BITS, PILANI- DUBAI CAMPUS
INTERNATIONAL ACADEMIC CITY, DUBAI
I YEAR FIRST SEMESTER- 2013-2014
Comprehensive Exam (Closed book)

Course Title :General Chemistry | **Course No: CHEM F111**
Date: 05.01.14 | **Total Marks: 80**
Time: 3 Hrs | **Weightage:40%**

1. Answer all questions-Part-A, B and C should be answered separately
2. Show stepwise calculation indicating the units wherever it is required
3. Useful data: h =6.626 x 10^{-34} J s, c = 3 x 10^{8} m/s, m_e = 9.11 x 10^{-31} Kg, R=8.314 J/K/mol
1 eV = 1.602 x 10^{-19}J, m_p = 1.672 x 10^{-27} Kg , 1 a.m.u = 1.660x 10^{-27} Kg, R_H = 109677 cm^{-1}
Atomic No: H=1, C=6, B=5,Be=4,Al=13, N=7,O=8,Br=35, Co=27, Mn=25, Zn=30

PART-A

1. (i) A microscope using photons is employed to locate an electron in an atom within a distance of 0.75 Å .What is the uncertainty involved in the measurement of its velocity?
(ii) A particle of mass 3.50 X 10^{-27} Kg is confined in a one dimensional box of length L. If the energy is 2 X 10^{-24} J in third level, find L.
(iii) The atomic radius of boron is lesser than that of beryllium, but the atomic radius of aluminium is higher. Justify. **[3+4+3M]**

2. (i) Write the gross and specific selection rules for vibrational Raman transitions.
(ii) The standard reaction Gibbs energy of the isomerization of cis-2-pentene to trans-2-pentene at 400K is -3.67kJmol^{-1}. Calculate the equilibrium constant for the isomerization.
(iii) Calculate the allowed energy level for a hydrogenic atom with n=2 . **[3+3+2M]**

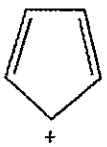
3 (i) Aniline is colorless, but in tetracyanoethylene aniline is deep blue in color. Justify.
(ii) Calculate the standard reaction entropy for
$C_{12}H_{22}O_{11}(s) + 12O_2(g) \rightarrow 12CO_2(g) + 11H_2O(l)$ at 298K.
(The standard reaction entropies for $C_{12}H_{22}O_{11}$, O_2, CO_2 and H_2O at 298K are 360,205,214 and 70 JK^{-1}mol^{-1} respectively.)
(iii) Draw the molecular orbital energy level diagram for NO and deduce its electronic configurations, bond order and the magnetic behavior. **[2 + 3 + 4 M]**

PART-B

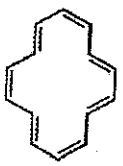
1. Draw the potential energy diagram for energy changes that arise from rotation about C_2-C_3 bond of 1,4-dichloro butane. Show the structure of six extreme configurations with their names. **[6M]**

2. Write the product of the reaction between CH_3I and sodium ethoxide showing the mechanism of the reaction. Write the rate expression for the reaction. **[6M]**

3. Find out whether the following compounds are aromatic or anti-aromatic. Justify your answer.



(i) Cyclopentadienyl cation



(ii) 14-annulene **[4M]**

4. Dehydrohalogenation of 2-bromo-2-methyl butane using sodium ethoxide can yield 2-methyl-2 – butene and 2-methyl-1 – butene. Show the two pathways, identify the most stable product. Justify your answers. **[5M]**
5. Propene undergoes addition reaction with HBr. Of the two products formed which is the major product and give reason. **[5M]**

PART-C

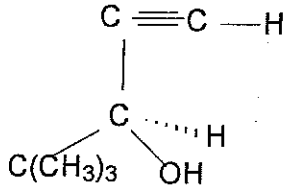
1.(i) Using VB theory explain the hybridization involved , magnetic behaviour and geometry of the given complexes.
(a) $[CoF_6]^{3-}$ (b) $[Zn(en)_2]^{2+}$
(ii) Write any two limitations of VB theory.
(iii) Draw the CF splitting diagram of the complex $[Mn(CN)_6]^{4-}$. Indicate clearly the distribution of d electrons of the central metal atom. Calculate the μ_s and CFSE (in terms of Δ_o) . Write the geometry of the molecule. **[6+2+6M]**

2.(i)Write any three examples indicating the importance of chelating complexes in living systems.
(ii) The gas phase reaction between methane and diatomic sulphur is given by the equation

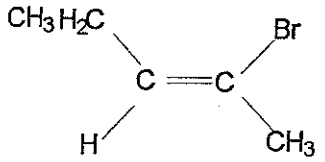
$$CH_{4(g)} + 2S_{2(g)} \rightarrow CS_{2(g)} + 2H_2O_{(g)}$$

At 550° C the rate constant of this reaction is 1.1 litre / mol.sec and at 625°C the rate constant is 6.4 litre / mol.sec. Calculate E_a for this reaction.
(iii) Write the principle involved in stopped flow technique , the method used in measuring the reaction kinetics. **[3+3+2M]**

3. (i) Assign R / S designation to the compound given below.



(ii) Using (E) /(Z) nomenclature give the IUPAC name of the following



(iii) Write the acceptable rate law for the oxidation of nitrogen monoxide . **[2+2+1M]**

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BITS PILANI, DUBAI CAMPUS
I YEAR FIRST SEMESTER, 2013-2014
TEST-II- OPEN BOOK

Course Title: General Chemistry **Course No: CHEM F111**
Date:31.10.2013 **Total Marks: 40**
Time: 50 Min **Weightage: 20%**

1. Answer all questions sequentially. 2. Show stepwise calculation indicating the units wherever it is required.

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1. (i) Define Hydrogen bonding. Illustrate inter and intra molecular H-bonding with suitable example.With which technique inter and intra molecular H-bonding can be differentiated?

   (ii) Derive unnormalized VB wave function of KI molecule with appropriate explanation.

   (iii)Find the state of hybridization of the central atom of the following compounds.
   (a) CO_3^{2-} (b) CH_3Cl **(4+4+6M)**

2. (i) Draw the M.O.diagram for NeO molecule, write down the electronic configuration, calculate the bond order and the magnetic character of the molecule.

   (ii) Arrange the following species in the increasing order of their bond length. Justify.
   F_2 , F_2^-, F_2^+ .

   (iii) Why Be_2 molecule does not exist? **(8+3+2M)**

3. (i) Calculate the number of vibrational modes for the molecules given below :

   Carbon disulphide , Aniline

   (ii) Which of the following molecules will show infrared absorption spectra .

   2-hexanone, Ethanol , Chlorine , Phenol , Ozone

   (iii) The force constant for HI is 3.1×10^5 dyne/cm. At what frequency in cm^{-1} should the transition from ground to first vibrational excited state occur in HI ? At what frequency will it occur in DI ? (Atomic mass H=1, D=2) **(4+3+6M)**

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BITS PILANI, DUBAI CAMPUS
I YEAR FIRST SEMESTER, 2013-2014
TEST-I-CLOSED BOOK

Course Title: General Chemistry | **Course No: CHEM F111**
Date:26.09.2013 | **Total Marks: 50**
Time: 50 Min | **Weightage: 25%**

1. Answer all questions sequentially. 2. Show stepwise calculation indicating the units wherever it is required.
3. Useful Data: h= 6.626 x 10^{-34} J.s, c = 3 x 10^{10} cm/s, m_e= 9.110 x 10^{-31} Kg, a_o=52.9pm, 1amu = 1.660x10^{-27} Kg
1 eV = 1.602 x 10^{-19} J, e = 1.602 x 10^{-19} C Atomic number: Li = 3

1. (i) The threshold energy of a given alkaline earth metal is 1.75eV. Show whether ejection of electron from the metal is possible or not when ultra violet light of wavelength 220nm is made to strike the metal. Calculate the kinetic energy and speed of the ejected photo electrons.

   (ii) Name the experiment and discuss briefly the experiment that shows that the energy of atoms and molecules is confined to discrete values.

   (iii) Estimate the wavelength of electrons that has been accelerated from rest through a potential difference of 1.5 kV **(7+6+4M)**

2. (i) The wave function of an electron in the lowest energy state of a Li^{2+} ion is proportional to e^{-3r/a_o}. Calculate the relative probabilities of finding the electron inside a small volume located at (a) nucleus (b) a distance a_o from the nucleus.

   (ii) Calculate the minimum uncertainty of a bullet of mass 10.0 g having a speed somewhere between 200.00 000 1 and 200.00 000 0 ms^{-1}.

   (iii) Based on Born interpretation, mention the conditions for a wave function to be an acceptable one. **(5+5+6M)**

3. (i) Give any two conditions responsible for the tunnelling of a particle incident on a barrier. Give any two applications of tunnelling.

   (ii) In the near IR spectrum of CO there is an intense band at 2144 cm^{-1}. Calculate the fundamental vibrational frequency of CO, the force constant and zero point energy. (Atomic weight C=12,O=16)

   (iii) Calculate the energy difference between n=2 and n=3 levels for an electron confined to a one dimensional box having length 4 x 10^{-10} m. **(6+8+3M)**

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BITS PILANI, DUBAI CAMPUS

I YEAR FIRST SEMESTER, 2013-2014

QUIZ-II-CLOSED BOOK

Course Title: General Chemistry **Course No: CHEM F111** **Date: 05.12.2013**

Total Marks: 14 Weightage: 7% **Time: 20 Min**

R = 8.314 J / K /mol.

Name : **ID No :** **Sec:**

Answer all questions

1. Give an example for a charge transfer complex indicating the donor and acceptor molecule. **(2M)**

2. Write the conditions under which $\Delta r\, G^{\ominus} < 0$ and $K > 1$ in the case of exothermic reactions. **(3M)**

3. What do you mean by a pseudo first order reaction?.Give one example. **(2M)**

4. The rate constant for the decomposition of a certain substance is 1.70×10^{-2} $dm^3 mol^{-1} s^{-1}$ at 24^0 C and Ea of the reaction is 9.9 $kJmol^{-1}$. Evaluate the Arrhenius parameter of the reaction. **(2M)**

5. Mention the chemical formula of the intermediate in the gas phase oxidation of nitric oxide. **(1M)**

6. One mole of an ideal gas at 25°C is allowed to expand reversibly at constant temperature from a volume of 10 litres to 20 litres .Calculate the work done by the gas in Joules. **(1M)**

7. Calculate the entropy change for fusion of 1 mole of a solid which melts at 300 K. The latent heat of fusion is 2930J / mol. **(1M)**

8. The heat of combustion of CO at constant volume and at 17°C is –283.3 kJ. Calculate the heat of combustion at constant pressure. **(2M)**

$$CO_{(g)} + \tfrac{1}{2} O_{2\,(g)} \rightarrow CO_{2(g)}$$

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BITS PILANI, DUBAI CAMPUS

I YEAR FIRST SEMESTER, 2013-2014

QUIZ-I-CLOSED BOOK

Course Title: General Chemistry **Course No: CHEM F111** **Date: 10.10.2013**

Total Marks: 16 **Weightage: 8%** **Time: 20 Min**

At.no : C = 6, B =5, Na = 11, Ne = 10, Cl = 17)

Name : ID No : Sec:

Answer all questions

1. Write the Johannes expression that describes all the series of spectroscopic lines. **(2M)**

2. Write the Schrodinger expression for the allowed energy levels of the hydrogenic atom. **(2M)**

3. How many orbitals are there in a shell with n = 4 and what are their designations? **(2M)**

4. Give the selection rules for the hydrogenic atoms.. **(1M)**

5. An s electron is more tightly bound than a p electron in the same shell. Why? (2M)

6.The effective nuclear charges experienced by s and p electrons are different. Justify. **(2M)**

7. The atomic radius of carbon is lesser than that of boron. Justify. **(1M)**

8. Why the ionization energy of sodium is substantially lower than that of neon? **(2M)**

9. What is the reason for the higher electron affinity of chlorine? **(2M)**

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