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KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2017/2018 ACADEMIC YEAR

SECOND YEAR FIRST SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF B.ED (SCIENCE)

COURSE CODE: SCH 240

COURSE TITLE: BASIC CHEMICAL THERMODYNAMICS

DURATION: 2 HOURS

DATE:9TH JANUARY 2018 TIME: 2 – 5PM

INSTRUCTIONS TO CANDIDATES

- Answer **QUESTION ONE** (Compulsory) and any other two (2) Questions.
- Indicate **answered questions** on the front cover.
- Start every question on a new page and make sure question's number is written on each page.

This paper consists of **4** printed pages. Please Turn Over

KIBU observes ZERO tolerance to examination cheating

Question 1

a) Differentiate between the following terminologies in thermodynamics.

i. State variable and state function. **[2mks]**

ii. Closed and open system **[2mks]**

iii. Reversible and irreversible processes. **[2mks]**

iv. Isothermal and isobaric process. **[2mks]**

b) Explain the **Zeroth Law** of thermodynamics and state its physical significance. **[2mks]**

c) State three properties that satisfy ideal gases. **[3mks]**

d)Using the laws of gases, derive the general equation for ideal gases. **[4mks]**

e) Two moles of ammonia are confined to a five litre flask at 27°C. Calculate its pressure using the;

I. Ideal gas equation. **[2mks]**

II. Van der Waals equation (given $a = 4.17$ atm.dm^{3}mol^{-1}, $b = 0.0371$ dm^{3}mol^{-1}, $R = 0.082$ dm^3.mol^{-1}k^{-1}. **[3mks]**

f) State the Law of corresponding states. **[1mk]**

g) Calculate the pressure for 1 mole of a gas at 313 K occupying a volume of 0.107 dm^3 /mol using law of corresponding states. $V_c = 0.0957$ dm^{3}mol^{-1}; $T_c = 21$°C ; $P_c = 100$ atm . ; $R = 0.0821$ atm.dm^3 K^{-1}mol^{-1} **[4mks]**

h) Explain why the specific heat capacity at constant pressure C_p is greater than the specific heat capacity at constant volume C_v for an ideal gas. **[3mks]**

Question 2

(a) Write the formulation of 1st law of thermodynamicsgiving its physical significance and itslimitations. **[3mks]**

(b) Assuming that a volume **V** of an ideal gas is confined into a cylindrical container with the help of a frictionless piston at a gas pressure **P** and a temperature **T**, show that;

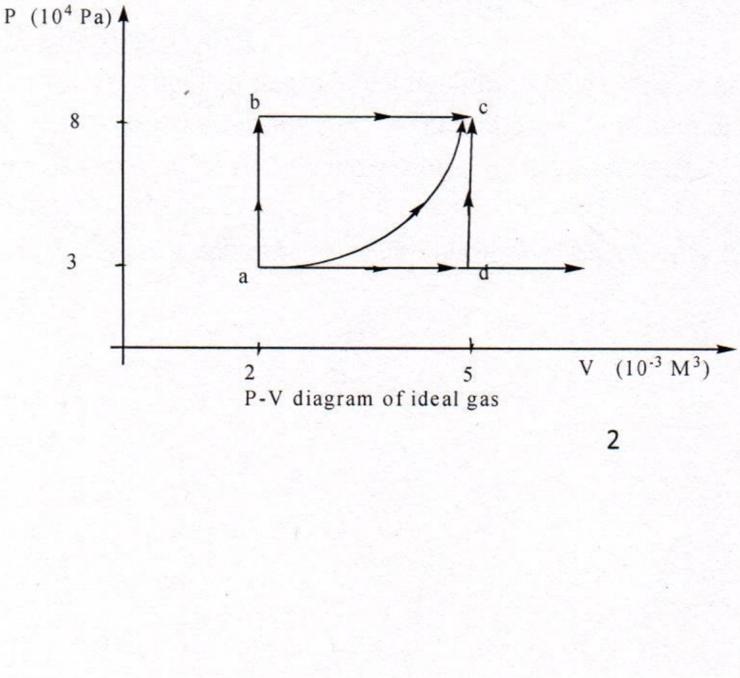
$Work = nRT\ln(\frac{v2}{v1})$ **[4mks]**

c) In the Figure below, an Ideal gas system can be taken from state **a** to **c** either through **a-b-c** or **a-d-c**. In processes **a-b** and **b-c**, 600 J and 200J are given to the system respectively. Calculate;

i. **dU** along **a-b** **[2mks]**

ii. **dU** along **a - b - c** **[3mks]**

iii. Total heat added in **a-d-c** **[3mks]**



P-V diagram of ideal gas

(d) A quantity of nitrogen gas at an initial pressure $P_1 = 2 \times 10^{-5}$ Nm^{-2}and an initial volume $V_1 =$ 4.0 M^3 is compressed rapidly to a volume $V_2 = 2.5$ M^3.

i. What is the final pressure? (γ for nitrogen = 1.4) **[3mks]**

ii. If the nitrogen is now cooled to the original temperature, find the final pressure.**[2mks]**

QUESTION THREE

a). Distinguish between exothermic and endothermic reaction. **[2mks]**

b). State Hess law of heat summation. **[1mk]**

c). The table below lists a number of average bond enthalpy values

Bond	Average bond enthalpy/kJ mol^{-1}
C—C	348
C=C	612
C—H	413
O—H	463

i. Given that the enthalpy of combustion to form carbon dioxide and steam is –2102 kJ mol^{-1} for propane and –1977 kJ mol^{-1} for propene, determine the enthalpy change for the oxidation of 1 mol of propane to propene and steam.

$C_3H_8(g) + \frac{1}{2} O_2(g) = C_3H_6(g) + H_2O(g)$ **[4mks]**

ii. Use the average bond enthalpies in the table above, together with your answer to part c (i), to calculate the bond enthalpy of the O=O bond in the oxygen molecule.**[4mks]**

iii. State three factors affecting bond energies. **[3mks]**

(d) Explain four enthalpy changes in ionic crystal formation.**[4mks]**

(e) The table below lists the enthalpy changes in the formation of caesium chloride crystal.

Enthalpies	**Enthalpy value (kj/mol^{-1})**
Atomisation energy, ΔH_{at}	+79
Ionisation energy of caesium, $\Delta H_{i.e}$	+376
Electron affinity of chlorine, ΔH_{ea}	-121
Formation of Caesium chloride, ΔH_f	-433

Calculate the value of the lattice energy ΔH_{latt}.**[2mks]**

QUESTION FOUR

a) Explain what is a phase andstate Gibb's phase rule as an equation. **[2mks]**

b) State three conditions that fulfill a phase in a system at equilibrium. **[3mks]**

c) Dissociation of PCl_5 is represented by the equation;

$PCl_{5(g)} = PCl_{3(g)} + Cl_{2(g)}$

i. Identify and determine the number of chemically distinct species, or constituents present. **[2mks]**

ii. State the number of additional constraints imposed by conditions of either electroneutrality or stoichiometry. Hence determine the number of independent components. **[3mks]**

iii. Assuming the system to exist only as vapour phase, use the phase rule to determine the variance of the system. **[2mks]**

d) Draw a clearly labelled P-T diagram for water existing in three phases at equillibrium and on it label; triple point and critical point. **[4mks]**

e) State two characteristics of a first order phase change. **[2mks]**

f) Meat cooks faster in a pressure cooker than in a sufuria. Explain. **[2mks]**

QUESTION FIVE

a) Explain the following;

i. Entropy of a system **[1mk]**

ii. Spontaneous process **[1mk]**

b) State the second law of thermodynamics. **[1mk]**

c) Calculate the change in entropy when transferring 100kJ of heat to a large mass of water at 0°C and when the same is transferred at 100°C. Comment on your results. **[4mks]**

(d) Hydrogen used in the manufacture of ammonia is produced by the reaction between methane and steam shown in the following equation.

$$CH_4(g) + 2H_2O(g) \rightleftharpoons CO_2(g) + 4H_2(g)$$

Use the data given below to answer the questions which follow.

	$CH_4(g)$	$H_2O(g)$	$CO_2(g)$	$H_2(g)$
$\Delta H_f^{\ominus}$/kJ mol^{-1}	–74.8	–241.8	–393.5	0
$S^{\ominus}$/J K^{-1}mol^{-1}	186.2	188.7	213.6	130.6

i. Calculate the standard enthalpy change, $\Delta H^{\ominus}$, for this reaction. **[3mks]**

ii. Calculate the standard entropy change for this reaction. **[3mks]**

iii. Calculate the temperature at which the free-energy change, ΔG, for the above reaction is zero. What is the significance of this temperature? (Assume that ΔH and ΔS do not vary with temperature.) **[4mks]**

e) State three consequences of the third law of thermodynamics. **[3mks]**