

CHEM 361A - Lecture 4 Activity  
Enthalpy

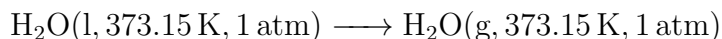
## In Class

1. Make the following table and fill in as much as you can:

Table 1: Table of thermodynamic properties.

	Isothermal	Adiabatic	Isobaric	Isochoric
q				
w				
$\Delta U$				
$\Delta H$				

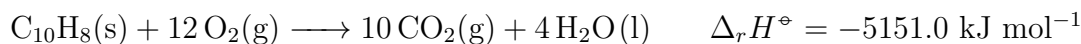
2. Consider an isothermal, reversible expansion of 1.5 moles of Neon gas.
- What is the  $C_{p,m}$  for this gas?
  - If the gas expands from 1.3 L to 5.4 L against an external pressure of 1 atm, what is the  $\Delta H$  of the process? Assume that Neon behaves ideally.
3. Calculate the standard enthalpy of formation of diamond, given that:
- $\text{C}(\text{graphite}) + \text{O}_2 \longrightarrow \text{CO}_2(\text{g}) \quad \Delta_r H^\ominus = -393.5 \text{ kJ mol}^{-1}$
  - $\text{C}(\text{diamond}) + \text{O}_2 \longrightarrow \text{CO}_2(\text{g}) \quad \Delta_r H^\ominus = -395.4 \text{ kJ mol}^{-1}$
4. Given the following two combustion reactions:
- $\text{CH}_4(\text{g}) + 2 \text{O}_2(\text{g}) \longrightarrow \text{CO}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{g})$
  - $\text{C}_2\text{H}_4(\text{g}) + 6 \text{O}_2(\text{g}) \longrightarrow 2 \text{CO}_2(\text{g}) + 2 \text{H}_2\text{O}(\text{g})$
- which one yields the larger explosion at 1 bar?
5. The difference between  $\Delta H$  and  $\Delta U$
- At 373.15 K and 1 atm, the volume of liquid water and steam are  $1.88 \times 10^{-5} \text{ m}^3$  and  $3.06 \times 10^{-2} \text{ m}^3$ , respectively. Given that the heat of vapourization ( $\Delta_{\text{vap}}H$ ) of water is  $40.79 \text{ kJ mol}^{-1}$ , calculate  $\Delta U$  for 1 mol in the following process:



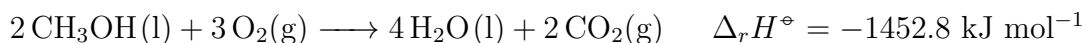
# Homework

## 6. Calculating $\Delta H$

- (a) If 3.0 moles of Argon gas (a monatomic gas) is heated from 298 K to 368 K, determine  $\Delta H$  for this process. ( $\Delta H = 4365 \text{ J}$ )
- (b) Calculate the enthalpy of formation of naphthalene ( $\text{C}_{10}\text{H}_8$ ) based on the following combustion reaction ( $\Delta H_f^\circ = 72.7 \text{ kJ mol}^{-1}$ ):

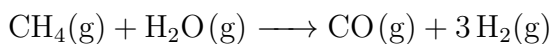


- (c) Consider the following reaction:



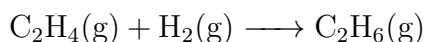
What is the value of  $\Delta_r H^\circ$  if

- the order of the reaction is reversed? ( $\Delta_r H^\circ = 1452.8 \text{ kJ mol}^{-1}$ )
  - water vapour instead of liquid water is the product? ( $\Delta_r H^\circ = -1276.8 \text{ kJ mol}^{-1}$ )
7. Calculate  $\Delta_r H^\circ$  ( $206.2 \text{ kJ mol}^{-1}$ ) and  $\Delta_r U^\circ$  ( $201.2 \text{ kJ mol}^{-1}$ ) at 298.15 K for the following reaction



## 8. Kirchhoff's Law

- (a) The hydrogenation for ethylene is



Calculate the change in enthalpy of hydrogenation from 298 K to 398 K. The values of  $C_{p,m}^\circ$  for ethylene, ethane and hydrogen are  $43.6 \text{ J K}^{-1} \text{ mol}^{-1}$ ,  $52.7 \text{ J K}^{-1} \text{ mol}^{-1}$  and  $28.8 \text{ J K}^{-1} \text{ mol}^{-1}$ , respectively. Assume the heat capacities are temperature independent. ( $\Delta_r H^\circ(T') - \Delta_r H^\circ(T) = -1970 \text{ J mol}^{-1}$ )

- (b) The standard molar enthalpy of formation of molecular oxygen ( $\text{O}_2$ ) at 298 K is zero. What is the value at 315 K? Hint: Use  $C_{p,m} = 29.4 \text{ J K}^{-1} \text{ mol}^{-1}$ . ( $\Delta_r H^\circ(315\text{K}) = 500 \text{ J mol}^{-1}$ )