SOUTH EASTERN KENYA UNIVERSITY
UNIVERSITY EXAMINATIONS 2016/2017

FIRST SEMESTER EXAMINATION FOR THE DEGREE OF BACHELOR SCIENCE IN (CHEMISTRY) AND BACHELOR OF EDUCATION (SCIENCE)

SCH 203: THERMODYNAMICS 1 AND THERMOCHEMISTRY

8TH DECEMBER, 2016 **TIME: 8.00-10.00 A.M**

INSTRUCTIONS TO CANDIDATES

(a) Answer question One and any other Two questions

(b) Question 1 carries 30 marks while the other questions carry 20 marks each

(c) Illustrate your answers with well label diagrams where applicable

Constants

R= 8.314 JK^{-1} mol^{-1} or 0.08314 $Lbarmol^{-1}k^{-1}$, 0.0821 $LatmK^{-1}mol^{-1}$

Question 1 (30 marks)

a). Define the terms:

i) isochoric process 4 marks

ii) isobaric process

b). Distinguish between reversible and irreversible work. 4 marks

c). Give an example of :

i) an adiabatic change

ii) Isochoric change 2 marks

d). Compare work of expansion of an ideal gas and van dar waals gas 5 marks

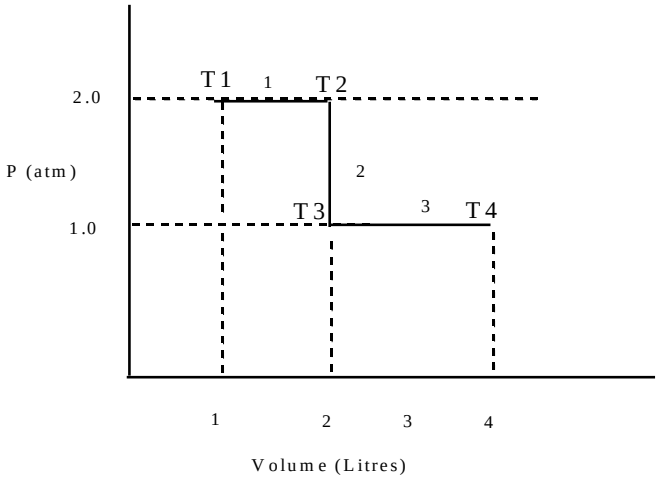
e). Show that $C_{p,m} = C_{v,m} + R$. 5 marks

f). Calculate w, q, Δu and ΔH for reversible isothermal compression of 0.5 mole of an ideal gas from 2.0 L to 1.0 L at 298 K. 5 marks

g). The enthalpy of vapourization (ΔH_v^{θ}) of a certain liquid is 32.0 kJ/mol. Calculate q, w, ΔH and Δu when 0.5 mol is vapourised at 260 K and pressure of 65 bar. 5 marks

Question 2 (20 marks)

a) 0. 1mole of gas undergoes an irreversible expansion along the path shown below.
q, w and Δu**.** 20marks



Calculate:

i) T1, T2 ,T3 and T4 8 marks

ii) w_{step1}, w_{step2} and w_{step3} 6 marks

iii) q_{step1}, q_{step2} and q_{step3} 6 marks

Question 3 (20 marks)

a) The combustion of benzene is given by the following equation.

$C_6H_{6\,(L)} + 15/2O_{2(g)} \rightarrow 6CO_{2(g)} + 3H_2O_{(L)}$ $\Delta H_c^{\theta} = -3267.4$ Kj/mol

Given that:

$\Delta H_f^{\theta}\, CO_{2\,(g)} = -393.3$ kJ/ mol

$\Delta H_f^{\theta}\, H_2O_{(L)} = -285.8$ kJ/ mol

$\Delta H_v^{\theta}\ H_2O_{(g)}$ =-241.8 kJ/mol

b) Calculate the:

i) heat of formation of benzene. 5 marks

ii) Standard enthalpy of reaction (ΔH_r^{θ}) of ;

$12CO_{2\ (g)} + 6H_20_{\ (L)} \rightarrow 2C_2H_{6\ (L)} + 15\ O_{2(g)}$ 2 marks

iii) ΔH_r^{θ} for the reaction below if ΔH_v^{θ} for benzene at 25 ^oC is +33.6 Kj/mol 6 marks

$C_6H_{6(g)} + 15/2O_{2(g)} \rightarrow 6CO_{2(g)} + 3H_2O_{(g)}$

b) Compare isothermal expansion and adiabatic expansion. 7 marks

Question 4 (20 marks)

a).Calculate the final temperature of one mole of a gas at 200.0 atm and 19.0 ^oC as it is forced through a porous plug to final pressure of 0.95 atm. The joule-Thomson coefficient of the gas is 0.0150 K/ atm 8 marks

b). The dependence of the molar constant pressure heat capacity of a real gas can be represented by the function

$$C_{p,m}=\alpha + \beta t + \gamma T^2$$

For nitrogen gas the constants α=26.984Jmol^{-1}K^{-1}, β=5.91×10^{-3} Jmol^{-1}K^{-2} and γ=-3.377×10^{-7} J mol^{-1}K^{-3}. Determine the amount of heat required to raise the temperature of one mole of nitrogen gas from 300 K to 1000k at constant pressure.

8 marks

c). The internal energy (u) of one mole of monoatomic perfect gas is 3/2 RT. Calculate ΔH of the gas when the temperature of the gas rises from 300 K to 400 K. 4 marks

Question 5 (20 marks)

a) Assuming that CO_2 is a perfect gas. Calculate ΔH^{θ} , w and Δu for one mole of the gas undergoing a reversible process.

10 marks

$CO_{2(g)}$ (298 K, I bar)$\rightarrow$ $CO_{2(g)}$ (1000 K, 1 bar)

Take $C_{p,m}$ = 26.648 + 42.262 × 10^{-3} T-142.4 × 10^{-7} T^2 (units are JK^{-1}mol^{-1})

b) i)The reaction below represents the decomposition of hydrogen peroxide and the corresponding bond energies.

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

Bond	Bond energy (kJ/mol)
O=O	498
O—O	146

H─O	464

Calculate the energy change for the reaction and state whether the reaction is exothermic or endothermic. 5 marks

ii) Using the following data below calculate the bond energy of C=O if the heat of combustion of propene is -1752 kJ/mol. 5 marks

Bond	Bond energy (kJ/mol)
C=C	612
C─C	348
O=O	496
O─H	463
C─H	412