

# 1021SCG Chemistry 1A – Module 3: Physicochemical Concepts

## Week 8

References and resources: Blackman, Bottle, Schmid, Mocerino and Wille, 3<sup>rd</sup> Edn., Chapter 8, Sections 8.1 – 8.4

### Learning Objectives

You should be able to:

- Define enthalpy and entropy.
- Determine whether enthalpy and entropy is increasing or decreasing in a reaction.
- Predict what will happen when two substances are mixed, based on enthalpy and entropy considerations.

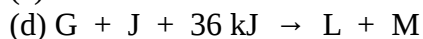
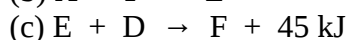
### Workshop and Study Questions

1. Define and explain enthalpy and enthalpy change.

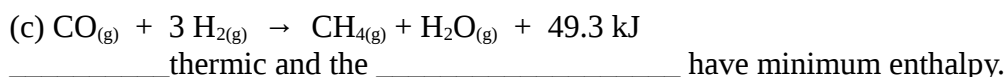
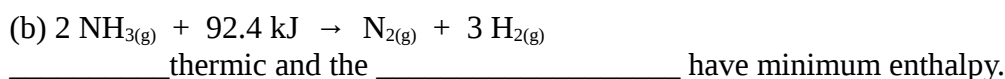
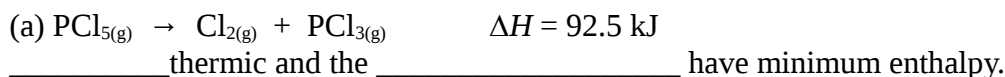
2. Calculate the maximum non- $p \cdot V$  work available from the oxidation of 1 mol of octane ( $C_8H_{18}$ ) by oxygen at 25°C and standard pressure.

Substance	$\Delta_f G^\ominus$ (kJ mol <sup>-1</sup> )
$C_8H_{18(l)}$	+17.3
$CO_{2(g)}$	-394.4
$H_2O_{(l)}$	-237.2
$O_{2(g)}$	0

3. In the following examples, is the enthalpy increasing or decreasing? Are the reactions endothermic or exothermic?



4. Tell whether each of the following is endothermic or exothermic and state which has minimum enthalpy, the reactants or the products:



(d)  $\text{Cl}_{2(g)} \rightarrow \text{Cl}_{2(aq)} \quad \Delta H = -25 \text{ kJ}$   
\_\_\_\_\_ thermic and the \_\_\_\_\_ have minimum enthalpy.

5. When no other factors are considered, a reaction will move in such a way (left or right) in order to achieve a state of \_\_\_\_\_ enthalpy.

6. Given the equation:  $2 \text{NH}_{3(g)} + 92.4 \text{ kJ} \rightarrow \text{N}_{2(g)} + 3 \text{H}_{2(g)}$   
if only the enthalpy is considered, the \_\_\_\_\_ ( reactant / products ) will be favoured.

7. Given the equation:  $\text{Cl}_{2(aq)} \rightarrow \text{Cl}_{2(g)} \quad \Delta H = 25 \text{ kJ}$   
if only the enthalpy is considered, the \_\_\_\_\_ ( reactant / product ) will be favoured.

8. If the reaction:  $\text{CO}_{(g)} + 3 \text{H}_{2(g)} \rightarrow \text{CH}_{4(g)} + \text{H}_2\text{O}_{(g)} + 49.3 \text{ kJ}$   
was proceeding to the right, the enthalpy would be \_\_\_\_\_ ing. Is this a favourable change? \_\_\_\_\_.

9. If the reaction:  $\text{PCl}_{5(g)} \rightarrow \text{Cl}_{2(g)} + \text{PCl}_{3(g)} \quad \Delta H = 92.5 \text{ kJ}$   
was proceeding to the right, the enthalpy would be \_\_\_\_\_ ing. Is this a favourable change? \_\_\_\_\_.

10. If the reaction:  $\text{Cl}_{2(g)} \rightarrow \text{Cl}_{2(aq)} \quad \Delta H = -25 \text{ kJ}$   
was proceeding to the right, the enthalpy would be \_\_\_\_\_ ing. Is this a favourable change? \_\_\_\_\_.

11. If the reaction:  $2 \text{NH}_{3(g)} + 92.4 \text{ kJ} \rightarrow \text{N}_{2(g)} + 3 \text{H}_{2(g)}$   
was proceeding to the right, the enthalpy would be \_\_\_\_\_ ing. Is this a favourable change? \_\_\_\_\_.

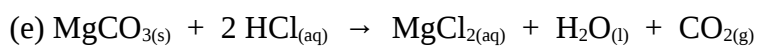
12. For each of the following, decide whether the reactants or the products have greater entropy:

(a)  $\text{I}_{2(s)} \rightarrow \text{I}_{2(aq)}$   
The \_\_\_\_\_ have greater entropy.

(b)  $2 \text{NH}_{3(g)} \rightarrow \text{N}_{2(g)} + 3 \text{H}_{2(g)}$   
The \_\_\_\_\_ have greater entropy.

(c)  $\text{NH}_{3(g)} \rightarrow \text{NH}_{3(aq)}$   
The \_\_\_\_\_ have greater entropy.

(d)  $\text{CO}_{(g)} + \text{Cl}_{2(g)} \rightarrow \text{COCl}_{2(g)}$   
The \_\_\_\_\_ have greater entropy.



The \_\_\_\_\_ have greater entropy.

**A chemical reaction will favour the side with maximum entropy, if no other factors are considered. Also, a chemical reaction will tend toward a state of minimum enthalpy, if sufficient activation energy is available and no other factors are considered. Therefore, there is a tendency in nature towards minimum enthalpy and maximum entropy. If the two tendencies in a process oppose each other, the process will reach a state of equilibrium.**

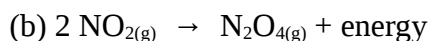
13. For each of the following reactions, decide which has minimum enthalpy (reactants or products), which has maximum entropy (reactants or products), and if the reactants are mixed, what will happen? (go to completion / reach a state of equilibrium / not occur at all).



The \_\_\_\_\_ has/have minimum enthalpy.

The \_\_\_\_\_ has/have maximum entropy.

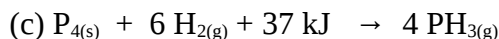
If  $\text{PCl}_3$  and  $\text{Cl}_2$  are put together, the reaction \_\_\_\_\_.



The \_\_\_\_\_ has/have minimum enthalpy.

The \_\_\_\_\_ has/have maximum entropy.

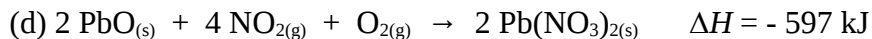
If  $\text{NO}_2$  was put in a flask, the reaction \_\_\_\_\_.



The \_\_\_\_\_ has/have minimum enthalpy.

The \_\_\_\_\_ has/have maximum entropy.

If  $\text{P}_{4(s)}$  and  $\text{H}_{2(g)}$  was put in a flask, the reaction \_\_\_\_\_.



The \_\_\_\_\_ has/have minimum enthalpy.

The \_\_\_\_\_ has/have maximum entropy.

If  $\text{PbO}_{(s)}$  and  $\text{NO}_{2(g)}$  were put in a flask, the reaction \_\_\_\_\_.