Section 10.2

The Flow of Energy

Objectives

1. To understand how energy flow affects internal energy
2. To understand how how heat is measured

The Flow of Energy

A. Thermodynamics

- Thermodynamics – study of energy
- First law of thermodynamics
  - Energy of the universe is constant

The Flow of Energy

A. Thermodynamics

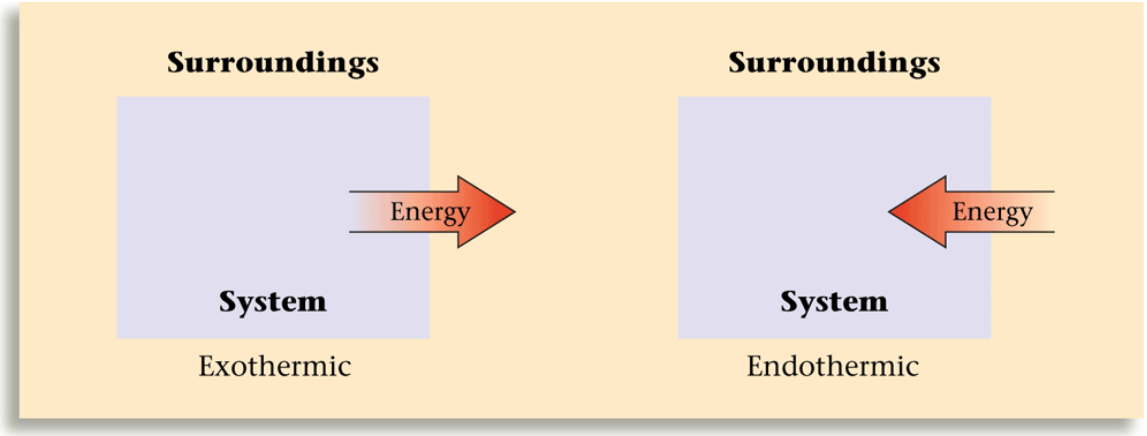
- Internal energy, E – sum of kinetic and potential energies of all the "particles" in a system
  - Internal energy can be changed by two types of energy flow:
    - Heat (q)
    - Work (w)

$$\Delta E = q + w$$

The Flow of Energy

A. Thermodynamics

- Thermodynamic quantities always consist of 2 parts:
  - A number (magnitude of the change)
  - A sign (indicates the direction of flow)
    - Reflects the systems point of view



- $q = -x$
- negative $q \rightarrow$ system's energy decreases
- $\Delta E < 0$

- $q = +x$
- positive $q \rightarrow$ system's energy increases
- $\Delta E > 0$

The Flow of Energy

B. Measuring Energy Changes

- The common energy units for heat are the calorie and the joule.
  - Calorie – the amount of energy (heat) required to raise the temperature of one gram of water 1°C.
  - Joule – 1 calorie = 4.184 joules

The Flow of Energy

B. Measuring Energy Changes

Let's Review

The energy (heat) required to change the temperature of a substance depends on:

- The amount of substance being heated (number of grams)
- The temperature change (number of degrees)

The Flow of Energy

B. Measuring Energy Changes

- Specific heat capacity is the energy required to change the temperature of a mass of one gram of a substance by one Celsius degree.

The Specific Heat Capacities of Some Common Substances

Substance	Specific Heat Capacity (J/g °C)
water (*l*)* (liquid)	4.184
water (*s*) (ice)	2.03
water (*g*) (steam)	2.0
aluminum (*s*)	0.89
iron (*s*)	0.45
mercury (*l*)	0.14
carbon (*s*)	0.71
silver (*s*)	0.24
gold (*s*)	0.13
copper (*s*)	0.385

*The symbols (*s*), (*l*), and (*g*) indicate the solid, liquid, and gaseous states, respectively.

The Flow of Energy

B. Measuring Energy Changes

- To calculate the energy required for a reaction:

Energy (heat) required (Q)	=	Specific heat capacity (s)	×	Mass (m) in grams of sample	×	Changes in temperature (ΔT) in °C

$$Q = s \times m \times \Delta t$$