

**BITS PILANI INTERNATIONAL ACADEMIC CITY, DUBAI**

**I YEAR FIRST SEMESTER, 2008-2009**

**TEST- 1 (Closed book)**

Course Title : Chemistry-I

Course No: CHEM C141

Date: 12.10.2008

Total Marks: 75

Time: 50 min

Weightage: 25%

**1. Answer all questions**

**2. Show stepwise calculation indicating the units wherever it is required**

**3. Useful data :  $h = 6.626 \times 10^{-34}$  J sec,  $c = 3 \times 10^8$  m/sec,  $m_e = 9.11 \times 10^{-31}$  Kg.**

**$1\text{eV} = 1.602 \times 10^{-19}$  J,  $m_H = 1.008$  units,  $1\text{ a.m.u} = 1.6605 \times 10^{-27}$  Kg.**

**4. Question paper has 2 pages.**

1. (i) (a) Write the mathematical form of matter wave and mention the modern term used for matter wave.  
(b) Differentiate atomic and molecular spectra (any 2 differences).  
(c) Mention the conditions under which Quantum mechanical tunnelling can occur to an appreciable extent.
- (ii) The threshold wavelength for photo electric emission in Tungsten is 230 nm. Calculate the wavelength of incident light that must be used in order to eject electrons with a maximum velocity of  $5 \times 10^5$  m/s.
- (iii) Calculate the energy difference between  $n=1$  and  $n=2$  levels for an electron confined to a one dimensional box having length of  $5 \times 10^{-10}$  m. What wavelength corresponds to a spectral transition between these levels?

**(9+8+8M)**

2. (i) Consider the rotation of H-atom around stationary Bromine atom in HBr molecule in a plane at a distance 120pm. Calculate (a) the moment of inertia of the molecule (b) the highest wavelength of the radiation that can excite the molecule into rotation.
- (ii) Calculate the number of photons emitted in 10 hrs by a 60W sodium lamp ( $\lambda$  of photon = 5893 Å).
- (iii) Write the permitted energies of a particle moving in a circular path.
- (iv) According to classical physics, every time you strike a match, you blast the surroundings with  $\gamma$ - rays. -comment on this.

**(10+8+3+4M)**

3. (i) State the quantitative version of uncertainty principle and calculate the uncertainty in the momentum of an electron if the uncertainty in the position is 200 pm.
- (ii) What is the significance of  $\Psi$  and  $\Psi^2$ ? Calculate the probability of electron present in an atom at  $r = a_0$  if the wave function is  $(1/4\pi)^{1/2} e^{(-r/2a_0)}$
- (iii) Write the Schrodinger equation and specify the terms present in it. Mention the permitted  $\lambda$  values for allowed wave function of translational and rotational motion of a particle
- (iv) Calculate and compare the force constants for the bonds in CN and  $\text{CN}^+$  molecules. The vibrational frequencies of CN and  $\text{CN}^+$  are  $2068.61\text{cm}^{-1}$  and  $1580\text{cm}^{-1}$  respectively. The atomic weights of C and N are  $1.9940 \times 10^{-26}$  and  $2.3261 \times 10^{-26}$  Kg respectively.

(5+5+5+10M)

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**BITS PILANI, INTERNATIONAL ACADEMIC CITY, DUBAI**

**I YEAR FIRST SEMESTER, 2008-2009**

**TEST- 2 (Open book)**

Course Title : Chemistry-I

Course No: CHEM C141

Date: 27.11.2008

Total Marks: 60

Time: 50 min

Weightage: 20%

1. Answer all questions sequentially.

2. Show stepwise calculation indicating the units wherever it is required

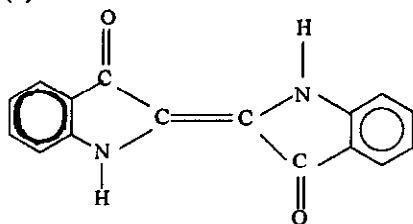
3. Question paper has 2 pages.

1. (i) Specify only the allowed transitions for

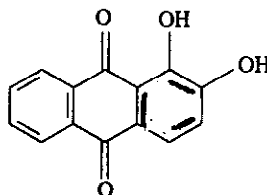
(a) cyclohexane (b) Iodine (c) Acetone

(ii) Identify and write only the chromophores present in the following molecules

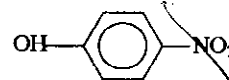
(a)



(b)



(c)



(iii) A substance when dissolved in water at  $10^{-3}$  M concentration absorbs 15 percent of an incident radiation in a path of 2 cm length. What should be the concentration of the solution in order to absorb 85 percent of the same radiation ?

[6+6+8M]

2. (i) Which of the following molecules are IR active? Justify your answer.

(a) Nitrobenzene (b) molecular chlorine (c) Prop-1-ene.

(ii) How many vibrational modes are possible in the following molecules.

(a) Phenol (b) n-hexane (c) Sulphur dioxide

(iii) Calculate the frequency of the transition from  $J=0 \rightarrow 1$  of the H-I molecule. The mass of H =  $1.673 \times 10^{-27}$  kg and I =  $8.8 \times 10^{-26}$  kg and the equilibrium bond length is 140 pm.

[6+6+8M]

3. (i) Draw the molecular orbital diagram of NO molecule, clearly label the orbitals and calculate its bond order. State whether it is paramagnetic or diamagnetic.
- (ii) Calculate the hybridization of  $\text{SF}_6$  and state its geometry.
- (iii) Give reasons for the following
- (a)  $\sigma_{2pz}$  orbital is raised in energy compared to  $\Pi_{2px}$  and  $\Pi_{2py}$  orbitals in the MO diagram of CO.
  - (b) Ethylene is trigonal planar but Acetylene is linear.
- (iv) What is the approximation used for the formation of molecular orbitals? State the three important conditions required for the formation of molecular orbital.

[6+4+6+4M]

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**BITS PILANI INTERNATIONAL ACADEMIC CITY, DUBAI**  
**I YEAR FIRST SEMESTER, 2008-2009**  
**COMPREHENSIVE EXAMINATION**

Course Title : Chemistry- I

Course No: CHEM C141

Date: 3.01.2009

Total Marks: 120

Time: 3 hours

Weightage: 40%

1. Answer all questions sequentially.
2. Answer PART A, B and C in separate answer sheets.
3. Show stepwise calculation indicating the units wherever its required
4. Useful data :  $h = 6.626 \times 10^{-34}$  J.sec ,  $c = 3 \times 10^{10}$  cm/s,  $m_e = 9.110 \times 10^{-31}$  Kg,  
 $1 \text{ eV} = 1.602 \times 10^{-19}$  C,  $R_H = 109677 \text{ cm}^{-1}$ ,  $R = 8.314 \text{ J/K/mol}$ ,  $a_0 = 52.9 \text{ pm}$   
 $R = 0.0821 \text{ litre atmK}^{-1} \text{ mol}^{-1}$ ,  $F = 96500 \text{ C}$ ,  $1 \text{ a.m.u} = 1.66 \times 10^{-27} \text{ kg}$ .  
Atomic mass of C = 6, F = 9, H = 1
5. Question paper contains 3 pages .

**PART - A**

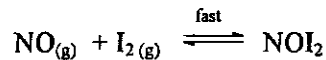
1. (i) For the principal quantum number  $n = 4$  , write down the  $l$  and  $m_l$  values clearly labeling the subshells and corresponding orbitals.  
(ii) The allowed energy level for a hydrogenic atom is given by the expression  $E_n = -hcRZ^2 / n^2$  . Discuss the role of  $n$  and significance of the negative sign.  
(iii) Calculate the probability that the electron will be found between a shell of radius  $a_0$  and a shell of radius 3 pm greater. [2+3+5M]
2. (i) Give the gross selection rule and specific selection rule for vibrational Raman spectra.  
(ii) What are overtone bands? How do they arise?  
(iii) Write the name and represent the IR active modes of carbondioxide molecule. [3+3+4M]
3. (i) For the complete combustion of ethanol  
$$\text{C}_2\text{H}_5\text{OH}_{(l)} + 3\text{O}_{2(g)} \rightarrow 2\text{CO}_{2(g)} + 3\text{H}_2\text{O}_{(l)}$$
the amount of heat produced as measured in a bomb calorimeter is 1364.47 kJ per mole at 25°C. Calculate  $\Delta_c H$  for the reaction .  
(ii) Mention any two practical applications of Henry's law.  
(iii) 0.002 Kg of a solute dissolved in 0.3 Kg of solvent gave depression of freezing point 0.3 K. Calculate the molecular mass of the solute .(Cryoscopic constant for water is 5.0 K Kg/mol) [4+2+4M]
4. (i) Write the Henderson - Hasselbalch equation.  
(ii) Draw the pH curve for the titration of weak acid vs strong base and clearly indicate the stoichiometric point.  
(iii) Calculate the molar solubility of silver chloride in water and in 0.20 M sodium chloride . ( $K_s$  of silver chloride =  $1.6 \times 10^{-10}$ ) [2+4+4M]

**PART-B**

1. (i) Draw the molecular orbital diagram of  $F_2$  molecule. Write the MO configuration, calculate the bond order and find out its magnetic behavior.  
 (ii) Find out the state of hybridization of  $Co^{3+}$  in  $[Co(NH_3)_6]^{3+}$  and geometry of the complex. (Co{Z=27}). [7+3M]

2. (i) The heat of reaction for  $N_2 + 3H_2 \rightarrow 2NH_3$  at  $27^\circ C$  is  $-91.94 kJ$ . What will be its value at  $50^\circ C$ ? The molar heat capacities at constant pressure and  $27^\circ C$  for  $N_2$ ,  $H_2$  and  $NH_3$  are 28.45, 28.32 and 37.07 J respectively.  
 (ii) Differentiate between physical and chemical change in thermochemical reactions with one example each.  
 (iii) Define the term complementary colour with one example. [4+3+3M]

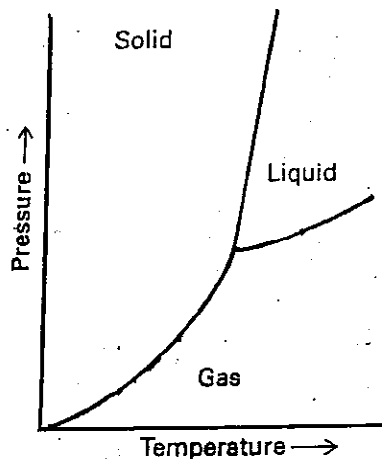
3. (i) The reaction  $2NO_{(g)} + I_{2(g)} \rightarrow 2NOI$  obeys the following mechanism



- (ii) Briefly discuss the phenomenon of Circular dichroism.  
 (iii) Calculate the degrees of freedom for the following system.



4. (i) Give one example each for metal – insoluble salt electrode, redox and gas electrode.  
 (ii) If standard electrode reduction potential  $E^\circ_{\text{red}}$  for copper electrode is  $+0.34V$ . How will you determine its electrode potential when it is in contact with  $0.1M$   $Cu^{2+}$  ions? How does electrode potential change if concentration of  $Cu^{2+}$  ion in solution is decreased?  
 (iii) In the given phase diagram, mark the important points indicating the corresponding temperature and pressure. [2+4+4M]



The phase diagram of carbon dioxide.

1. (i) Calculate the uncertainty product for a moving ball of iron weighing 400 g.  
 (ii) Calculate and find whether photoelectric effect will occur or not if a light of wavelength 750 nm is allowed to fall on metallic Caesium with work function 2.14 eV.  
 (iii) State the failure of classical mechanics(3 points) [3+4+3M]
2. (i) The microwave spectrum of CN shows a series of lines separated by  $3.7978 \text{ cm}^{-1}$ . Find the internuclear distance in the molecule(atomic masses of C and N are  $1.994 \times 10^{-26} \text{ Kg}$  and  $2.3255 \times 10^{-26} \text{ Kg}$  respectively)  
 (ii) What is the thermodynamic criteria of spontaneity for exothermic and endothermic reactions? [6+4M]
3. (i) State Trouton's rule and explain why  $\Delta S_v$  of  $\text{H}_2\text{O}$  is  $109.1 \text{ JK}^{-1} \text{ mol}^{-1}$  whereas for  $\text{H}_2\text{S}$ ,  $\Delta S_v = 87.9 \text{ JK}^{-1} \text{ mol}^{-1}$   
 (ii) Find out the entropy changes for 1 mol of  $\text{H}_2\text{O}$  when it undergoes reversible vapourization and fusion at  $100^\circ\text{C}$  and  $0^\circ\text{C}$  respectively. Compare the values and make a comment over the magnitude of the values. ( $\Delta H_v = 40.656 \text{ kJ mol}^{-1}$ ,  $\Delta H_f = 6.009 \text{ kJ mol}^{-1}$ )  
 (iii) The boiling point of  $\text{NH}_3$ ,  $\text{H}_2\text{O}$ ,  $\text{HF}$  is higher compared to the boiling point of  $\text{PH}_3$ ,  $\text{H}_2\text{S}$  &  $\text{HCl}$ . Give reason. [3+5+2M]
4. (i) Write the order, molecularity and rate law for acid catalyzed hydrolysis of methyl acetate.  
 (ii) Write the steps involved in Lindemann mechanism for unimolecular reaction.  
 (iii) Specify which of the following ion will have more polarizing power and give reason  
 (a)  $\text{Na}^+$  and  $\text{Cs}^+$  (b)  $\text{I}^-$  and  $\text{F}^-$  (c)  $\text{Ca}^{2+}$  and  $\text{Al}^{3+}$  (d)  $\text{SO}_4^{2-}$  and  $\text{Cl}^-$  [3+3+4M]

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(3)