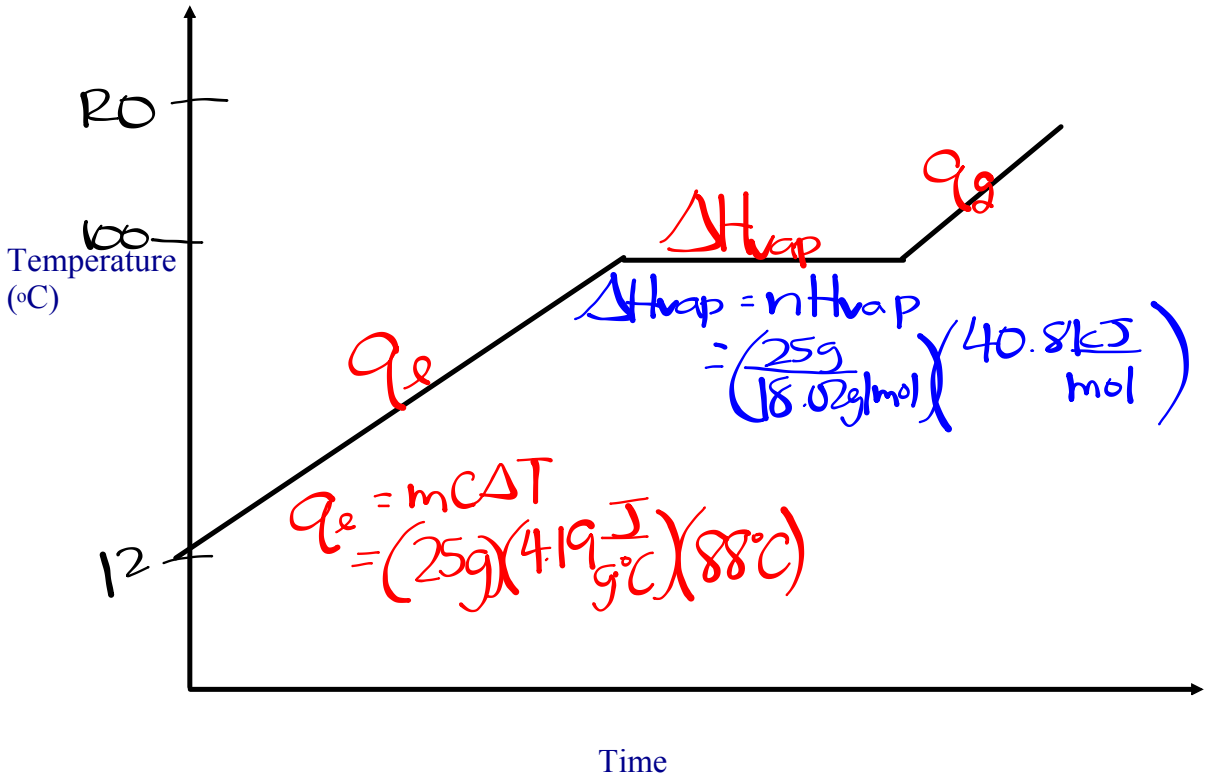
Energy Changes / Reaction Enthalpies

Major Topics

- Total Energy
- Calorimetry
- Hess's Law
- Heats of Formation
- Multi-Step Problems

Total Energy

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



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.

$NaNO_3$ H_2O

$\Delta H_s = -q$

$nH_s = -mC\Delta T$

Hess's Law

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

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

$$N_{2(g)} + 3H_{2(g)} \longrightarrow 2NH_{3(g)} \qquad H_r = -91.8 \text{ kJ}$$
$$NO_{2(g)} + H_{2(g)} \longrightarrow NH_{3(g)} + 2H_2O_{(l)} \qquad H_r = 85.5 \text{ kJ}$$
$$H_2O_{(l)} \longrightarrow H_{2(g)} + O_{2(g)} \qquad H_r = 285.8 \text{ kJ}$$

Heats of Formation

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

$$CH_{4(g)} + 2O_{2(g)} \longrightarrow CO_{2(g)} + 2H_2O_{(g)}$$

$$\Delta H_r = \sum n H_{fp} - \sum n H_{fr}$$

$$\Delta H_r = -1535\,kJ$$

$$\Delta H_r = n H_r$$

$$H_r = \frac{\Delta H_r}{n} = \frac{-1535\,kJ}{1\,mol} = -1535\,kJ/mol$$

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: Hr (general)

$\Delta Hr = n Hr$

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

Step 2: n (specific)

$100\,000\,g\,NaHCO_3 \times \frac{1\,mol\,NaHCO_3}{84.01\,g\,NaHCO_3} = 1190.33\,mol$

Step 3: ΔHr (specific)

$\Delta Hr = n Hr$

$\Delta Hr = (1190.33\,mol)(64.6\,\frac{kJ}{mol})$

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