UNIVERSITY OF NAIROBI

THIRD YEAR EXAMINATIONS FOR THE DEGREE OF BACHELOR OF EDUCATION

SCIENCE BY DISTANCE LEARNING

FIRST SEMESTER EXAMINATIONS 2012/2013

SPH 302: THERMODYNAMICS

Date: **Time: 1 1/2 Hours**

- **This paper consists of five (5) Questions**
- **Attempt any THREE Questions**

Constants

Gas constant R = 8.31 JK^{-1} mol^{-1}

Atmospheric Pressure = 1.01×10^5 NM^{-2}

Question 1

(a) Differentiate between the following terminologies in thermodynamics
   (i) Adiabatic and diathermal wall
   (ii) State variable and state function
   (iii) Extensive and intensive variables
   (iv) Heat and work **[8 marks]**

(b) Explain the Zeroth Law of thermodynamics and state its physical significance. **[4 marks]**

(c) Starting from the same initial point, show the following processes both on a **P-V** and **T-S** diagrams for an ideal gas
   (i) PV = constant (ii) PV^{γ} = constant
   (iii) P = constant, and (iv) V = constant. **[8 marks]**

Question 2

(a) (i) State in formulation the first law of thermodynamics giving its physical significance and its limitations.
   (ii) Differentiate between isothermal and adiabatic processes. **[8 marks]**

(b) An ideal monatomic gas expands reversibly from state V_1, P_1 to a volume V_2. Derive expression for work done by the gas if the change takes place
   (i) Isothermally (ii) adiabatically **[8 marks]**

(c) Explain the following
   (i) Air escaping from an air hose at a gas station always feels cold.
   (ii) The specific heat at constant pressure, C_P, is always greater than the specific heat at constant volume C_V. **[4 marks]**

Question 3

(a) State the mandates of the 2^{ND} Law of thermodynamics and explain the physical significance of the 2^{ND} law of thermodynamics. **[6 marks]**

(b) (i) Explain **Entropy** and state its significance

(ii) A hypothetical device takes 1000 J of heat from a hot reservoir at 300 K, ejects 200 J of heat to a cold reservoir at 100K, and produces 800 J of work. Does the device violate the 2^{ND} Law? **[8 marks]**

(c) A carnot cycle operates between 200 ^{o}C and 1200 ^{o}C. Calculate its thermal efficiency if it operates as a heat engine and its coefficiency of performance if it operates as

(i) Refrigerator (ii) Heat pump **[6 marks]**

Question 4

(a) Explain the following terms

(i) A phase

(ii) Component

(iii) Complete Thermodynamic equilibrium **[5 marks]**

(b) The Clausius-Clapeyron equation for the slope of a phase boundary is given by

$$\frac{dP}{dT} = \frac{L}{TdV}$$ where symbols have their usual meanings.

(i) Sketch the P-T projections for a substance which expands on melting and one which contracts on melting giving examples of such substances

(ii) Explain the effect of pressure on the melting point of ice.

(iii) Explain why it is advisable to cover cooking pots when boiling food

(iv) Will an egg boil faster on top of Mt. Kenya or at the coast. **[10 marks]**

(c) Explain the 3^{RD} law of thermodynamics and list at least TWO consequences of the 3^{RD} Law. **[5 marks]**

Question 5

(a) State the "**Engine**" and the "**Refrigerator**" Statements of the 2^{ND} Law and give an example of a perpetual machine of the second kind. **[5 marks]**

(b) Explain the following

(i) Carnot engine

(ii) why efficiency of real engines is always less than that of Carnot engine

(iii) Hybrid engine giving its advantages over conventional engines **[10 marks]**

(c) An inventor claims to have developed an engine which takes in 11×10^7 J at 400K, rejects 5×10^7 J at 200K and delivers 16.67 kW hours of work. Would you advice investing money in this project? Explain **[5 marks]**