1.2 Systems & Models

IB ESS
Pg 17-26

Learning Objectives

- Outline the concepts & characteristics of systems
- Apply the concepts of a system to a range of different scales
- Define open, closed and isolated systems
- Understand how the systems approach can help in the study of a complex environmental issue
- Understand how the systems approach enables us to take a more holistic view

Key Questions:

- How does the systems approach help us study complex environmental issues?
- What are the key features of any system?
- How are models used to help us understand how a system works?

Systems approach

- Considers whole ecosystems & examines the best ways to protect our natural heritage
- Looks at the environment (or complex system) as a set of components that work together as integrated units

EX. ecology...instead of studying plants, animals and atmosphere separately, consider them together as components of a complex environment (including the relationships and interactions within)
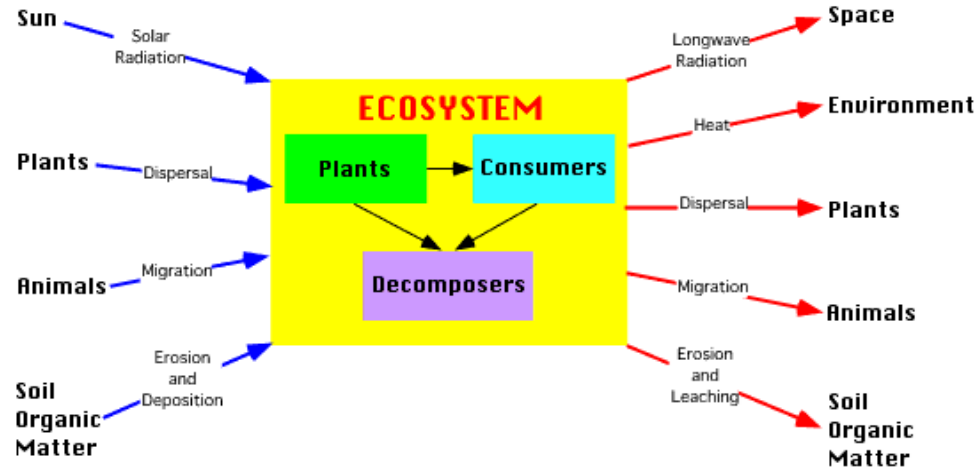
Can be represented in a diagram (inputs, flows, storages & outputs)

Rules:

Component of a System	Shown as
Storages (stores of matter or energy)	boxes
Flows (into, within & out of the system)	arrows
inputs	Arrows into the system
outputs	Arrows out of the system
Processes (transfer or transform energy or matter from 1 storage to another)	Labels such as respiration, consumption or photosynthesis

Make a systems model for this

Photosynthesis
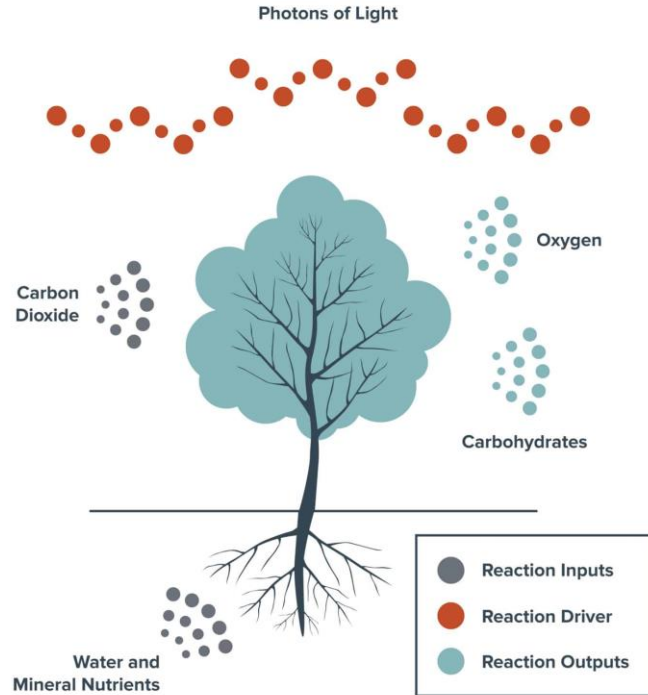
Systems: living or nonliving, small or large scale

Make a model for one of these

Consider a tree

- INPUTS, STORES & OUTPUTS

and a biome

- INPUTS, STORES & OUTPUTS

3 types of systems:

- Open system - exchanges both matter & energy with its surroundings
    - EX. most living systems, all ecosystems
    - Inputs include energy & matter, outputs include energy & matter
- Closed system - exchanges energy but NOT matter with its surroundings
    - Rare in nature, most are used in experiments or artificial
    - Most don't survive...unbalanced
    - Inputs include energy only, outputs include energy only
    - EX. ecosystem in a bottle, Biosphere 2
- Isolated system - exchange neither energy nor matter with its surroundings
    - None known to exist...the universe??

Transfers

-flow of matter & energy through an ecosystem (movement only)

- NOT a change in form or state
- Examples:
  - Matter through a food chain as one animal eats another
  - Energy as wind carries heat energy from one part of the world to another
 - Matter as water flows from a river to the sea
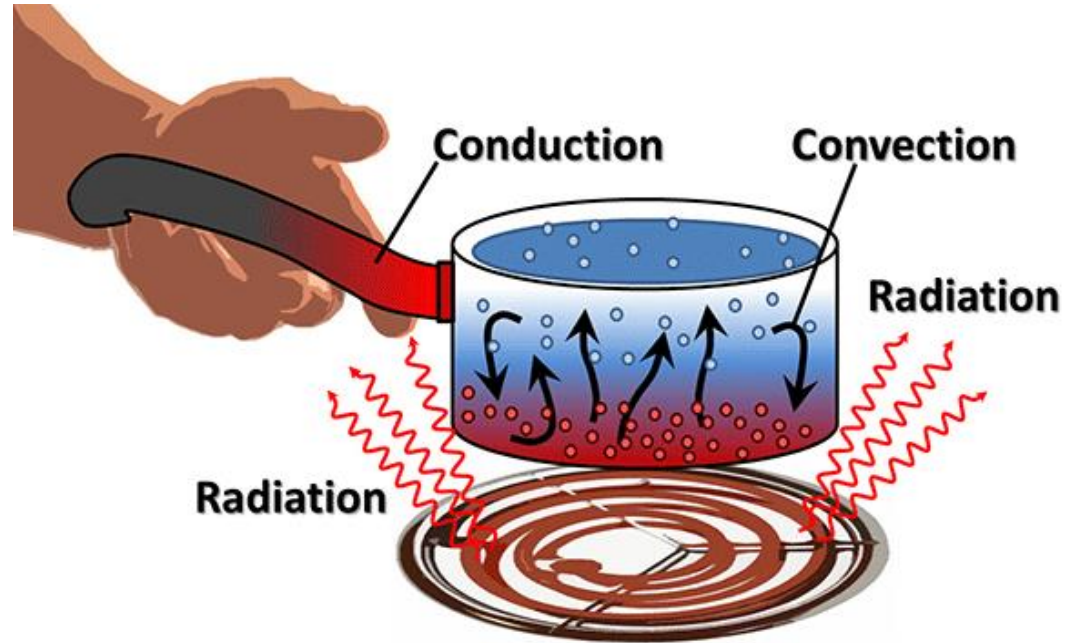
Transformations

- When flow in a system involves a <u>change of form or state or leads to an interaction</u> within the system
- Examples
    - <u>Evaporation</u> of water from a river
    - <u>Photosynthesis</u> converting sunlight into chemical energy in the bonds of molecules
    - Cell <u>respiration</u> converting chemical energy into heat and kinetic energy
    - Light energy to electrical energy in a solar panel
    - <u>Decomposition</u> of leaf litter into inorganic compounds
    - <u>Burning</u> coal to produce heat & light

Flows (inputs & outputs) AND Storages (stock) in a system

- Energy & matter flow in, out and are stored in a system
- Flows = arrows (size can indicate how much)
- Storage = boxes (size can indicate how much)
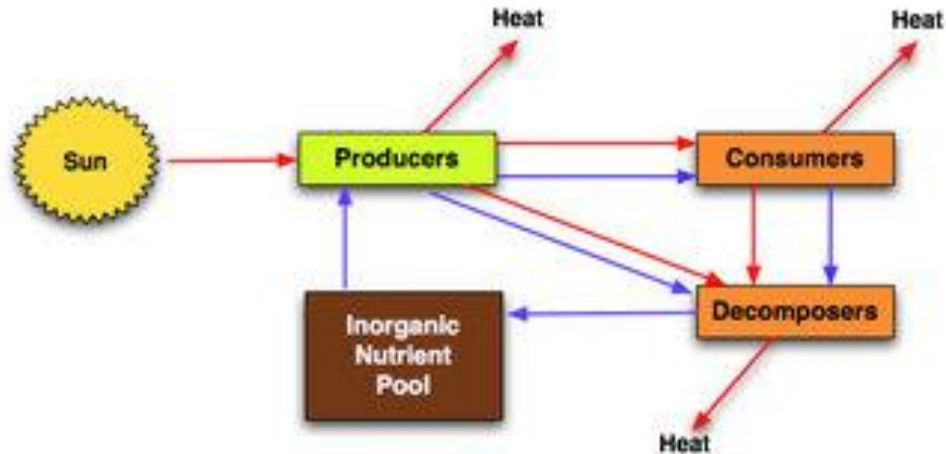
MODELS (flow & storage)

- Allow scientists to draw comparisons between different ecosystems
- Drawn to represent situations found in real systems
- Approximations & predictions mostly
- Computer models & simulations - used for prediction
- Advantages:
  - Simplifies complex systems
  - Allows predictions about future events
  - Can consider different scenarios by changing inputs & calculating likely outcomes
  - Can form the basis for discussion & consultation of interested parties
- Disadvantages:
  - Can be oversimplified so accuracy is lost
  - Depend on the skills and experience of the people making them
  - Can be interpreted differently by different scientists
  - Different models may predict different outcomes
  - Data may not be accurate
  - Can be manipulated for financial or political gain