JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

UNIVERSITY EXAMINATIONS

END SEMESTER EXAMINATIONS

BECHELOR OF EDUCATION SCIENCE

YEAR 3 SEMESTER 1 AUGUST 2013

SPH302: THERMODYNAMICS

(REGULAR PROGRAM)

This paper consists of FIVE Questions. Answer QUESTION ONE (COMPULSORY) and any other TWO Questions.

QUESTION ONE (Compulsory) (30 Marks)

a. Describe the following classifications of thermodynamic properties citing an example of each:
   i. Intensive properties
   ii. Extensive properties (2marks)

b. Define the following thermodynamic properties:
   i. Enthalpy
   ii. Entropy (2 marks)

c. Describe the following types of thermodynamic systems:
   i. Isolated system
   ii. Closed system
   iii. Open system (3 marks)

a. Describe the following terms concerning thermodynamic processes:

   i. Adiabatic process
   ii. Isentropic process
   iii. Throttling process (3 marks)

b. Briefly explain the following laws of thermodynamics (3Marks)
   i) The zeroth law
   ii) The first law, and
   iii) The second law

c. Explain the Maxwell’s relations of thermodynamics. (4marks)

d. Briefly define the following thermodynamics potentials. (4 Marks)
   i) Helmoltz free energy
   ii) Gibbs function

e. Draw both a P-V and T-S diagrams for a Carnort Cycle of an ideal gas and explain all the processes involved. (6 Marks)

f. The speeds of 10 molecules are 12, 14, 15, 15, 18, 19, 20, 21, 22 and 25.Find the root mean square speed. (3 Marks)

QUESTION TWO **(20 Marks)**

a. Show that the pressure P exerted by a gas of density *p* on the walls of its container is given by

$$P = \frac{1}{3} \circ \bar{v}^{2}$$ (6 marks)

b. The speeds of 10 molecules of a gas are 2, 4, 5, 15, 8, 9, 20, 21, 22 and 25 m/s. Given that its density is 2.5 kg/m^3, determine the pressure exerted by the gas on the walls of the container. (4 marks)

c. Starting with the first law of thermodynamics and the definitions of c_p and c_v show that

$$c_p - c_v = \left[P + \left(\frac{\partial U}{\partial V}\right)_T\right]\left(\frac{\partial V}{\partial T}\right)_P$$

Where c_p and c_v are the specific heat capacities per mole at constant pressure and volume, respectively, *U* and ***V*** are energy and volume of one mole. (10 Marks)

QUESTION THREE **(20 Marks)**

a. State and explain the four thermodynamic potentials in their differential forms (10 marks)

b. Show that for a closed system where the only work is the displacement work, the internal energy U, Helmholtz function F , Gibbs function G and temperature T are related as follows

$$U = F - T\left(\frac{\partial F}{\partial T}\right)_V$$

$$G = F - V\left(\frac{\partial F}{\partial V}\right)_T$$

Which are known as the Gibbs-Helmholtz equations (10 marks)

QUESTION FOUR (20 Marks)

a. A mass of ideal gas at 15^0 C occupies $400cm^3$. If its temperature falls to $0^{o}C$ when it expands adiabatically, what is the new volume if γ=1.4? (7 marks)

If it is then compressed isothermally until its pressure returns to the original value, calculate the final volume. (7 marks)

b. Calculate molar specific heats c_p and c_v of oxygen given that the γ =1.4 and density at S.T.P is $1.43kgm^{-3}$

(6 marks)

QUESTION FIVE (20 Marks)

a. Given that entropy is a function of temperature and pressure only, that is S=S(T,P), use appropriate Maxwell's relation to show that (10 Marks)

$$TdS = C_P dT - T\left(\frac{\partial V}{\partial T}\right)_P dP$$

b. Show that during a reversible isothermal expansion of an ideal gas from 1to V2 there is a corresponding change of entropy given by (10 Marks)

$$\Delta S = \int \left(\frac{\partial P}{\partial T}\right)_V dV$$