Chem 112 **Spring 2020** **Quiz 8** **Whelan**

SID | | | | | | | | | **Last** Key **First** Answer

Question 1 (3 Points)

Consider the reaction: $2\ C_2H_6(g) + 7\ O_2(g) \longrightarrow 4\ CO_2(g) + 6\ H_2O(g)$

for which ΔH° = **-2855 kJ** and ΔS° = **92.70 J/K** at **298 K**.

Calculate **the entropy change** of the **UNIVERSE when 1.606 moles of $C_2H_6(g)$** react under standard conditions at **298 K**.

$\Delta S^\circ_{Universe}$ = 7768 **J/K**

See bottom of page for explanation

- Is this reaction **reactant** or **product** favored? Product
- **If the reaction is product favored**, is it **enthalpy favored**, **entropy favored**, or favored by **both** enthalpy and entropy? **If the reaction is reactant favored**, choose **reactant favored**. Both

Question 2 (2 Points)

A student determines the value of the **equilibrium constant** to be **3.9×10^{13}** for the following reaction. $4\ HCl(g) + O_2(g) \longrightarrow 2\ H_2O(g) + 2\ Cl_2(g)$

Based on this value of K:

- ΔG° for this reaction is expected to be **>0** or **<0**: <0
- Calculate the free energy change for the reaction of **1.57 moles of HCl(g)** at standard conditions at **298K**.

Must show work for full credit

$DG^0 = -RT\ Ln\ K$

$= -8.314(298)Ln3.9 \times 10^{13}$

$= -7.75 \times 10^4$ J

$= -77.5$ kJ

Note the stoichiometry highlighted

$DG^0_{rxn} = 1.57 \times (-77.5/4)$

$= -30.4$ kJ

ΔG°_{rxn} = -30.4 kJ

Question 3 (3 Points)

Without doing any calculations, **match** the following **thermodynamic properties** with their appropriate numerical value given on the right for the following **exothermic reaction**.

$2\ NH_3(g) + 3\ N_2O(g) \longrightarrow 4\ N_2(g) + 3\ H_2O(g)$

- ΔS_{rxn} 1
- ΔG_{rxn} 2
- $\Delta S_{universe}$ 1

1. > 0
2. < 0
3. = 0
4. > 0 at low T, < 0 at high T
5. < 0 at low T, > 0 at high T

Question 1
Explanation

I am going to use different colors for each part of this which I hope will help.

$DS^0_{univ} = DS^0_{sys} + DS^0_{Surr}$

$DS^0_{sys} = 92.7$ J/K ... see question, this is given.

$DS^0_{surr} = -DH^0_{rxn} / T$
$= -(-2,855,000/298)$
$= 9581$ J/K

$DS^0_{univ} = 92.7 + 9581$
$= 9673.7$ J/K

In an Exam many would given this answer and received significant partial credit but you would have omitted the stoichiometry.
a) The question asks DS^0_{univ} when 1.606 mol of $C_2H_6(g)$ reacts
b) The balanced chemical equation:-
$2\ C_6H_6(g) + 7\ O_2(g) = 4\ CO_2(g) + 6\ H_2O(g)$

$DS^0_{univ} = 1.606 \times (9673.7/2)$
$= 7767.9$ J/K