THERMOCHEMISTRY

Objective: Explain how energy is communicated in a reaction. Classify a process as either exothermic or endothermic.

Thermochemistry:
The study of energy changes that occur during chemical reactions and changes of state.

Chemical Potential Energy:
Potential energy is the energy stored in the bonds of a substance.

Heat:
Energy that is transferred from one object to another because there is a temperature difference between them. warm → cool

Law of conservation of energy-
energy is conserved during a chemical reaction.

System:
The aspect of the universe your focus is on.

Surroundings:
Everything else-typically referring to the immediate area around the system.

ENDOTHERMIC process:
Is a change in which energy (usually heat) is absorbed from the surroundings, by the system. This increases the potential energy of the system The system will feel cold.

reactants + energy → products.

EXOTHERMIC process:
Is a change in which energy (heat) is released from the system to the surrounding. This decreases the potential energy of the system and the system will feel hot.

reactants → products + energy

Heat flow- heat can be used or given off.
- measured in Joules or KJ.

Heat Capacity (q)
The amount of heat needed to increase the temperature of an object exactly 1 degree celsius Depends on mass and composition.

specific heat capacity (c)
the amount of heat required to raise 1g of a substance 1°C. see back of periodic table

Heat Capacity and specific heat....

given a mass-

$$q=mc\Delta t$$

q = heat flow (J)
m = mass (g)
c = specific heat capacity (J/g·°C)
Δt = change in temp. (°C)

given volume-

$$q=vc\Delta t$$

q = heat flow (KJ)
v = volume (L)
c = volumetric heat capacity (KJ/L·°C)
Δt = change in temp (°C)

EX 1

What is the amount of heat (q) needed to raise the temperature of 1550 (m) g of ice from -52.50 °C to -49.30 °C ? ΔT

$q = mc\Delta t = 1550\,g \cdot 2.01\,J/g\cdot{}^\circ C \cdot 3.20\,{}^\circ C$

$= 9969.6\,J$

$\hookrightarrow 9970\,J$

$9.97 \times 10^3\,J$

EX 2

By removing 242.0 J of energy, the temperature of a substance is lowered from 28.1° C to 14.6° C. Calculate the specific heat capacity if there is 10.6 g of the substance.

q, m, ΔT 13.5°C

$q = mc\Delta t$

$\frac{q}{m\Delta t}$

$c = \frac{q}{m\Delta t}$

$c = \frac{242.0\,J}{10.6\,g \cdot 13.5°C}$

$= 1.69 \frac{J}{g \cdot °C}$

HW 1 → 3

2. 1.41×10^4 J 14.1 kJ

Practice

1 The temperature of 335 g of water changed from 24.5°C to 26.4°C. How much heat did this sample absorb?

$q = mC\Delta t = 335g \cdot 4.19\frac{J}{g \cdot °C} \cdot 1.9°C = 2667J \rightarrow 2.67 \times 10^3 J$

2. How much heat in kilojoules has to be removed from 225g of water to lower its temperature from 25.0°C to 10.0°C?

$q = mC\Delta t = 225g \cdot 4.19\frac{J}{g \cdot °C} \cdot 15°C = 14144J \rightarrow 14.1KJ$

3. To bring 1.0kg of water from 25°C to 99°C takes how much heat input?

$q = mC\Delta t = 1000g \cdot 4.19J/g \cdot °C \cdot 74°C = 310060J \rightarrow 3.1 \times 10^5 J$

4. An insulated cup contains 75.0g of water at 24.00°C. A 26.00g sample of metal at 82.25°C is added. The final temperature of the water and metal is 28.34°C. What is the specific heat of the metal?

5. What is the specific heat of silicon if it takes 192J to raise the temperature of 45.0g of Si by 6.0°C?

$q = mC\Delta t$

$C = \frac{q}{m\Delta t} = \frac{192J}{45.0g \cdot 6.0°C} = 0.71\frac{J}{g \cdot °C}$

heat gain$_{(water)}$ = heat lost$_{(metal)}$

$mC\Delta t = -mC\Delta t$

$C = \frac{mC\Delta t}{-m\Delta t} = \frac{75.0g \cdot 4.19J/g \cdot °C \cdot 4.34°C}{-26.0g \cdot -53.91°C}$

$C = 0.973\frac{J}{g \cdot °C}$