

THE MOMBASA POLYTECHNIC UNIVERSITY COLLEGE

(A CONSTITUENT COLLEGE OF JKUAT)

(A Centre of Excellence)

Faculty of Applied and Health Sciences

DEPARTMENT OF **PURE AND APPLIED SCIENCES**

DIPLOMA IN ANALYTICAL CHEMISTRY

(DAC 11M)

ACH 2210: CHEMICAL THERMODYNAMICS AND PHASE EQUILIBRIA

SPECIAL/SUPPLEMENTARY: EXAMINATIONS

SERIES: February 2013

TIME: 2 HOURS

INSTRUCTIONS:

You should have the following for this paper

- *Answer booklet*

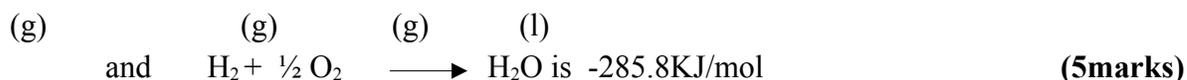
This paper consists of **FIVE** questions.

Question ONE

- a) Briefly discuss each of the following:
- Universe in thermodynamics
 - Indicator diagram
 - Equation of state
 - Calorimetry
 - Isolated system
- (10marks)**
- b) A certain gas expands in volume from 2.0 litres to 6.0 litres at constant temperature. Calculate the work done by the gas if it expands:
- Against a vacuum **(2marks)**
 - Against a constant pressure of 1.2 atm **(3marks)**
- c) The following is an example of an equation of state
 $P = f(T, V, n)$
- Describe the meaning of the equation **(2marks)**
 - Give the meaning of each term **(4marks)**
- d) The equation below shows the reaction between ammonia and fluorine.
 $NH_3 + 3F_2 \rightleftharpoons 3HF + NF_3$
 (g) (g) (g) (g)
- Use the standard molar enthalpy change of formation (ΔH°_f) data in the table below to calculate the molar enthalpy change for this reaction.
- | Compound | ΔH°_f (KJ/Mol) |
|-----------------|-----------------------------|
| NH ₃ | -46 |
| HF | -269 |
| NF ₃ | -114 |
- (5marks)**
- e) If a system does 75.45 of work on its surroundings and simultaneously there is 25.7J of heat transfer from the surroundings determine the change in internal energy for the system? **(4marks)**

Question TWO

- a) Enthalpy, it is defined as:
 $H = U + PV$
- Describe the meaning of each term in this equation for enthalpy **(3marks)**
 - Discuss why enthalpy is treated as a state function. **(2marks)**
 - By taking infinitesimal increments to H, U, P and V, show that $\Delta H = 2P$ **(8marks)**
- b) i) State Hess's law of heat summation **(2marks)**
- ii) The standard reaction enthalpy for the hydrogenation of propene
 $CH_2 = CHCH_3 + H_2 \longrightarrow CH_3CH_2CH_3$
 (g) (g) (g)
 is -124KJ/Mol. The standard reaction enthalpy for the combustion of propane,
 $CH_3CH_2CH_3 + 5O_2 \longrightarrow 3CO_2 + 4H_2O$
 (g) (g) (g) (l)
 is -2220KJ/mol. Calculate the standard enthalpy of combustion of propene given
 $CH_2 = CHCH_3 + 9/2O_2 \longrightarrow 2CO_2 + 3H_2O$



Question THREE

- a) By the use of a suitable model, show that isothermal reversible expansion work is given as:

$$W = -nRT \ln \frac{V_f}{V_i}$$
 (11marks)
- b) i) Differentiate between entropy and free energy (4marks)
 ii) The change in free energy is given as $\Delta G = \Delta H - T\Delta S$
 Describe the meaning of each term. (5marks)

Question FOUR

- a) Distinguish between:
 i) Reversibility and irreversibility in thermodynamics (4marks)
 ii) Isochoric process and isobaric process (4marks)
 iii) Spontaneous and non-spontaneous process. (4marks)

- b) The standard entropy values for some compounds is given below:

Compound	Entropy value (J/K)
CaO	39.8
CO ₂	213.6
CaCO ₃	92.9
NH ₃	193.0
N ₂	192.0
H ₂	131.0

Using this data, determine the standard entropy changes for the reactions at 25°C.

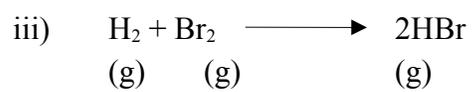
- i) $\text{CaCO}_3 \longrightarrow \text{CaO} + \text{CO}_2$
 (s) (s) (g) (4marks)
- ii) $\text{N}_2 + 3\text{H}_2 \longrightarrow 2\text{NH}_3$
 (g) (g) (g)

Question FIVE

- a) Discuss briefly each of the following:
 i) Entropy (3marks)
 ii) Free energy (3marks)
 iii) Microstates (3marks)
 iv) Distribution (3marks)
- b) Discuss qualitatively the sign of the entropy change expected for each of the following processes.
 i) $2\text{H}_2 + \text{O}_2 \longrightarrow 2\text{H}_2\text{O}$
 (g) (g) (l) (2marks)
- ii) $\text{NH}_4\text{Cl} \longrightarrow \text{NH}_3 + \text{HCl}$

(s) (g) (g)

(3marks)



(3marks)