1.1.4 Describe how the first and second laws of thermodynamics are relevant to environmental systems.

CC p. 75

What is thermodynamics?

Thermo = relating to heat

Dynamics = in motion/change

What is thermodynamics?

- the study of the relationships between heat and energy *flow* (transfers and transformations) in systems

- understanding these laws is important because most processes in natural systems, involve a flow of energy.

1st Law:
law of energy conservation

- energy can NOT be ***created*** nor ***destroyed*** it can only be ***transferred*** from one system/ form to another (fixed – isolated system)
- i.e. energy entering a system equals energy leaving it (although it may change forms)

Example of 1st Law

- The **sun's** energy came to the earth hundreds of millions of years ago. It was captured by **green plants** and used for **photosynthesis** and the formation of **carbohydrate** molecules. Over eons of time, the carbon atoms of ancient plant decay were **transformed** into energy-rich **deposits of coal**. The coal is excavated and **burned**, giving off **heat energy** which drives a **steam** turbine to produce **electricity**. The electricity is used to **heat the coils** that toast your bread with your morning coffee.

Example of 1st Law (learn it!)

- The s energy came to the earth hundreds of millions of years ago. It was captured by g p and used for p and the formation of c molecules. Over eons of time, the carbon atoms of ancient plant decay were t into energy-rich deposits of . The coal is excavated and b , giving off h energy which drives a s turbine to produce e . The electricity is used to h the coils that toast your bread with your morning coffee.

Example of 1st Law

sun's

green plants

photosynthesis

carbohydrate

transformed

deposits of coal

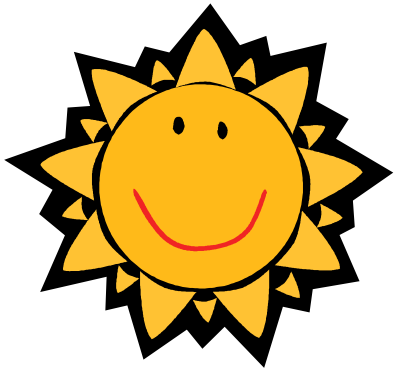
burned

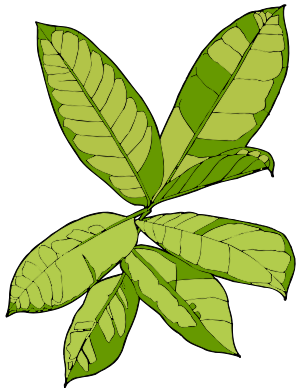
heat energy

steam

electricity

heat the coils

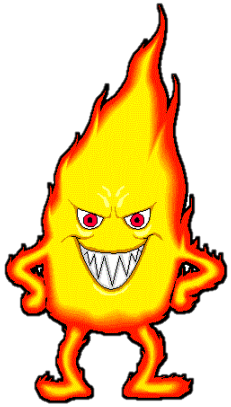


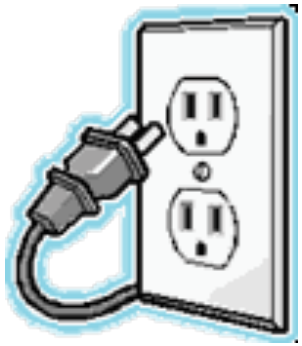


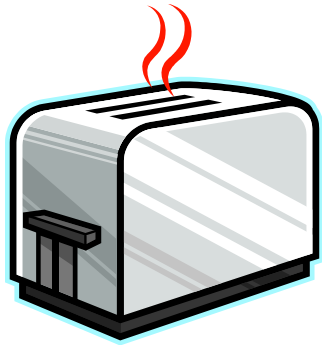
Definition - Carbohydrates are sugar polymers
Carbohydrate = Carbon + Water

$C_n(H_2O)_n$

or $C_6H_{12}O_6$







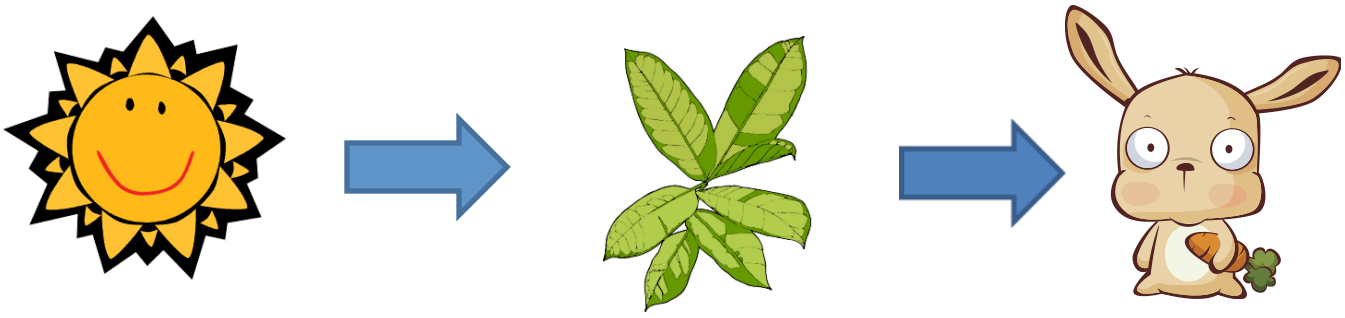
How is the 1st law this relevant to Environmental Systems?

food chains, webs, pyramids

- the amount of energy being transferred through the food web *cannot be larger than the amount of energy initially supplied* by the primary producer (originally supplied as sunlight)

2nd Law: Energy dissipation

- whenever energy is changed (transferred or transformed) from one form to another (e.g. sun to plant then plant to animal), there is always a "loss" or "waste" of *usable* energy.



Recap 2nd law:

- Energy is inefficiently transferred/transformed through food chains in the process of respiration and production of heat energy

- Initial absorption and transfer of energy by producers is also inefficient due to reflection, transmission, wrong light wavelength, and the process photosynthesis

2nd Law - entropy

2nd Law:

"In any isolated system *entropy* tends to increase spontaneously."

- This means <u>energy and materials go from a concentrated to a *dispersed* form</u>

(the availability of energy to do work diminishes) and the system becomes increasingly disordered.

- energy is ‘lost’ to the system but not destroyed, usable energy is *dissipated* so the amount of disorder increases

- Entropy can be thought of as a measure of the disorder in a system – the disorder of an isolated system can never decrease

How is the 2nd law relevant to food chains and pyramids of productivity?

- although sometimes total *size* or *number* of organisms can either increase or decrease with increasing trophic levels, the total productivity *ALWAYS* decreases with increasing trophic levels, as energy is constantly being 'lost' or dissipated from the system
- The transfer of energy from one trophic level to another is **never 100% *efficient*** because some of the energy is always 'wasted' by processes (heat->R, excretion, etc.)