

AHSANULLAH UNIVERSITY OF SCIENCE AND TECHNOLOGY**Department of Arts and Sciences****Program: B.Sc. in Computer Science and Engineering****Semester Final Examination of Spring 2017****1st Year, 1st Semester****Course No.: Chem 1115; Course Title: Chemistry****Time: 3 (Three) hours****Full Marks: 70****Out of 7 (Seven) questions you have to answer any 5 (five).****Marks allotted are indicated in the margin.**

1. (a) Briefly discuss the Bohr's model of an atom. Show how it successfully explains 4 the spectra of hydrogen atom.
- (b) Derive an expression for the radius of the n^{th} orbit of a hydrogen atom and 4 hence calculate the energy of an electron in the first Bohr's orbit.
- (c) Find the wavelength of the line in Balmer series for the electron jump from the 4 5^{th} orbit. Calculate the energy associated with the electron transition. The value of Rydberg constant is 109676 cm^{-1} .
- (d) Explain why each of the following sets of quantum numbers would not be 2 permissible for an electron, according to the rules for quantum numbers.
- i) $n=1, l=0, m_l=0, m_s=+1$ ii) $n=1, l=3, m_l=+3, m_s=+\frac{1}{2}$
 iii) $n=3, l=2, m_l=+3, m_s=-\frac{1}{2}$ iv) $n=0, l=1, m_l=0, m_s=+\frac{1}{2}$
2. (a) Define Ionization potential. Why the second ionization potential of lithium is 3 very high compared with its first ionization potential?
- (b) Explain how electron affinity of elements varies in a period and a group of the 3 periodic table.
- (c) What are inert gases? Discuss some uses of inert gases. 3
- (d) Write the electronic configuration for the ground state of iridium ($Z = 77$). 3
 What are the group and period for this element and classify the element as *s*, *p*, *d* or *f*-block element.
- (e) Explain the atom of sodium is bigger than the atoms of both lithium and 2 magnesium.
3. (a) What are σ and π bonds? What are the differences between σ and π bonds? 3
- (b) State the basic ideas of VSEPR theory. Using VSEPR theory, predict the shape 4 of the molecules- PCl_3 , NH_4^+ , F_2O , $\text{CH}\equiv\text{CH}$, XeF_4 , SF_6
- (c) What is chemical bond? Briefly discuss two characteristics of ionic compounds. 3
- (d) Draw the molecular orbital diagram of fluorine and helium molecules and 4 answer the followings:
 i) Bond order of the molecules? ii) Which one is a stable molecule?
 iii) Which one is diamagnetic?

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18/26

4. (a) Define molarity and normality. 10.6 g Na_2CO_3 is dissolved in 2000 g water. If the density of the resulting solution is 0.0989g/mL, calculate molarity, molality and normality of the solution. 4
- (b) What is an ideal solution? State and derive Raoult's law for lowering of the vapour pressure of a dilute solution. 4
- (c) Derive van't Hoff's equation of osmotic pressure for dilute solution. Calculate the osmotic pressure of a 5% solution of urea ($\text{MW} = 60$) in water at 0 °C. 4
- (d) Molal elevation constant of benzene is 2.67 °C. Explain the meaning of the statement. 2
5. (a) Define component. Draw the phase diagram for a one component system and discuss its important points. 5
- (b) Calculate degrees of freedom for the following systems: 2
- Solution of NaCl
 - Saturated solution of NaCl
- (c) State Le Chatelier's principle. Predict the effect of concentration, temperature and pressure on the following reaction: 3
- $$\text{N}_2(\text{g}) + \text{O}_2(\text{g}) \rightleftharpoons 2\text{NO}(\text{g}) - 43.2 \text{ kcal}$$
- (d) What is heterogeneous equilibrium? Carbon dioxide upon heating with carbon at high temperature reduced to carbon monoxide. In a particular experiment the total pressure at equilibrium was found 2.0 atm. If K_p for the reaction is 1.90 atm. What were the partial pressure of CO and CO_2 ? 4
6. (a) Differentiate between order and molecularity of a reaction. 3
- (b) Discuss the main points of transition state theory of reaction rate and draw the potential energy diagram for an endothermic reaction. 3
- (c) What is rate of a reaction? Prove that half life of a second order reaction depends on initial concentration. 4
- (d) What is activation energy? The gas-phase reaction between methane (CH_4) and diatomic sulfur (S_2) is given by the equation 4
- $$\text{CH}_4(\text{g}) + 2\text{S}_2(\text{g}) \rightarrow \text{CS}_2(\text{g}) + 2\text{H}_2\text{S}(\text{g})$$
- At 550 °C the rate constant for this reaction is $1.1 \text{ Lmol}^{-1}\text{sec}^{-1}$ and at 625 °C the rate constant is $6.4 \text{ Lmol}^{-1}\text{sec}^{-1}$. Calculate the activation energy for this reaction.
7. (a) Define the following terms: heat of neutralization, heat of combustion and heat of fusion. 3
- (b) Explain Hess's law of constant heat summation with an example. 2
- (c) What is a suitable indicator? Explain why methyl orange is a suitable indicator for the titration of a strong acid and a strong base. 3
- (d) What is an acid buffer? Give the mechanism of buffer action of an acid buffer. 3
- (e) A liter of solution containing 0.1 moles of CH_3COOH and 0.1 moles of CH_3COONa provides a buffer of pH 4.74. Calculate the pH of the solution after the addition of 0.02 moles of HCl. $K_a = 1.8 \times 10^{-5}$ 3