KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2019/2020 ACADEMIC YEAR

FOURTH YEAR SECOND SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF B.ED (SCIENCE) AND BSC (PHYSICS)

COURSE CODE: SPH 415

COURSE TITLE: THERMODYNAMICS

DURATION: 2 HOURS

DATE: 11TH NOVEMBER, 2020 **TIME:** 9:00AM-12:00PM

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

QUESTION ONE (30 MARKS)

a) Differentiate between an open and a closed system (1 mark)

b) When is a system said to be in equilibrium? (1 mark)

c) What constitutes the internal energy of a system? (3 marks)

d) A fluid of volume 0.05 m^3 is contained behind a piston at a pressure of 1.0 x $10^6 N/m^2$. After a reversible expansion of constant pressure, the final volume is $0.2m^3$. Calculate the work done by the fluid. (2 marks)

e) What is a cyclic process? (1 mark)

f) Explain with an example the term quasi-static process (3 marks)

g) State the Carnot's theorem (1 mark)

h) The compression ratio of a diesel engine is about 15. The cylinder contains air of volume $10^{-3}m^3$ at 1.05×10^5 pa and 15.6°C, at the start of the compression stroke. Calculate the pressure, temperature and the work done at the end of this stroke. Assume that air behaves as an ideal gas and that the compression is adiabatic. Take the value of γ for air to be 1.4 (4 marks)

i) Given the following constants for the van der Waals equation for carbon dioxide $a = 0.37Nm4mol^{-2}$ and $b = 43Cm^3mol^{-1}$. Using the Van der Waals equation find the pressure exerted by carbon dioxide gas at 0^0C if it has a specific volume of $0.55Lmol^{-1}$. (4 marks)

j) Define the Zeroth Law of thermodynamics (1 mark)

k) A certain volume of gas contained behind a position is expanded reversibly. If the initial pressure and volume are 1.0 x 10^6 N/m^2 and 0.05 m^3 respectively and final volume is 0.06 m^3. Determine the work done given that the expansion follows the law $PV^3 = K$. (3 marks)

l) An Engine absorbs heat at 227°C and rejects at 27°C. Determine its efficiency. (2 marks)

m) Ten grams of water at 20°C are converted into ice at 0°C at constant atmospheric pressure. Calculate the entropy change. (4 marks)

QUESTION TWO (20 MARKS)

a) What is thermodynamics? (1 mark)

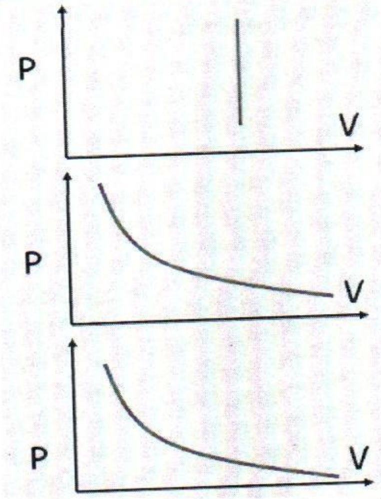
b) What do you understand by the following terms as used in thermodynamics; classical thermodynamics, Statistical thermodynamics and chemical thermodynamics (3 marks)

c) A certain volume of fluid at a pressure of 1.0 x 10^6 N/m^2 is contained in a cylinder behind a piston. If the initial volume is 0.05 m^3, calculate the work done by the fluid when it expands reversibly according to a law $P = \frac{a}{V^2} - \frac{b}{V}$ to a final volume of 0.1 m^3 final pressure of 1.0 x 10^5 N/m^2. (a and b are constants) (6 marks)

d) Differentiate between extensive and intensive variable in a thermodynamic system giving an example in each case (2 marks)

e) For two systems namely A and B that are in thermal contact with each other and the surrounding, show that heat gained by one equals to heat lost by the other (4 marks)

f) Using Figure 1 below, answer the following



i) State the terms that remain constant in each of the observed graph (in figure 1) (2 marks)

ii) Define the thermodynamic terms associated to each of the stated constant terms in (i) above (2 marks)

QUESTION THREE (20 MARKS)

a) A gram molecule of gas at $227^{o}C$ is compressed isothermally until its volume is doubled. Find the amount of work done and Heat absorbed. $(R = 8.3\times10^{7}\,ergs/K)$ (2 marks)

b) From basic principles of an isothermal process show that (6 marks)

$$Q = TR\ \ln\frac{V_2}{V_1} = RT\ \ln\frac{P_1}{P_2}$$

c) State the three characteristics of Carnot's cycle (3 marks)

d) Derive the Poisson's law for a reversible adiabatic change (6 marks)

e) Determine the specific heat for a closed system for constant pressure (3 marks)

QUESTION FOUR (20 MARKS)

a) One kilogram of ice at 0°C is melted and converted to water at 0°C. The water is then heated from its original temperature to 100°C. Compute the total change in entropy. Take the specific latent heat of fusion of ice as 333, 624.2 J/Kg and the specific heat capacity of water as 42000J/Kg (8 marks)

b) Show that the condition for a thermodynamic equilibrium in a system in thermal and mechanical contact with a heat and pressure reservoir is that the Gibbs function is a minimum (6 marks)

c) Derive the Clausius – Clapeyron's Latent heat equation (6 marks)

QUESTION FIVE (20 MARKS)

a) A block of metal is squashed reversibly and isothermally at temperature T from pressure (P_1) to pressure (P_2). Calculate the heat that flows out of the metal (8 marks)

b) Use the energy equation to show that the rate of change of internal energy with respect to volume at constant temperature is zero (8 marks)

c) Determine the work done by an ideal gas in an adiabatic expansion (4 marks)