MACHAKOS UNIVERSITY

University Examinations 2019/2020 academic Year

SCHOOL OF PURE AND APPLIED SCIENCES

DEPARTMENT OF PHYSICAL SCIENCES

SECOND YEAR SPECIAL/SUPPLEMENTARY EXAMINATION FOR

BACHELOR OF EDUCATION (SCIENCE)

SCH 201: CHEMICAL THERMODYNAMICS

DATE: 22/1/2021 **TIME:**

INSTRUCTIONS:

1. Question number one is **compulsory**
2. Choose any other two questions.

Useful constants

R=8.314J/mol k or R=0.08206L.atm/mol k

$C_p=\frac{5}{2}R$ $C_v=\frac{3}{2}R$(monoatomic ideal gases)

$C_p=\frac{7}{2}R$ $C_v=\frac{5}{2}R$(Diatomic ideal gases)

STP(T=273.15K, 1atm=101325,V=22.415dm^3)

QUESTION ONE (30 MARKS)

a) State and give a mathematical expression for the first law of thermodynamics (3 marks)

b) Classify the following as open, closed or isolated system (3 marks)

i. A thermos flask

ii. The earth

iii. Living organisms

c) i) Using $Cv = \frac{dE}{dT}$ and $Cp = \frac{\delta q_p}{dT}$ show that for a perfect gas $C_p=C_v$ +R (3 marks)

ii) Explain why $Cp>C_v$ (3 marks)

d) Two Carnot engines operate with a temperature difference of 250K between their hot and cold reservoirs. If engine A's hot reservoir is maintained at 1000K, while that of engine B is maintained at 750K, determine the one which is more efficient engine. (3 marks)

e) Calculate the change in free energy when 11.21dm^3 of a perfect gas at 0^oC and 760mmHg pressure expands isothermally until its pressure is 190mmHg (3 marks)

f) A certain gas expands from 250mL to 750mL very slowly at 25^oC. If there is one mole of the gas in the chamber, calculate the work involved when the gas behaves ideally (3 marks)

g) Critical temperature of methane and carbon dioxide are -81.9^oC and 31.1^oC. which of these gases has stronger intermolecular forces and why (3 marks)

h) Determine the entropy of the following reaction using information below (3 marks)

Substance	**S^o($Jmol^{-1}K^{-1}$)**
$C_2H_{2(g)}$	200.82
$H_{2(g)}$	130.59
$C_2H_{4(g)}$	219.45

$C_2H_{2(g)}+H_{2(g)} \longrightarrow C_2H_{4(g)}$

i) State and give mathematical expression for the third law of thermodynamics (3 marks)

QUESTION TWO (20 MARKS)

a) i Provide an expression for work done by a gas as it expands by volume ΔV against an external pressure P_{ext} (3 marks)

ii Give an expression for the change in internal energy of the system as it expands by volume ΔV against an external pressure P_{ext} on absorbing q joules of heat (3 marks)

b) Calculate theΔS_{univ} when I mole of ice melts when placed in a room at 25^oC at 1atm, given ΔH^o_{fus}=6.03Kj/mol k and state if the melting is spontaneous or not (5 marks)

c) 3dm^3 of hydrogen gas initially at STP is expanded isothermally and reversibly to a volume of 4dm^3.Calculate the work donegiven that molar gas volume at STP=22.415dm^3 (5 marks)

d) Define the following terms (4 marks)

i. Enthalpy of a reaction

ii. Molar heat capacity

QUESTION THREE (20 MARKS)

a) State the physical concept of entropy and its variation with temperature (5 marks)

b) Sample of 1 mole of silver at 150^{o}C is placed in contact with 1mole of silver at 0^{o}C forming an isolated system at constant pressure. Calculate

i. The final temperature of both the silver samples (5 marks)

ii. ΔS for the hot silver (3 marks)

iii. ΔS for the cold silver (3 marks)

iv. The total ΔS of the system (2 marks)

c) Is the process above spontaneous (2 marks)

QUESTION FOUR (20 MARKS)

a) State the Hess's law (2 marks)

b) Calculate the enthalpy of the reaction, $C_2H_{4(g)}+H_{2(g)} \longrightarrow C_2H_{6(g)}$ at 298k using the information given below (6 marks)

$C_2H_{4(g)}+3O_{2(g)} \longrightarrow 2CO_{2(g)}+2H_2O_{(g)}$ ΔH=-1395kJ

$C_2H_{6(g)}+{}^{7}/_{2}O_{2(g)} \longrightarrow 2CO_{2(g)}+3H_2O_{(g)}$ ΔH=-1550kJ

$H_{2(g)}+{}^{1}/_{2}O_{2(g)} \longrightarrow H_2O_{(g)}$ ΔH=-243kJ

c) The volume of a sample of an ideal gas at 0^{o}C is 44.83litres. To what volume must the gas be compressed adiabatically to attain a temperature of 30^{o}C (6 marks)

d) A sample of gas changes in volume from 4L to 6L against an external pressure of 1.5atm and simultaneously absorbs 1000J of heat. Determine the change in the internal energy of the system (6 marks)

QUESTION FIVE (20 MARKS)

A 4L sample of hydrogen gas at 15atm and 25^{o}C is allowed to expand to a final pressure of 1atm. Calculate q,w, ΔU and ΔH if the gas expands

a) Isothermally and reversibly (10 marks)

b) Isothermally and irreversibly (10 marks)