JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

UNIVERSITY EXAMINATION FOR THE DEGREE OF MASTERS OF SCIENCE IN PHYSICS

MAIN

REGULAR

COURSE CODE: SPB 9313

COURSE TITLE: THERMODYNAMICS

EXAM VENUE: **STREAM: YEAR THREE**

DATE: **EXAM SESSION:**

TIME: 3:00HRS

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1. **<u>Instructions:</u> Answer question 1 (Compulsory) in Section A and ANY other 2 questions in Section B.**
2. **Answer Question 1 (compulsory) and ANY other 2 questions**
3. **Candidates are advised not to write on the question paper.**
4. **Candidates must hand in their answer booklets to the invigilator while in the examination room.**

Question 1 (30 Marks)

a. Give the definitions of an isolated system [2marks]

b. State the Second law of thermodynamics [2marks]

c. Derive the expression for the Fermi-Dirac distribution. Explain the meaning of all the symbols you write down. [5marks]

d. Show that $(\partial S/\partial p)_T = -(\partial V/\partial T)_p$ [4marks]

e. In a gas thermometer, the pressure needed to fix the volume of 0.80 g of Helium at 0.40 L is 120.3 kPa. What is the temperature? [5marks]

f. Define State fuctions [2marks]

g. Consider a tank of gas of volume V containing N gas molecules with a total energy E. Write down the corresponding the three conjugate variables for each [5marks]

h. By definition, Helmholtz function f = u – Ts. Show that $(\partial p/\partial T)_v = (\partial s/\partial v)_T$ [5marks]

Question 2 [20 marks]

Discuss the following thermodynamic processes

a. Isothermal process [5marks]

b. Isobaric Process [5marks]

c. Isochoric Process [5marks]

d. Isobaric Process [5marks]

Question 3 [20 marks]

a. Show that for an ideal gas obeying $pv = RT$, $u(T,v) = u(T)$, and, $c_v(T,v) = c_v(T)$ [5marks]

b. show that $c_p - c_v = [RT/(v - b)](\partial v/\partial T)_p$ [7marks]

c. Explain the four processes in the Carnot cycle [4marks]

d. Show the Maxwell relation $(\partial T/\partial V)_S = -(\partial p/\partial S)_V$ [4 marks]

Question 4 [20 marks]

a. Define **adiabatic expansion** [2marks]

b. At 12°C, two moles of an ideal monatomic gas occupy a volume V. The gas is adiabatically expanded to a volume 4V.

i. Calculate the ratio of final pressure to the initial pressure [4marks]

ii. Change in internal energy [4marks]

iii. Calculate the molar specific heat capacity of the process Change in internal energy

[5marks]

iv. Calculate the molar specific heat capacity of the process [5marks]

Question 5 [20 marks]

a. Compute the internal energy change and temperature change for the two processes involving 1 mole of an ideal monatomic gas.

i. 1800 J of heat are added to the gas and the gas does no work and no work is done on the gas [5marks]

ii. 1800 J of work are done on the gas and the gas does no work and no heat is added or taken away from the gas [5marks]

b. Discuss exhaustively a system in thermal equilibrium [10marks]