KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2015/2016 ACADEMIC YEAR

FOURTH YEAR SECOND SEMESTER
MAIN EXAMINATIONS

FOR THE DEGREE OF B.ED (SCIENCE)

COURSE CODE: SPH 415

COURSE TITLE: THEMODYNAMICS

DURATION: 2 HOURS

DATE: THURSDAY 5TH MAY 2016 TIME: 8 – 10AM

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 **3** printed pages. Please Turn Over

KIBU observes ZERO tolerance to examination cheating

Constants

Latent heat of ice = 336J/g

$R = 8.3 \times 10^7 \, ergs / K$

$C_{PL} = 4.187$

$h_{fg} = 1888$

$T_f = 212.36^{\circ}C$

Density of ice = 0.917 g/cm^3

QUESTION ONE

a) Explain the implications of the laws of thermodynamics

b) Consider a hypothetical refrigerator that takes 1000 J of heat from a cold reservoir at 100K and ejects 1200 J of heat to a hot reservoir at 300K. (i) How much work does the refrigerator do? (ii) What happens to the entropy of the universe? (iii) Does this violate the 2nd law of thermodynamics?

c) Discuss any five types of thermodynamic systems.

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

e) If A,B,C and D are four baths, the efficiency of a reversible engine working between A and C is half way between the efficiencies of the same engine working between A and B and between A and D. Show that the temperature of C is half-way between those of B and D on the absolute scale.

f) Derive the *Clausius – Clapeyron's* Latent heat equation.

[4, 3, 5, 3, 3, 6Marks]

QUESTION TWO

a) Show that (i) the thermodynamic and the ideal gas scales of temperature are identical
(ii) the efficiency of a real engine increases with the compression ratio

b) A reversible engine works between two temperatures whose difference is 100°C. If it absorbs 746 Joule of heat from the source and give 546 to the sink, calculate the temperatures of source and sink. *[6, 5, 3Marks]*

QUESTION THREE

a) Calculate the value of the specific entropy of wet steam at $2MN/m^2$ and 0.8 dry.

b) Determine distinctively the changes in entropy for processes where $\Delta P=0$, $\Delta T=0$ and $\Delta V=0$. *[2, 12Marks]*

QUESTION FOUR

a) Get the Maxwell's equations from thermodynamic potentials

b) Show that $\boldsymbol{C_P - C_V = R}$ using Maxwell's equations. *[8, 6Marks]*

QUESTION FIVE

A reversible *Stirling heat engine* uses 0.001 moles of helium gas and works by extracting and dumping heat between two reservoirs at 127 ^{0}C and 27 ^{0}C. The is then taken through four stages to complete a cycle such that Process AB: an isothermal expansion at 127 °C from 1 cm^3 to 2 cm^3; Process BC: an isochoric cooling to 27 °C; Process CD: an isothermal compression at 27 °C back to 1 cm^3; and Process DA: an isochoric heating back to the initial conditions.

(i) Draw the four steps of the *Stirling cycle* on a T-S diagram. Label the axes, the directions of each of the steps and the temperatures of any isotherms. Explain every process in the diagram.

(ii) Determine the work done by the engine W, the heat absorbed by the engine Q, and the change in entropy ΔS of the engine in all processes and determine the total work done.

(iii) Determine the efficiency of this engine and compare with the efficiency of a Carnot engine working between the same two heat reservoirs?

[2, 10, 2 Marks]

QUESTION SIX

a) Get the *Mayer's relation* using thermodynamic relations.

b) Show that the slope of the adiabatic at a particular point (P,V) on the $P-V$ indicator diagram is γ times that of the Isotherm.

c) A gram molecule of gas at 500K is compressed isothermally until its volume is doubled. Find the amount of work done and Heat absorbed. *[7, 5, 2 Marks]*