Pracce Sheet 11

1) Sarah increases the temperature of a 1.0 kg gold bar by 45°C. If the specific heat capacity of gold is 0.129 J/g°C, how much thermal energy is absorbed by the bar?

Q: ?
m: 1000g
c: 0.129 J/g·°C
Δt: 45°C

Q = mcΔt
= (1000g)(0.129 J/g·°C)(45°C)
= 5805 J
= 5.8 × 10³ J 5.8 kJ

2) Rory heats 420 g of water in a pot on the stove from 32° C to 96° C. If the specific heat capacity of water is 4.19 J/g°C, how much thermal energy is absorbed by the water?

Q: ?
m: 420g
c: 4.19 J/g·°C
Δt: 64°C

Q = mcΔt
= (420g)(4.19 J/g·°C)(64°C)
= 112627.2 J
= 1.1 × 10⁵ J

3) An iron bar absorbs 1.58 x 10^6 J of thermal energy as it is heated from 20 °C to 350 °C? If the specific heat capacity of iron is 0.449 J/g°C, how heavy was the iron bar?

330°C

Q: 1.58 × 10⁶ J
m: ?
c: 0.449 J/g·°C
Δt: 330°C

Q = mcΔt
1.58 × 10⁶ J = m (0.449 J/g·°C × 330°C)
m = 10663.42…g
= 1.07 × 10⁴ g 10.7 kg

4) A chunk of silicon with a mass of 1.25 kg is exposed to 2.56 x 10^4 J of thermal energy. If its temperature increased by 29 °C, what is the specific heat capacity of silicon?

Q: 2.56 × 10⁴ J
m: 1250g
c: ?
Δt: 29°C

Q = mcΔt
2.56 × 10⁴ J = (1250g) c (29°C)
c = 0.70620… J/g·°C
= 0.71 J/g·°C

5) A nickel plate with a mass of 12.4 kg has an inial temperature of approximately 45°C is placed into a blast furnace where it absorbs 1.92 x 10^6 J of thermal energy. If the specific heat capacity of nickel is 0.444 J/g°C, what is the final temperature of the nickel plate?

Q: 1.92 × 10⁶
m: 12400g
c: 0.444 J/g·°C
Δt: ?

Q = mcΔt
(1.92 × 10⁶ J) = (12400g)(0.444 J/g·°C) Δt
Δt = 348.73…°C
tf = 45°C + 348.73… = 393.73…
tf = 394°C

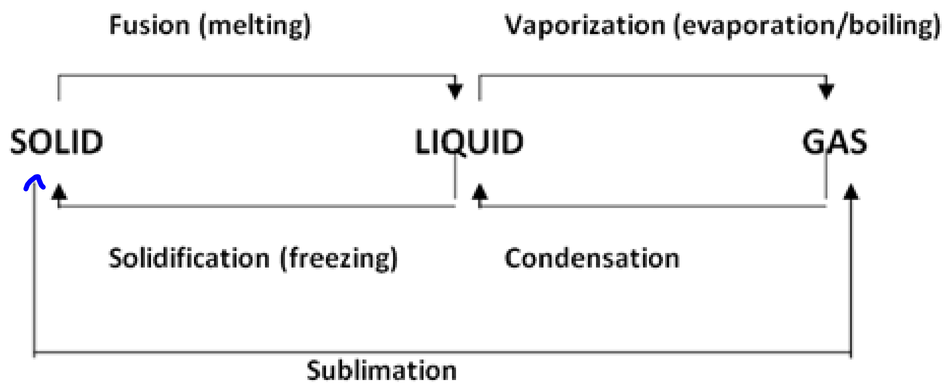
6) A kele with 450 g of boiling water at a temperature of 100°C is le out to cool. If 8.61 x 10^4 J of energy is released to the surroundings as the water cools, what is its final temperature? Assume that the specific heat capacity of water is 4.19 J/g°C.

Δt: ?
m: 450g
c: 4.19 J/g·°C
Q: 8.61 × 10⁴ J

Q = mcΔt
8.61 × 10⁴ J = (450g)(4.19 J/g·°C)(Δt)
Δt = 45.664… °C
tf = 100°C − 45.6… = 54.33…°C
= 54°C

Outcome 3
Topic 3 – Energy involved in state changes

Changes of State:



The phase changes that require energy input include:

<u>Fusion (melting) – think about melting an ice cube</u>

<u>Vaporization (boiling) – think about boiling water in a pot</u>

The phase changes that don't require energy and release energy:

<u>Solidification (freezing) – think about making ice (you put it in a freezer)</u>

<u>Condensation –</u>

Heat of Fusion/Vaporization/Solidification/Condensation

Whenever a substance changes phase, thermal energy is either released or absorbed. During a phase change, the temperature of the substance remains the same even though thermal energy was constantly being added

<u>Heat of Fusion:</u> of a substance is the amount of energy (Q) **<u>absorbed</u>** when 1 mole of a substance melts (solid to liquid)

$Q = n \times H_{fus}$

Q is the incoming energy in J
H_{fus} is the heat of fusion in J/mol (known for most common substances)
n is the number of moles of the substance

<u>Heat of solidification:</u> is the amount of energy (Q) **<u>released</u>** when 1 mole of a substance solidifies (liquid to solid)

The heat of solidification for a substance is the opposite of the heat of fusion for that substance

$Q = n \times H_{sol}$

<u>Heat of vaporization:</u> is the amount of energy (Q) absorbed when 1g of a substance vaporizes (liquid to gas)

$Q = n \times H_{vap}$

Q is the incoming energy in J
H_{vap} is the heat of fusion in J/mol (known for most common substances)
n is the number of moles of the substance

<u>Heat of condensation:</u> is the amount of energy (Q) released when 1 mole of a substance condenses (gas to liquid)

The heat of condensation for a substance is the opposite of the heat of vaporization for that substance

$Q = n \times H_{cond}$

Examples

1. Calculate the amount of energy absorbed when 45.0 g of ice at 0.0 °C melts. The H_{fus} of water is 6.01 kJ/mol.

$Q = ?$

$n = ?$

$H_{fus} = 6.01\ kJ/mol$

$Q = nH_{fus}$

$= (2.49....mol)(6.01\ kJ/mol)$

$= 15.0083....kJ$

$= 15.0\ kJ$

$n = \frac{m}{M} = \frac{45.0\ g}{18.02\ g/mol}$

$n = 2.49....mol$

2. Calculate the experiment heat of vaporization of water, given that it requires 81.4 kJ of thermal energy to vaporize 2.00 mol of liquid water.

$H_{vap} = ?$

$n = 2.00\ mol$

$Q = 81.4\ kJ$

$Q = nH_{vap}$

$81.4\ kJ = (2.00\ mol)\ H_{vap}$

$H_{vap} = 40.7\ \frac{kJ}{mol}$

3. What mass of water will vaporize if 488 kJ of thermal energy is absorbed by the water. The H_{vap} of water is 40.65 kJ/mol

$Q = 488\ kJ$

$H_{vap} = 40.65\ kJ/mol$

$n = ?$

$Q = nH_{vap}$

$488\ kJ = n\ (40.65\ kJ/mol)$

$n = 12.0049....mol$

$n = \frac{m}{M}$

$(12.0049....mol) = \frac{m}{18.02\ g/mol}$

$m = 216.328....g$

$= 216\ g$