MACHAKOS UNIVERSITY COLLEGE

(A Constituent College of Kenyatta University)
University Examinations for 2015/2016 Academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

SECOND SEMESTER EXAMINATION FOR THE DEGREE OF
BACHELOR OF EDUCATION (SCIENCE)
BACHELOR OF SCIENCE
SPH 203: THERMAL PHYSICS 1

DATE: 10/8/2016 **TIME: 8.30 – 10.30 AM**

INSTRUCTIONS:

Answer question **ONE** which is compulsory and any other **TWO**

The following constants may be useful,

n is number of moles, Universal gas constant R = 8.31J/mol.K, specific heat capacity of gold and water is 129 J/kg. °C and 4186 J/kg. °C respectively, Latent heat of fusion of ice 3.33×10^5 J/kg, specific heat capacity of argon c_p = 20.5 and c_v= 12.5, 1 atm = 1.01×10^5 N/m^2. Coefficient of linear expansion of copper is $17 \times 10^{-6}(°C)^{-1}$, for steel is $11 \times 10^{-6}(°C)^{-1}$, for aluminum $24 \times 10^{-6}(°C)^{-1}$

QUESTION ONE.

a) Some water trapped in a volcano undergoes heating and blows off the volcano in a big explosion, give an explanation why this happens. (1 mark)

b) The lowest temperature -273.15 cannot be measured directly. Explain how it can be inferred with aid of well labeled diagram. (4 marks)

c) A man is seated on a 10 ℃ concrete floor in a police cell, insulation provided by his clothing is 0.5 cm thick with a coefficient of thermal conductivity of 0.09 J/s.m. ℃ and the area of contact is 0.10 m^2. If his body temperature is 37 ℃, compute his rate of heat loss. (4 marks)

d) A person with a skin temperature of 33 ℃ is in a room at 24 ℃. What is the net rate of heat transfer by radiation? (take emissivity as e = 0.95) (4 marks)

e) 3 moles of Hydrogen gas initially at 10 ℃ and at 1.00 atmexpands to twice its initial volume isothermally in one case and adiabatically in another. Calculate the work done during the

- i) Isothermal process (5 marks)
- ii) Adiabatic process (5 marks)

f) A fluorescent tube of cross sectional area 10 cm^2 and length 100 m contains argon gas at 20 ℃. It is being heated at a rate of 50 J/s from 7.00 pm to 10 pm at constant atmospheric pressure. (assume the process is adiabatic)

- i) Find total heat energy absorbed by the gas (2 marks)
- ii) Determine the number of moles of argon gas in the tube (2 marks)
- iii) Find the temperature rise? (3 marks)

QUESTION TWO.

A cylinder with a movable piston contains 0.016 mole of helium. A researcher expands the gas via the process illustrated in figure 1.

a) To achieve this, does she need to heat the gas or cool it? (2 marks)

b) From the graph read the initial and final volume of the gas in SI units (4 marks)

c) Using ideal gas law find initial and final temperature of the gas in kelvin (K) (4 marks)

d) Compute change in internal energy (ΔU) given that $\Delta U = \frac{3}{2} nR\Delta T$ (3 marks)

e) From the graph estimate work done by the gas? (4 marks)

f) How much heat energy must be added or removed? (3 marks)

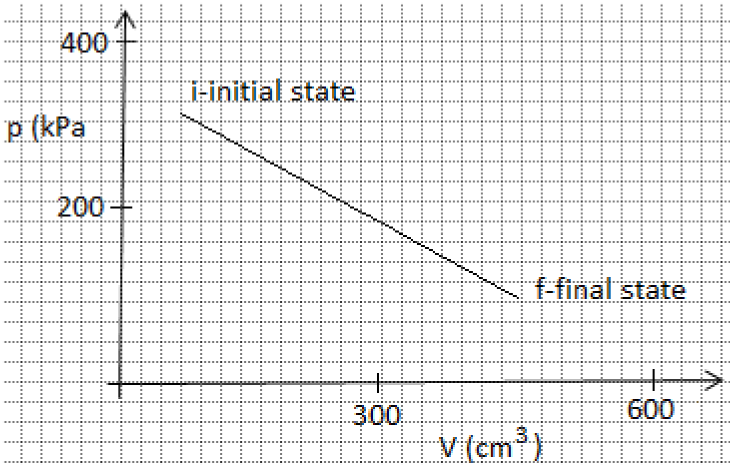

Figure 1

QUESTION THREE

a) Explain the changes that water undergoes while changing the phase from solid to liquid at 0 ℃ (2 marks)

b) Show that thermal coefficient of volume (β) is thrice as large as the coefficient of linear expansion (α) (6 marks)

c) Temperature of water in Lake Naivasha changes from 12 ℃ to 16 ℃ given that the thermal coefficient of volume for water is β =2.07 X 10^{-4}(℃)$^{-1}$ and coefficient of linear expansion (α)

   i) Estimate the fractional change in volume of water in lake Naivasha, (6 marks)

   ii) If initial depth of the Lake is 4.0 X 10^3m, find the change in depth. (6 marks)

QUESTION FOUR

a) A plate with a circular hole (Figure 2) on the center is heated. What happens to the hole, does it become larger or smaller. (2 marks)

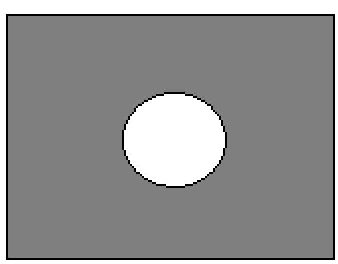

Figure 2

b) A squared metallic plate of side L is heated from initial temperature T_i to a final temperature T_f, If the new dimension of its side is L_f, derive an equation for its fractional change in area. (8 marks)

c) A steel ring with a hole having area of 3.99 cm^2 is to be placed on an aluminum rod with cross sectional area of 4 cm^2. Both ring and rod are initially at a temperature of 35 ℃. At what common temperature can the steel ring be slipped onto one end of the aluminum rod? (8 marks)

QUESTION FIVE

a) What mass of water at 25 ℃ must be allowed to come to thermal equilibrium with a 3 kg gold bar at 100 ℃ in order to lower the temperature of the bar to 50 ℃? (10 marks)

b) A 100 g cube of ice at 0 ℃ is dropped into 1.0 kg of water that was originally at 80 ℃. What is the final temperature of the water after the ice has melted? (10 marks)