Unit #1 Assessment Statements

Systems, Transfer and Transformations, Feedback Loops, EVS

• Significant historical influences on the development of the environmental movement have come from literature, the media, major environmental disasters, international agreements and technological developments.

• An Environmental Value System (EVS) is a worldview or paradigm that shapes the way an individual, or group of people, perceives and evaluates environmental issues, influenced by cultural, religious, economic and socio-political contexts.

• An EVS might be considered as a system in the sense that it may be influenced by education, experience, culture and media (inputs), and involves a set of interrelated premises, values and arguments that can generate consistent decisions and evaluations (outputs).

• There is a spectrum of EVSs, from ecocentric through anthropocentric to technocentric value systems.

• An ecocentric viewpoint integrates social, spiritual and environmental dimensions into a holistic ideal. It puts ecology and nature as central to humanity and emphasizes a less materialistic approach to life with greater self-sufficiency of societies. An ecocentric viewpoint prioritizes biorights, emphasizes the importance of education and encourages self-restraint in human behaviour.

• An anthropocentric viewpoint argues that humans must sustainably manage the global system. This might be through the use of taxes, environmental regulation and legislation. Debate would be encouraged to reach a consensual, pragmatic approach to solving environmental problems.

• A technocentric viewpoint argues that technological developments can provide solutions to environmental problems. This is a consequence of a largely optimistic view of the role humans can play in improving the lot of humanity. Scientific research is encouraged in order to form policies and to understand how systems can be controlled, manipulated or changed to solve resource depletion. A pro-growth agenda is deemed necessary for society's improvement.

• There are extremes at either end of this spectrum (for example, deep ecologists–ecocentric to cornucopian–technocentric), but in practice, EVSs vary greatly depending on cultures and time periods, and they rarely fit simply or perfectly into any classification.

• Different EVSs ascribe different intrinsic value to components of the biosphere.

- A systems approach is a way of visualizing a complex set of interactions which may be ecological or societal.
- These interactions produce the emergent properties of the system.
- The concept of a system can be applied at a range of scales.
- A system is comprised of storages and flows.
- The flows provide inputs and outputs of energy and matter.
- The flows are processes that may be either transfers (a change in location) or transformations (a change in the chemical nature, a change in state or a change in energy).
- In system diagrams, storages are usually represented as rectangular boxes and flows as arrows, with the direction of each arrow indicating the direction of each flow. The size of the boxes and the arrows may be representative of the size/magnitude of the storage or flow.

- An open system exchanges both energy and matter across its boundary while a closed system exchanges only energy across its boundary.

- An isolated system is a hypothetical concept in which neither energy nor matter is exchanged across the boundary.

- Ecosystems are open systems; closed systems only exist experimentally, although the global geochemical cycles approximate to closed systems.

- A model is a simplified version of reality and can be used to understand how a system works and to predict how it will respond to change.

- A model inevitably involves some approximation and therefore loss of accuracy.

- The first law of thermodynamics is the principle of conservation of energy, which states that energy in an isolated system can be transformed but cannot be created or destroyed.

- The principle of conservation of energy can be modelled by the energy transformations along food chains and energy production systems.

- The second law of thermodynamics states that the entropy of a system increases over time. Entropy is a measure of the amount of disorder in a system. An increase in entropy arising from energy transformations reduces the energy available to do work.

- The second law of thermodynamics explains the inefficiency and decrease in available energy along a food chain and energy generation systems.

- As an open system, an ecosystem will normally exist in a stable equilibrium, either in a steady-state equilibrium or in one developing over time (for example, succession), and maintained by stabilizing negative feedback loops.

- Negative feedback loops (stabilizing) occur when the output of a process inhibits or reverses the operation of the same process in such a way as to reduce change—it counteracts deviation.

- Positive feedback loops (destabilizing) will tend to amplify changes and drive the system toward a tipping point where a new equilibrium is adopted.

- The resilience of a system, ecological or social, refers to its tendency to avoid such tipping points and maintain stability.

- Diversity and the size of storages within systems can contribute to their resilience and affect their speed of response to change (time lags).

- Humans can affect the resilience of systems through reducing these storages and diversity.

- The delays involved in feedback loops make it difficult to predict tipping points and add to the complexity of modelling systems.

- Organisms in an ecosystem can be identified using a variety of tools including keys

Name Date Period

Chapter 7 Scientific America Environmental Science for a Changing World

Engineering Earth

Read the chapter and fill out the following questions. Print off on due date.

Fill out the table below with the vocabulary from the Chapter

Vocabulary Word	Definition	Vocabulary Word	Definition
biosphere		Biotic	
ecosystem		Abiotic	
Habitat		Reservoirs	
species		Producer	
niche		Consumer	
Energy flow		Cellular respiration	
Nutrient cycles		Carbon cycle	
biomass		Nitrogen cycle	
biome		Nitrogen fixation	
Limiting factor			

1. What were the 2 goals of Biosphere 2?

2. Fill out the chart below based off of the failures of Biosphere 2.

Failures	Effect of Failure on the System

3. A) What is a closed system?

   B) How does Biosphere 2 emulate a closed system?

   C) How did the scientists violate the system?

4. Why was Biosphere 2 ideal for conducting field science?

5. What natural biomes are housed in Biosphere 2?

6. Give examples of the limiting factors the scientists had to consider when building the different biomes.

7. On page 102 the author talks about too much CO_2 in the air because of organic matter being decomposed by microbes in the soil. CO_2 is released during cellular respiration. Write the chemical formula for cellular respiration.

8. On page 103 the author writes that the biosphere glass dome did not let in enough sunlight and that affected biomass. How does less sunlight decrease biomass?

9. Oxygen fell from 21% to 14%. Where did the oxygen go?

10. Draw the carbon cycle on page 120. In the diagram include storages and write the words "transfer" and "transformation" on the arrows.

11. Draw the nitrogen cycle on page 122. In the diagram include storages and write the words "transfer" and "transformation" on the arrows

12. How have we affected CO_2 levels on planet Earth? What has this increased amount of CO_2 lead to?

13. How did soil microbes affect the nitrogen cycle?

14. List some of the successes of Biosphere 2.

15. Do you think Biosphere 2 was a success or failure? Explain.

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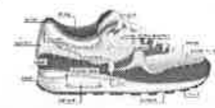
Systems

Systems are ____ among interdependent components.

- It is an organized group of ______________________________ that form a whole.
- Systems have
  - ____________________,
  - components,
  - resources flow (input and output),
  - and ____________________.
- 3 examples from your group
  - 1.
  - 2.
  - 3.

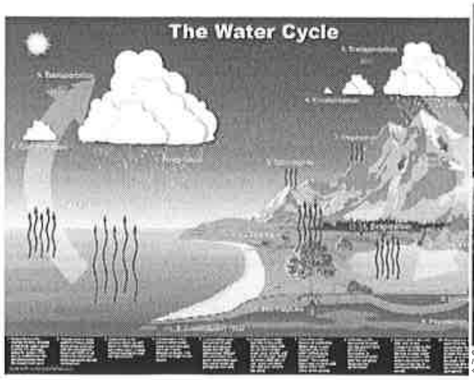
Examples of systems:

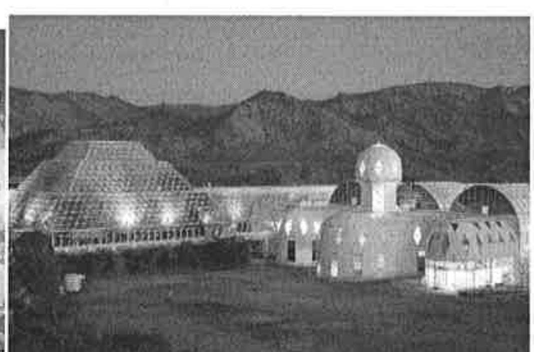


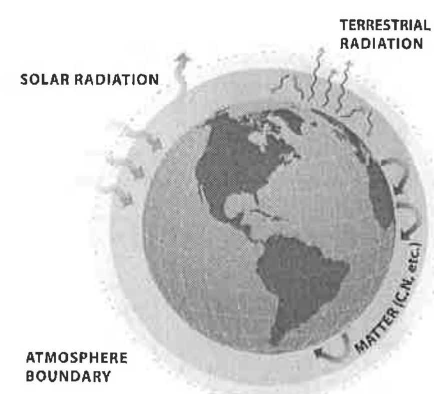
- Some systems we will discuss in this class include:
  - ________________________________ that recycle nutrients
  - ____________________ where living and nonliving factors interact.
  - Social systems
  - Value systems
  - ________________ systems
- Systems can be **closed, open, or isolated**.

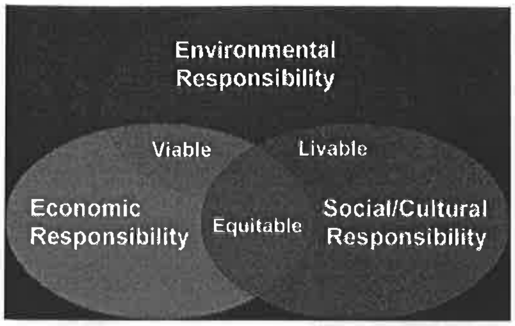
System	Energy exchanged	Matter exchanged	Examples
Open			
Closed			
Isolated			

Are these systems open or closed?









____________________ is a type of system that encompasses the whole society.

Parts = ____.
Whole = __________________________________

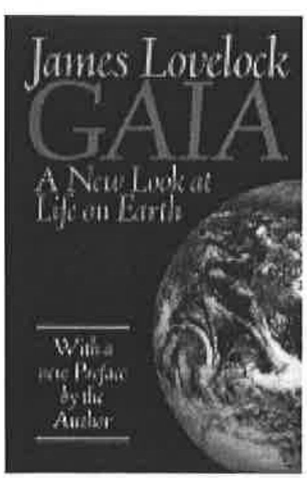
Sizes of systems can vary

Systems can be large like ________________________, or they can be small like _______________

Emergent Properties (synergy)

▪Emergent properties are characteristics of a _____________________ that are greater than ____.

▪Eg. Humans consist of tissues, organs and metabolic reactions, but they can sing, dance, produce ideas and art, etc. All these properties emerge because humans function as a system.



Gaia Hypothesis

___________________________________ proposed that organisms interact with their inorganic surroundings on earth to form synergistic, self-regulating, complex systems that helps to maintain and perpetuate the conditions for life on the planet.

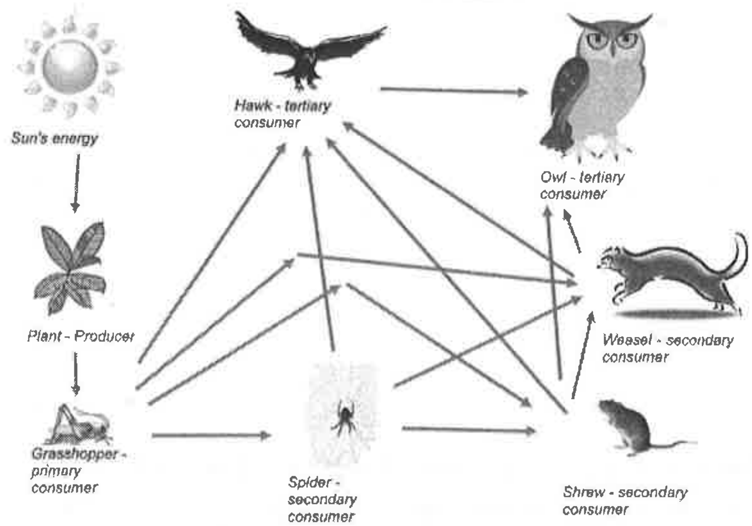
Mother earth---______________---is an ____________ ____________ living being.

Storage Flow Models with the Water Cycle, the Carbon Cycle, and the Nitrogen Cycle

Models are a simplified version of reality and can be used to understand how a system works and to predict how it will respond to change within an ecosystem.

Eg. Food web

Figure 1



Let's analyze the food web model as a class:

1. List some matter and energy inputs to the ecosystem.

2. List some matter and energy outputs to the ecosystem.

3. List where energy and matter are stored in the ecosystem

In flow diagrams inputs and outputs are considered "flows". In this case both energy and matter are flowing throughout.

- Inputs are represented by arrows with arrowheads that point towards where the energy/matter is headed.
  The magnitude of the arrow (the thickness or thinness) represents the quantity of matter/energy. See the diagram to the right.
- Outputs are represented by arrows with arrowheads that point out from where the energy/matter is headed.
  The magnitude of the arrow (the thickness or thinness) represents the quantity of matter/energy. See the diagram to the right.
- Storages (AKA Stocks) are the accumulation of matter/energy in a system. It is represented by a box.

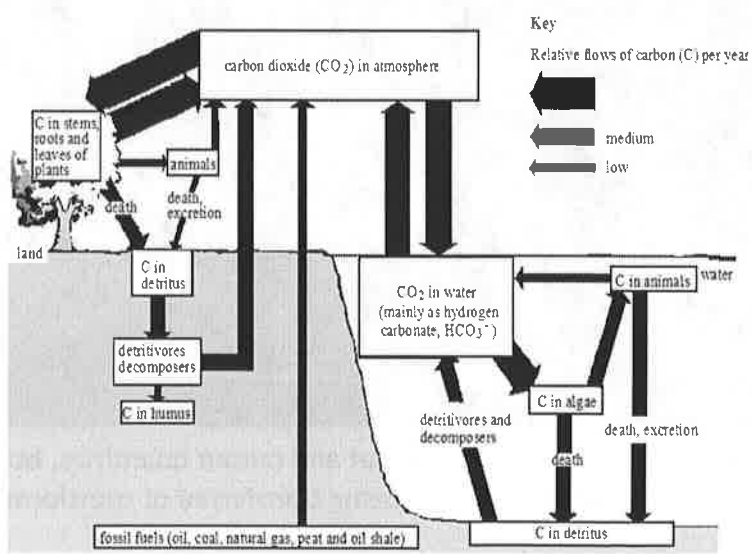


Figure 2: Flow Model showing inputs and outputs along with magnitude of the flows.

Let's take the food web in figure 1 and make it look like the flow model in figure 2.

In addition to inputs/outputs and storage boxes, flow diagrams show transfers and transformations of energy/matter. They are shown by writing the word "transfer" or "transformation" on the input/output arrows.

The difference between a transfer and transformation is the following:

Take the water cycle picture below and convert it into a flow model diagram on the next page

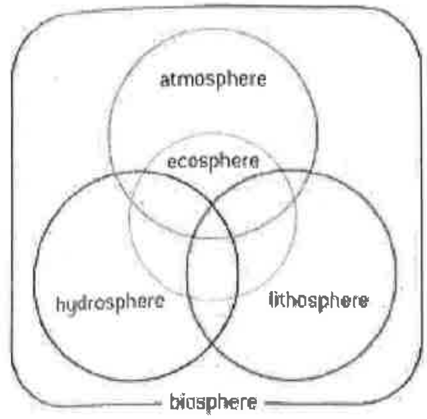
Draw arrows to represent input and output quantities, boxes for storages, label the input/output arrows with whether you think water is being transferred or transformed. Your drawing should look similar to figure 2.

Water Flow Diagram Model

Now take the food web diagram (figure1) and turn it into a flow diagram keeping in mind that both energy and matter are flowing.

Name ____ Date ____________ Period___________

Carbon and Nitrogen Cycles Worksheet and Notes



Although this handout is in worksheet form, it belongs in your note section of your notebook. It is a good resource for studying for the tests.

Introduction:

There is a link between the hydrosphere (water), the lithosphere (soil), the atmosphere, and the ecosphere. Both matter and energy are exchanged throughout all of these spheres to make up the biosphere. See picture to the right for a visual. This flow of matter involves transfers and transformations. Although each component is a system in and of itself, the larger system—the biosphere—is a complete system as well with the lithosphere, the hydrosphere, the atmosphere, and the ecosphere being parts of the whole biosphere.

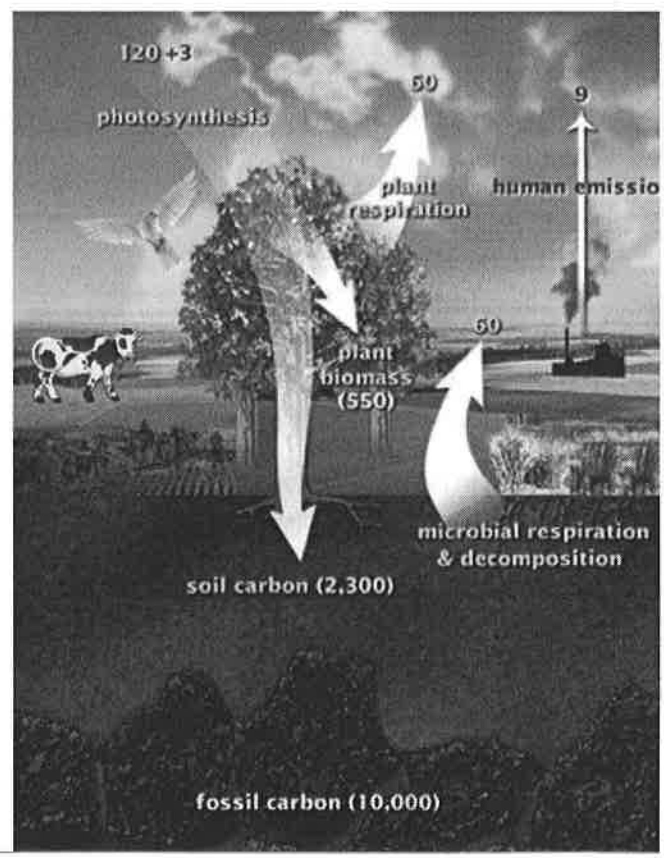
In this worksheet/notes you will be modeling the carbon and nitrogen cycles. Keep in mind that **a model is a simplified version of reality and can be used to understand how a system works and to predict how it will respond to change.** The carbon and nitrogen cycles are used to illustrate this flow of matter using flow diagrams. These cycles contain storages (sometimes referred to as sinks) and flows, which move matter between storages.

Carbon Cycle

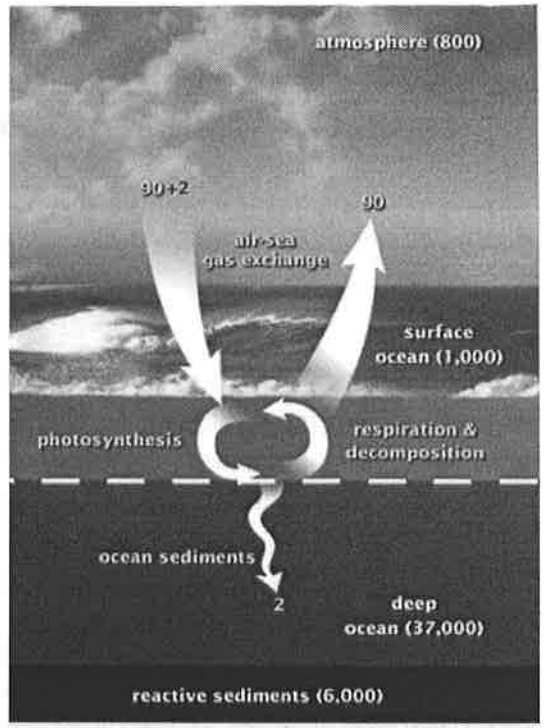
- Storages in the carbon cycle include organisms and forests (both organic), the atmosphere, soil, fossil fuels and oceans (all inorganic).
- Flows in the carbon cycle include consumption (feeding), death and decomposition, photosynthesis, respiration, dissolving and fossilization.

In the space below let's look at the picture of the land carbon cycle. As a class let's change these diagrams into a **matter/energy flow diagram** making sure to reflect the amount of carbon being taken in and released by:

1. drawing different *magnitude input/output arrows.*
2. including *boxes* for storages and
3. writing the words "*transfer*" and "*transformation*" on the arrow.



Now draw a matter/energy flow diagram for the ocean carbon cycle in the space below.



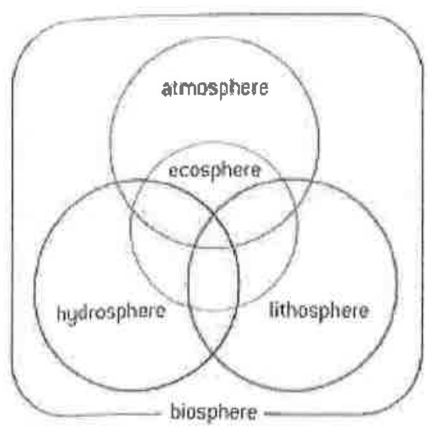
Carbon storages (sinks)
Organisms
Forests
Fossil Fuels
Soil
Oceans

Flows
consumption
decomposition
photosynthesis
respiration
Dissolving
Fossilization
Combustion

***Notice in the carbon cycle diagram that humans impact the cycle by adding CO_2 into the atmosphere by the combustion of fossil fuels

Nitrogen Cycle

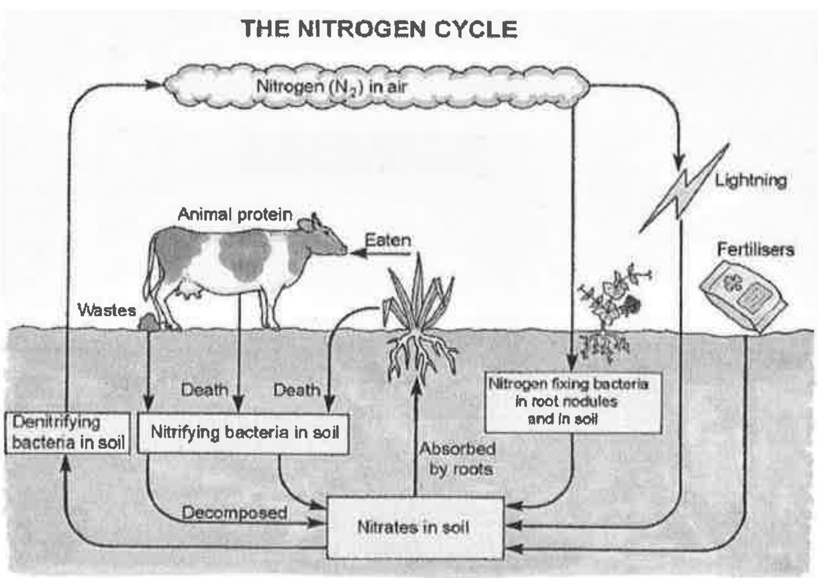
Next let's look at the nitrogen cycle remembering that there are links between the hydrosphere (water), the lithosphere (soil), the atmosphere, and the ecosphere. Both matter and energy are exchanged throughout all of these spheres to make up the biosphere.



• Storages in the nitrogen cycle include organisms (organic), soil, fossil fuels, atmosphere and water bodies (all inorganic).

• Flows in the nitrogen cycle include nitrogen fixation by bacteria and lightning, absorption, assimilation, consumption (feeding), excretion, death and decomposition, and denitrification by bacteria in water-logged soils.

In the space on the next page take the nitrogen cycle picture and turn it into a matter/energy flow diagram. Make sure you reflect the amount of carbon being taken in and release by drawing different **magnitude input/output arrows**. Also include **boxes** for storages and write the words "**transfer**" and "**transformation**" on the arrow.



Nitrogen storages (sinks)
Organisms
Atmosphere
Fossil Fuels
Soil
Oceans and Lakes

Flows
fixation
consumption
excretion
Death and decomposition
Denitrification

***Notice the human impact on the nitrogen cycle includes adding fertilizer to the soil to help crops grow faster. We will discuss the impact of fertilizers on the environment more in 2nd semester during our water unit.

Environmental Value Systems

The Nature of Environmental Science

▪Environmental systems is an ______________________________

____

Environmental Value Systems

▪Conflicting values

–Examples:

▪Undeveloped rivers are __________________ because the potential energy it contains vs. __________________________________ provides a pristine habitat for living things.

▪Old growth forests = __________________ vs. _______________________ __________________________ have a kind of value beyond their economic value.

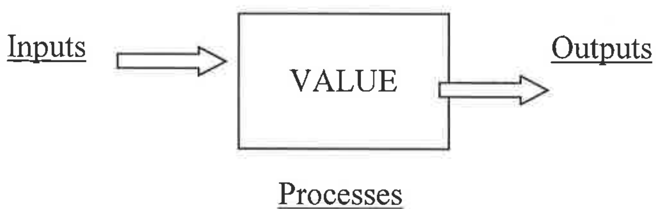
▪An environmental value system is a ___________________________ that shapes the way an individual or group of people ____.

▪Influenced by:

- __________________ (including religion)
- _________________________
- _______________________ (eg. ____________________________________)

▪An environmental value system has _________________________.

- ________________________



▪3 Philosophical Approaches

–Anthropocentrism

–Ecocentrism

–______________________

1. Anthropocentrism

- **An anthropocentric viewpoint argues**
  - **that humans must ________________________ the global system.**
    - **through the use of taxes, environmental regulation and legislation.**
    - **Eg. Gas tax**
  - **_________________ would be encouraged to reach a consensual, pragmatic approach to solving environmental problems.**
  - **Humans are not dependent on nature but nature is there to _______________ __________________________.**

Economic growth is _______________________

We can always keep the economy growing.

There will always be more _______________ to exploit.

2. Ecocentrism

- An ecocentric viewpoint integrates ______________________________________ into a ____________ ideal.
  - It puts ecology and nature as __________ to humanity and emphasizes a less __________________ approach to life with greater self-sufficiency of societies.
    - An ecocentric viewpoint prioritizes _______________, emphasizes the importance of education and encourages _______________________ in human behavior.
      –The Gaia Hypothesis ____

3. Technocentrism

- In addition to the three philosophical approaches discussed earlier, a new approach has recently emerged.
- Technocentrics have ____ and firmly believe that humans have control over nature.
- We can solve any _______________________ problem that we cause
  Whatever we do, we can solve it.

Let's compare the following two societies:
First Nation American vs. European pioneers environmental value systems

First Nation America	European Pioneer

Each approach values different parts of the environment differently.
Eg. An anthropocentric might look at a forest as timber while an ecocentric would look at it as beauty and a place for organisms to live.

Different Categories of Env. Value Systems. Fill in the boxes and include the lines.

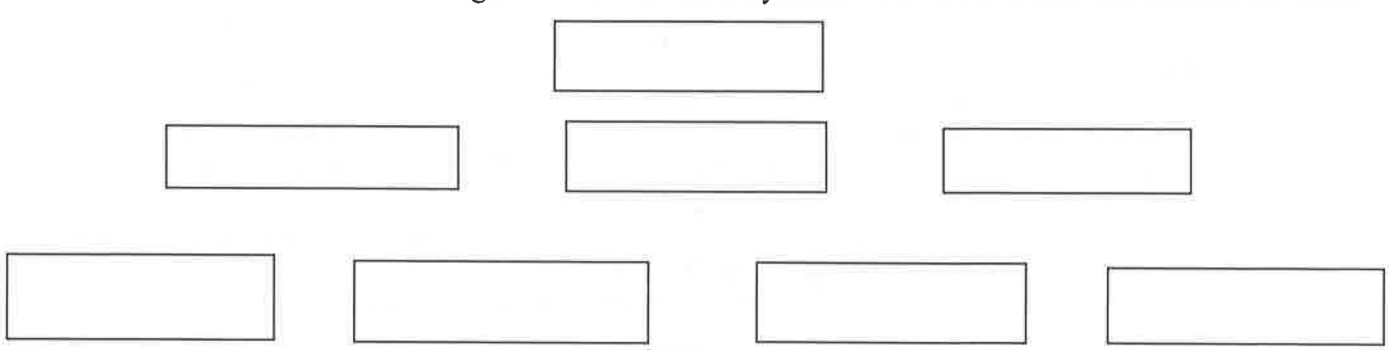
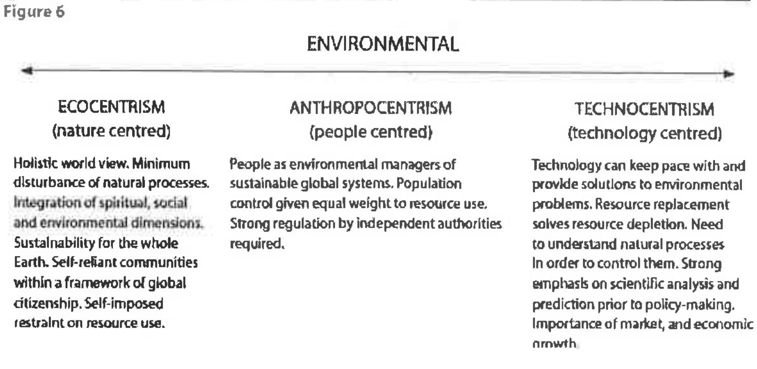


Figure 6



There is a spectrum of viewpoints and a person may be extreme ecocentric on one topic but more middle of the line on another. It all depends on the inputs a person receives during her/his lifetime.

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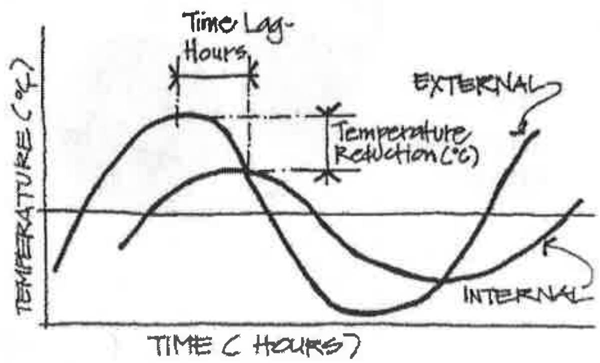
Feedback Loops

▪Feedback loop is when a ___________________ can serve as an input to that same system. It is a ______________________________.

▪Feedback loops ____________________________________.



▪There are 2 different kinds of feedback loops

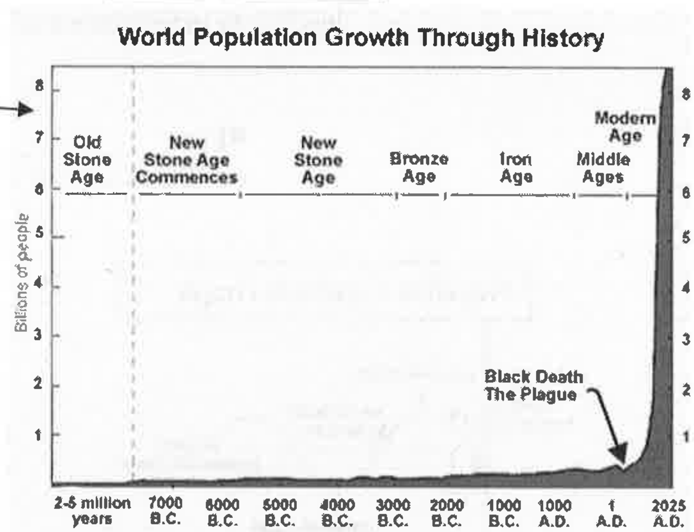
▪1. _______________ Feedback Loops

▪2. ________________Feedback Loops

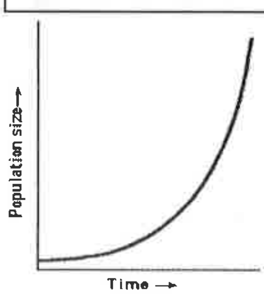
▪Positive Feedback Loops

▪Uses the _______________ from a process to ________________ that process

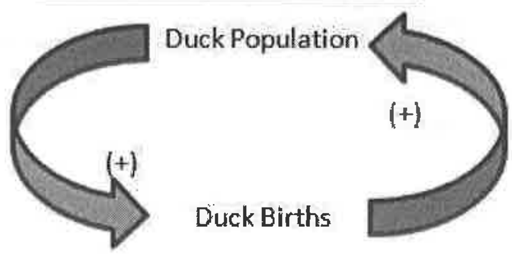
▪Eg. ______________________



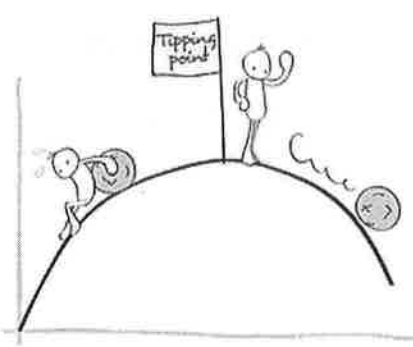
Positive Feedback Graph

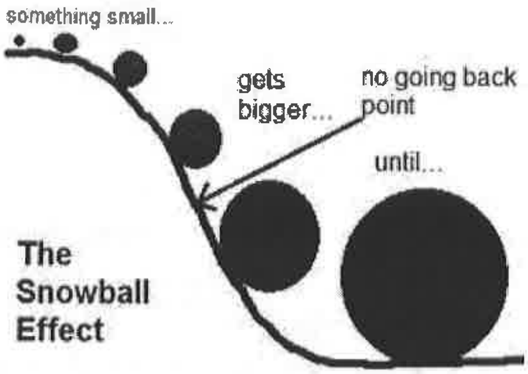


Positive Feedback Loop



- Positive Feedback loops are _____________________.
- Drives the system toward a ______________________________ where a new equilibrium is adopted.
  - o Eg.





▪Each __________ involves another _________; there is a ________________________.

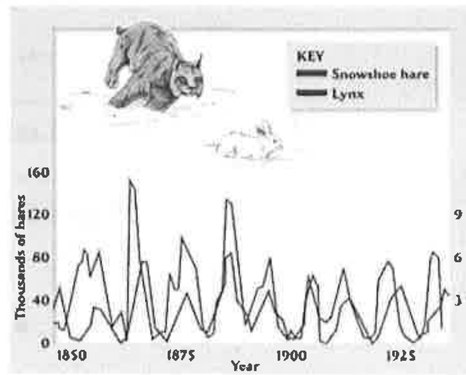
▪A positive feedback loop left to itself can lead only to

____

▪The wild behavior of positive loops - a veritable death wish-

____

2. ______________________ Feedback Loops

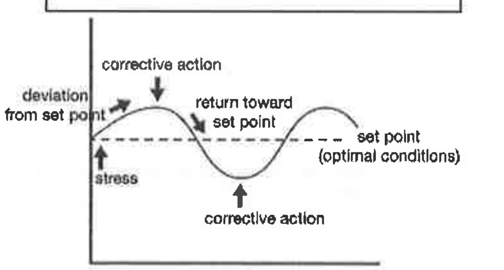


▪______________ the direction in which a system is moving.

▪It is a ______________________ method of control leading to maintenance of a steady state equilibrium

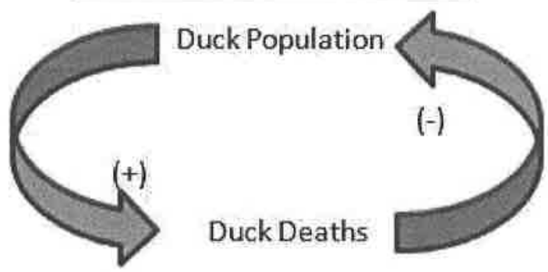
▪Eg. ________________________________ oscillate with lag times between highs and lows.

Negative Feedback Graph



Stress or disturbance changes the internal environment.
Change is detected by receptors.
Corrective measures are activated.
Corrective measures counteract the change back toward set point.

Negative Feedback Loop



Equilibria

Homeostasis is when_________________________________. Regulatory processes

_____________________________ and internal conditions are _________________.

Disturbances and Resiliency

▪**Disturbances**—periodic, destructive events _____________________________ that are a normal part of natural systems.

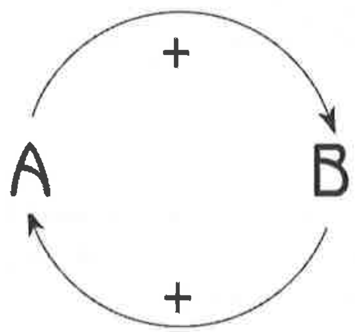
▪The ________________________ of a system, ecological or social, refers to its tendency to avoid such tipping points and maintain stability.

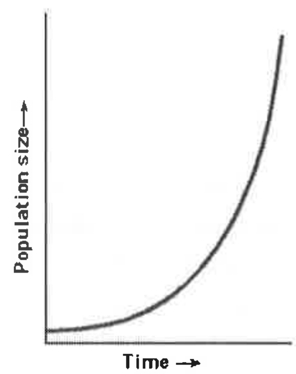
Name ______________________________ Date ____________

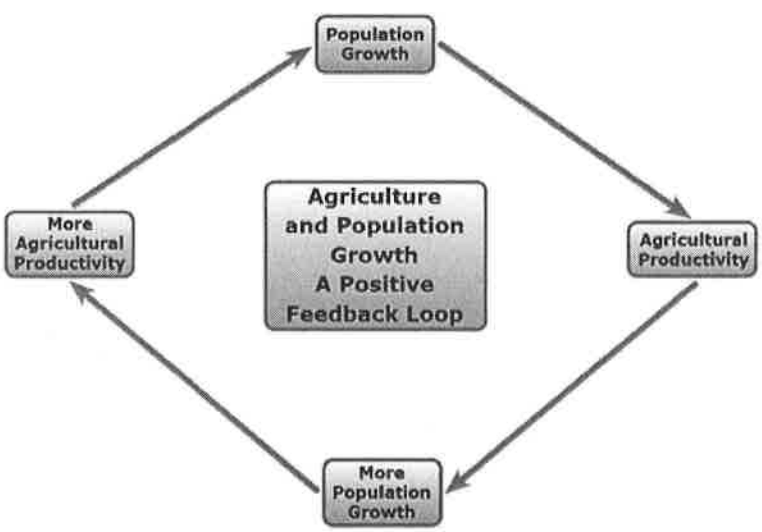
Positive and Negative Feedback Loops

Feedback loops can be shown on 2 different types of graphs.

The graph to the left below is called a feedback loop graph. Specifically this one is illustrating a positive feedback loop in the fact that A leads to B which in turn leads to an **increase** A which in turn leads to an **increase** B and so on and so forth—a snowball effect. The same is true of a decrease as well. A system that is in a positive feedback loop is normally considered in a state of chaos because this system cannot proceed indefinitely. The graph to the right below is a trend line graph of a positive feedback. It shows exponential growth.

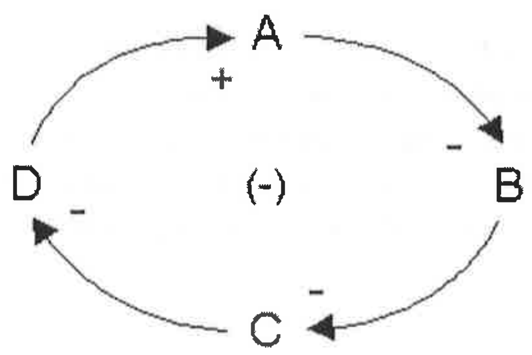


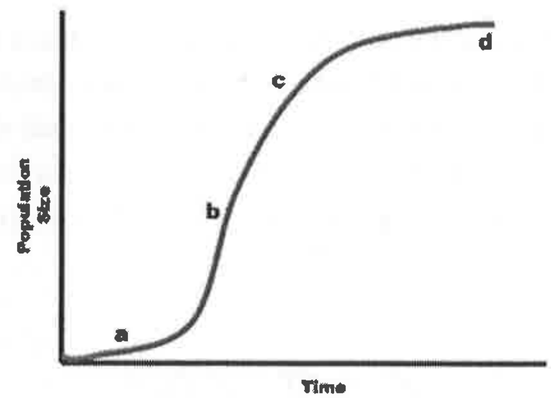




The example to the left shows how **increased** production of food leads to an **increase** in the human population. The more people there are the more food is needed which leads to an **increase** in food production which, in turn, leads to an **increase** in the number people.

A negative feedback loop keeps the system from going into a snowball effect. The graph to the left below show how some factors **decrease** thus keeping the **increases** in check. The graph to the left below shows how a negative feedback looks on a trend line. It shows a logistical growth. A system in a negative feedback is normally considered in equilibrium and can proceed this way indefinitely.





In the negative feedback loop below you can see how your thermostat at home works to keep your house at a constant temperature. As your house temperature **decreases** the thermometer on your thermostat detects the drop in temperature which tells your furnace to switch on. This causes the temperature to **increase** back to the normal temperature which, in turn, switches the heat off. Eventually the temperature in your house **decreases**, so the heat switches back on.

Draw a feedback loop AND a trend graph (with labeled axis) for the following scenarios:

1. An under-resourced company is trying to raise quality. If customer satisfaction is raised then demand for the product will increase. More demand typically makes the quality of the resources go down.

2. A theatre is trying to improve its profitability by investing more in productions. As more investment is put into a production, the theatre is able to put on more lavish plays with more famous actors. Better plays should bring better reviews, and therefore higher ticket sales. This should lead to higher profitability, and therefore more money available to invest in future productions.

Global Warming and Feedback Loops

3. Here are a number of examples of how both positive and negative feedback mechanisms might operate in the physical environment. No one can be sure which of these effects is likely to most influential, and consequently we cannot know whether or not the Earth will manage to regulate its temperature, despite human interference with many natural processes.

Label each example as either positive or negative feedback. Draw loop graphs of one example of positive feedback and one example of negative feedback. Label your arrows with the words increase or decrease and put a + or – sign in the middle of the loop to show a positive or negative feedback.

______________ a. As carbon dioxide levels in the atmosphere rise, the temperature of the Earth rises. As the Earth warms the rate of photosynthesis in plants increases, more carbon dioxide is therefore removed from the atmosphere by plants, reducing the greenhouse effect and reducing global temperatures.

______________ b. As the Earth warms, ice cover melts, exposing soil or water. Albedo decreases (albedo is the fraction of light that is reflected by a body or surface). More energy is absorbed by the Earth's surface. Global temperature rises. More ice melts.

______________ c. As the Earth warms, upper layers of permafrost melt, producing waterlogged soil above frozen ground. Methane gas is released into the environment. The green house effect is enhanced. The Earth warms, melting more permafrost.

______________ d. As the Earth warms, increased evaporation produces more clouds. Clouds increase albedo, reflecting more light away from the Earth. The temperature falls. Rates of evaporation fall.

______________ e. As the Earth warms, organic matter in soil is decomposed faster, more carbon dioxide is released, the enhanced greenhouse effect occurs, the Earth warms further and rate of decomposition increase.

______________ f. As the Earth warms, evaporation increases. Snowfall at high latitudes increases. Icecaps enlarge. More energy is reflected by increased albedo of ice cover. The Earth cools. Rates of evaporation fall.

______________ g. As the Earth warms, polar icecaps melt, releasing large numbers of icebergs into oceans. Warm ocean currents such as the Gulf Stream are disrupted by additional freshwater input into oceans. Reduced transfer of energy to the poles reduces temperature at high latitudes. Ice sheets reform and icebergs retreat. Warm currents are re-established.

Diagram 1

I diagramed letter _________

Diagram 2

I diagramed letter _______