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UNIVERSITY EXAMINATIONS 2022/2023

THIRD YEAR, SECOND SEMESTER SPECIAL/SUPPLEMENTARY EXAMINATION FOR DEGREE OF BACHELOR OF SCIENCE IN MATHEMATICS AND PHYSICS AND BACHELOR OF EDUCATION SCIENCE

SPH 3302: THERMAL PHYSICS II

DATE: AUGUST 2023 **TIME: 2 HOURS**

INSTRUCTIONS: Answer Question ONE and any other TWO questions.

QUESTION ONE (30 MARKS)

a) Define extensive thermodynamic variables and give an example. (2 Marks)

b) Find the change in entropy if 500 g of water at 80^0C is added to 300 g of water at 20^0C. (5 Marks)

c) Define internal energy of a system. (2 Marks)

d) Aa refrigerator is placed in a room which is completely sealed except for a working electrical outlet. The refrigerator is plugged in, and the door of the refrigerator is opened. Does the temperature in the room increase, decrease or remain the same? Justify your answer. (3 Marks)

e) Discuss the physical meanings of: -

i. Heat capacity (2 Marks)

ii. Helmholtz free energy (2 Marks)

iii. Gibbs free energy (2 Marks)

f) Differentiate between a reversible and an irreversible process. (2 Marks)

g) A heat engine has efficiency of 0.25. If the temperature of the sink is 200K, determine of the source. (4 Marks)

h) Using a schematic describe the carnot cycle. (6 Marks)

QUESTION TWO (20 MARKS)

a) For an idea gas show that

i. Coefficient of volume expansion is a function of only temperature. (4 Marks)

ii. The isothermal compressibility is a function of only pressure. (8 Marks)

b) When two phases of a substance co-exist in equilibrium at constant temperature and pressure, their specific Gibbs free energies are equal. Using this fact, obtain Clausius Clapeyron equation. (8 Marks)

QUESTION THREE (20 MARKS)

a) Briefly discuss;

i. The physics behind the operation of a heat engine (7 Marks)

ii. The physics behind the operation of a refrigerator. (7 Marks)

b) A heat engine has a sink temperature of 350K and efficiency of 24% . It is intended to have efficiency of 40%. By what value should the temperature of the source be raised if the temperature of the source be raised if the temperature of the sink is maintained at 350k. (6 Marks)

QUESTION FOUR (20 MARKS)

a) Derive the Heelmholtz free energy maxwels relation for a thermodynamic system. (8 Marks)

b) Using the equation $\left(\frac{\partial S}{\partial V}\right)_T = \left(\frac{\partial P}{\partial T}\right)_V$ prove that work is done in expanding an idea gas at constant temperature. (10 Marks)