Energy Changes in Reactions

Section 5.1

Thermochemistry is the study of the **energy changes** that accompany physical or chemical changes.

The Law of Conservation of Energy:
Energy can't be created or destroyed

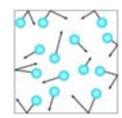
When a physical or chemical change happens, energy is **transferred** between the **CHEMICAL SYSTEM**, and its SURROUNDINGS.

a set of reactants and products being studied

Transferred energy is…

- in the form of **THERMAL ENERGY**

  the energy of the motion of particles



- experienced as **HEAT**, q

  the amount of energy that is transferred

- measured as a change in the **temperature** of the system, and surroundings

Temperature ≠ Heat!!

Thermal energy is transferred as **heat**:

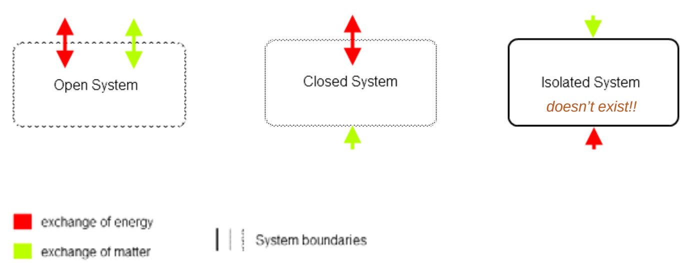
system → surroundings

"surroundings"

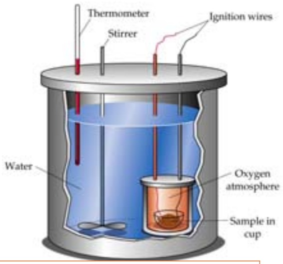
Measurable temperature changes:

- system:
- surroundings:

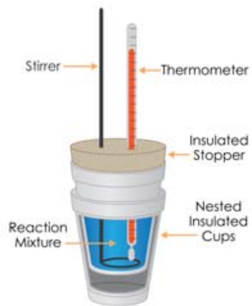
Classifying Systems



Calorimeters are closed systems used for measuring energy changes during reactions.



Bomb calorimeter: Used for studying combustion reactions



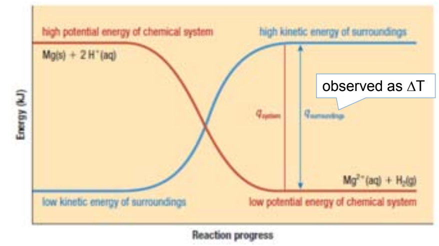
Simple coffee cup calorimeter: For reactions that occur in solution

Calorimetry is the process of measuring energy changes in a chemical system.

Basic principle:

Measure **the change in temperature (ΔT) of the surroundings**, to infer the amount of energy absorbed/released by the system.

Exothermic reaction:
$Mg (s) + 2 H^+ (aq) \rightarrow Mg^{2+} (aq) + H_2 (g)$ + **energy**



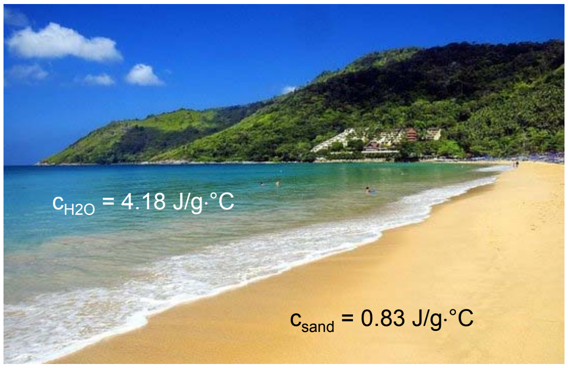
Substances vary in their ability to absorb certain amounts of heat.

Factors:

- mass, m
- temp. change, ΔT
- quantity of heat transferred, q

$$q = m\ c\ \Delta T$$

Specific heat capacity: The quantity of energy needed to raise the temperature of 1 g of substance, by 1°C



Example 1.

When 0.600 kg of H_2O is heated from 20°C to 85°C, **how much heat, q,** flows into the water? c_{H2O} = 4.18 J/g·°C

STRATEGY

SOLUTION

GIVEN

Example 2.

What would be the **final temperature**, if 250.0 J of heat were transferred into 10.0 g of methanol, initially at 20.0°C?

STRATEGY

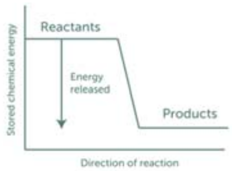
SOLUTION

GIVEN

Based on energy changes, reactions can be classified as exothermic or endothermic.

Exothermic

Heat is transferred from the system to the surroundings, because products have less chemical energy than before



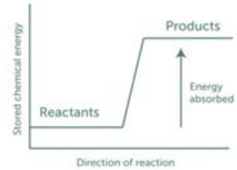
SYSTEM
$q_{system} < 0$

SURROUNDINGS
$q_{surroundings} > 0$

$|q_{system}| = |q_{surroundings}|$

Endothermic

Heat is absorbed by the system, from the surroundings, because products have more chemical energy than reactants



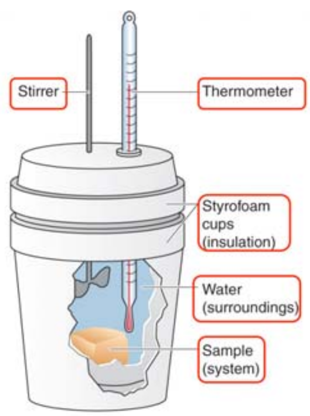
SYSTEM
$q_{system} > 0$

SURROUNDINGS
$q_{surroundings} < 0$

$|q_{system}| = |q_{surroundings}|$

Example 3a.

50.0 mL of liquid water at 21.00°C is placed into a coffee cup calorimeter. A sample of gold at 100.00°C is placed into the calorimeter. The final temperature of the water is 21.33°C. The specific heat capacity of water is 4.18 J/g°C, and the density of water is 1.00 g/mL. **What quantity of thermal energy, q, is absorbed by the water in the calorimeter?**



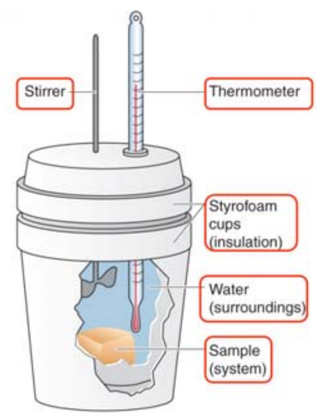
Example 3b.

From 3a… **$q_{surroundings}$ = +69 J**

Calculate the specific heat capacity of gold, if the sample had a mass of 6.77 g. Assume that the final temperature of the gold was the same as the final temperature of the water in the calorimeter.

GIVEN

- m_{gold} = 6.77 g
- T2 = 21.33°C
- T1 = 100.00°C
- q = ______ J



Summary

- The amount of thermal energy absorbed or released by a system is heat, which is calculated by $q=mc\Delta T$.

Homework

- Pg. 291 #2, 3, 8, 9
- Pg. 297 Practice #1-3
- Pg. 306 #1, 2