UNIVERSITY OF EMBU

2016/2017 ACADEMIC YEAR

FIRST SEMESTER EXAMINATION

SECOND YEAR EXAMINATION FOR THE BACHELOR OF SCIENCE IN ANALYTICAL CHEMISTRY, BACHELOR OF SCIENCE IN INDUSTRIAL CHEMISTRY, BACHELOR OF EDUCATION (SCIENCE), BACHELOR OF SCIENCE IN BIOLOGY, BACHELOR OF SCIENCE IN CONSERVATION OF ECOSYSTEM & NATURAL RESOURCES, BACHELOR OF SCIENCE

SCH 203: THERMODYNAMICS I & THERMOCHEMISTRY

DATE: DECEMBER 5, 2016 **TIME: 2:00-4:00PM**

INSTRUCTIONS:

Answer Question ONE and ANY Other TWO Questions

QUESTION ONE (30 MARKS)

a) State the First law of thermodynamics (2 marks)

b) Define the following terms

i) Universe (2 marks)

ii) surrounding (2 marks)

iii) Internal energy (2 marks)

iv) State functions (2 marks)

c) The standard enthalpy of formation of gaseous Ammonia at 25 ^{0}C is -46.1Kjmol^{-1}. Estimate its value at 400K given the following thermochemical data of molar heat capacity at constant pressure (3 marks)

$$NH_3 = 29.75JK^{-1}mol^{-1}$$
$$H_2 = 27.28JK^{-1}mol^{-1}$$
$$N_2 = 28.58JK^{-1}mol^{-1}$$

d) State the Hess law (2 marks)

e) Calculate the total change in internal energy, ΔE, of a system when 400 J heat is applied to expand oxygen gas and the gas does 350 J of work on its surroundings. (3 marks)

f) Outline four properties of energy (2 marks)

g) Outline major limitation of the first law of thermodynamics (1 mark)

h) Identify the type of system in each of the following cases (3 marks)

i) A beaker covered with a lid

ii) A Closed thermos flask

iii) A beaker without lid.

i) When 1.0L of 1.0M $Ba(NO_3)_2$ solution at 25 ^{0}C is mixed with 1.0L of 1.0M Na_2SO_4 solution at 25 ^{0}C in a calorimeter, the white solid $BaSO_4$ forms and the temperature of the mixture increases to 28 ^{0}C. Assuming that the calorimeter absorbs only a negligible quantity of heat, that the specific heat capacity of the solution is 4.18J/^{0}C g and the density of the final solution is 1.0 g/mL. Calculate the enthalpy change per mole of $BaSO_4$ formed (3marks)

j) When 1 mole of methane is burned at constant pressure, 890KJ of energy is released as heat. Calculate ΔH for a process in which a 5.8g sample of methane is burned at constant pressure (3 marks)

QUESTION TWO (20 MARKS)

a) What is meant by the term calorimetry (2 marks)

b) Calculate the work, heat and change in internal energy involved in the expansion of 154g of carbon (IV) oxide gas from 20 litres to 40 litres in an isothermal process at 400K assuming the ideal gas behavior and given that R=8.314Jmol^{-1} K^{-1}

(6 marks)

c) Distinguish between

i) Adiabatic and Isothermal process (4 marks)

ii) Isochoric and isobaric process (4 marks)

iii) Heat and Energy (4marks)

QUESTION THREE (20 MARKS)

a) State the Zeroth Law (2 marks)

b) Explain five forms of energy (10 marks)

c) A sample of gas expands in volume from 4.0 litres to 8.0 litres at a constant temperature of 600 ^{0}C. Calculate the work in joules done by the gas if it expands

i) Against a vacuum and (4 marks)

ii) Against a constant external pressure of 2.4 bar (4 marks)

QUESTION FOUR (20MARKS)

a) Distinguish between

i) Reversible process and irreversible process (4 marks)

ii) Open and closed system (4 marks)

iii) Intensive and extensive properties (4 marks)

b) From the first law of thermodynamics, show that the heat capacity at constant volume, C_v and the heat capacity at constant pressure, C_p are related as

$$C_p = C_v + nR$$ (8 marks)

QUESTION FIVE (20 MARKS)

a) Show that the maximum work in isothermal expansion of a gas is given by

$$W = -nRT \ln\left(\frac{p_2}{p_1}\right)$$ (9 marks)

b) The standard enthalpy change for the reaction

$$2H_{2(g)} + O_{2(g)} \rightarrow 2H_2O_{(l)}$$

is $-571.6 kJmol^{-1}$ at $25\ ^0c$. Calculate the value of ΔH_{rxn} at $100\ ^0C$ assuming that all $\bar{C}_P^0$ values are independent of temperature given that; (6 marks)

Compound	$\bar{C}_P^0$ values ($Jmol^{-1}\ k^{-1}$)
O_2	29.4
H_2	38.2
H_2O	75.3

c) A 1.0 g sample of propane, C_3H_8, was burned in calorimeter. The temperature rose from $28.5\ ^0C$ to $32.0\ ^0C$ and heat of combustion 10.5 kJ/g. Calculate the heat capacity of the calorimeter apparatus in $kJ/^0C$ (2 marks)

d) What is the resulting temperature when 35.0 g of water at $75\ ^0C$ is mixed with 15.0 g of water at $10\ ^0C$? (Heat capacity (Cp) of water = 4.184 $J/g\ ^0C$) (3 marks)

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