** Date: Thursday 15th Jan. 2015**

**Chemistry Dept. Course name: K 231,** *ك231* **time allowed: (120 min) from 10 am to 12 am**

**Name of the Examiner:** *Prof. Dr. Mohamed Mokhtar*

**Thermodynamics Exam (Final first term) for 2nd year students (Special Chemistry).**

***Answer 4 questions only from the followings:***

***Question number 1: 20 point***

1. If the work done is only due to gas expansion, then according to the first law of thermodynamics, we have ΔE=q+(-W); in view of this derive the relation of heat change at constant volume qv and pressure qp.
2. 8.0 moles of ideal gas is held at a temperature of 200oC while expanding reversibly from 0.2 to 0.4 L. How much work is done by the gas?
3. Which of the following processes will lead to an increase in the entropy of the system? Explain.

(i) CaCO3(*s*) --->CaO(*s*) + CO2(*g*)

(ii) NH4NO3(*s*)  + H2O(*l*)  --->  NH4+ (*aq*) + NO3- (*aq*)

1. Which of the following changes are reversible and which are irreversible, explain.
2. An ideal gas expands against a constant pressure.
3. Vapouraizaion of benzene into vacuum at 60oC.

***Question number 2: 20 point***

1. By means of the main equation to study the effects of different conditions on the Gibbs free energy dG=Vdp-SdT, derive the equation of the pressure dependence on the free energy.
2. Nitrogen dioxide, NO2, dimerizes to form nitrogen tetroxide according to the reaction:

2NO2 (g) ⇔ N2O4 (g). Using the data of *Gόf*N2O4 = 97.89 kJ/mol and *Gόf* NO2 = 51.31 kJ/mol, calculate the standard molar Gibbs free energy of reaction, *GόR* , and the equilibrium constant, *Keq* , at 298 K.

1. For a reaction A + B → C + 50 KJ, calculate ΔG value at 200 K when ΔS value is 0.2 KJ/k. Is it spontaneous or not and why?
2. Is the density has intensive or intensive thermodynamic property? Why.

***Question number 3: 20 point***

1. Show how the chemical potential of species i in a mixture is an intensive property.
2. Derive the relation of the chemical potential of a pure ideal gas.
3. Twelve grams of Nitrogen (N2) in a tank are heated from 25.0 to 125ºC. How much heat is transferred to the nitrogen? Putting into consideration that the heat capacity at constant volume of N2=5/2 R
4. State the third law of thermodynamics with mentioning the conditions should be available to realize it.

***Question Number 4: 20 point***

***Chose the right answer: Part A:***

-Usually things do not go wrong in second law speculations because of

1. Times arrow b) activation energy C) Gibbs free Energy d) all the them

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| --- |
| - An adiabatic process is one in which |
| |  |  | | --- | --- | | [a)](javascript:%20void%200;) | no heat enters or leaves the gas b) the temperature of the gas changes | | [c)](javascript:%20void%200;) | the change in internal energy is equal to the mechanical work done d) all of the above | |  |  | |  |  | |

-The entropy of crystalline substances at absolute zero going by the third law of thermodynamics should be taken as

(a) 100 (b) 50 (c) Zero (d) Different for different substances

- A system is taken from state A to state B along two different paths 1 and 2. The heat absorbed and works done by the system along these paths are Q1 and Q2 and W1 and W2 respectively. Then

(a) Q1 = Q2 (b) W1 + Q1 = Q2 + W2 (C) W1 = W2 (d) Q1 - W1 = Q2 - W2

***Part B:***

-Explain briefly the methods of cooling to reach absolute zero.

- Calculate ΔG° for the electrochemical reaction: 2 Cl¯ + Br2  →Cl2 + 2Br¯ E°=-0.3 V

***Question Number 5: 20 point***

1. Derive Vant Hoffs equation.
2. Consider the following redox reaction:

Zn(s) + Cu2+(aq) → Zn2+(aq) + Cu(s) **Where E0Cu = +0.340 V and E0Zn = -0.763 V,** write the two half cell equation and find ΔG considering F=96485 coul/mol.

1. Explain briefly with graph carnot cycle.