



NATIONAL UNIVERSITY OF SCIENCE AND TECHNOLOGY

FACULTY OF APPLIED SCIENCES

DEPARTMENT OF APPLIED CHEMISTRY

PHYSICAL CHEMISTRY 1

SCH2104

Supplementary Examination Paper

July 2016

This examination paper consists of 3 pages

Time Allowed: 3 hours

Total Marks: 100

Examiner's Name: Dr. S. Majoni

Useful information: $R = 8.314 \text{ JK}^{-1} \text{ mol}^{-1}$; 1 atm = 101 325 Pa; 1 bar = 100000 Pa

INSTRUCTIONS

1. Answer ALL questions
2. Each question carries 25 marks

MARK ALLOCATION

QUESTION	MARKS
1.	25
2.	25
3.	25
4.	25
TOTAL	100

Copyright: National University of Science and Technology, 2016

1. The Haber process can be represented as; $\text{N}_2(\text{g}) + 3\text{H}_2(\text{g}) \rightleftharpoons 2\text{NH}_3(\text{g})$:
 - a) Discuss the information that can be obtained from the change in the Gibbs free energy of a system. [5 Marks]
 - b) Calculate ΔG° and K_p for the reaction at 700K, and at 298K; given that $\Delta H^\circ = -92.38 \text{ kJ}$ and $\Delta S^\circ = -198.3 \text{ J/K}$ [8 Marks]
 - c) Suppose the equilibrium constant at 700 K is 1.02×10^{-5} and the reaction mixture consists of 15% NH_3 , 21% N_2 , and 64% H_2 . Is the forward reaction spontaneous at a total pressure of 150 bar? At what total pressure is the reaction at equilibrium? [12 Marks]

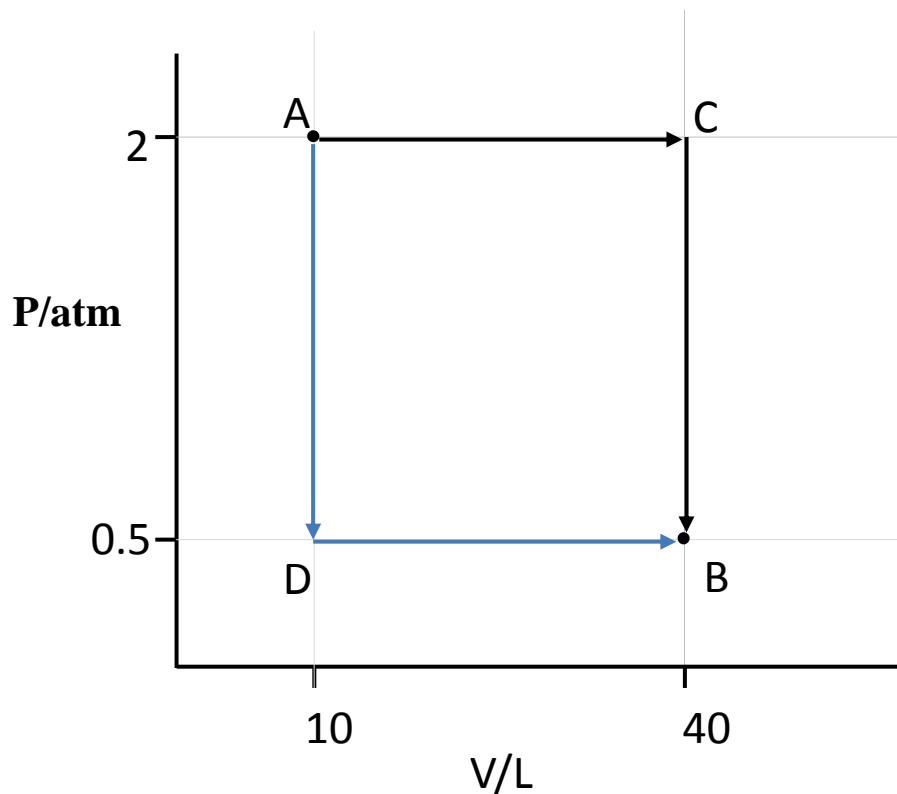
2.
 - a) What is a phase diagram, and what information can be obtained from it? [5 Marks]
 - b) Draw a well labelled phase diagram for CO_2 and hence explain why solid CO_2 is called dry ice. [10 marks]
 - c) If you are climbing Mount Kilimanjaro, explain how the time to cook a cup of rice is going to vary at each campsite as you go up the mountain. [6 Marks]
 - d) What can you do/use in the cooking process to prevent the effect in “c” above [4 Marks]

3. A system composed of an ideal gas was moved from state A to state B via two paths, path ACB and path ADB as shown in the diagram.

Given that $C_{p,m} = \frac{5}{2}R$ and $C_{v,m} = \frac{3}{2}R$

 - a) Is the transformation A to B isothermal? [4 Marks]
 - b) Calculate w , q , and ΔU for each path. What would be the values of the same parameters if the system had expanded reversibly? [17 Marks]

- c) Indicate on a diagram the total amount of work done if the system undergoes a cyclic process A – D – B – C –A. [4 Marks]



4. a) What is the thermodynamic definition of entropy? [2 Marks]
- b) Use the Carnot cycle to prove that entropy is a state function. [8 Marks]
- c) Name the four simple types of processes used in thermodynamic studies and for each type state the variable held constant. [8 Marks]
- d) At 353K, the vapour pressures of two liquids A and B which are completely miscible and form an ideal solution are 757 and 66 mmHg, respectively. For an equimolar mixture [$X_A = X_B = 0.5$] calculate the total vapour pressure and the mole fraction of A in the vapour phases. Assume that the mixture follows Raoult's Law. [7 Marks]

End of Question Paper!!!

Copyright: National University of Science and Technology, 2016