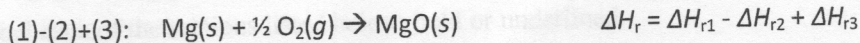


# INV 30 How is heat of combustion measured indirectly? – Two-day lab

## Student handout

### 1. Theory:

- Reaction: (1)  $\text{Mg (s)} + 2\text{HCl (aq)} \rightarrow \text{MgCl}_2\text{ (aq)} + \text{H}_2\text{ (g)}$   $\Delta H_{r1} = \text{_____ kJ/mol Mg}$   
 (2)  $\text{MgO (s)} + 2\text{HCl (aq)} \rightarrow \text{MgCl}_2\text{ (aq)} + \text{H}_2\text{O (l)}$   $\Delta H_{r2} = \text{_____ kJ/mol MgO}$   
 (3)  $\text{H}_2\text{ (g)} + \frac{1}{2}\text{O}_2\text{ (g)} \rightarrow \text{H}_2\text{O (l)}$   $\Delta H_{r3} = -285.8 \text{ kJ/mol H}_2\text{ (or } \frac{1}{2} \text{ mol O}_2\text{)}$



### ○ Formula:

- experimental  $\Delta H_{r1}$  or  $\Delta H_{r2} = q_r / n$   $q_r = q_{\text{sys}}$   
 $q_{\text{sys}} = -q_{\text{sur}}$   $q_{\text{sur}} = q_{\text{sol}}$   
 $q_{\text{sol}} = m_{\text{sol}} \cdot C_s \cdot (T_{\text{final}} - T_{\text{initial}})$
- $V_{\text{HCl sol}} = n_{\text{HCl}} / C_{\text{HCl}}$

$n$ : # of moles of Mg or MgO  
 $m_{\text{sol}}$ : mass of the solution (surroundings)  
 $C_s$ : specific heat  
 $C_{s(\text{sol})} \approx C_{s(\text{H}_2\text{O})} = 4.184 \text{ J/g} \cdot ^\circ\text{C} \sim \text{constant}$

### 2. Experiment:

#### Day 1:

- Calculate the amount of HCl solution when using 0.3-0.4 g Mg(s) as the limiting reagent. *Example:*  
 For trial # \_\_\_\_, \_\_\_\_ g Mg (s) is measured (you should record the exact weight measured by the balance), so \_\_\_\_ mL HCl solution + 10~15 mL extra HCl solution = \_\_\_\_ mL HCl solution will be used in the experiment.
- Measure the weight of the reaction container (2 cups) on balance. Transfer calculated amount of HCl solution into it and measure the weight again.  $m_{\text{sol}} = m_{\text{sol+cup}} - m_{\text{cup}} = \text{_____ g HCl solution}$ .
- Record  $T_{\text{initial}}$  of HCl solution.
- Add Mg(s) to the reaction container and seal the lid quickly.
- Record the highest temperature ( $T_{\text{final}}$ ) during the reaction.
- Do one sample calculation for experimental  $\Delta H_{r1}$  in the notebook.
- If time allows, finish one or two trials for reaction (2).

#### Day 2:

- Calculate the amount of HCl solution when using 0.25-0.5 g MgO(s) as the limiting reagent. *Example:*  
 For trial # \_\_\_\_, \_\_\_\_ g MgO (s) is measured (you should record the exact weight measured by the balance), so \_\_\_\_ mL HCl solution + 10~15 mL extra HCl solution = \_\_\_\_ mL HCl solution will be used in the experiment.
- Measure the weight of cup#1 on balance. Transfer calculated amount of HCl solution into it and measure the weight again.  $m_{\text{sol}} = m_{\text{sol+cup}} - m_{\text{cup}} = \text{_____ g HCl solution}$ .
- Use cup#2 to measure the weight of MgO on balance.
- Record  $T_{\text{initial}}$  of HCl solution.
- Transfer HCl solution to cup#2 which contains MgO, and seal the lid quickly.
- Record the highest temperature ( $T_{\text{final}}$ ) during the reaction.
- Do one sample calculation for experimental  $\Delta H_{r2}$  in the notebook.

### 3. Reminder:

- At least three formal trials for each reaction. Put two cups together to make it more insulating (to avoid losing heat).
- Keep balance room clean.
- After experiment, rinse cup and place it back on the cart. Turn in the copies of notes.

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