

Royal University of Bhutan
Paro College of Education
Autumn semester Examination November, 2012

B.Ed(S) III- Thermodynamics and Chemical Kinetics (CHE306)

Full marks: 100

Pass Mark: 50

Time: 3hours

Instruction:

1. Do not write for the first ten minutes. This time is to be spent in reading the questions.
2. This question paper consists of two sections A & B. Section A is short answer type and Section B subjective type.
3. All the question from Section A are compulsory and Section B has choice
4. You are allowed to use Scientific Calculator **fx82 or fx100**

Section A (40 marks)

Answer all the Questions.

Question 1

Each question carries four possible answers, choose the most appropriate answer from the given options; [2 X10= 20 marks]

- a. In a thermodynamic process which of the following is not true;
 - i. Driving force is less than opposing force in irreversible processes
 - ii. Driving force is greater than opposing force in reversible processes
 - iii. Driving force is less than opposing force in reversible processes
 - iv. Opposing force is greater than driving force in irreversible processes
- b. "It is impossible for a self acting machine, unaided by any external agency, to transform heat from a colder to hotter body". This statement of the 2nd Law of Thermodynamics given by;
 - i. Plank
 - ii. Clausius
 - iii. Kelvin
 - iv. Carnot
- c. The internal energy change in a system that has liberated 20 joules of heat and done 500 joules of work is;
 - i. +480 J
 - ii. -480 J
 - iii. +520 J
 - iv. -520 J

- d. When $\Delta G=0$, the system undergoes is.....reaction
- spontaneous reversible
 - spontaneous irreversible
 - non-spontaneous reversible
 - non-spontaneous irreversible
- e. All the naturally occurring processes proceed in a direction which leads to;
- increase in enthalpy
 - decrease in free energy
 - decrease in entropy
 - increase in entropy
- f. At 373 K, the enthalpy change for the transition of liquid water to steam is 40.657KJ/mol. The change in entropy (ΔS) for the process is;
- 109 J/mole.K
 - 109 KJ/mole
 - .109 J/mole.K
 - 10900 J/mole.K
- g. When ΔH =positive and $T\Delta S$ =positive, then for the spontaneous irreversible reaction;
- $\Delta H > T\Delta S$
 - $T\Delta S > \Delta H$
 - $\Delta H = T\Delta S$
 - $T\Delta S < \Delta H$
- h. The maximum conversion of heat into work occurs in;
- spontaneous process
 - non-spontaneous process
 - cyclic process
 - non-cyclic process
- i. In many reaction, the reaction proceeds in a sequence of steps. The overall rate of such reaction is determined by;
- Order of reaction
 - Molecularity of reaction
 - Slowest step of reaction
 - Fastest step of reaction
- j. The system proceeds spontaneously and it tries to attain lower energy when;
- $\Delta H = +ve$
 - $\Delta H = -ve$
 - $\Delta S = +ve$
 - $\Delta U = +ve$

Question 2

Define the following terms:

[1x6 = 6 marks]

- Standard entropy.
- Absolute Zero
- Adiabatic process.
- Universe in thermodynamic.
- Gibbs free energy.
- Internal energy change.

Question 3

State whether the following are TRUE or FALSE. Rewrite the false statements in their correct form

[1 x 4 = 4 marks]

- The closed system is accompanied by the exchange of energy but not mass.
- All the irreversible reactions occur in multiple steps.
- The entropy of the universe always tends to increase in order to attain maximum stability.
- The driving force of a system determines the spontaneity of a process.

Question 4

Differentiate the following with the area specified in the bracket for each question. Give appropriate example wherever possible:

[2 x 5 = 10 marks]

- Activation energy and threshold energy (definition and graphical representation)
- Closed system and isolated system (change in energy and mass)
- Extensive property and intensive property (definition with atleast two examples)
- First order reaction and second order reaction (illustration with example)
- Molecularity of reaction and order of reaction (definition)

Section B (60 marks)

Answer any Five Questions.

Question 5

[3+3+3+3=12 marks]

- Calculate the standard entropy change in the following reaction.
 - $2\text{FeS}_{(s)} + 3\text{O}_{2(g)} \longrightarrow 2\text{FeO}_{(s)} + 2\text{SO}_{2(g)}$
 - (Given $S^0_{\text{FeS}}=67.4 \text{ JK}^{-1}$, $S^0_{\text{O}_2}=205.0 \text{ JK}^{-1}$, $S^0_{\text{FeO}}=54 \text{ JK}^{-1}$ and $S^0_{\text{SO}_2}= 248.5 \text{ JK}^{-1}$)
- What is Hess's Law? Verify experimentally.
- State atleast six characteristics of Entropy.
- What is Isochoric process? Show that in isochoric process, work done is equal to Zero.

Question 6

[3 + 3 + 3 + 3 = 12 marks]

- How do you find out the entropy change (ΔS) and enthalpy change (ΔH) for a system? State their Unit of measurement.
- Derive Gibbs-Helmholtz equation.
- State First Law of Thermodynamics. Support your statement.
 - Write down four limitation of first Law of Thermodynamic.
- Explain SN1 and SN2 reaction with appropriate example each.

Question 7

[3 + 3 + 3 + 3 = 12 marks]

- State atleast four factors that affect the rate of chemical reaction. Explain any two.
- Derive the work done in isothermal and reversible expansion of gas.
- Calculate the free energy change (ΔG) at 25°C and predict whether the reaction is spontaneous or not. Given $\Delta S = 285 \text{ J/K}$ and $\Delta H = 177 \text{ kJ}$
 $\text{NH}_4\text{Cl}_{(g)} \longrightarrow \text{NH}_{3(g)} + \text{HCl}_{(g)}$
- What is exothermic reaction and endothermic reaction? How can you predict the reaction whether it is exothermic or endothermic with the change in entropy.

Question 8

[4+2+3+3=12 marks]

- Calculate the heat of formation of Methane from the following data.
 $\text{C} + \text{H}_2 \longrightarrow \text{CH}_4 ; \Delta H = ?$
 - $\text{C} + \text{O}_2 \longrightarrow \text{CO}_2 ; \Delta H_1 = -94.40 \text{ k.cal}$
 - $\text{H}_2 + \frac{1}{2} \text{O}_2 \longrightarrow \text{H}_2\text{O} ; \Delta H_2 = -68.3 \text{ k.cal}$OR
 $2\text{H}_2 + \text{O}_2 \longrightarrow 2\text{H}_2\text{O} ; \Delta H_3 = -68.3 \text{ k.cal} \times 2 = -136.6 \text{ k.cal}$
 - $\text{CH}_4 + 2\text{O}_2 \longrightarrow \text{CO}_2 + \text{H}_2\text{O} ; \Delta H_4 = -212.8 \text{ k.cal}$
 - $\text{CO}_2 + 2\text{H}_2\text{O} \longrightarrow \text{CH}_4 + 2\text{O}_2 ; \Delta H_5 = +212.8 \text{ k.cal}$
- State Zeroth Law of thermodynamics and third Law of thermodynamics
- Explain Collision Theory of reaction with conditions and the main features.
- 2 mole of an ideal gas is allowed to expand reversibly at a constant temperature of 25°C from volume of 20 L to 40L. Calculate the work done in Joules. ($R = 8.314$)

Question 9

[3+3+3+3=12 marks]

- What do you mean by Standard Free energy change of a chemical reaction? Give the simple formula to calculate it.
- The enthalpy of formation of ethane at 298K and at constant pressure is – 110.46 kJ/mole. Calculate the change in internal energy at constant volume. (Given $R = 8.314$)
 $2\text{C}_{(s)} + 3\text{H}_{2(g)} \longrightarrow \text{C}_2\text{H}_{6(g)}$
- Define chemical energetic. Write down atleast six applications of Thermodynamic.

- d. What do you understand by homogenous system and heterogeneous system? Give a suitable example each.

Question 10

[3+3+3+3 =12 marks]

- a. What are the various parameters which can predict the spontaneity or non-spontaneity of the process? Explain in brief how these parameters predict the nature of process.
- b. 10.0 mol l^{-1} of lime stone on heating for 12 sec produced CO_2 . On analyzing after 12 sec. it was found out that 8 mol l^{-1} of lime stone were left. Calculate the rate of decomposition of the lime stone. Provide the chemical equation for this change also.
- c. What is Carnot Engine? Explain the efficiency of Carnot Engine.
- d. How do you find out the rate of the reaction? Illustrate with simple example.
How do you represent graphically the change in the concentration of the reactants and products? Explain the significance of the curves.