digestion)
 - Quantitative relationships ($D=M/V$, $A=B=C$, graph)

Everything Relies of Everything



Matter cannot be created or destroyed. So – matter cycles...



EVERY
BOTTLE
BACK

AN INITIATIVE OF

FLORIDA
Beverage Association

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LEARN MORE
www.FlaBev.org/EBB



Packaging EPR Laws in the U.S.



Extended Producer Responsibility (EPR) is a globally used legislative tool that makes producers responsible for the entire lifecycle of their products. While EPR laws can apply to any product placed on the market, the packaging and packaging waste, electronic or electrical waste, and battery categories have been identified by global legislators as crucial waste streams due to their volume and toxicity. EPR legislation was **first implemented in the European Union (EU)**. Since then, EPR laws have continued to expand steadily worldwide, including in the United States (U.S.) at the state level. While **e-waste and battery laws** exist in the U.S., recent EPR legislation has focused on packaging and packaging waste. In 2021 and 2022, seven states passed packaging laws, and several states aim to introduce similar legislation soon.

The Life of a Little
**PLASTIC
BOTTLE**



Discover an amazing story about **reusing** and **recycling**



Written by
Suzanne Fossey

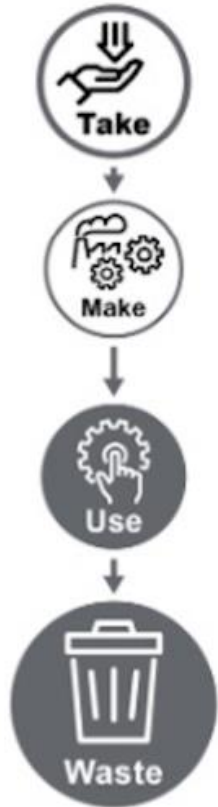
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5 circular economy business models for competitive advantage | World Economic Forum

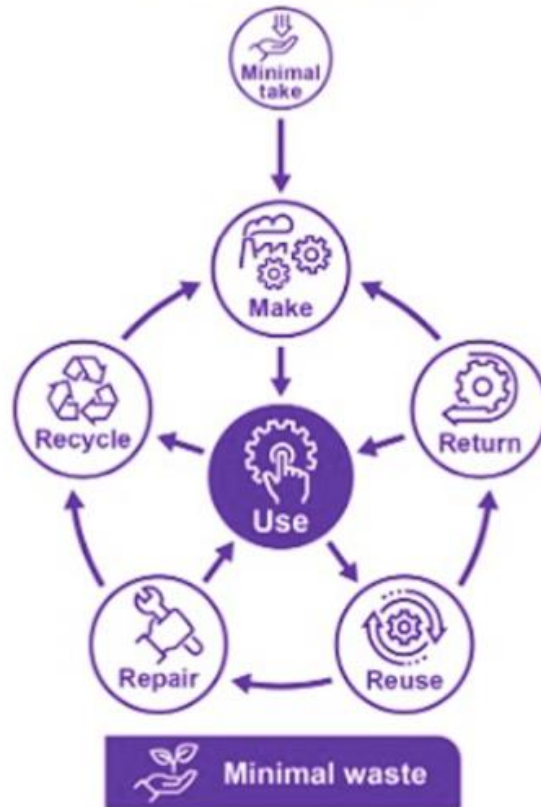
Linear Economy



Recycling Economy



Circular Economy



Circular Economy Benefits

- Transforms our current throwaway economy, eliminating waste and pollution, and circulating resources
- Tackles climate change and biodiversity loss simultaneously
- Separates the ability to achieve economic growth from the consumption of natural resources
- Create jobs, prosperity and resilience while cutting greenhouse gas emissions, waste and pollution
- Presents a business case for each sector to be more sustainable while increasing competitiveness.

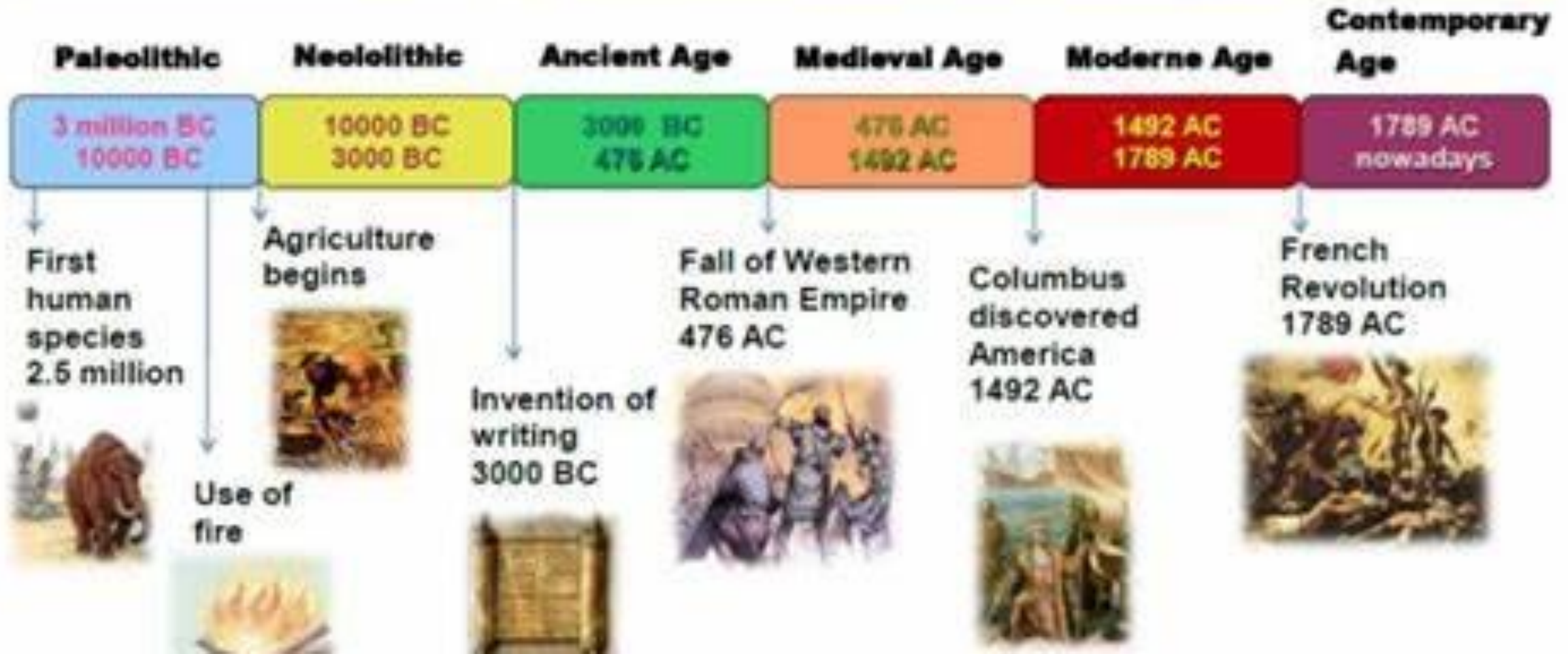


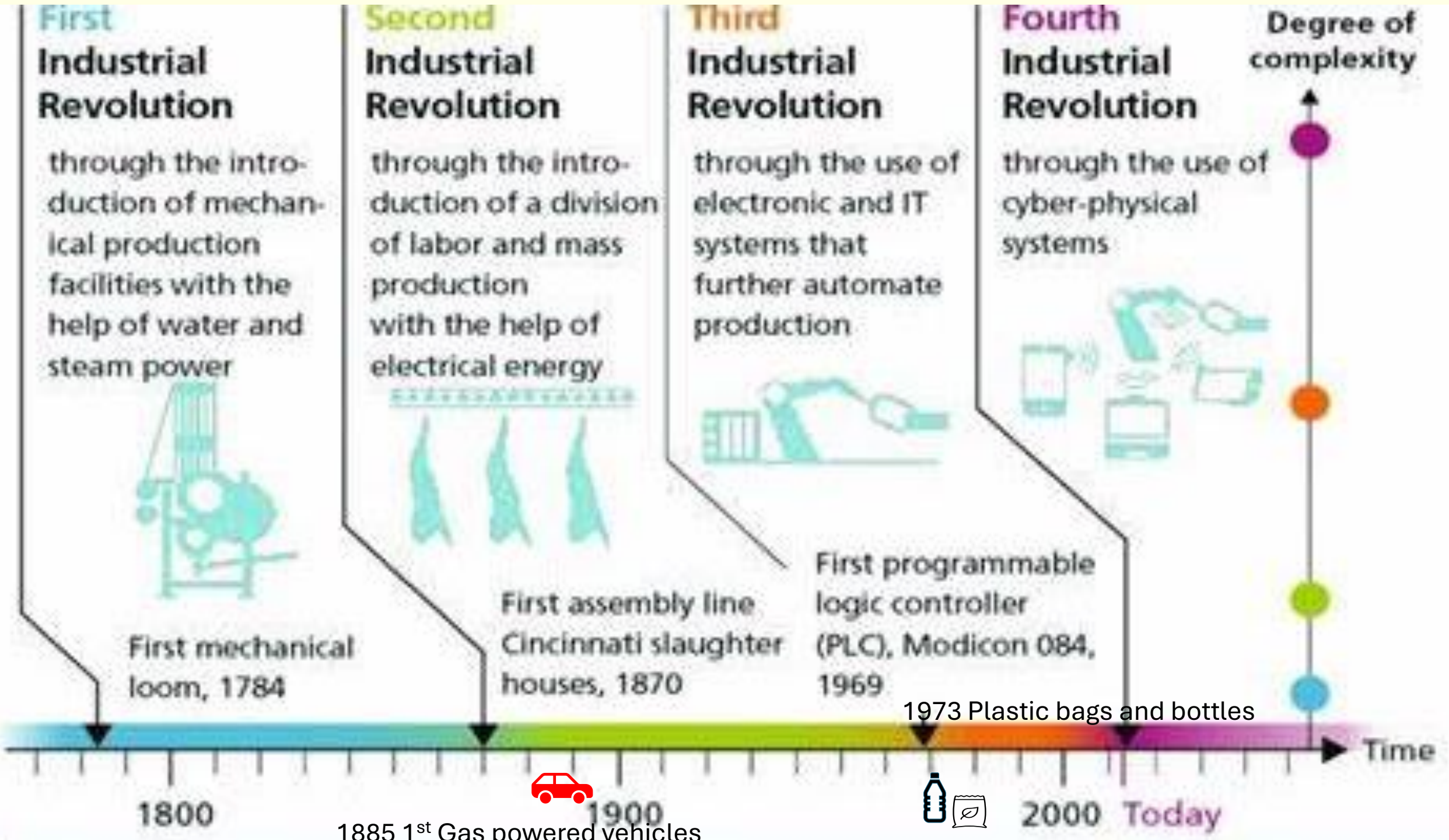
CNBC EXPLAINS

WHAT IS THE CIRCULAR ECONOMY?



When did a linear economy begin?



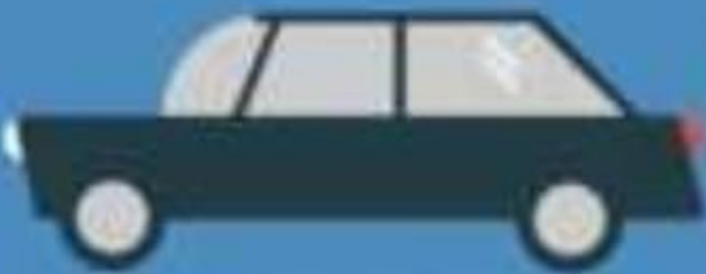




Renewables



Ferro materials



Mineral systematic:
usage and negative externalities

Stock management



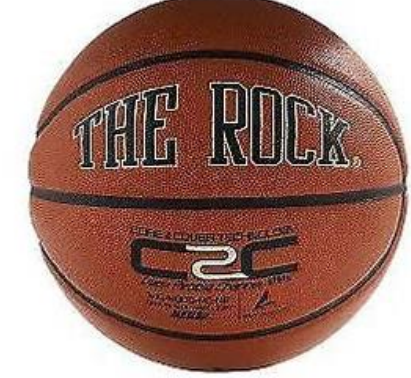
Technical cycles

Recovery

Recycling

CRADLE TO CRADLE DESIGN





- What product will you redesign?
- How will you make the product become C2C?
- How will your product be reused or recycled?



Redesign a Product to Create a C2C Product

The Water Cycle



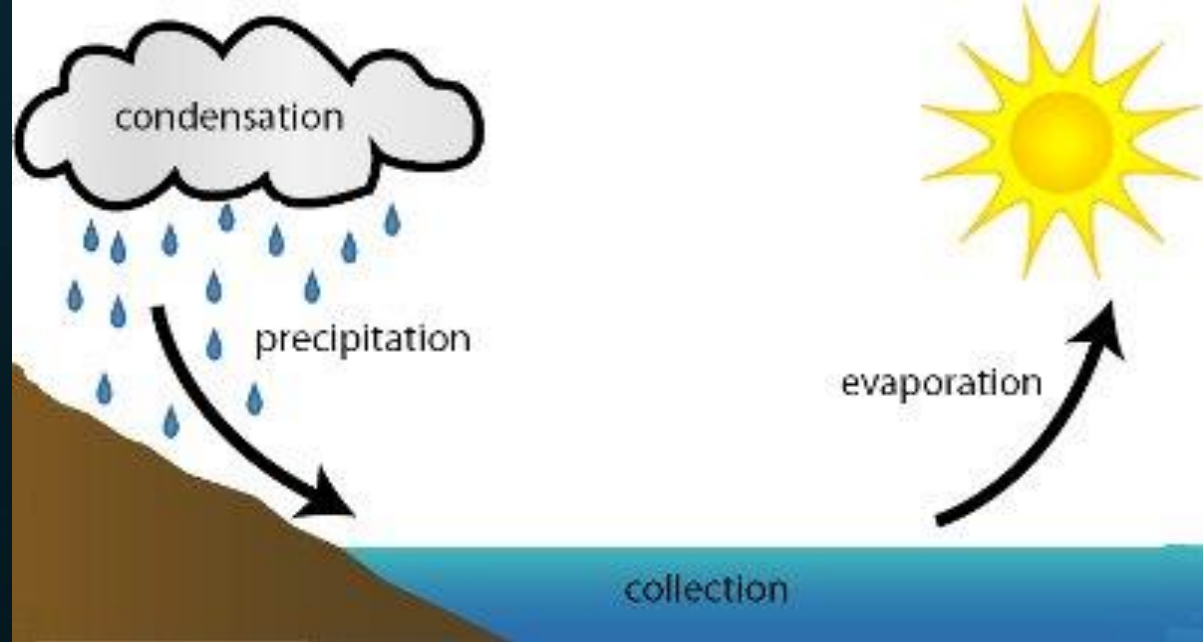
What causes water to change from a vapor to a liquid, or a liquid to a solid?

How can you identify which process is happening during the water cycle? What happens to water during each process?

Does water become cleaner when it evaporates into a water vapor? Why or Why not?

What type of model is this? Why do we need to use a model?

Water Cycle in a Bag



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Save the Plants!
Model-Eliciting
Activity (MEA)

What Contains Carbon?

Name: _____

Date: _____

- **Seashells** come from organisms that extract calcium and carbon from the water around them to form calcium carbonate shells. CaCO_3 is a white, insoluble solid and is also the main component of chicken eggshells and pearls.
- **Wood** contains carbon because it comes from a plant that once completed photosynthesis, taking in carbon dioxide to produce glucose and build its cell walls out of cellulose.
- **Plastic** is derived from petroleum, which contains hydrocarbons, compounds composed entirely of hydrogen and carbon. Petroleum was once tiny marine organisms that lived millions of years ago in the world's oceans.
- **Fabric** contains carbon. In plant-based fabrics such as cotton or modal, the carbon comes directly from plants. If it is polyester or acrylic, it is made from petroleum products which contain carbon, and petroleum was once marine organisms. If it is wool or silk, the carbon came from an animal, which ate plants to acquire its carbon.
- **Carbonated beverages** are named for the carbon dioxide gas that has been dissolved in the liquid, creating their fizz. Some carbon dioxide remains dissolved in the liquid even if the drink has stopped making bubbles.
- **A glass of water** also contains carbon dioxide gas, although in much lower concentrations than carbonated beverages. This is because carbon dioxide diffuses into water. The amount of carbon dioxide in the glass of water is directly related to the amount of carbon dioxide in the air. This is the same way the carbon dioxide gets into the oceans to cause ocean acidification.

Object	Carbon	No Carbon	Explain Your Answer
Seashell			
Wood			
Plastic			
Fabric			
Carbonated Drink			
Water			

How does carbon help the planet?

- Carbon is an important element in living things.
- Plants need carbon dioxide to photosynthesize and grow.
- Carbon dioxide in the atmosphere keeps the planet warm and livable.
- Some of the things we use everyday contain carbon.

How does carbon hurt the planet?

- Too much carbon dioxide in the atmosphere changes the climate.
- Too much carbon dioxide dissolving in the ocean makes it more acidic. Many marine organisms make their skeletons out of calcium carbonate. They may decline and their ecosystems may be affected.
- Plastic can accumulate in nature as pollution.

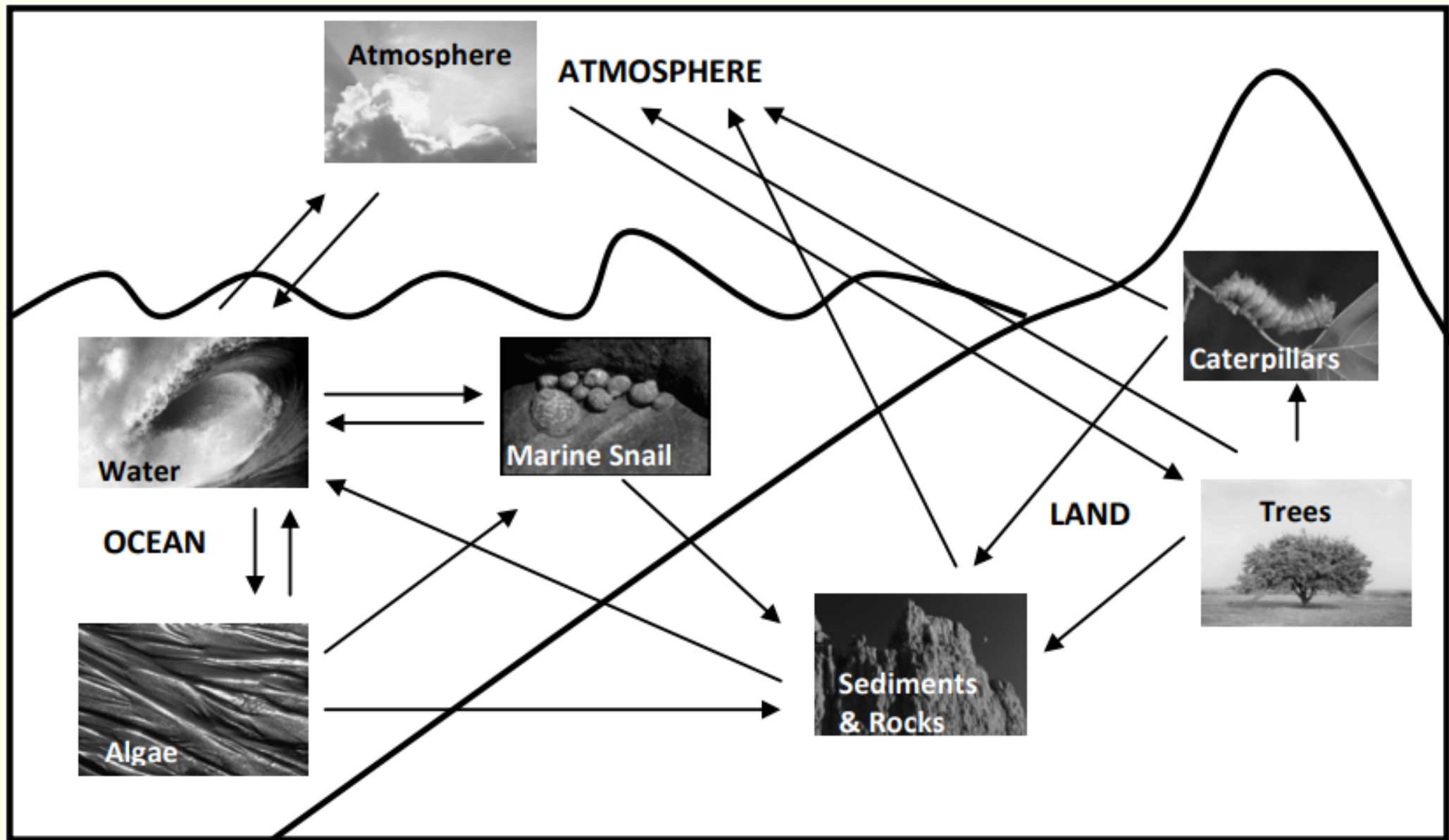
THE CARBON CYCLE



Be the Carbon Cycle

Role-Play

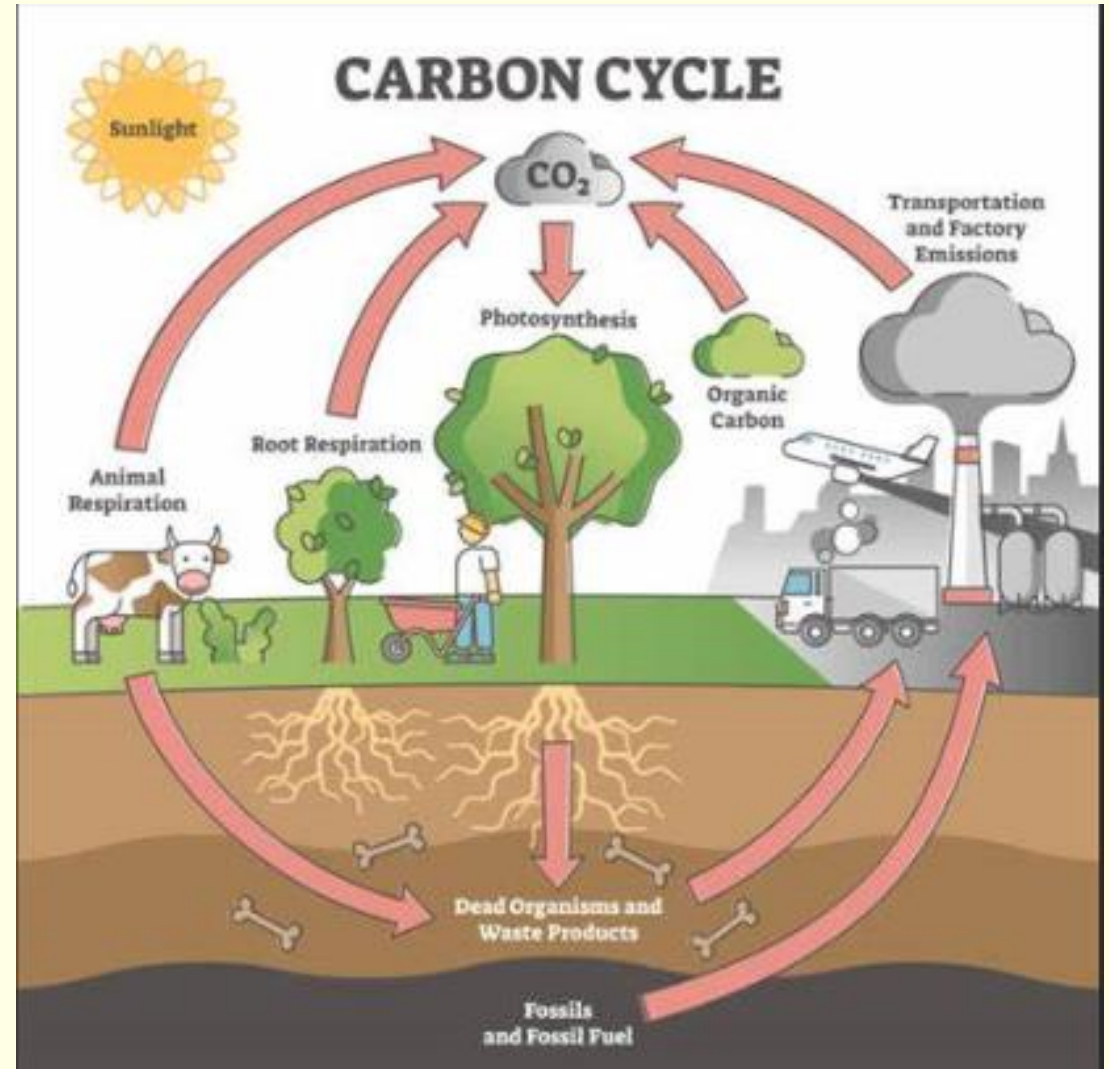
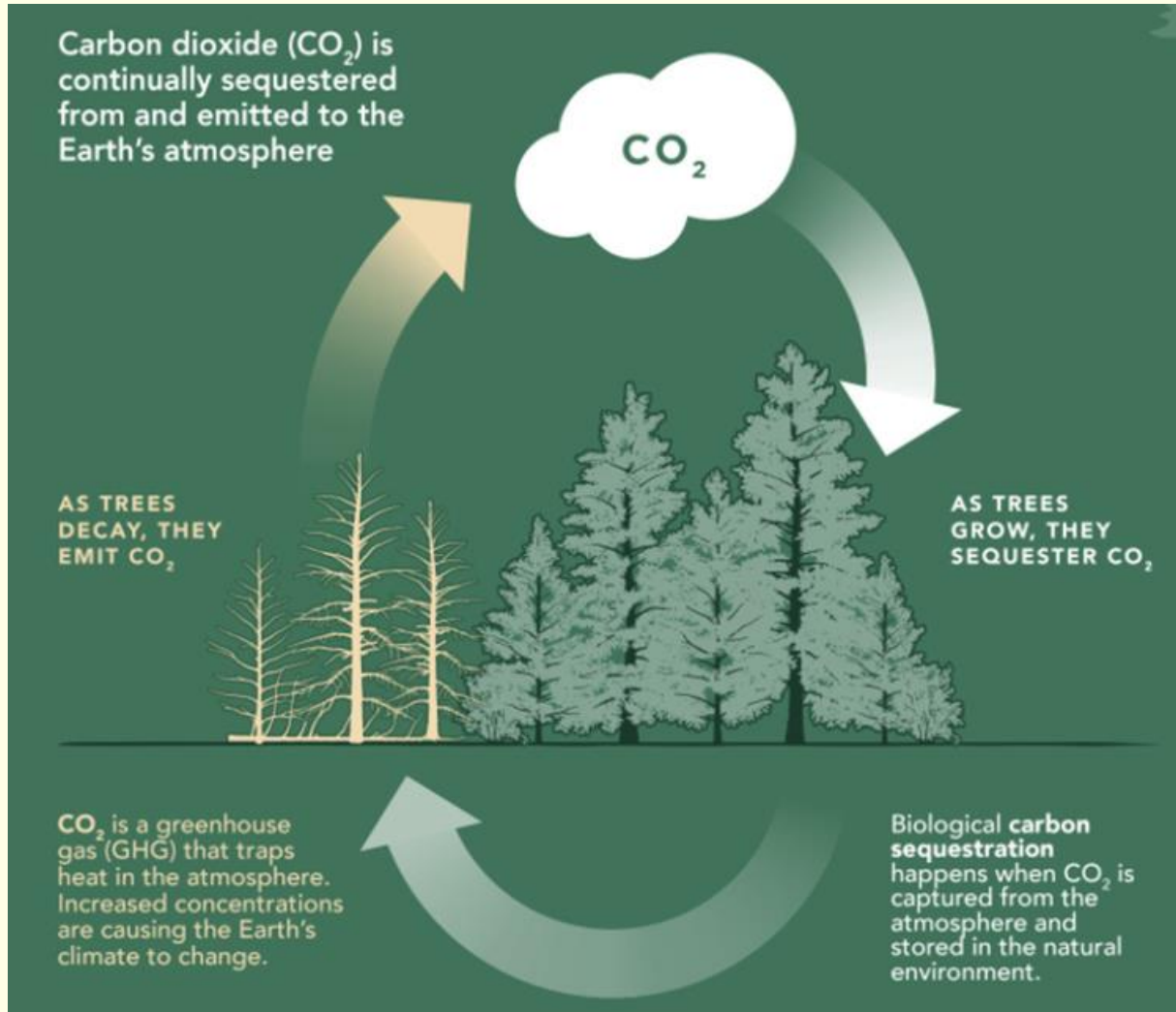
1. Divide students evenly into 7 groups and distribute the appropriate role-play card to each group. Each group will be a team of actors that will play a certain part of the carbon cycle (**atmosphere, water, algae, marine snail, sediments & rocks, trees, or caterpillars**). The table provided at the end of the lesson plan summarizes all the groups, their options for carbon flow, the explanation for each carbon flow, and their script lines.
2. Distribute **2-4** ping pong balls to each group and explain that these represent carbon atoms.
3. Have students in each group review their role play card to figure out their role in the carbon cycle and decide as a group using their “Options for carbon movement” how they are going to move their carbon.
 - Explain that they can give their carbon to only one other group, or if they have plenty, they can give the carbon to more than one group.
 - Explain that carbon exists in all of these things at the same time and only a portion of the carbon in each thing moves. Therefore, when each group moves their carbon, they can't give away all their carbon: **they must keep at least one carbon atom**.
 - As they move their carbon, they must say their script lines to explain the carbon movement that they have chosen.
4. One at a time, ask each group to give their carbon to another group (or groups).
5. Run the role-play a number of times, telling students to make different choices about carbon movement each time.



Discussion: Human Impacts on the Carbon Cycle

1. Explain to students that they just acted out the carbon cycle without human involvement, but humans greatly influence the carbon cycle with some of their activities.
2. Have students guess what movement corresponds to the following human activities:
 - Humans extract and burn fossil fuels for energy (*carbon moves from the sediments and rocks where fossil fuels are buried into the atmosphere*).
 - Humans cut and burn trees to use land for farming, ranching, or building (*carbon moves from the land plants into the atmosphere*).
3. Pull students aside and have them be the humans. Ask them to move the carbon in the appropriate manner for the human activities that you discussed. How did this affect the carbon cycle?
4. Explain that humans have not created more carbon on earth, but that we move carbon from one place to another more quickly than would naturally happen and that this has consequences for the climate of the planet. Some salient examples:
 - Burning fossil fuels takes carbon from sediments and rocks where fossil fuels are buried and puts it into the atmosphere because when fossil fuels are burned they release carbon-containing gases.
 - Cutting and burning trees takes carbon from the land plants and puts it into the atmosphere because when trees are burned, the carbon that was stored in their structures is released as carbon-containing gases.
5. Ask students if they can think of other human activities that might affect the carbon cycle.

Carbon Cycle

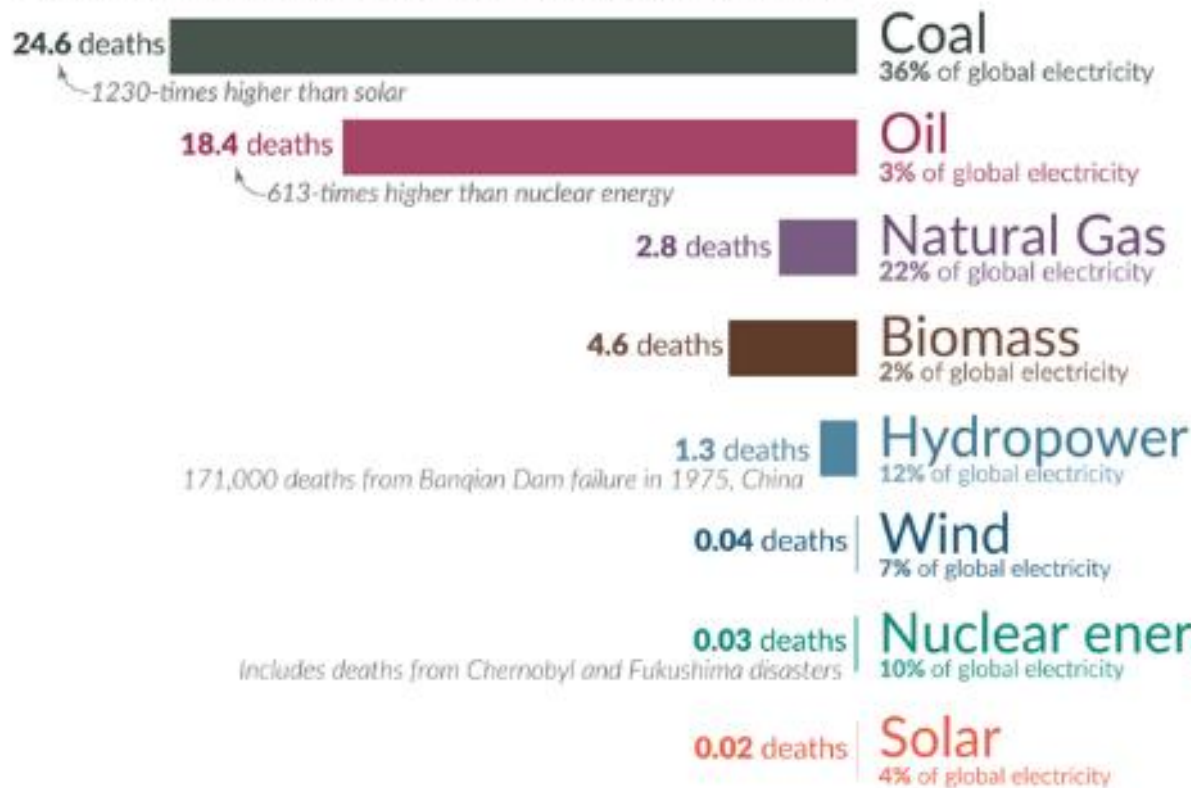


What are the **safest** and **cleanest** sources of energy?

Death rate from accidents and air pollution

Measured as deaths per terawatt-hour of electricity production.

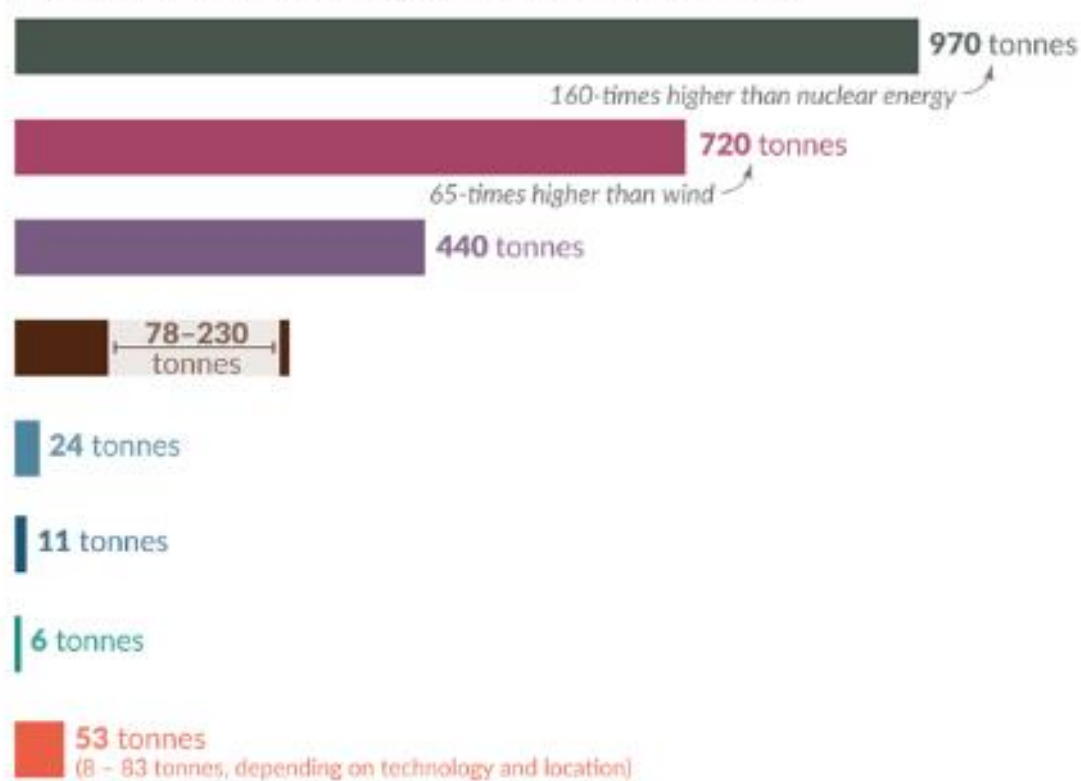
1 terawatt-hour is the annual electricity consumption of 150,000 people in the EU.



Greenhouse gas emissions

Measured in emissions of CO₂-equivalents per gigawatt-hour of electricity over the lifecycle of the power plant.

1 gigawatt-hour is the annual electricity consumption of 150 people in the EU.



Death rates from fossil fuels and biomass are based on state-of-the-art plants with pollution controls in Europe, and are based on older models of the impacts of air pollution on health. This means these death rates are likely to be very conservative. For further discussion, see our article: [OurWorldinData.org/safest-sources-of-energy](https://ourworldindata.org/safest-sources-of-energy). Electricity shares are given for 2021.

Data sources: Markandya & Wilkinson (2007); UNSCEAR (2008; 2018); Sovacool et al. (2016); IPCC AR5 (2014); UNECE (2022); Ember Energy (2021).

Energy Infobooks · National Energy Education Development Program


Our city is planning to build a new power plant to provide electricity. What form of energy should we use to produce electricity for our city?


Please review the Energy Infobook and advise us on your recommendation. Please explain why you are recommending this form of energy.

Thank you,
City Planning Committee

Intermediate Energy Infobook 2024-2025

A comprehensive classroom resource containing fact sheets that introduce students to energy, and describe energy sources, electricity, consumption, efficiency, conservation, transportation, climate change, and emerging technologies. The infobooks can be used as a resource for many energy activities.





Grade Level:

Intermediate

Subject Areas:


Science

Math

Technology

Social Studies

Language Arts



Intermediate Energy Infobook





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HOW WOLVES

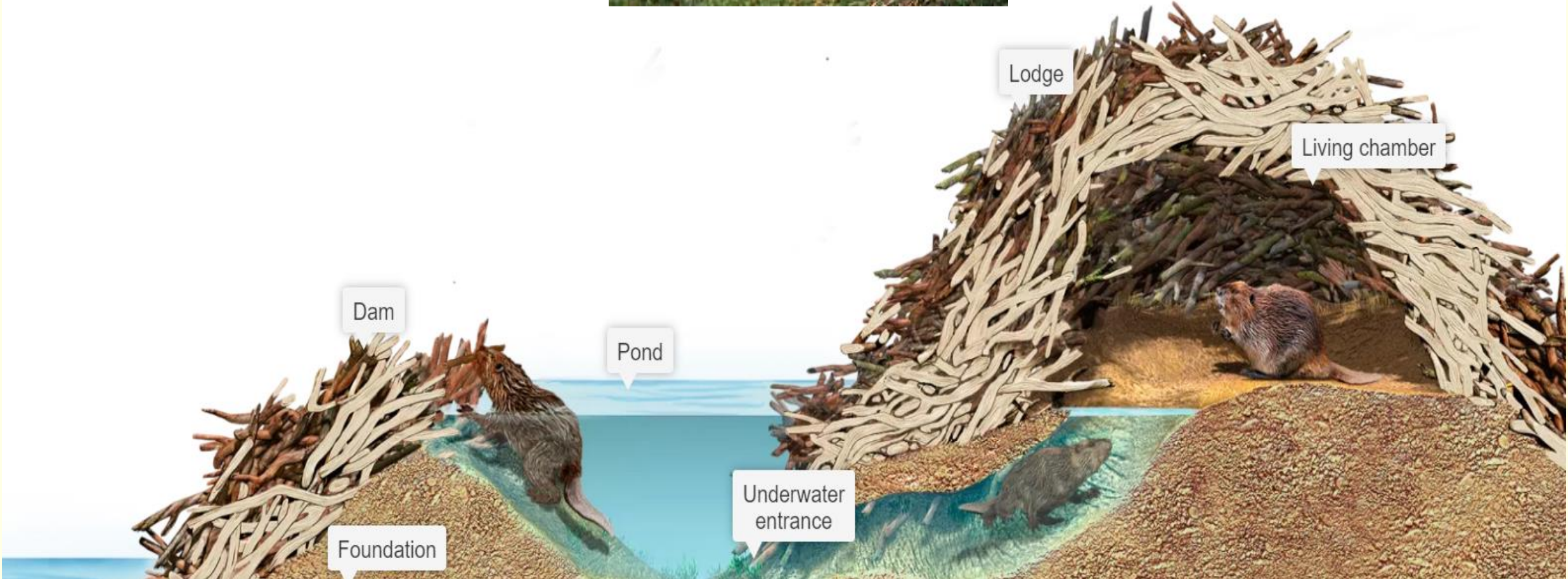


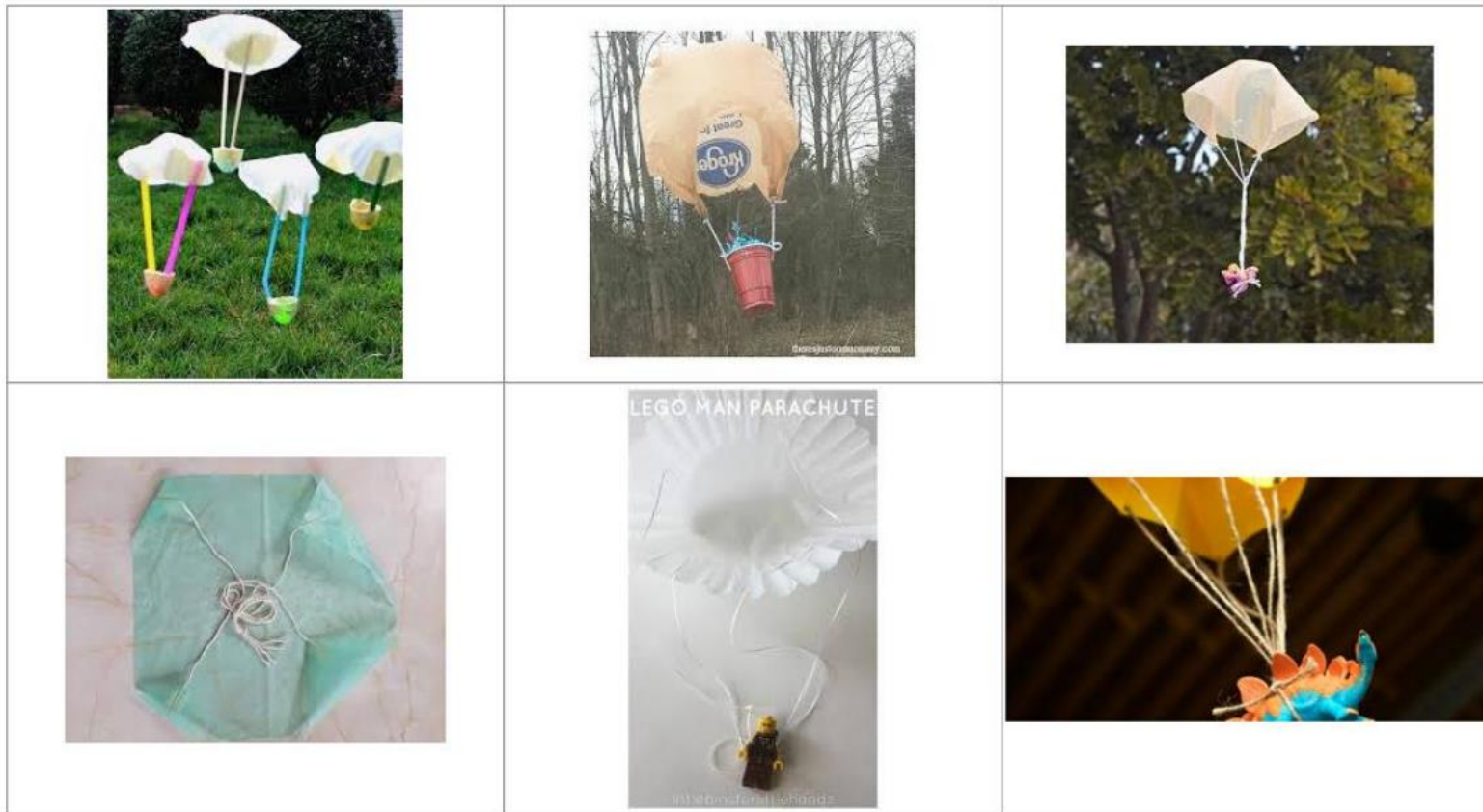
CHANGE RIVERS

Beavers



Beavers are the engineers of the rodent world. They fell trees by gnawing through their trunks, then use the branches to dam streams. The dams create a pond, in the middle of which the beaver family





You are going to design a parachute.
 Well you might be asking- “what do beavers
 have to do with parachutes?”

In 1948 in Idaho there was a problem that Engineers and Scientists decided only beavers could solve. There were floods happening and they needed beavers to create their natural dams to stop the floods. But there were no beavers in the rivers... and no roads to get the beavers to the river.

Scientists turned to engineers- and yes parachutes!
Why would scientists need engineers to help them solve this problem? What solution do you think they could come up with?

Why did humans make parachutes for beavers?

**Please know that the beavers were not harmed when these scientists moved them to the river location!



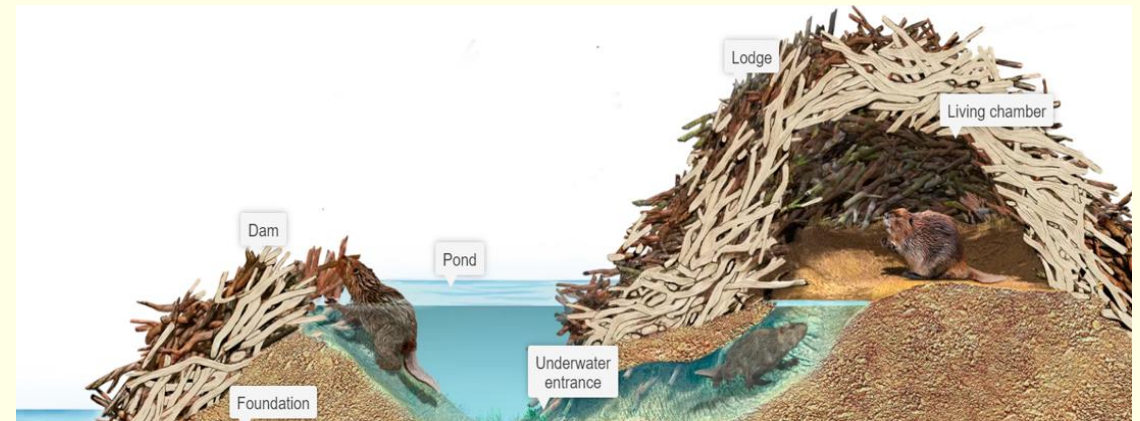
Watch the video of engineers that created parachutes for these beavers. How could you improve the parachutes?

**Please know that the beavers were not harmed when these scientists moved them to the river location!





Problem:
There were floods happening and they needed beavers to create their natural dams to stop the floods. But there were no beavers in the rivers... and no roads to get the beavers to the river.



As a scientist you will conduct an experiment by keeping all of your materials the same, but only changing the size of your parachute. Engineers use science data to create new solutions. They use a different process called the engineering design process.

What do you notice about the processes (steps) engineers go through to develop solutions? Why do you think this process is in a circle?





Idaho Fish and Wildlife

The scientists at the Idaho Fish and Wildlife Foundation are looking for engineers that can create a parachute that can safely carry a beaver to the Idaho backcountry to stop the river from flooding.

Criteria:

You must work with an engineering partner.

The parachute must SAFELY carry the beaver.

The parachute prototype must use data from scientific research (your experiment).

The parachute must safely land on the designated target (the backcountry river).

The parachute prototype must be made from recycled materials.

Your team must collect data on the time it take your beaver to safely land.

Submit your prototype as a model with its data.



Test your prototype by following the procedure. Collect data as you test. Record your data for each trial of your prototype.
















Beaver Drop			
Prototype Trial	Time it takes to land	Safety of the beaver observations	How do you want to change the prototype
1			
2			
3			
4			
5			



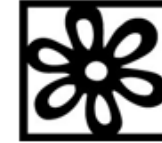
Create a Model of an Ecosystem

Food Chain Repair In this STEM lesson, students will build a food chain with Florida organisms

Food Chain Repair Page 16

 <p>Swamp Lily Uses sunlight to make energy/food Eaten by: White Tailed Deer, Florida Apple Snail Points: 10</p>	 <p>Algae Uses sunlight to make energy/food Eaten by: Mosquito Fish Points: 10</p>	 <p>Saw Grass Uses sunlight to make energy/food Eaten by: Mosquito Fish, White tailed deer Points: 10</p>
 <p>Great Blue Heron Eats: Mosquito Fish, Florida Apple Snail Eaten By: Panther, Bobcat, American Alligator Points: 80</p>	 <p>White Tailed Deer Eats: Swamp Lily, Saw Grass Eaten By: American Alligator, Florida Panther, Python Points: 40</p>	 <p>Mosquito Fish Eats: Saw Grass, Algae Eaten By: Raccoon, Great Blue Heron, Opossum Points: 20</p>
 <p>Florida Apple Snail Eats: Saw Grass, Swamp Lily, and Algae Eaten By: Snail Kite and Great Blue Heron Points: 20</p>	 <p>Raccoon Eats: Swamp Lily, Mosquito Fish Eaten By: American Alligator, Bobcat, Panther Points: 40</p>	 <p>Opossum Eats: Mosquito Fish, Swamp Lily Eaten By: Panther, American Alligator, Bobcat, Python Points: 40</p>
 <p>Panther Eats: White tailed deer, Opossum, Raccoon, Snail Kite, and Great Blue Heron Eaten By: Python Points: 160</p>	 <p>Snail Kite Eats: Florida Apple Snail Eaten By: Bobcat, Panther, American Alligator Points: 80</p>	 <p>American Alligator Eats: White Tailed Deer, Great Blue Heron, Opossum, Snail Kite, Raccoon Eaten by: Python Points: 160</p>
 <p>Python Eats: White Tailed Deer, American Alligator, Bobcat, Opossum, Raccoon Eaten by: N/A Points: 200</p>	 <p>Bobcat Eats: Raccoon, Opossum, Great Blue Heron, Snail Kite Eaten by: Python, American Alligator Points: 80</p>	 <p>Human Eats: American Alligator, White Tailed Deer Eaten by: N/A Points: 200</p>

Food Chain Repair Page 15



**Forget Me Not
Landscaping**

Dear Student Engineers,

We need your help! Forget Me Not, our landscaping company, has just mistakenly bulldozed the wrong one square mile plot of land in Western Florida. The land has a small lake, wetlands and dry land. We are hoping to undo all the damage to the ecosystem and have asked for your help in designing an ecosystem to reestablish the area successfully. We are asking that you make a budgeted list of organisms that we need to purchase, plant and grow to create the missing ecosystem. Please follow the criteria listed below.

Budgeted List:

Quantity of organisms (number) we need to purchase

Cost per organism

Cost of total number of each organism

For example: 4 Florida Apple Snails (each 10 points) for a total of 40 points.

The ecosystem should equal 900 points

Model of the Ecosystem:

All organisms listed in budget must be represented on the model in the quantity listed. (If you stated 4 Florida Apple Snails, then 4 Florida Apple Snails should be on the model.

An organism's points lists the amount of energy they need from the previous level of the ecosystem. For example, a 40-point deer will need 40 points of saw grass or swamp lilies to consume to survive. These items can only be used once for one organism. So, if another organism needs sawgrass, you will have to budget for more sawgrass.

Models should be connected and not have outliers that are not a contributing part of the ecosystem.

Models should equal 900 points to be "self-sustaining," meaning that they will continue to repopulate and fill needs of the organisms through time.

Models with at least 9 organisms are required.

Please submit your models and your budgeted list to your teacher for your proposal.

Sincerely,

Oops E. Daisy



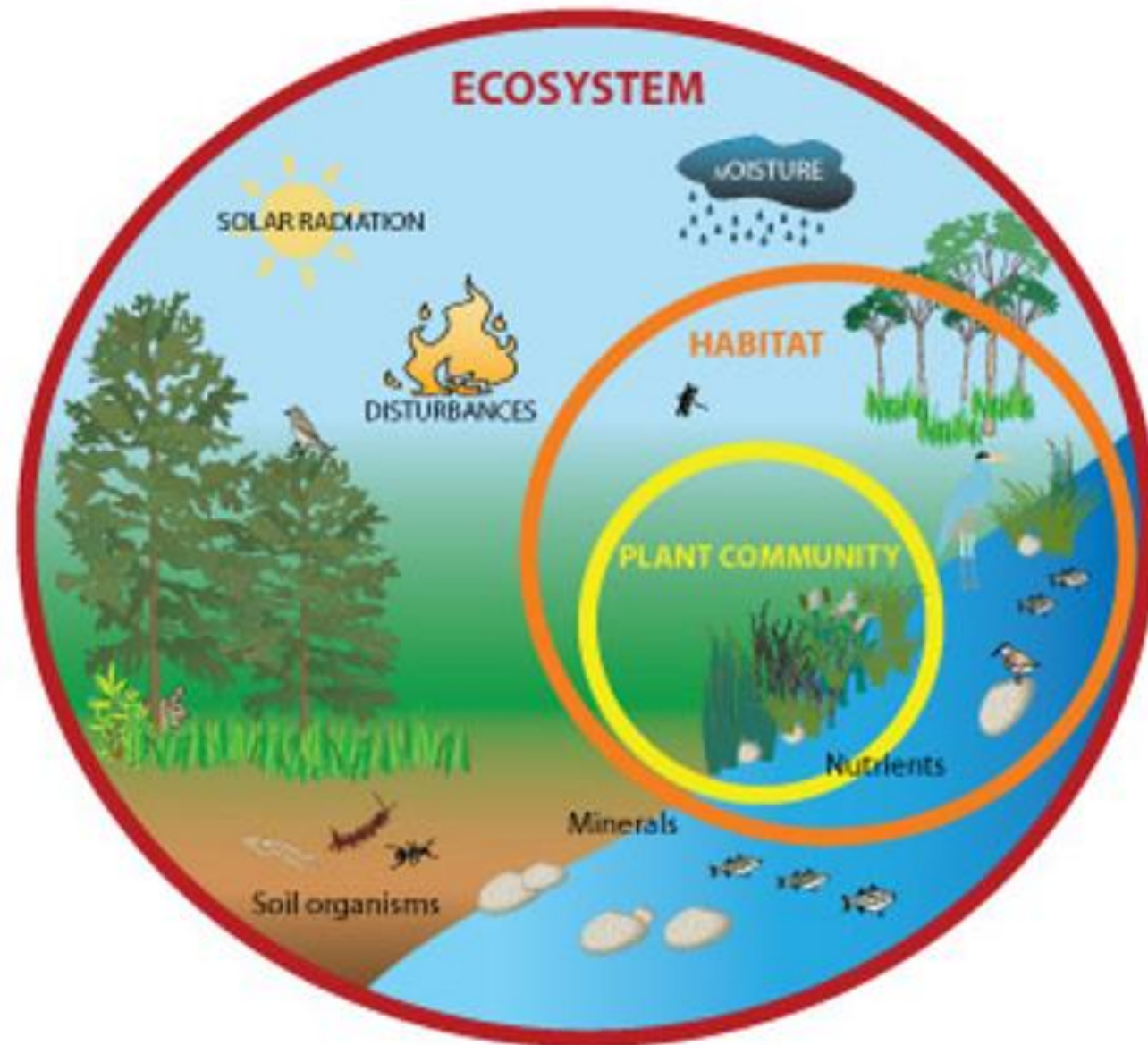
HOW WHALES



CHANGE CLIMATE

REMASTERED

Everything Relies of Everything



Additional Resources

- [K-12 Lesson Clearinghouse - Grades 3-5 - Science - Page 2 of 8 - Green Education Foundation | GEF | Sustainability Education](#)
- [Save the Plants! In this Model-Eliciting Activity \(MEA\), students are asked to design a system to wa ...](#)