THE CATHOLIC UNIVERSITY OF EASTERN AFRICA

A. M. E. C. E. A

P.O. Box 62157

00200 Nairobi - KENYA

Telephone: 891601-6

Ext 1022/23/25

MAIN EXAMINATION

JANUARY – APRIL 2022

FACULTY OF SCIENCE

DEPARTMENT OF NATURAL SCIENCES

REGULAR PROGRAMME

PHY 203: THERMOODYNAMICS II

Date: APRIL 2022	**Duration: 2 Hours**
INSTRUCTIONS: Answer Question ONE and any TWO Questions	

Q1.

(a) Define the following terminologies:

i. Thermodynamics

ii. thermodynamic system

iii. phase **(6marks)**

(b) Write down the four thermodynamic potentials in their equation form **(8marks)**

(c) Show that for an ideal gas, the specific heat capacity at constant pressure is given by

$$C_p = \left(\frac{\gamma}{\gamma - 1}\right) R$$

Where R is the universal gas constant and γ is the adiabatic constant **(6marks)**

(d) One mole of an ideal gas undergoes a reversible isothermal expansion from volume V to volume 2V. Show that the change in entropy of the gas is given by

$\Delta S_{gas} = R \ln 2$ **(4marks)**

(e) Given that $U = U(PT)$ and $V = V(PT)$, show that the specific heat capacity at constant pressure can be expressed as

$$C_p = \left(\frac{\partial H}{\partial T}\right)_P$$ **(6marks)**

Q2.

(a) Distinguish between:

i. closed and isolated systems **(4marks)**

ii. adiabatic and diathermal walls **(4marks)**

(b) define Gibb's free energy and show that for a reversible isothermal and isobaric process, $\Delta G = 0$ **(4marks)**

(c) A liquid of mass M and specific heat capacity C_p at temperature $T_1$is mixed with an equal amount of the same liquid at temperature T_2.the system is thermally insulated. Find the total entropy and show that it is always positive. **(8marks)**

Q3.

(a) Distinguish between Intensive and Extensive variables **(2marks)**

(b) Show that if two bodies of thermal capacities C_1 and C_2 at temperatures T_1 and T_2 are brought to the same temperature T by means of a reversible engine, then

$$lnT = \frac{C_1 \ln T_1 + C_2 \ln T_2}{C_1 + C_2}$$ **(8marks)**

(c) Derive the Clausius- Clapeyron equation **(10marks)**

Q4.

(a) State

i. Helmholtz free energy **(2marks)**

ii. Enthalpy **(2marks)**

(b) Calculate the change in entropy of 5 kg of water when it is heated reversibly from $0\,°C$ to $100\,°C$ given that the specific heat capacity of water is 4200J/kg K

(4marks)

(c) Derive the Maxwell's thermodynamic relations from the thermodynamic potentials **(12marks)**

Q5.

(a) Using Maxwell's first relation and any other appropriate relations and functions , derive

i. The energy equations **(5marks)**

ii. The first Tds equation **(5marks)**

(d) In a cyclic process, heat transfer are +14KJ, -25.2KJ, -356KJ and +31.5KJ. for the cyclic process, determine the net work done **(4marks)**

(e) The equation of state for a certain gas is given by $Pv = RT\left(I + \frac{b}{v}\right)$

Show that the internal energy U of the gas expressed in terms of entropy S and volume V

is given by $U = f\left(S - RlnU + \frac{bR}{v}\right)T$

Where f is some functions **(6marks)**

END