THE CONSERVATION OF ENERGY

• The total energy of a contained system is constant.
• This is an observed law, NOT a derived law.
• This law appears to be universally true.

THE FIRST LAW OF THERMODYNAMICS:

Specific Heat Capacity

Thermochemistry is the science of heat (energy) flow. A difference in temperature leads to energy transfer. The heat “lost” or “gained” is related to

a) sample mass
b) change in T and
c) specific heat capacity by

Specific heat capacity =

\[
\text{heat lost or gained by substance (J)}
\]

(mass, g)(T change, K)
If 25.0 g of Al cool from 310 °C to 37 °C, how many joules of heat energy are lost by the Al?

Specific heat cap. = C
= (heat gained or lost)/(mass)(ΔT) J/g K
= q/mΔT J/g·K
Specific Heat Capacity

If 25.0 g of Al cool from 310 °C to 37 °C, how many joules of heat energy are lost by the Al?

heat change = \( q = (\text{sp. ht.})(\text{mass})(\Delta T) = C \cdot m \cdot \Delta T \)

\[ \Delta T = T_{\text{final}} - T_{\text{initial}} = 37 \, ^\circ C - 310 \, ^\circ C \]

\[ q = (0.902 \, \text{J/g•K})(25.0 \, \text{g})(37 - 310) \, \text{K} \]

\[ q = -6160 \, \text{J} \]

The minus sign means that heat flows out of Al.

Heat Transfer and Changes of State

Changes of state involve energy:

Ice → Water requires 333 J/g.

This is called the heat of fusion or the heat of melting.
Heat Transfer and Changes of State

Liquid $\rightarrow$ Vapor
Requires energy (heat).
This is the reason
a) you cool down after swimming
b) you use water to put out a fire.

Heat and Changes of State

- 1 g of ethanol requires 850 J to evaporate at 25 °C (liq. to gas).
- To drop the air temperature from 55 °C to 25 °C in a car requires air to give up 3.6 kJ.
- How much ethanol must be evaporated to do this?
Heat and Changes of State

3.6 x 10^3 J (1 g/850 J)
= 4.2 g of ethanol

Heat and Changes of State

What quantity of heat is required to melt 500 g of ice at 0 °C and heat the water to steam at 100 °C?

- Specific heat of water = 4.2 J/g•K
- Heat of fusion of ice = 333 J/g
- Heat of vaporization = 2260 J/g
What quantity of heat is required to melt 500 g of ice at 0 °C and heat the water to steam at 100 °C?

1. To melt the ice:
   \[ q = (500 \text{ g})(333 \text{ J/g}) = 1.67 \times 10^5 \text{ J} \]

2. To raise the water T from 0 °C to 100 °C:
   \[ q = (500 \text{ g})(4.2 \text{ J/g•K})(100 - 0)\text{K} = 2.1 \times 10^5 \text{ J} \]

3. To evaporate the water at 100 °C:
   \[ q = (500 \text{ g})(2260 \text{ J/g}) = 1.13 \times 10^6 \text{ J} \]

4. Total heat energy = 1.51 \times 10^6 \text{ J} = 1510 \text{ kJ}