NOTES: 17.1 – Thermochemistry – The Flow of Energy

Thermochemistry

- **THERMOCHEMISTRY**: the study of energy (in the form of heat) changes that accompany physical & chemical changes

- Heat flows from high to low (hot to cool)

Energy (E):

- measures the capacity to do work or supply heat
- energy is weightless, odorless, and tasteless
- can only be detected because of its effects

Energy (E):

- energy stored within the structural units (i.e. molecules) of chemical substances is called: **CHEMICAL POTENTIAL ENERGY (PE)**

EXAMPLE: gasoline contains a large amount of chemical PE; when the gasoline burns in your car engine, the energy is released to do mechanical work

Heat (q):

- measure of the total amount of energy (E) transferred from an object with high energy to an object with low energy
- cannot be detected by the senses or instruments…only changes caused by heat can be detected

Magnitude of Heat Flow

- Units of heat energy:

1 kcal = 1,000 cal = 1 Cal (nutritional)

1 kJ = 1,000 J

1 calorie = 4.184 J

1 kcal = 4.184 kJ

Heat (q):

- heat always flows from a warmer object to a cooler object

EXAMPLE: when you put an ice cube into a cup of hot water, heat will flow from the hot water to the ice cube… the ice melts and the water's temp. decreases

Temperature (T):

- Measure of average kinetic energy
- Indicates relative amounts of energy
- Indicates the hotness or coldness of an object

Thermochemistry

- all chemical reactions and changes in physical state (melting, freezing, etc.) involve either the **release or absorption of HEAT**

- in thermochemistry we examine the flow of heat from a “system” (i.e. a chemical reaction) to its surroundings (or vice versa)

How does energy change?

- **Law of Conservation of Energy:**

  -In any chemical reaction or physical process, **energy is neither created nor destroyed**;

  -all of the energy involved in a process can be accounted for as: work, stored energy, or heat.

Thermochemistry

- **exothermic reactions:** release energy in the form of heat; show a negative value for quantity of heat **($q < 0$)**

- **endothermic reactions:** absorb energy in the form of heat; show a positive value for quantity of heat **($q > 0$)**

EXOTHERMIC CHANGE:

- losing energy
- products have less energy than the reactants
- $\Delta H = (-)$

ENDOTHERMIC CHANGE:

- gaining energy
- products have more energy then reactants
- $\Delta H = (+)$

Endothermic or Exothermic?

- $H_2O_{(l)} \rightarrow H_2O_{(s)}$

Endothermic or Exothermic?

- $H_2O_{(l)} \rightarrow H_2O_{(s)}$

Exothermic
(liquid water freezing to solid ice)

Endothermic or Exothermic?

- Melting - solid to liquid
- Boiling - liquid to gas
- Condensing - gas to liquid
- Freezing - liquid to solid
- Sublimation - solid to gas

Endothermic or Exothermic?

- Melting - solid to liquid **endothermic**
- Boiling - liquid to gas **endothermic**
- Condensing - gas to liquid **exothermic**
- Freezing - liquid to solid **exothermic**
- Sublimation - solid to gas **endothermic**

In conclusion…

- Solid ➔ Liquid ➔ Gas (**endothermic**)
- Gas ➔ Liquid ➔ Solid (**exothermic**)

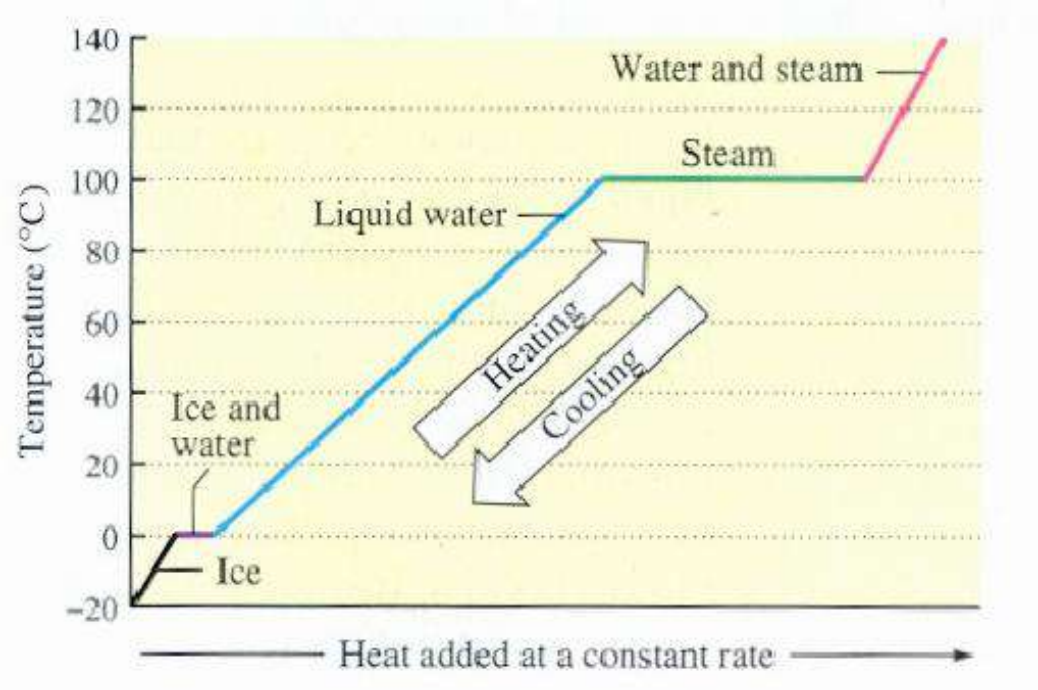
Cup of water at 30º C vs. tub full of water at 28º C:

- Which has a higher kinetic energy?

- If the cup of water was poured into the tub of water, would there be a transfer of heat at that moment? Would the temperature change?

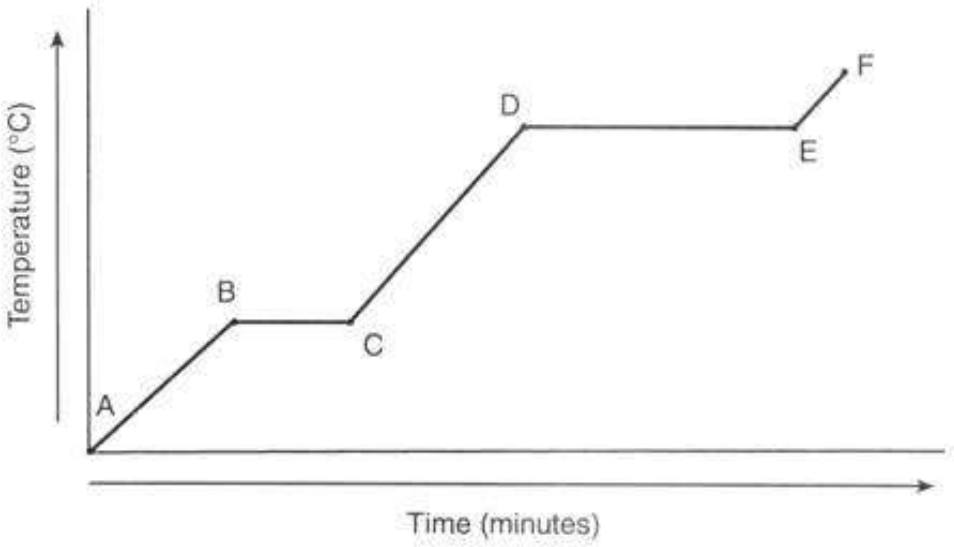
Heating and Cooling Curves:

- When a plot of temperature vs. time is plotted as a pure substance is heated or cooled, a plateau is observed at the substance's melting and boiling points.



Heating and Cooling Curves:

- In other words, as energy is added or removed from a substance, there is no change in temperature at the pure substance's melting and boiling points until it has completely melted or boiled.



- mmkay