**Salt Lake Community College, Chemistry Department**

**Chem 1110 Workshop 9**

**Topic: Thermodynamics**

***Objective:***

* To be able to explain what factors influence energy loss or gain during reactions
* To understand the relationship between free-energy, enthalpy, and entropy changes in reactions
* To understand the concept of equilibrium and relate it to chemical reactions

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**Effects of Temperature, Concentration, and Catalysts on Reaction Rates:**



**Practice problems:**

1. **True (T) or false (F)?**

1. If the heat is transferred from the surrounding to the system and the work is done by the surroundings on the system, ΔE > 0\_\_**T**\_\_\_\_\_.

2. 1. Indicate the sign of the enthalpy change, ΔH, in each of the following processes, P = constant:

1. Baking Bread (endothermic, **ΔH = +**)
2. Burning a Candle (exothermic, **ΔH = -**)
3. an ice cube melts (endothermic, **ΔH = +**)

3. Calculate the change of internal energy of a system, ∆E, if 0.010 kJ of heat is added to this system and the system does 20 J of work on the surroundings. Be careful with the units!

**∆E= q + w 🡪 q= 10 J, w= -20 J**

**∆E= 10 J- 20 J= -10 J**

4. Calculate the amount of heat transferred when 1.60 kg of CH3OH(g) is produced during the following reaction

**CO(g) + 2H2(g) → CH3OH(g) ΔH = -90.7 kJ**

1.60 Kg CH3OH x 1000 g / 1 kg = 1600 g CH3OH

MM => CH3OH= 12+ 4(1) + 16 = 32 g/mol

1600 g CH3OH x 1 mol/ 32 g = 50 mol CH3OH

50 mol CH3OH x -90.7 KJ/ mol= - 4535 KJ

5. Use **ΔH° = -890 kJ** to find the heat produced when 4.80 g of CH4 gas is burned in O2 at 25° C and 1 atm?

4.80 g CH4 x 1 mol/ 16 g = 0.3 mol

0.3 mol CH4 x -890 KJ/ 1 mol= **-267 KJ**

6. Consider the reaction shown:

 **N2 + O2 → 2 NO ΔH = 43.2 kcal**

When 50.0 g of N2 react, \_\_\_77.1\_\_\_\_\_ kcal will be \_consumed\_\_\_\_\_\_ (produced or consumed).

50.0 g N2 x 1 mol/ 28 g N2 = 1.79 mol x 43.2 Kcal/ 1 mol= 77.1 Kcal

7. Write the equilibrium equations for the following reactions:

1. 2CO(g) + O2(g) 🡪 2CO2(g) 🡪 **K= [CO2]2/ [O2][CO]2**
2. 3O2(g) 🡪 2O3(g) 🡪 **K= [O3]2/ [O2]3**

8. For the following reaction: PCl5(g) ⇄ PCl3(g) + Cl2(g) with ΔH° = 90.0 kJ in which direction will the equilibrium shift when: (possible answers: left, right, no shift)

(a) Cl2(g) is removed? \_\_**right**\_\_\_\_\_\_

(b) PCl3(g) is added? \_\_**left**\_\_\_\_\_\_\_

9. **2 Al2O3 (s) → 4 Al(s) + 3 O2 (g) ΔG = +138 kcal**

Consider the contribution of entropy to the spontaneity of this reaction. As written, the reaction is \_\_\_\_\_\_\_\_, and the entropy of the system \_\_\_\_\_\_\_\_.

a) spontaneous; increases

b) spontaneous; decreases

**c) non-spontaneous; increases**

d) non-spontaneous; decreases

e) non-spontaneous; does not change

10. Which statement best describes the way a catalyst works?

a) It decreases the value of ΔH.

b) It increases the value of ΔH.

**c) It decreases the value of Eact.**

d) It increases the value of Eact.

e) It increases the value of ΔG