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: ../11/2020 EXAM **SESSION:**

DURATION: 2 HOURS

Instructions

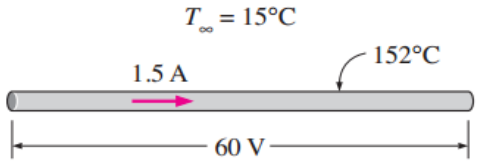
1. **Answer question 1 (Compulsory) and ANY other two questions**
2. **Candidates are advised not to write on question paper**
3. **Candidates must hand in their answer booklets to the invigilator while in the examination room**

QUESTION ONE **(30 marks)**

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

b) A temperature is given of an object as 300 K. Express it in °F and °C. **(4 marks)**

c) A 2-m-long, 0.3-cm-diameter electrical wire extends across a room at 15°C, as shown in the figure below. Heat is generated in the wire as a result of resistance heating, and the surface temperature of the wire is measured to be 152°C in steady operation. Also, the voltage drop and electric current through the wire are measured to be 60 V and 1.5 A, respectively. Disregarding any heat transfer by radiation, determine the convection heat transfer coefficient for heat transfer between the outer surface of the wire and the air in the room. **(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) What is vapour pressure? **(2 marks)**

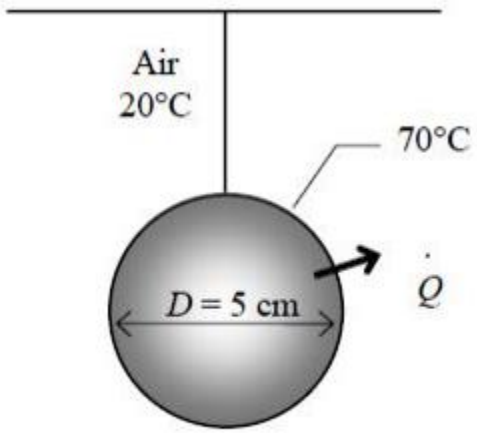
g) Determine using steam tables, the volume occupied by 2kg of steam at 5 bar under the following conditions **(8 marks)**

I. Pure liquid state
II. When it is in a pure vapour state
III. 20 % moisture content
IV. 20 % dry

QUESTION TWO **(20 marks)**

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

b) Spherical ball whose surface is maintained at a temperature of 70°C is suspended in the middle of a room at 20°C. The total rate of heat transfer from the ball is to be determined. The emissivity of the ball surface is given to be ε = 0.8 and the convection heat transfer coefficient is 15 W/m2.°C. **(7 marks)**



c) Consider a person standing in a room maintained at 22°C at all times. The inner surfaces of the walls, floors, and the ceiling of the house are observed to be at an average temperature of 10°C in winter and 25°C in summer. Determine the rate of radiation heat transfer between this person and the surrounding surfaces if the exposed surface area and the average outer surface temperature of the person are 1.4 m^2 and 30°C, respectively **(4 marks)**

d) The inner surface of a plane brick wall is at 60°C and the outer surface is at 35°C. Calculate the rate of heat transfer per m^2 of surface area of the wall, which is 220 mm thick. The thermal conductivity of the brick is 0.51 W/m°C **(3 marks)**

QUESTION THREE **(20 marks)**

a) Show that the work done during an isothermal irreversible change is given $q=P_{ex}\ (V_f-V_i)$ **(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) Determine the work done by the air which enters into an evacuated vessel from atmosphere when the valve is opened. The atmospheric pressure is 1.013 bar and 1.5 m^3 of air at atmospheric condition enters into the vessel.

(4 marks)

f) An engine that has an efficiency of 25% takes in 200 J of heat during each cycle. Calculate the amount of work this engine performs. **(2 marks)**

QUESTION FOUR (20 marks)

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 (20 marks)

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) Using a diagram explain the state-diagram for steam **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)