Thermochemistry

Temperature - average kinetic energy of all the particles in substance

Heat: flow of energy from a place of higher temperature to lower temperature

Cold: absence of heat

- Understanding heat flow

system

when heat flows INTO a substance/object, it gets warmer, called ENDOTHERMIC

when heat flows OUT OF a substance/object, it gets colder, called EXOTHERMIC

Temperature Conversion

Fahrenheit (°F) vs Celsius (°C)

°F → °C $\quad T_{°C} = \frac{(T_{°F} - 32°)}{1.8}$

°C → °F $\quad T_{°F} = 1.8(T_{°C}) + 32°$

Ex) Outer space is -459°F. Convert it to °C.

$$T_{°C} = \frac{(-459° - 32°)}{1.8} = -273°C$$

Convert 98.6° F to °C

$$T_{°C} = \frac{(98.6° - 32°)}{1.8} = 37.0°C$$

Convert 100.°C to °F

$$T_{°F} = 1.8(100°) + 32° = 212°F$$

Calculating Heat

$$q = mC\Delta T$$

- q = quantity of heat (J or calories) Joules
- m = mass (g)
- C = specific heat capacity (J/g°C or cal/g°C)
- ΔT = change in temperature (°C) $= T_{final} - T_{initial}$

Ex) m 5.0 g of copper is heated from T_i 20.0°C to T_f 80.0°C. The heat capacity of copper is 0.385 J/g°C. Calculate the heat absorbed by the copper. Is this process endothermic or exothermic?

q = ?
m = 5.0 g
C = .385 J/g°C
ΔT = 80.0°C − 20.0°C = 60.0°C

$q = (5.0\,g)(.385\,J/g°C)(60.0°C)$

$q = 115.5\,J \Rightarrow 120\,J$

q is a positive # when the process is ENDOTHERMIC

Ex) How much heat is released when 31.0 g of water cools from T_i 100.0°C to T_f 26.0°C? The heat capacity of water is 4.184 J/g°C. Is this process ~~endothermic~~ or exothermic?

q = ?
m = 31.0 g
C = 4.184 J/g°C
ΔT = 26.0°C − 100.0°C = −74.0°C

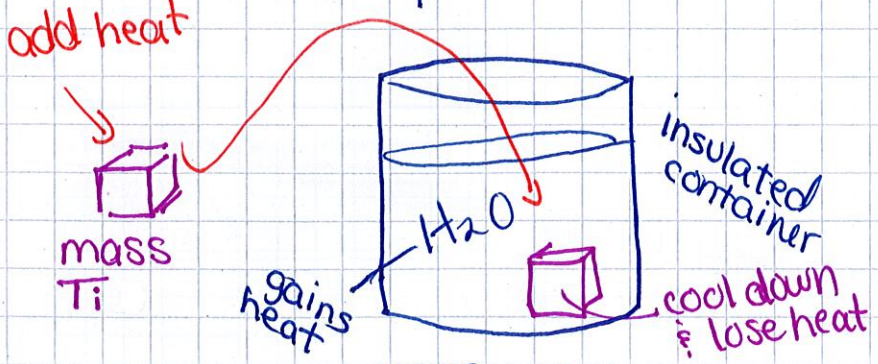
$q = (31.0\,g)(4.184\,J/g°C)(-74.0°C)$

$q = -9598.096\,J = -9600\,J$

$-9.60 \times 10^3\,J$

q is negative when the process is EXOTHERMIC

Calorimetry



mass H_2O
T_i
T_f
C

can I solve for how much heat the water gained?

$$-q_{cube} = q_{H_2O} = m_{H_2O} C_{H_2O} \Delta T_{H_2O}$$

Ex) An unknown metal, weighing 150.0g is heated from 25.0°C and placed in 500.0g of water, initially at 15.0°C. The water eventually reaches a temperature of 21.6°C. The heat capacity of water is 4.184 J/g°C. Calculate the heat released by the metal & its heat capacity.

metal
$m = 150.0\,g$
$T_i = 25.0°C$
$T_f = 21.6°C$
$C = ?$
$q = ?$

water
$m = 500.0\,g$
$C = 4.184\,J/g°C$
$T_i = 15.0°C$
$T_f = 21.6°C$
$q = ?$

$\Delta T = 21.6° - 15.0° = 6.6°C$

$$q_{H_2O} = (500.0\,g)(4.184\,J/g°C)(6.6°C)$$

$$q_{H_2O} = 13807.2\,J$$

$$-q_{metal} = q_{H_2O} = 13807.2\,J$$

$$q_{metal} = -13807.2\,J$$

$\Delta T = 21.6° - 25.0° = -3.4°C$

$$C = \frac{q}{m\Delta T} = \frac{-13807.2\,J}{(150.0\,g)(-3.4°C)} = 27\,J/g°C$$