BITS PILANI -DUBAI CAMPUS,KNOWLEDGE VILLAGE ,DUBAI
I YEAR FIRST SEMESTER,2004-2005
TEST 1 (Closed book)
Make up Test
Course Title :Chemistry-I CHEM UC141

Date: 5.10.2004 **Total Marks:30**
Time:50 min **Weightage:20%**

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1. **Answer all questions**
2. **Show stepwise calculation indicating the units wherever it is required.**
   Useful data : Planck's constant = 6.626 x 10^{-34} J sec, 1eV = 1.602 x 10^{-19} J ,
   c = 2.998 x 10^{8} m/sec, Mass of electron = 9.110 x 10^{-31} Kg , R_H=109677cm^{-1}
   1 a.m.u = 1.6605 x 10^{-27} Kg

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1. **Multiple choice questions & fill in the blanks** (1 x 5 = 5)

(i)The wavelength of the first line of Balmer series of H atom is 6561 Å .
The wavelength of the second line of the series is
(a)13122 Å (b) 3280 Å (c) 4860 Å (d) 2180 Å

(ii)The wavelength of a spectral line for an electronic transition is inversely related to
(a)the number of electrons undergoing the transition
(b)the nuclear charge of the atom
(c)the difference in the energy of the energy levels involved in the transition
(d)the velocity of the electron undergoing the transition

(iii)Line spectra is characteristic of
(a) molecules (b)atoms (c)radicals (d) none of these

(iv)The light radiations with discrete quantities of energy are called _____.

(v)The Schrodinger equation for a single particle of mass m moving in one dimension with energy E is _____.

2. Treat a vibrating HI molecule as a stationary I atom with the H atom oscillating towards and away from the I atom. Given that the force constant of the HI bond is 314 Nm^{-1}. Calculate (a) vibrational frequency of the molecule (b) the wavelength required to excite the molecule into vibration.

(5)

3. The energy required for the ionization of a certain atom is 3.44aJ(1aJ = 10^{-18}J a denotes atto). The absorption of a photon of unknown wavelength, ionizes the atom and ejects an electron with velocity 1.03 x 10^6 m/s. Calculate the wavelength of the incident radiation.

(5)

4. An electron is confined to a molecule of length 1.0 nm(10 Å)(about 5 atoms long) what is its minimum energy? What is the minimum excitation energy from this state?

(5)

5.Calculate the minimum uncertainty in velocity of a particle of mass 1.1X 10^{-27} Kg, if uncertainty in its position is 3X10^{-10} cm.

(4)

6.Calculate the energy emitted when electrons of 1.0g atom of hydrogen undergo transition giving the spectral line of lowest energy in the visible region of its atomic spectrum.

(6)

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BITS PILANI -DUBAI CAMPUS,KNOWLEDGE VILLAGE ,DUBAI
I YEAR FIRST SEMESTER,2004-2005

TEST 1 (Closed book)
Course Title :Chemistry-I CHEM UC141

Date: 26.9.2004 **Total Marks:40**
Time:50 min **Weightage:20%**

1. **Answer all questions**
2. **Show stepwise calculation indicating the units wherever it is required.**
   Useful data : Planck's constant = 6.626×10^{-34} J sec, 1eV = 1.602×10^{-19} J, c = 2.998×10^{8} m/sec, Mass of electron = 9.110×10^{-31} Kg , R_H=109677cm^{-1}

SECTION - A

Multiple choice questions: (1 x5 =5)

1) The spectrum of He^+ is expected to be similar to that of
   (a)Li^+ (b) H (c) Na (d) He

2) Which of the following relates to photons both as wave motion and as a stream of particles
   (a) photoelectric effect (b) $E= mc^2$ (c) diffraction (d) $E=h\nu$

3)Which of the following electron transition in a hydrogen atom will require largest amount of energy ?
   (a) from n = 1 to n = 2 (b) from n = 2 to n = 3 (c) from n = ∞ to n =1
   (d) from n = 3 to n = 5

4) The uncertainty in the position of an electron moving with a velocity of 3.0×10^4 cm / s accurate upto 0.011% will be
   (a) 1.92 cm (b) 7.68 cm (c) 0.175 cm (d) 3.84 cm

5) A photon of radiation of wavelength 6000 Å has an energy E. The wavelength of photon or radiation corresponds to an energy equal to 2E is
   (a) 6000 Å (b) 3000Å (c) 12000Å (d) 24000 Å

Fill in the blanks:

6) The transition of the electron in hydrogen atom from fourth to first energy state emits a spectral line which belongs to _____ and falls in _____.
(2)

7) The expression for energy density ρ for a black body radiation calculated by planck using his quantization postulate is given as _____.
(1)

8) _____ metal exhibit photoelectric effect readily. (1)

9) The kinetic energy of ejected electron varies linearly with the frequency of the radiation but is independent of its _____. (1)

SECTION-B

1) (i) Represent the array of energy levels of an harmonic oscillator.
(ii) Calculate the wavelength of an electron with kinetic energy 3.0×10^{-25} J.
(3+5)

2) It is possible to produce a ceramic material that could be used as a filament at 3800°C instead of 3000 °C, By what factor would the power output of a lamp that used the new material increase?
(3)

3) A particle of mass 6.65×10^{-27} Kg confined in a one dimensional box of length ' L". If the energy is 2×10^{-24} J in third level, find L.
(4)

4) The fundamental vibration frequency of HCl has been found to be $2886 cm^{-1}$. Find out the force constant of this molecule. Given $^{1}H = 1.673 \times 10^{-27}$kg and $^{35}Cl = 58.06 \times 10^{-27}$ kg.
(5)

5) Calculate the wavelength of radiation emitted for the electronic transition from infinity (∞) to stationary state of the hydrogen atom.

(2)

6) How fast would a particle of mass 1.0g need to travel to have the same linear momentum as a photon of radiation of wavelength 300 nm?

(3)

7) A photon has energy equal to 10MeV. Calculate the wavelength to which this corresponds.

(5)

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BITS PILANI -DUBAI CAMPUS,KNOWLEDGE VILLAGE ,DUBAI
I YEAR FIRST SEMESTER 2004-2005

COMPREHENSIVE EXAMINATION (Closed book)
Course Title :Chemistry I Course No CHEM UC141

Date: 13.1.2005 **Total Marks:80**
Time: 3 hours **Weightage:40%**

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 ,1eV = 1.602×10^{-19} J ,
$c = 3 \times 10^{8}$ m/sec , $m = 9.110 \times 10^{-31}$ Kg ,$R_H = 109677\ cm^{-1}$

SECTION – A

1.(i)A chemical reaction takes place in a container of cross- sectional area 55.0 cm^2,the container has a piston of mass 250g at one end.As a result of the reaction ,the piston is pushed out (a) horizontally (b) vertically through 155 cm against an external pressure of 105 kPa .Calculate the work done by the system in each case. **(5)**

(ii) One mole of toluene is vaporized at its boiling point 111° C .The heat of vaporization at this temperature is $363.3 Jg^{-1}$.Calculate the maximum work done against 1atm,q , ΔH,ΔU and ΔS for the vaporization of 1 mole of toluene.(Assume the vapour to behave as ideal gas)

$C_6H_5CH_3$ (liquid) $\rightarrow$ $C_6H_5CH_3$ (vapour) **(5)**

2. (i) The reaction mechanism

$A_2 \rightleftharpoons A + A$

$A + B \rightarrow P$ (slow)

involves intermediate A .Deduce the rate law for the formation of P . **(3)**

(ii) By applying the steady state approximation derive the rate law for the gas phase oxidation of nitrogen monoxide. Show that it follows second-order kinetics. **(6)**

3. (i) The work function of molybdenum is 4.5 eV.If ultraviolet light of wavelength 100 Å is incident upon molybdenum find the maximum velocity of the ejected photo-electron. **(5)**

(ii) Calculate the heat required to melt 224 Kg of Na metal at 371 K.
$\Delta_{fus}H^{(-)} = 2.60\ kJmol^{-1}$. **(2)**

4.(i)Derive Clausius- Clapeyron equation for a liquid –vapour equilibrium. What are the assumptions made in deriving this equation. **(5)**

(ii)Determine the number of components,number of phases and the degrees of freedom for the following systems.

(a) an aqueous solution of glucose

(b) $CaCO_3(s) \rightleftharpoons CaO(s) + CO_2(g)$ **(2)**

5.(i)Consider the following electrochemical cell

$Fe, Fe^{2+}(0.1M) \,/\, Cd^{2+}(0.001M), Cd$

assuming that activities equal concentrations.

(a)Write the cell reaction (b) Calculate the emf of the cell and determine the direction of spontaneous reaction (c)Calculate the equilibrium constant of the cell reaction.($E^0_{Cd} = -0.40V$, $E^0_{Fe} = -0.44V$) **(5)**

(ii)What are the subshells and orbitals possible in n = 3 energy level? **(2)**

SECTION B

6. (i)A hydrogenation reaction is carried out at 500K.If the same reaction is carried out in the presence of a catalyst at the same rate,the temperature required is 400K.Calculate the activation energy of the reaction if the catalyst lowers the activation energy barrier by 20kJ /mol. **(4)**

(ii)What is the principle involved in flash photolysis technique? **(2)**

7.(i)The vapour pressures of pure ethylene bromide and propylene bromide are 170 and 127 mm of Hg at a temperature .Find out the vapour pressure of ethylene bromide in a 60% by weight solution of ethylene bromide in propylene bromide at same temperature. Also calculate the vapour pressure of propylene bromide as well as total vapour pressure of solution. **(4)**

(ii)What partial pressure of methane is needed to achieve 21 mg of methane in 100g of benzene at 25°C **(4)**

(Henry's law constant for methane in benzene = 4.27×10^5 Torr)

8.(i)Sketch the pH curve for the titration of acetic acid with sodium hydroxide and mark the specific points in the diagram. **(2)**

(ii)Taking barium hydroxide to be completely ionized calculate the pH of 0.001M solution of it. **(3)**

(iii) The solubility product of magnesium hydroxide at 25°C is 1.4×10^{-11}. What is the solubility of magnesium hydroxide in gm/litre. **(3)**

9.(i)Of the following species which has the shortest bond length?Give reasons. NO, NO^+, NO^{2+}, NO^- **(2)**

(ii)Why does He_2^+ exist whereas He_2 does not? **(2)**

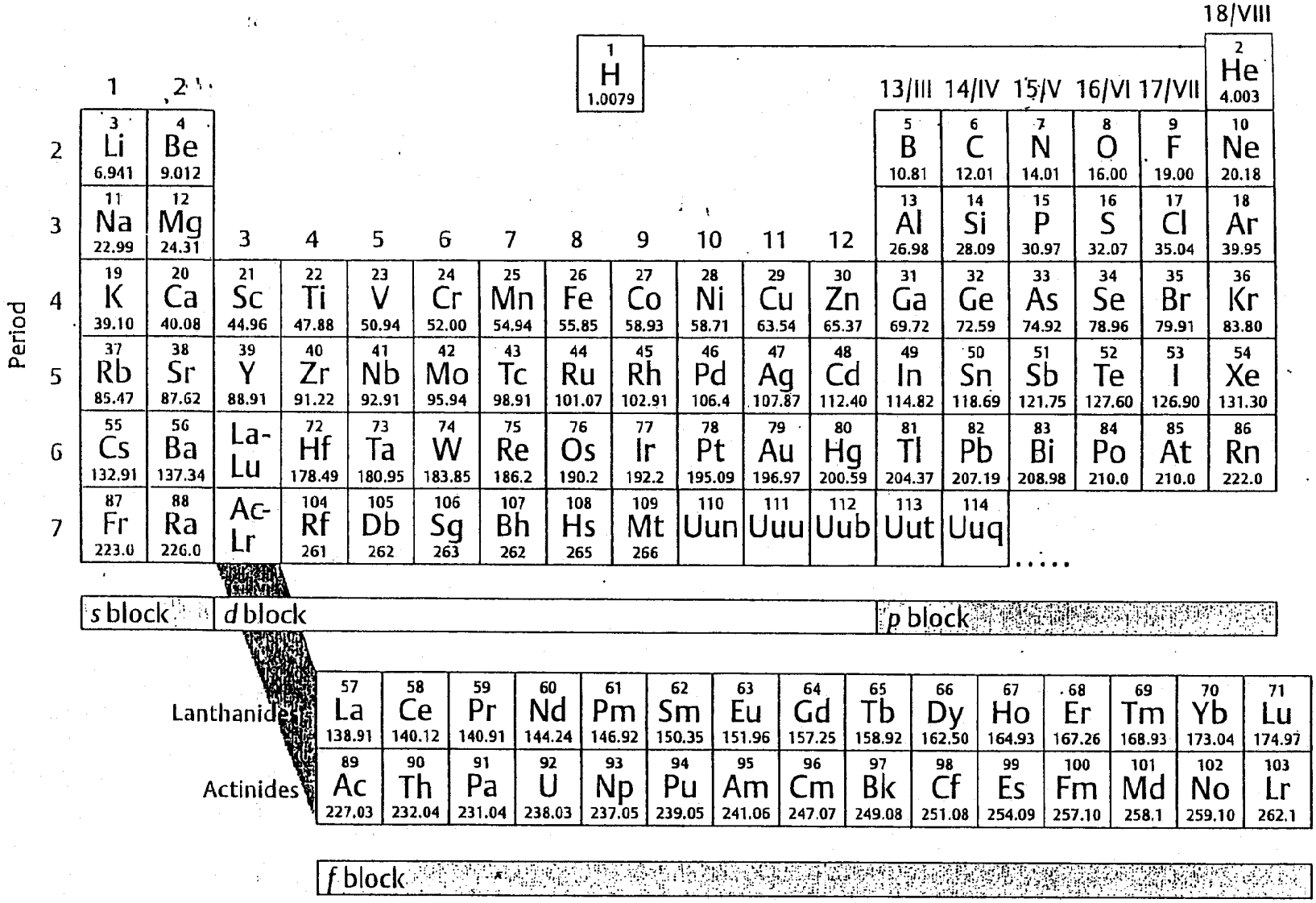
(iii)Draw the molecular orbital (MO) energy level diagram of O_2 showing the electronic arrangements in the molecular orbitals.Calculate the bond order and show the magnetic behaviour. **(5)**

10.(i)Explain the charge transfer complexes with a suitable example. **(3)**

(ii)Sketch the different modes of vibration for carbondioxide molecule. **(2)**

(iii)The rotational spectrum of CO shows a series of lines placed $3.84285\ cm^{-1}$ apart.Calculate the moment of inertia and the bond length of C = O **(4)**

**********Good luck**********


18/VIII
1
2
13/III
14/IV
15/V
16/VI
17/VII
Period
1 H 1.0079
2 He 4.003
2 3 Li 6.941 4 Be 9.012 5 B 10.81 6 C 12.01 7 N 14.01 8 O 16.00 9 F 19.00 10 Ne 20.18
3 11 Na 22.99 12 Mg 24.31 3 4 5 6 7 8 9 10 11 12 13 Al 26.98 14 Si 28.09 15 P 30.97 16 S 32.07 17 Cl 35.04 18 Ar 39.95
4 19 K 39.10 20 Ca 40.08 21 Sc 44.96 22 Ti 47.88 23 V 50.94 24 Cr 52.00 25 Mn 54.94 26 Fe 55.85 27 Co 58.93 28 Ni 58.71 29 Cu 63.54 30 Zn 65.37 31 Ga 69.72 32 Ge 72.59 33 As 74.92 34 Se 78.96 35 Br 79.91 36 Kr 83.80
5 37 Rb 85.47 38 Sr 87.62 39 Y 88.91 40 Zr 91.22 41 Nb 92.91 42 Mo 95.94 43 Tc 98.91 44 Ru 101.07 45 Rh 102.91 46 Pd 106.4 47 Ag 107.87 48 Cd 112.40 49 In 114.82 50 Sn 118.69 51 Sb 121.75 52 Te 127.60 53 I 126.90 54 Xe 131.30
6 55 Cs 132.91 56 Ba 137.34 La-Lu 72 Hf 178.49 73 Ta 180.95 74 W 183.85 75 Re 186.2 76 Os 190.2 77 Ir 192.2 78 Pt 195.09 79 Au 196.97 80 Hg 200.59 81 Tl 204.37 82 Pb 207.19 83 Bi 208.98 84 Po 210.0 85 At 210.0 86 Rn 222.0
7 87 Fr 223.0 88 Ra 226.0 Ac-Lr 104 Rf 261 105 Db 262 106 Sg 263 107 Bh 262 108 Hs 265 109 Mt 266 110 Uun 111 Uuu 112 Uub 113 Uut 114 Uuq .....
s block
d block
p block
Lanthanides
57 La 138.91 58 Ce 140.12 59 Pr 140.91 60 Nd 144.24 61 Pm 146.92 62 Sm 150.35 63 Eu 151.96 64 Gd 157.25 65 Tb 158.92 66 Dy 162.50 67 Ho 164.93 68 Er 167.26 69 Tm 168.93 70 Yb 173.04 71 Lu 174.97
Actinides
89 Ac 227.03 90 Th 232.04 91 Pa 231.04 92 U 238.03 93 Np 237.05 94 Pu 239.05 95 Am 241.06 96 Cm 247.07 97 Bk 249.08 98 Cf 251.08 99 Es 254.09 100 Fm 257.10 101 Md 258.1 102 No 259.10 103 Lr 262.1
f block

BITS PILANI -DUBAI CAMPUS,KNOWLEDGE VILLAGE ,DUBAI
I YEAR FIRST SEMESTER,2004-2005

TEST 2 (Open book)
Course Title :Chemistry-I (CHEM UC141)

Date: 1.12.2004 **Total Marks:40**
Time: 50 min **Weightage:20%**

1.Answer all questions
2.Show stepwise calculation indicating the units wherever it is required
3.Only text book is allowed.

SECTION – A

Multiple choice questions: (5 x 1 = 5)

1.The bond strength is maximum in
(a) O_2^+ (b) O_2^- (c) O_2^{2-} (d) O_2

2.The orbitals which provide most efficient overlap are
(a) s—s (b) s—p (c) sp—sp (d) sp^2—sp^2

3.The total number of spectral lines obtained in Lyman series when an electron jumps from 6^{th} level is
(a) 10 (b) 15 (c) 20 (d) 6

4.Pick out the isoelectronic species from the following
I : CH_3^+ II:H_3O^+ III: NH_3 IV: CH_3^-
(a) I & II (b) III & IV (c) I & III (d)II , III & IV

5.Which of the following species have undistorted octahedral structures
(1)SF_6 (2) XeF_6 (3) SiF_6^{2-} (4) PF_6^-
(a) 1,2 & 3 (b) 1,3 & 4 (c) 1,2 & 4 (d)2,3 & 4

6.Why are line spectra observed for atoms but band spectra are observed for molecules ? (2)

7. Predict the kind of electronic transitions possible for
(a) C_2H_6 (b) HCHO (2)

8. Which of the following molecules will show a vibrational infrared spectrum and why?
NH_3, C_2H_4, CCl_4, liquid H_2 (2)

9. Represent the molecular orbitals formed by the combination of $2p_x$ and $2p_z$ orbitals. (2)

10. How many normal vibration modes are possible in the ethane molecule and aniline molecule? (2)

SECTION B

1. In the Balmer series of atomic spectra of hydrogen there is a line corresponding to wavelength 4344 Å .Calculate the number of higher orbits from which the electron drops to generate other line. (6)

2. Hydrogen bromide gives a series of lines in the far infrared having a separation of 16.94 cm^{-1}.Calculate the moment of inertia of the molecule and the internuclear distance. (5)

3. The force constant for HI is 3.1×10^5 dyne cm^{-1} .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 ? (4)

4. Draw the molecular orbital diagram for the NO molecule .Write the MO electronic configuration Predict the bond order and the magnetic behaviour. (5)

5. An aqueous solution of a compound A of concentration 10^{-3} mole / litre absorbs 50 % of incident radiation in a cell of length 1 cm and another compound B of concentration 2×10^{-3} mole / litre absorbs 60% of the incident radiation at a particular wavelength .Calculate the percentage absorbed by a solution containing 10^{-3} mole / litre of A and B each in the same cell at the same wavelength. (5)

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