NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCES

DEPARTMENT OF APPLIED CHEMISTRY

PHYSICAL CHEMISTRY 1

SCH2104

Supplementary Examination Paper

August 2015

This examination paper consists of 4 pages

Time Allowed: 3 hours

Total Marks: 100

Examiner's Name: Dr. Stephen Majoni

Useful information: $R = 8.314 JK^{-1} mol^{-1}$; 1 atm = 101 325 Pa; 1 $bar = 1\times10^{5} Pa$

INSTRUCTIONS

1. Answer ALL questions in section A and any three (3) questions in section B
2. Each question in section A carries 10 marks and in section B carries 20 marks

MARK ALLOCATION

QUESTION	MARKS
A1.	**10**
A2.	**10**
A3.	**10**
A4.	**10**
B1	**20**
B2	**20**
B3	**20**
B4	**20**
TOTAL	**100**

SECTION A

1. (a) Calculate the ionic strength in a solution that is 0.0750 *m* in K_2SO_4, 0.0085 m in Na_3PO_4, and 0.0150 m in $MgCl_2$. [5 marks]

   (b) Using the Debye-Hückel limiting law given below, calculate the mean ionic activity coefficient in a 0.00225 m solution of $CaHPO_4$.

   $$\log \lambda_{\pm} = -0.5092 \left| z_+ z_- \right| \sqrt{I}$$ [5 marks]

2. Explain the following predicted signs of entropy change for the following transformations.

   a) $O_2\,(g) \rightarrow 2\,O\,(g)$ positive
   b) $N_2\,(g) + 3\,H_2(g) \rightarrow 2\,NH_3(g)$ negative
   c) $C(s) + H_2O(g) \rightarrow CO(g) + H_2(g)$ positive
   d) $Br_2(l) \rightarrow Br_2(g)$ positive
   e) $N_2(g, 10\ atm) \rightarrow N_2(g, 1\ atm)$ negative [10 marks]

3. Calculate ΔH_{tot} and ΔS_{tot} when 2 iron blocks, each of mass 1.00 kg, one at 200 ^oC and the other at 25^oC, are placed in contact in an isolated container. The specific heat capacity of iron is 0.449 $JK^{-1}\ g^{-1}$ and may be assumed constant over the temperature range involved. [10 marks]

4. (a) Using indicator diagrammmes, compare and contrast work done during reversible and non-reversible expansion. [6 marks]

   (b) Draw a fully labelled phase diagram of water. [4 marks]

SECTION B

1. Draw a well labelled Carnot cycle, and from the cycle show that entropy is a state function. [20 marks]

2. (a) Making use of diagrammes discuss the difference between adiabatic and isothermal change. [8 marks]

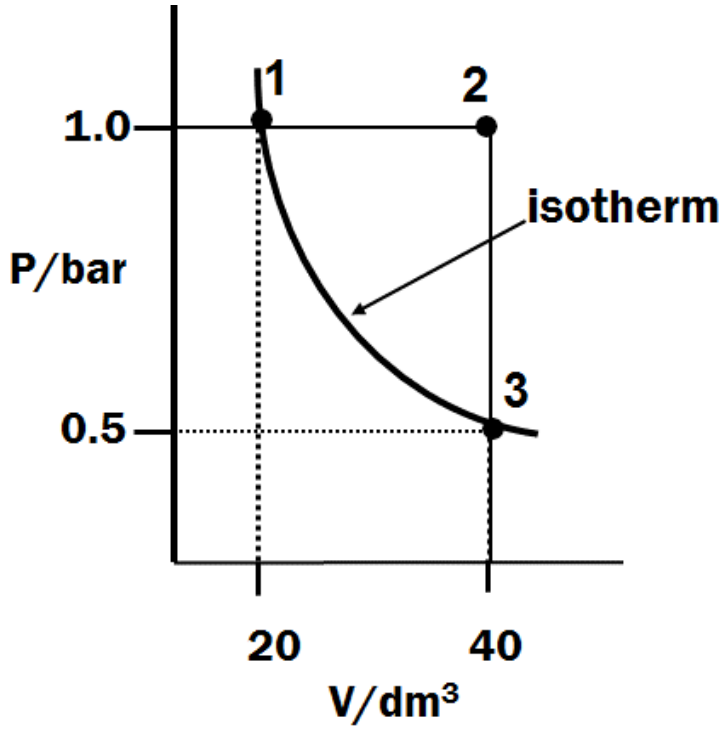
   (b) Discuss how the Carnot cycle represents the most efficient engine. [12 marks]

3. (a) State Kelvin's and Clausius' statements of the Second Law of Thermodynamics.

   [4 marks]

   (b) For a Carnot heat engine show all the results of work and heat transfer for each stage, and derive the carnot efficiency in terms of temperature. [16 marks]

4. A sample consisting of 1 mol of perfect monatomic gas (for which $C_{v,m} = \frac{3}{2} R$) is taken through the process shown below.



(a) Determine the temperature at the points 1,2, and 3.

(b) Calculate q, w, ΔU, and ΔH for each step and for the overall cycle. If a numerical answer cannot be obtained from the information given, then write the answer as positive, negative, or zero as appropriate. [20 marks]

End of Question Paper!!!