KIBABII UNIVERSITY

UNIVERSITY EXAMINATIONS
2017/2018 ACADEMIC YEAR

THIRD YEAR SECOND SEMESTER
SPECIALS/SUPPLEMENTARY EXAMINATIONS

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

COURSE CODE: SPH 415

COURSE TITLE: THERMODYNAMICS

DURATION: 2 HOURS

DATE: 11/10/2018 **TIME: 3.00 – 5.00 PM**

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

KIBU observes ZERO tolerance to examination cheating

USEFUL CONSTANTS

$R = 8.31 J/K.mol$ = 0.082L.atm/mol.K

QUESTION ONE (30 MARKS)

(a) Define the following terms

(i) A thermodynamic system (2 marks)

(ii) A system boundary (2 marks)

(b) Differentiate between the following

(i) An open system and a closed system (2 marks)

(ii) Adiabatic wall and diathermic wall (2 marks)

(iii) A reversible process and a cyclic process. (2 marks)

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

(d) A fluid of volume 0.05m^3 is contained behind a piston at pressure of $1.0 \ x \ 106 N/m^2$. After a reversible expansion of constant pressure the final volume is $0.2 m^3$. Calculate the work done by the fluid. (3 marks)

(e) Air is expanded reversibly behind a piston according to a law $PV = constant$. If the final volume is twice the initial volume and the work done on the fluid during the expansions is $3.47 \ x \ 10^4 Nm$. Determine the initial volume and pressure if the final volume is $0.5 m^3$. (3 marks)

(f) State the first law of thermodynamics (1 mark)

(g) An ideal gas absorbs $5 \ x \ 10^3 J$ of energy while doing work of $2 \ x \ 10^3 J$ to its surroundings. Find the change in internal energy. (3 marks)

(h) An engine absorbs heat at $227^0 C$ and rejects at $27^0 C$. Determine its efficiency. (3 marks)

(i) Show that for a monoatomic ideal gas undergoing adiabatic process $TV^{2/3} = C$ where C is a constant. (4 marks)

QUESTION TWO (20 MARKS)

(a) Given that in a PVT system the differential changes in P are related to those in V and T by the equation $\partial P = \left(\frac{\partial P}{\partial V}\right)_T \partial V + \left(\frac{\partial P}{\partial V}\right)_V \partial T$. Using the volume expansivity β and isothermal compressibility κ show that at constant volume $(P_2 - P_1) = \frac{\beta}{\kappa}(T_2 - T_1)$ when the pressure and volume changes (8 marks)

(b) When a gas expands adiabatically its volume is doubled while its absolute temperature is decreased by a factor of 1.32. Calculate the degree of freedom for the gas molecule.

(4 marks)

(c) Show that the work done on a gas during an adiabatic compression from (P_1, V_1) to (P_2, V_2) is given by $W = \frac{1}{\gamma - 1}(P_2V_2 - P_1V_1)$. (8 marks)

QUESTION THREE 20 MARKS.

(a) State second law of thermodynamics. (1 mark)

(b) Define the following terms as used in thermodynamics

(i) Work (1 mark)

(ii) Quasi-static process (1 mark)

(c) Given the ideal gas equation $PV = nRT$ where all the symbols have their usual meaning:

(i) Derive the expression for work done on the gas (6 marks)

(ii) Calculate the work done for $2\ moles$ if an ideal gas were kept constant temperature 0^0C if the gas was compressed from a volume of $4L$ to $1L$. (5 marks)

(d) Two Carnot engines A and B are operated in series. A receives heat from source at $900K$ and rejects to sink at TK. The rejected heat is taken by B which further rejects to the sink at $400K$. Find T if the efficiency of both engines are same. (6 marks)

QUESTION FOUR (20 MARKS)

(a) Given a PVT system

(i) Define the term enthalpy H (1 marks)

(ii) If the basic expression for enthalpy is given by $H = U + PV$ show that $dH = dQ + VdP$. (6 marks)

(b) Write the expression for the different form of the first law of thermodynamics for each of the following cases:

(i) Stretched wire (2 marks)

(ii) Surface film (2 marks)

(iii) A paramagnetic solid (2 marks)

(c) Define the term entropy (2 marks)

(d) State the third law of thermodynamics (2 marks)

(e) Determine the value of the specific entropy of water at 100^0C. (3 marks)

QUESTION FIVE (20 MARKS)

(a) Define the following processes: - isobaric, adiabatic, isochoric and isothermal. (4 marks)

(b) For an ideal gas derive expressions for molar specific heat at constant volume (C_v) and pressure (C_p) in terms of internal energy U and enthalpy H. (6 marks)

(c) A monoatomic ideal gas at $2x10^5Pa$ and initial temperature of 20^0C expands slowly at constant pressure from $1L$ to $2.5L$. Find the work done on the surrounding, change in internal energy and the thermal energy absorbed by the gas. (6 marks)

(d) A monoatomic ideal gas has temperature of $300K$and a constant volume of $1.5L$. If there are 5 moles of the gas and its temperature raised to $380K$ find the thermal energy added hence calculate the added thermal energy if the gas is diatomic. (4 marks)