UNIVERSITY OF NAIROBI

THIRD YEAR EXAMINATIONS FOR THE DEGREE OF BACHELOR OF EDUCATION SCIENCE BY DISTANCE LEARNING 2013/2014

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) State the 2^{ND} Law in terms of Entropy and explain the physical significance of the 2^{ND} law of thermodynamics. **[6 marks]**

(b) A hypothetical refrigerator takes 1000 J of heat from a cold reservoir at 100K and ejects 1200 J of heat to a hot reservoir at 300K.

(i) Determine work done by the refrigerator

(ii) What happens to the entropy of the universe?

(iii) Does this system violate the 2^{nd} Law of thermodynamics? **[8 marks]**

(c) A carnot cycle operates between 200 ^oC and 1200 ^oC. Calculate its thermal efficiency if it operates as a heat engine and its coefficiency of performance if it operates as refrigerator **[6 marks]**

Question 2

(a) Differentiate between the following terminologies in thermodynamics

(i) State variable and state function

(ii) Closed and open system

(iii) Reversible and irreversible processes

(iv) Heat and work **[8 marks]**

(b) 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]**

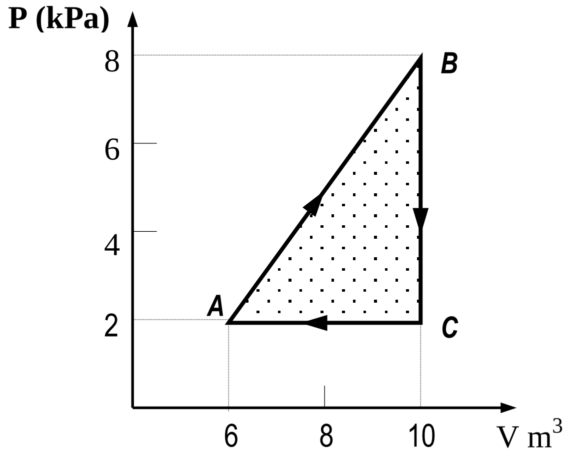
(b) Explain the Zero law of Thermodynamics stating its significance **[4 marks]**

Question 3

(a) State first law of thermodynamics giving its physical significance and its limitations. **[6 marks]**

(b) An ideal monoatomic gas ($\gamma = 5/3$) expands reversibly from a state V_1, P_1 to a volume V_2. Calculate the work done by the gas if the change takes place
   (i) isothermally
   (ii) adiabatically **[8 marks]**

(c) An ideal gas is taken through the cyclic process ABCA as shown in the figure below. Determine
   (i) The net heat transferred to the system in one cycle
   (ii) The net heat input for the reversed cycle ACBA. **[6 marks]**



Question 4

(a) Explain the following
   (i) the effect of pressure on the melting point of ice and boiling point of water.
   (ii) Why it is advisable to cover cooking pots when boiling food **[6 marks]**

(b) (i) Explain Entropy and principle of increasing entropy
   (i) A solid at low temperature has its specific heat capacity given by

   $C = aT + BT^3$ where a and b are constants. Determine the entropy of the solid as a function of temperature if the entropy is zero at T = 0. **[10 marks]**

(c) Which gives the greater increase in the efficiency of a carnot engine: Increasing the temperature of the hot reservoir or lowering the temperature of the cold reservoir by the same amount? **[6 marks]**

Question 5

(a) Explain the difference between the following devices
   (i) Heat engine and refrigerator
   (i) Carnot engine and real engine **[9 marks]**

(b) 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]**

(b) Explain the third law of thermodynamics and show that the following material parameters vanish as a consequence of the 3^{RD} law of Thermodynamics
   (ii) heat capacity, Cv (ii) Volume expansivity, β **[6 marks]**
