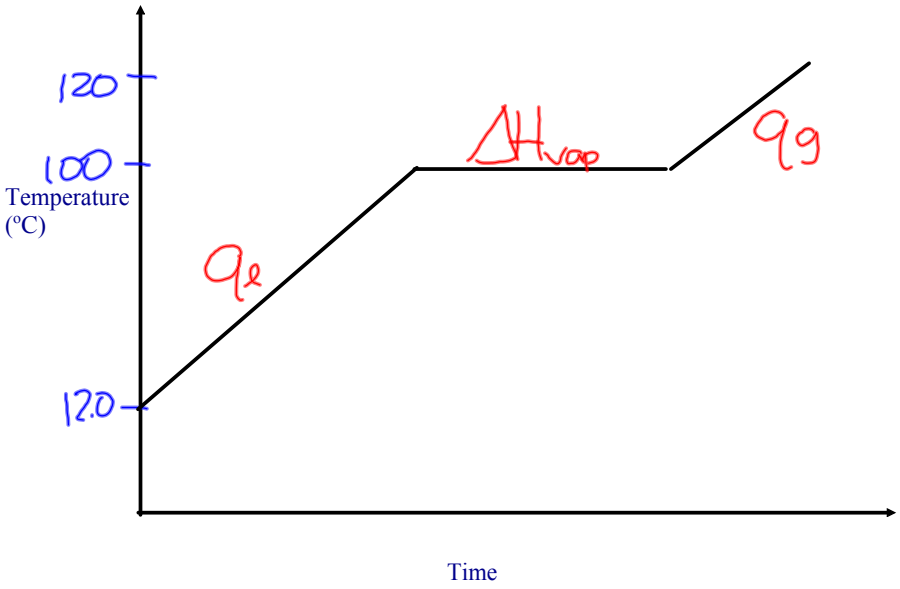
Total Energy

Calculate the total energy change if 25.0g of water at 12.0°C is completely converted to steam at 120.°C.



$$\Delta E_T = q_\ell + \Delta H_{vap} + q_g$$

$q_\ell = mc\Delta T$

$q_\ell = (25.0g)\left(4.19\frac{J}{g\cdot°C}\right)(88.0°C)$

$q_\ell =$ J

$\Delta H_{vap} = n H_{vap}$

$\Delta H_{vap} = \left(\frac{25.0g}{18.02g/mol}\right)\left(40.7\frac{kJ}{mol}\right)$

$\Delta H_{vap} =$ kJ

$q_g = mC\Delta T$

$q_g = (25.0g)\left(2.01\frac{J}{g\cdot°C}\right)(20.0°C)$

$=$ J

Calorimetry

7.37 g of sodium nitrate is dissolved in 100. mL of water at an initial temperature of 16.3°C. The final temperature of the solution is 25.1°C. Calculate the molar enthalpy of solution, H_s, for sodium nitrate.

$\Delta H_s = -q$

$nH_s = -vC\Delta T$

$\left(\frac{7.37\,g}{85.00\,g/mol}\right) H_s = -(0.100\,L)\left(4.19\,\frac{kJ}{L\cdot°C}\right)(8.8°C)$

$H_s = -42.5\,\frac{kJ}{mol}$

$NaNO_3$

$m = 7.37\,g$

$H_s = ?$

H_2O

$V = 100.\,mL$

$T_i = 16.3°C$

$T_f = 25.1°C$

$q_{Al} = -q_{H_2O}$

* T_f is same

Reaction Enthalpies

Major Topics

- **Hess's Law**
- **Heats of Formation**
- **Multi-Step Problems**

You Should Know...

- General formulas of alkanes, alkenes, alkynes, and cyclic compounds
- Aromatic compounds
- Pi bonds
- Characteristics of organic compounds

Hess's Law

$$2NO_{2(g)} \longrightarrow N_{2(g)} + 2O_{2(g)} \qquad \Delta H_r = ?$$

Calculate the standard enthalpy change for this reaction using the following information:

$N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)}$ $\Delta H_r = -91.8$ kJ

$NO_{2(g)} + 7/2H_{2(g)} \longrightarrow NH_{3(g)} + 2H_2O_{(l)}$ $\Delta H_r = 85.5$ kJ

$H_2O_{(l)} \longrightarrow H_{2(g)} + 1/2O_{2(g)}$ $\Delta H_r = 285.8$ kJ

Rev. ①

④ $2NH_{3(g)} \longrightarrow N_{2(g)} + 3H_{2(g)}$ $\Delta H_r = 91.8$ kJ

② x2

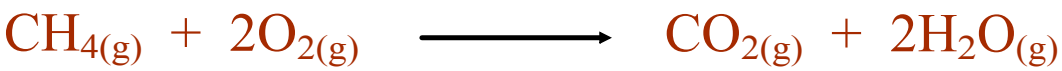
⑤ $2NO_{2(g)} + 7H_{2(g)} \longrightarrow 2NH_{3(g)} + 4H_2O_{(g)}$ $\Delta H_r = 171$ kJ

③ x4

⑥ $4H_2O_{(g)} \longrightarrow 4H_{2(g)} + 2O_{2(g)}$ $\Delta H_r = 1143.2$ kJ

Heats of Formation

Ex. What is the standard molar enthalpy of combustion of methane fuel?



Multi-Step Problems

Ex. $2NaHCO_{3(s)} + 129.2kJ \longrightarrow Na_2CO_{3(s)} + CO_{2(g)} + H_2O_{(g)}$

What quantity of energy, ΔH_r, is required to decompose 100. kg of $NaHCO_{3(s)}$?

Step 1: H_r

$\Delta H_r = nH_r$

$H_r = \frac{\Delta H_r}{n} = \frac{129.2\ kJ}{2\ mol} = 64.6\ kJ/mol$

Step 2: n(specific)

$100\,000g\ NaHCO_3 \times \frac{1\ mol\ NaHCO_3}{84.01g\ NaHCO_3} = 1190.3\ mol$

Step 3: ΔH_r(specific)

$\Delta H_r = nH_r$

$\Delta H_r = (1190.3\ mol)\left(64.6\ \frac{kJ}{mol}\right)$

$\Delta H_r = 76\,900\ kJ$

Chemical Equilibrium

Major Topics

- **Equilibrium Law**
- **Le Chatelier's Principle**
- **Water Equilibrium**

You Should Know...

- General formulas of alkanes, alkenes, alkynes, and cyclic compounds
- Aromatic compounds
- Pi bonds
- Characteristics of organic compounds

Equilibrium Law

A mixture of H_2 and I_2 is allowed to react at 448°C. When the equilibrium is established the concentrations of the participates are found to be $[H_2]$ = 0.46 mol/L, $[I_2]$=0.39 mol/L, and [HI] = 3.0 mol/L. Calculate the value of K at 448°C from these data.

Le Chatelier's Principle

$$2SO_{2(g)} + O_{2(g)} \longleftrightarrow 2SO_{3(g)} + \text{energy}$$

$\Rightarrow$ remove $SO_{3(g)}$

$\Rightarrow$ cool system (low T)

$\Rightarrow$ decrease volume (increase pressure)

Water Equilibrium

A solution of calcium hydroxide, $Ba(OH)_2$, has a pH of 4.25. Calculate the pOH, concentration of hydrogen ions, concentration of hydroxide ions, and the concentration of the $Ba(OH)_2$ solution.