CHUKA UNIVERSITY

UNIVERSITY EXAMINATIONS

EXAMINATION FOR THE AWARD OF DEGREE OF BACHELOR OF EDUCATION (SCIENCE) , BACHELOR OF SCIENCE

PHYS 161: HEAT AND THERMODYNAMICS

STREAMS:BED(SCI),BSC **TIME: 2 HOURS**

DAY/DATE: MONDAY 4/12/2017 **11.30 A.M – 1.30 P.M**

INSTRUCTIONS:

- **Answer question one in section A and any other two questions in section B**
- **Do not write on the question paper**
- **This is a closed book exam, no reference materials are allowed in the examination room**
- **There will be no use of mobile phones or any other unauthorized materials**
- **Write your answers legibly and use your time wisely**

Useful constants

Universal gas constant R = 8.31 $JK^{-1}mol^{-1}$

SECTION A

1. Differentiate between the following pairs of terms

   (i) Temperature and heat [2marks]

   (ii) Heat capacity and specific heat capacity. [2marks]

   (iii) Heat engine and reservoir . [2marks]

   (iv) Heat of fusion and specific heat transfer. [2marks]

   (b) Explain the three methods of heat transfer. [6marks]

(c) State the three law of thermodynamics. [3marks]

(d) Explain any four thermodynamic processes. [4marks]

(e) A gas at a pressure of 2.22 x 10^5 pa occupies a volume of 0.116 m^3at a temperature of 284K. If the gas is ideal, how many models are present? [2marks]

(f) Convert the following temperature units into the units indicated in brackets.

(i) 37°C (K) [1mark]

(ii) 212°F (K) [1mark]

(iii) 98° (K) [1mark]

(g) Two moles of a gas are in a container whose volume can be adjusted with a movable piston. When the volume is 3.2 L, the temperature is 25° . With constant pressure maintained, heat is added to the gas and the piston is allowed to move until the volume is 5.1L find the final temperature. [4marks]

2. (a) In each of the following thermometers, what is the thermometric property used to measure temperature?

(i) Mercury –in –glass thermometer [1mark]

(ii) Thermistor thermometer [1mark]

(iii) Constant volume gas thermometer [1mark]

(iv) Thermocouple thermometer [1mark]

(b) Consider a system with a temperature dependent property X such that the temperature θ is a linear function of X given by the function, X(θ) = aX where a is a constant to be determined . Show that the Celsius scale can be determined by this system where,

$\theta \frac{(x-x_{fp}}{(X_{bp}-X_{fp}\ )}$ x 100° C and all the symbols have their usual meanings. [9marks]

(c) Celsius temperature on a scale determined by a platinum resistance thermometer is called platinum temperature, where R_i, R_s and R are the resistances of the thermometer at the ice point, the steam (boiling) point, and the platinum temperature θ. The resistance of a certain thermometer is 10 Ω at the freezing (ice) point 13.861 Ω at the boiling point, and 26.27 Ω at the boiling point of sulfur.

(i) Find the temperature at the boiling point of sulfur. [3marks]

(ii) If the platinum temperature has a value of 284.9° C, determine the resistance at this temperature as determined by this thermometer. [4marks]

3. (a) A gas undergoes a series of pressure and volume changes as shown below,

Where P_f and P_i ios 2 x 10^5 and 10^5 pa respectively while V_i and V_f is m^3 and 4 m^3 respectively.

(i) Identify the thermodynamic processes labeled A,B,C and D 4marks]

(ii) How much work is done by the gas along the path abc. [3marks]

(iii) How much work is done along the path cda? [3marks]

(iv) How much heat enters the gas during the full cycle? [2marks]

(b) Paraffin and water are both liquids. Its requires different amount of heat to rise the temperature of 1kg of paraffin from 10°C to 20°C as required by 1 kg of water to raise the same temperature change. Explain? [2marks]

(c) At what temperature is the Fahrenheit scale reading equal to ;

(i) The reading on the Celsius scale. [3marks]

(ii) Half that of the Celsius scale. [2marks]

4. (a) One mole of monoatomic ideal gas is brought through a cycle A to B to C to D to A as shown in the diagram. All processes are performed slowly. Respond to the following in terms of p_0, V_0 and R.

(i) find the temperature at each vertex. [2marks]

(ii) Find the heat added to the gas for the process A to B. [2marks]

(iii) Find the work done on the gas for the process C and D. [2marks]

(iv)Find the heat added to the gas for the process D to A. [2marks]

(v)Find the change in internal energy for the process B to C. [2marks]

(b) 25g of -10° C ice is to be converted into 150°C steam (use: heat of fusion of water = 334 j/g, latent heat of vaporization of water = 2257 J/g, specific heat capacity of ice = 2.09 J/g/°$C, specific$ heat capacity of water = 4.2 J/g/°C, specific heat capcity of steam = 2.09 J/g/°C. Determine the heat required to convert the 25g of -10° ice into 150°C steam in joules. [5marks]

(c) 4.0 moles of argon gas is contained in a cylinder at 300k. How much heat must be added to the gas to raise its temperature to 600K at:

(i) Constant volume [3marks]

(ii) Constant pressure [2marks]

5. (a) It was unanimously passed by the MCAs of matonguine county that each member to have a modern office in which one of the walls have to be designed t have a permanent wondow made of glass of thickness 0.64 cm and measures 5m x 4.5m. During the cold season temperatures outside are -10°C. The inside is kept warm by electrical heating and maintained at 20°C

(i) How much heat is lost per hour through the glass? Use thermal conductivity if glass, k = 0.8 J$s^{-1}m^{-1}C^{-1}$. [5marks]

(ii) How much electrical power in W is used to maintain the temperature at $20°C$?
[5marks]

(b) The outer zone of the sun called photosphere is at a temperature 5.8 x 10^3K. Assuming the sun to be spherical body having a radius R = 700 x 10^6 km. Using Stefan law of radiation, calculate the total poer radiated by the sun (ε =1 and σ =5.671 x 10^{-8}) .
[5marks]

(c) A gas is heated and allowed to expand so that it does 1.01 x 10^5J of work. If 3 x 10^5J of heat eneters the system during expansion, what is the change in internal enetgy of the gas? [5marks]
