



UNIVERSITY OF MINES AND TECHNOLOGY, TARKWA
FIRST SEMESTER EXAMINATIONS, NOV/DEC 2018

COURSE NO: PE 275

COURSE NAME: CHEMICAL THERMODYNAMIC

CLASS: PE II

TIME: 3 HRS

Name: _____ Index Number: _____

Answer all questions UNDER sections A and two questions under section B.

SECTION A (20 MARKS)

Calculate $\Delta_r H^\circ$ for the reaction, $\text{Cl}_2(\text{g}) + 2\text{HF}(\text{g}) \rightarrow 2\text{HCl}(\text{g}) + \text{F}_2(\text{g})$

1. Using enthalpy of formation data below

$$\Delta_f H^\circ (\text{HCl}) = -92.5 \text{ kJ}$$

$$\Delta_f H^\circ (\text{HF}) = -269 \text{ kJ}$$

a. 335 kJ

c. 345 kJ

b. 354 kJ

d. 353 kJ

2. Using bond enthalpy data

$$\text{B.E. (H - Cl)} = 431 \text{ kJ mol}^{-1}$$

$$\text{B.E. (F - F)} = 155 \text{ kJ mol}^{-1}$$

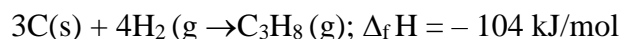
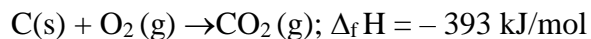
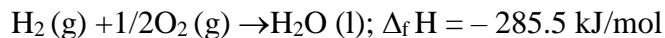
$$\text{B.E. (H - F)} = 563 \text{ kJ mol}^{-1}$$

$$\text{B.E. (Cl - Cl)} = 242 \text{ kJ mol}^{-1}$$

$$\text{B.E. (C - H)} = 415 \text{ kJ mol}^{-1}$$

$$\text{B.E. (H - H)} = 435 \text{ kJ mol}^{-1}$$

$$\text{B.E. (C - Cl)} = 339 \text{ kJ mol}^{-1}$$



- a. -645 kJ/mol
- b. -2217 kJ/mol
- c. 2217 kJ/mol
- d. 2127 kJ/mol

7. For an isolated system, any process that leads to an increase in the disorder of the system will be

From question 8 to 15, state whether it is true or false for each of the given statement.

8. The reaction quotient, Q_c is equal to the equilibrium constant, K_c at equilibrium.....

9. The enthalpy of reaction is dependent of the number and nature of the intermediate steps

10. Standard state condition for a gaseous system is 1 bar pressure at a specified temperature.....

11. Enthalpy of formation of any elementary substance is equal to zero.....

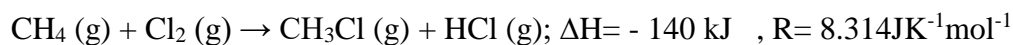
12. When a reaction is favored by both enthalpy ($\Delta H^\circ < 0$) and entropy ($\Delta S^\circ > 0$), there is no need to calculate the value of ΔG° to decide whether the reaction should proceed.....

13. Enthalpy of formation is the heat evolved or absorbed when one gram of a substance is formed from its elements in their most stable states.....

14. When one mole of H^+ (aq) and 1 mole of OH^- (aq) react, 57.1 kJ of energy is absorbed.....

15. Reversible processes are those processes in which the changes are carried out so slowly that the system and surrounding are always in equilibrium.....

Given the following reaction at 300 K,



16. What is the value of ΔG ?

.....

17. Calculate the value of ΔU at 300 K?

.....
.....
.....

18. According to the first law of thermodynamics, what are the two main driving forces that describe the internal energy of a system?

.....

19. State one importance of the third law of thermodynamics.....

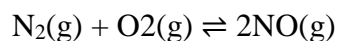
20. The energy available for a work done in system or reaction is known as.....

SECTION D B (40 marks)

Answer question one compulsorily and either question 2 or 3.

Question 1

- (i) Calculate the standard-state entropy of reaction and the standard state enthalpy for reaction for the following reactions:



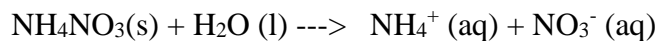
Data:

Compound	S° (J/mol-K)	ΔH_f° (kJ/mol)
NO(g)	210.76	90.25
N ₂ (g)	191.61	0
O ₂ (g)	205.14	0

- (ii) From the results obtained above, can we straight away conclude that the reaction is spontaneous?
- (iii) If the reaction is to occur at 25 °C, Evaluate with the results from (i) whether the reaction will occur spontaneously or not.
- (iv) Determine the equilibrium constant for this reaction at 100 °C

Question 2 (20 marks)

- (i) Calculate ΔH and ΔS for the following reaction:



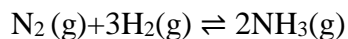
Data

Compound	$\Delta H_f^\circ(\text{kJ/mol})$	$S^\circ(\text{J/mol-K})$
$\text{NH}_4\text{NO}_3(\text{s})$	-365.56	151.08
$\text{NH}_4^+(\text{aq})$	-132.51	113.4
$\text{NO}_3^-(\text{aq})$	-205.0	146.4
$\text{H}_2\text{O}(\text{l})$	0	0

- (ii) Use the results of this calculation to determine the value of ΔG° for this reaction at 25°C
- (iii) Will NH_4NO_3 spontaneously dissolve in water at room temperature? Explain.
- (iv) What happens as the temperature of the reaction is increased to 400°C ?
- (v) Determine the equilibrium constant at 400°C

Question 3 (20marks)

- (i) Calculate ΔH and ΔS for the following reaction



Data

Compound	$\Delta H_f^\circ(\text{kJ/mol})$	$S^\circ(\text{J/mol-K})$
$\text{N}_2(\text{g})$	0	191.61
$\text{H}_2(\text{g})$	0	130.68
$\text{NH}_3(\text{g})$	-46.11	192.45

- (ii) Determine whether the reaction is spontaneous or not?
- (iii) Calculate ΔG for the reaction
- (iv) Will the reaction shift to the left or right to attain equilibrium given the answer you obtained at (iii)?
- (v) When two moles of H_2 gas and one mole of O_2 gas react to produce two moles of gaseous water at 373 K and 1 bar pressure, a total of 484 kJ are evolved. What are (a) ΔH and (b) ΔU for the production of a single mole of H_2O (g).

EXAMINER:

AMARFIO, Eric Mensah/ Dr Solomon Adjei-Marfo