THE CATHOLIC UNIVERSITY OF EASTERN AFRICA

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MAIN EXAMINATION

SEPTEMBER – DECEMBER 2019 TRIMESTER

FACULTY OF SCIENCE

DEPARTMENT OF PHYSICS

REGULAR PROGRAMME

PHY 203: THERMODYNAMICS II

Date: DECEMBER 2019	**Duration: 2 Hours**
INSTRUCTIONS: Answer Question ONE and ANY other TWO Questions	

Q1 a) Distinguish between the following terms
- (i) Isolated and open system **(2 marks)**
- (ii) isentropic and adiabatic processes **(2 marks)**
- (iii) isothermal and isochoric processes **(2 marks)**

b) Write down the four thermodynamics potentials in differential form **(4 marks)**

c) (i) Define Gibb's free energy **(1 mark)**

(ii) Show that for a reversible isothermal and isobaric process,

$\Delta G = 0$ **(4 marks)**

d) State the following
- (i) Zeroth law of thermodynamics **(1 mark)**
- (ii) first law of thermodynamics **(1 mark)**

e) Show that it is true that for an isothermal process
- (i) $\Delta U = 0$ **(3 marks)**
- (ii) $\Delta Q = \Delta W$ **(3 marks)**

f) Calculate the molar specific heat capacities c_p and c_v of oxygen given that the ratio of molar heat capacities $\gamma = 1.4$ **(4 marks)**

g) Calculate the change in entropy of 5 kg of water when it is heated reversibly from 0º C to 100º C given that the specific heat capacity of water is 4200 J/kg **(3 marks)**

Q2 a) Derive the Maxwell's thermodynamics relations from the thermodynamic potentials **(12 marks)**

b) Derive the Claussius - Clapeyron equation **(8 marks)**

Q3 a) Consider an arbitrary heat engine which operates between two reservoirs, each of which has the same finite temperature independent heat capacity c. The reservoirs have initial temperatures T_1 and T_2 where $T_2 > T_1$ and the engine operate until both the reservoirs have the same final temperature T_3. Give the argument which shows that

$$T_3 > \sqrt{T_1 T_2}$$ **(10 marks)**

b) Show that for a Carnot cycle, the ratio of the heat supplied Q_H to the heat rejected Q_C is the ratio of their absolute temperature T_H and T_C respectively **(10 marks)**

Q4 a) Show that the equation of a reversible adiabatic is given by pV^{γ} **(10 marks)**

b) A Carnot cycle operates between 200º C and 1200º C.

(i) calculate its efficiency **(4 marks)**

Calculate its coefficient of performance if it operates as a

(ii) refrigerator **(3 marks)**

(iii) heat pump **(3 marks)**

Q5 a) Given that U = U(P, T) and V = V(P, T), show that the specific heat capacity at constant pressure can be expressed as

$$c_P = \left(\frac{\partial H}{\partial T}\right)_P$$ **(10 marks)**

b) Determine the increase in entropy of solid magnesium when the temperature is increased from 300K to 800 K at atmospheric pressure. The heat capacity is given by the relation

$C_P = 26.04 + 5.586 \times 10^{-3} T + 28.476 \times 10^{4} T^{-2}$

Where C_P is in J/molK and temperature in K **(10 marks)**

END