JARAMOGI OGINGA ODINGA UNIVERSITY OF SCIENCE AND TECHNOLOGY

SCHOOL OF ENGINEERING AND TECHNOLOGY

UNIVERSITY EXAMINATIONS FOR THE DEGREE IN SCIENCE IN RENEWABLE ENERGY TECHNOLOGY AND MANAGMENT

FIRST YEAR RESIT EXAMINATIONS 2020/21 ACADEMIC YEAR

CENTRE: MAIN CAMPUS

COURSE CODE: SPH 3122

COURSE TITLE: HEAT AND THERMODYNAMICS

EXAM VENUE: **STREAM: BSc REN TECH & MGT**

DATE: ../12/2020 EXAM **SESSION:**

DURATION: 2 HOURS

Instructions

1. **Answer question 1 (Compulsory) and ANY other two questions**
2. **Candidates are advised not to write on question paper**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room**

QUESTION ONE

a) Explain intensive and extensive variables giving examples of each (4 marks)

b) A temperature is given of an object is given as 18 °C. Express it in °F, K, and R. (6 marks)

c) The roof of an electrically heated home is 6 m long, 8 m wide, and 0.25 m thick, and is made of a flat layer of concrete whose thermal conductivity is k =0.8 W/m · °C. The temperatures of the inner and the outer surfaces of the roof one night are measured to be 15°C and 4°C, respectively. Determine the rate of heat loss through the roof that night. (4 marks)

d) The vapour pressure of water is 1.00 atm at 373 K, and the enthalpy of vaporization is 40.7 kJ/mol. Estimate the vapour pressure at temperature 363 K. (4 marks)

e) Jogging along the beach one day, you do 4.3 X 10^5 J of work and give off 3.8 X10^5 J of heat. What is the change in your internal energy???switching over to walking,you give off 1.2 X 10^5 J of heat and your internal energy decreases by 2.6 X 10^5J.How much work have you done while walking?? (4marks)

f) Determine using steam tables, the volume occupied by 2kg of steam at 5 bar under the following conditions (8 marks)

i. Pure liquid state
ii. When it is in a pure vapour state
iii. 20 % moisture content
iv. 20 % dry

QUESTION TWO

a) Explain the three main methods through which heat is transferred (6 marks)

b) In a certain experiment to determine the thermal conductivity of a sample, cylindrical samples of diameter 5 cm and length 10cm are used. The two thermocouples in each sample are placed 3 cm apart. After initial transients, the electric heater is observed to draw 0.4 A at 110 V, and both differential thermometers read a temperature difference of 15°C. Determine the thermal conductivity of the sample. (7 marks)

c) Consider a person standing in a breezy room at 20°C. Determine the total rate of heat transfer from this person if the exposed surface area and the average outer surface temperature of the person are 1.6 m^2 and 29°C, respectively, and the convection heat transfer coefficient is 6 W/m2 · K (The emissivity of a person is 0.95) (7 marks)

QUESTION THREE

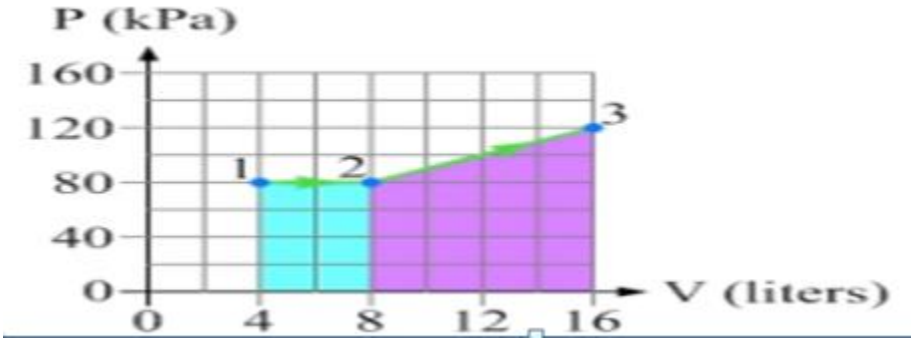
a) Show that the work done during an isothermal reversible change is given by 2.303 nRT log Vf/Vi (6marks)

b) 2 litres of an ideal gas at a pressure of 10 atm expand isothermally into a vacuum until the total volume is 10 litres .How much work is done in the process?? (1 Mark)

c) Consider the same expansion but this time against a constant external pressure of 1atm (2marks)

d) Consider the same expansion to a final volume of 10 litres conducted reversibly with an external pressure of 1atm (hint=Pv=nRT) (5 marks)

e) The p-v diagram shows an expansion from state 1 to 2 at constant pressure followed by another expansion that takes the system to state 3 along the path indicated. calculate the total work done from state 1 to 3 (6 marks)



QUESTION FOUR

a) State Zeroth law, the first and second law of thermodynamics (6marks)

b) State Clausius and Kelvin Statements of the second law (4marks)

c) A fluid at a pressure of 3 bar, and with specific volume (v) of 0.18 m3/kg, contained in a cylinder behind a piston exapands reversibly to a pressure of 0.6 bar according to a law, $p = C/v^2$ where C is a constant. Calculate the work done by the fluid on the piston (6 marks)

d) Heat is transferred to a heat engine from a furnace at a rate of 80 MW. If the rate of waste heat rejection to a nearby river is 50 MW, determine the net power output and the thermal efficiency for this heat engine. (4marks)

QUESTION FIVE

a) Differentiate between reversible and irreversible processes (2 marks)

b) A Carnot cycle operates between source and sink temperatures of 250°C and – 15°C. If the system receives 90 kJ from the source, find the efficiency of the system, the net work transfer and the heat rejected to sink. (6marks)

c) A heat engine receives heat at the rate of 1500 kJ/min and gives an output of 8.2 kW. Determine the thermal efficiency and the rate of heat rejection. (4 marks)

d) What is the highest possible theoretical efficiency of a heat engine operating with a hot reservoir of furnace gases at 2100°C when the cooling water available is at 15°C (2 marks)

e) The temperature inside the engine of a helicopter is 2000^0C and the temperature of the exhaust is 900^0C. The mass of the helicopter is M=2000kg,the heat of combustion of gasoline is Q=47000KJ/kg and the density of gasoline is p=0.8 kg/litre.What is the maximum height that the helicopter can reach by burning 1 litre of gasoline??? (6marks)