1. a. A system undergoes an enthalpy change and the temperature of the surroundings increases - is this an exothermic or endothermic reaction?

surr. erg goes up ∴ system loses energy ∴ exothermic

b. Is freezing an endothermic or exothermic process?

exothermic

c. An unknown amount of a solid is dissolved in 500ml of water in a polystyrene calorimeter. The temperature of the water after dissolving was complete decreases by 8.7°C . Is the reaction endothermic or exothermic?

Surr. water temp down

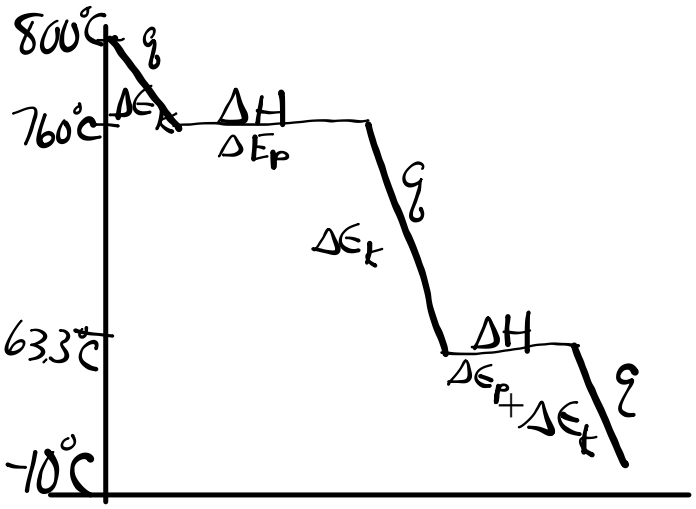
System solid dissolving endothermic

d. You have a beaker of unknown liquid at room temperature and you add a substance to it and an endothermic reaction occurs. What happens when you touch the beaker, does it feel hotter or colder than it initially did?

colder

2. Draw a cooling curve (temperature-time graph) for potassium vapor under standard pressure as it is cooled from 800°C to -10°C. Label each section of the graph as $\Delta H = nH$ or $q = mc\Delta t$, ΔE_k or ΔE_p.

The Melting point of Potassium = 63.3°C The Boiling point of Potassium is = 760°C

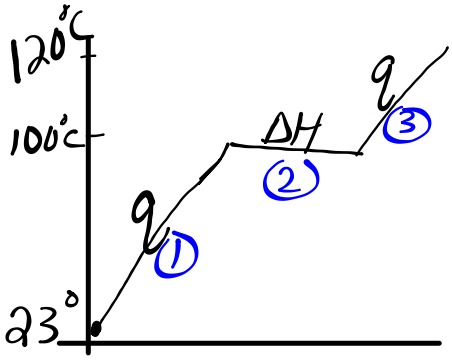


K
MP = 63.3°C

BP = 760°C

800°C to -10°C.

3. What is the total energy required to convert 75 g of water at 23°C to water vapor at 120°C.
(note: water H_2O has three different specific heat values - depending on the physical state)



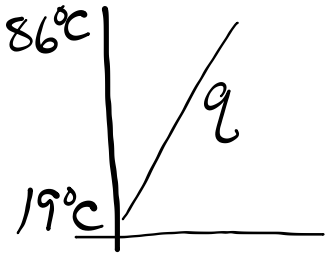
① $q = mc\Delta T$
$= 75g \times 4.18\frac{J}{g°C} \times 77°C$
$= 24139.5J$
$24.1395kJ$

② $\Delta H = n\Delta H$ water 601/60
$= 75g \times \frac{1mol}{18.02g} \times 40.7\frac{kJ}{mol}$
$= 169.395$

③ $q = mc\Delta T$
$= 75g \times 1.7\frac{J}{g°C} \times 20°C$
$= 2550J$
$= 2.550kJ$

TOTAL:
24.1395 kJ
169.395 kJ
2.550
196.08 kJ

4. A 55.0-g piece of copper wire is heated, and the temperature of the wire changes from 19.0°C to 86.0°C. The amount of heat absorbed is 1426J. What is the specific heat of copper?



Copper:

MP ~~1083°C~~

BP 2567°C

$q = mc\Delta T$

$1426J = 55.0g \times c \times 67°C$

$\frac{1426J}{3685g°C} = \frac{3685g°C \times c}{3685g°C}$

$0.387\ J/g°C = c$

5. Given the thermochemical equation: $2Al_{(s)} + 3H_2SO_{4(aq)} \longrightarrow Al_2(SO_4)_{3(aq)} + 3H_{2(g)}$; $\Delta H = -2650KJ$
How much heat is released when 200g of H_2SO_4 are reacted?

$$200g\ H_2SO_4 \times \frac{1mol\ H_2SO_4}{98.08\ g\ H_2SO_4} \times \frac{2650KJ}{3mol\ H_2SO_4} = \boxed{180.25KJ}$$

6. How many grams of water can be completely **vaporized** by the addition of 300kJ of heat.

n = moles

100°C | $\Delta H_{vaporize}$

$\Delta H = n H$

$300kJ = n \times 40.7 \frac{KJ}{mol}$

$\frac{300KJ}{40.7KJ/mol} = n$

$7.371mol = n$

Now convert 7.371 moles of water to grams

$7.371mol\ H_2O \times \frac{18.02g}{1mol}$

$= \boxed{132.83g}$

7. Given the following thermochemical equation:

$Al_2(SO_4)_{3\,(aq)} + 3H_{2\,(g)} \longrightarrow 2Al_{(s)} + 3H_2SO_{4\,(aq)}$; $\Delta H = 2650KJ$

Determine the energy required for the production of 125 g of H_2SO_4

$$125g\ H_2SO_4 \times \frac{1mol\ H_2SO_4}{98.08g\ H_2SO_4} \times \frac{2650\ kJ}{3mol\ H_2SO_4}$$

$$= 1125.78\ kJ$$

8. What is the heat of reaction for the combustion pentane to form carbon dioxide and water:

$C_5H_{12\,(g)}$ = -173.5 kJ ; $O_{2\,(g)}$ = 0.0 kJ ; $CO_{2\,(g)}$ = -393.5 kJ ; $H_2O_{(l)}$ = -285.8 kJ

$$C_5H_{12} + 8O_2 \rightarrow 5CO_2 + 6H_2O$$

$-173.5kJ \quad 0 \quad -393.5kJ \quad -285.8kJ$

$$\Delta H_{rxn} = \Sigma \Delta H_{prod} - \Sigma \Delta H_{reactants}$$

$$[5(-393.5) + 6(-285.8)] - [(-173.5) + 8(0)]$$

$$(-3682.3) - (-173.5)$$

$$= -3508.8\ kJ$$

9. As an alternative to combustion, coal gas can undergo a process called methanation.

$$3H_{2\,(g)} + CO_{(g)} \longrightarrow CH_{4\,(g)} + H_2O_{(g)}$$

a. Determine the standard enthalpy change for this methanation reaction using the following chemical equations and the value for the standard enthalpy changes.

b. Is this reaction endothermic or exothermic?

① $H_2\,(g) + 1/2\,O_2\,(g) \longrightarrow H_2O\,(g)$ $\Delta H = -241.8$ kJ

② $2C\,(s) + O_2\,(g) \longrightarrow 2CO\,(g)$ $\Delta H = -221.0$ kJ

③ $CH_4\,(g) + 2O_2\,(g) \longrightarrow CO_2\,(g) + 2\,H_2O\,(g)$ $\Delta H = -802.7$ kJ

④ $C\,(s) + O_2\,(g) \longrightarrow CO_2\,(g)$ $\Delta H = -393.5$ kJ

① x 3 $3H_{2(g)} + \frac{3}{2}O_{2(g)} \rightarrow 3H_2O_{(g)}$ -725.4 kJ

② ÷ 2 $CO_{(g)} \rightarrow C_{(s)} + \frac{1}{2}O_{2(g)}$ $+110.5$ kJ

③ <> $CO_{2(g)} + 2H_2O_{(g)} \rightarrow CH_{4(g)} + 2O_{2(g)}$ $+802.7$ kJ

④ $C_{(s)} + O_{2(g)} \rightarrow CO_{2(g)}$ -393.5 kJ

$$3H_{2(g)} + CO_{(g)} \rightarrow H_2O_{(g)} + CH_{4(g)}$$

$\Delta H = -205.7$ kJ

(b) exothermic

10. 45g of a compound is burned in a bomb calorimeter containing 0.75 L of water. If the initial temperature of the water was 18.2°C and the final temperature was 21.7°C, what is the enthalpy of combustion of the unknown compound?

The molar mass of the unknown is 75.3 g/mol

0.75L = 750mL = 750g H_2O

$\Delta H_{comb} = -q_{water}$ (calorimeter)

$nH = mc\Delta T$

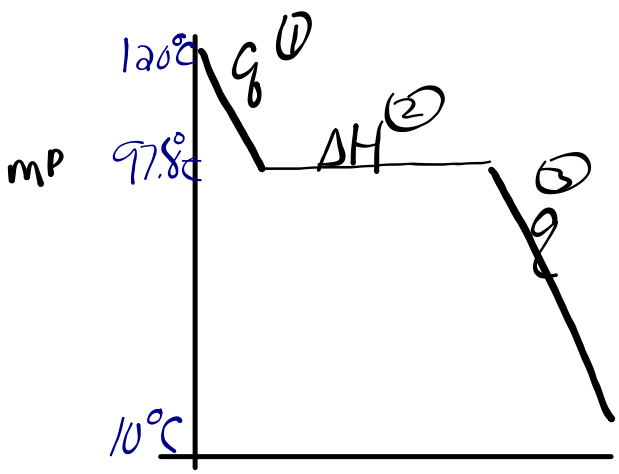
$45g \times \frac{1mol}{75.3g} \times H = 750g \times 4.18\frac{J}{g°C} \times 3.5°C$

$0.5976 mol \times H = 10972.5J$

$H = \frac{10972.5J}{0.5976 mol}$

$H = 18360.6 J/mol$

11. How much energy is lost when 500g of sodium is cooled from 120°C to 10°C?



mp = 97.8°C
BP = 883°C

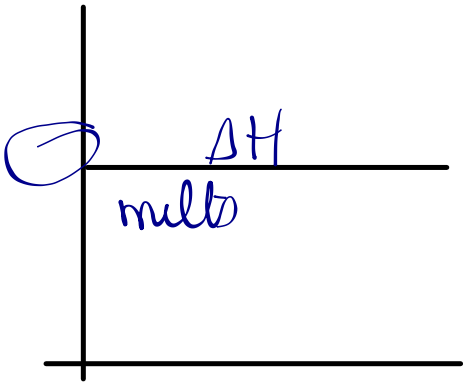
① $q = mc\Delta T$
$= 500g \times 1.23 \frac{J}{g°C} \times 22.2°C$
$= 13653 J$

② $\Delta H = n\Delta H$
$= 500g \times \frac{1 mol}{22.99g} \times 2.60 \frac{kJ}{mol}$
$= 56.546 kJ$

③ $q = mc\Delta T$
$= 500g \times 1.23 \frac{J}{g°C} \times 87.8°C$
$= 53997 J$

Total: 13.653kJ
56.546kJ
53.997kJ
124.196kJ

12. What is the energy change if 85 grams of lead melts?



$\Delta H = n H_f$

$85g \times \frac{1mol}{207.2g} \times 4.77 \frac{kJ}{mol}$

$= 1.957 kJ$