A

BITS PILANI -DUBAI CAMPUS,KNOWLEDGE VILLAGE ,DUBAI
I YEAR FIRST SEMESTER, 2006-2007

Name of the student :
ID No & Sec :

QUIZ -1 (Closed Book)

Course Title :Chemistry I **Course No:CHEMUC141**
Date: 17.10.2006 **Total Marks:30**
Time:30 min **Weightage:10%**

1. For multiple choice questions tick and underline the correct answer.
2.Overwriting will be taken as a wrong answer.
3.Useful data :Planck's constant $h=6.626 \times 10^{-34}$ J sec, $1eV = 1.602 \times 10^{-19}$ J, $c = 3 \times 10^{8}$m/sec, Mass of electron $= 9.110 \times 10^{-31}$ Kg, $R_H = 109677\ cm^{-1}$
4.Question paper contains 4 pages.
5.Steps not required for numericals.

1. The magnitude of orbital angular momentum of an electron in the 3d orbital is

_____ . **(1M)**

2. Line spectra is characteristic of
(a) molecules (b) atoms (c) radicals (d) none of the above **(1M)**

3. A particle of mass 10^{-27} Kg is confined in an one dimensional box of length 2 nm.The energy required to excite the particle from n=2 to n=3 level is equal to

(a) 0.36 eV (b) 8.83×10^{-3} eV (c)4.28×10^{-4} eV (iv) 0.91 eV **(2M)**

4. The work function of Cs metal is 2.14 eV .Calculate the speed of electrons emitted when the metal is irradiated with light of wavelength 300 nm. **(2M)**

5. Write the mathematical form of a $2p_z$ orbital. **(1M)**

6. Calculate the probability that the electron will be found between a shell of radius a_0 and a shell of radius 2.5 pm greater. **(1M)**

7. The transition of the electron in hydrogen atom from fourth to first energy state emits a spectral line which belongs to _____ and falls in _____ region . **(1M)**

8 . The Aufbau principle implies that a new electron will enter an orbital for which
(a) n has a lower value (b) l has a lower value
(c) (n + l) value is minimum (d) (n + l) value is maximum. **(1M)**

9. A lamp emits light of wavelength of 300 nm so its surface temperature should be close to _____. **(1M)**

10. The energy density in a region of the electromagnetic field due to radiation of wavelength λ is proportional to $1/\lambda^4$. This is _____ law.
(a)Wien's law (b) Stefan Boltzman law (c) Rayleigh- Jeans law (d)Debye's law **(1M)**

11. Dulong and Petit proposed that molar heat capacity of all mono atomic solids was equal to about
(a) 25 J $K^{-1}mol^{-1}$ (b) 25 J Kmol (c) 25 J^{-1} K mol^{-1} (d) 25 J K mol^{-1} **(1M)**

12. _____ found that the energy of each electromagnetic oscillator is limited to discrete values and cannot be varied arbitrarily. **(1M)**

13. The expression which relates to light as a stream of particles as well as wave motion is _____ . **(1M)**

14. The energy of one mole photons of a radiation having wavelength 3000Å.
a) 4×10^4 J b) 4.5×10^6 J c) 4×10^5 J d) None of the above **(2M)**

15. An s electron has a greater _____ through inner shells than a _____ electron of the same shell. **(1M)**

16. The individual orbitals of a given subshell remain degenerate-Why? **(1M)**

17. Write down the electronic configuration of the element with Z = 29 and give the number of unpaired electron present in it. **(1M)**

18. The property which determines the ability of atoms to involve in the bond formation is _____. **(1M)**

19. Why does the electron affinity for the formation of O^{2-} from O^{-} is strongly negative? **(1M)**

20. Which of the following transition is not allowed in the emission spectrum of Li^{2+}

(a) $5p \rightarrow 3s$ (b) $2p \rightarrow 1s$ (c) $3d \rightarrow 2p$ (d) $5d \rightarrow 2s$ **(1M)**

21. Specify the selection rules for hydrogenic atoms. **(2M)**

22. The reduction in radius of the elements from Cerium to Lutetium in the periodic table is called _____. **(1M)**

23. The quantitative version of position –momentum uncertainty relation is _____. **(1M)**

24. The Ionization energy of beryllium is higher than lithium because of _____. **(1M)**

25. The energy of an electron in a benzene molecule of diameter 500pm at $m_l = 1$ is

(a) 0.51 eV (b) 0.61 eV (c) 0.41 eV (d) 0.71 eV **(2M)**

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BITS PILANI -DUBAI CAMPUS,KNOWLEDGE VILLAGE ,DUBAI
I YEAR FIRST SEMESTER,2006-2007

COMPREHENSIVE EXAMINATION
Course Title :Chemistry- I (CHEM UC141)

Date: 26.12.2006 **Total Marks:120**
Time: 3 hours **Weightage: 40%**

1. Answer all questions
2. Answer PART A in the main answer sheet , PART 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, $1\ eV = 1.602 \times 10^{-19}$ C, $R_H = 109677\ cm^{-1}$,R = 8.314 J/K/mol, R = 1.987 cals ,F = 96500 C , Atomic mass of N = 14
5. Question paper contains 3 pages .

PART - A

1. (i) Determine the number of components , phases and the degrees of freedom in the following equilibria.
   (a) $H_2O_{(s)} \rightleftharpoons H_2O_{(l)} \rightleftharpoons H_2O_{(g)}$
   (b) $N_{2(g)} + O_{2(g)} \rightleftharpoons 2NO_{(g)}$
   (ii) Mention the temperature and pressure at which the liquid carbondioxide / compressed gas is present in the cylinders of carbondioxide.
   (iii) Benzene has a vapour pressure of 389 mm at 60°C and 754 mm at 80°C. Calculate the enthalpy of vapourisation in calories at this temperature range.

[3+2+5M]

2. (i) The hydrogen ion concentration of a fruit juice is 3.3×10^{-2} M.Calculate the pH of the juice.
   (ii) The solubility of $PbCl_2$ at 298 K is 2×10^{-2} mol / L. Calculate the solubility product at this temperature.
   (iii) Draw the pH curve for the titration of HCl vs NaOH and mark the specific points in the diagram.Write the Henderson –Hasselbalch equation.

[2+4+4M]

3. (i) Explain the principle involved in the quenching technique.
   (ii) Write the mechanism for unimolecular reactions and derive the rate law based on that mechanism.
   (iii) The rate constant of a second order reaction is $5.70 \times 10^{-5}\ dm^3\ mol^{-1}\ s^{-1}$ at 25°C and $1.64 \times 10^{-5}\ dm^3\ mol^{-1}\ s^{-1}$ at 40°C .Calculate the activation energy of the reaction .

[2+5+3 M]

4. (i) Write both gross and specific selection rules for microwave spectra.
(ii) HCl molecule has a force constant of 516 Nm^{-1}. Calculate the vibrational frequency of the molecule and the energy separation between any 2 neighbouring vibrational energy levels. The masses of H and Cl are 1.673×10^{-27} Kg and 5.807×10^{-26} Kg respectively.
(iii) Explain the terms overtones and parallel bands.

[2+5+3M]

PART-B

1. (i) Draw the molecular orbital diagram of O_2 molecule. Account for the presence of a double covalent bond and paramagnetic behaviour of Oxygen molecule.
(ii) Explain with the help of molecular orbital theory why H_2 exists and He_2 does not exist.
(iii) What is the effect of H-bonding on melting and boiling points ?

[5+3+2M]

2. (i) State Trouton's rule and give reason for exception to Trouton's rule.
(ii) Can ΔH be taken as a sole criterion of spontaneity of a process? Justify your answer.
(iii) Ethanol boils at 78.4°C, the enthalpy of vapourisation of ethanol is 42.4 $kJmol^{-1}$. Calculate entropy of vapourisation of ethanol.

[3+3+4M]

3. (i) What type of solutions are likely to behave as ideal solution ?
(ii) Solution of sodium chloride (molar mass = 58.5) is prepared by dissolving 5.85 g of it in 1000g of water. Find out freezing point of the solution. K_f for water is 1.86 K kg mol^{-1}.
(iii) Give any 2 practical applications of depression of freezing point.
(iv) Write the expression to show the relationship between standard chemical potential of the gas J and its partial pressure p_J.

[2+4+2+2M]

4. (i) How will you predict the spontaneity of a reaction based on emf values ?
(ii) Explain the principle and method of determination of pH using glass electrode (with a neat sketch).
(iii) Given the following cell
Al / Al^{3+}(0.01M) // Fe^{2+}(0.02M) / Fe, calculate the value of ΔG and E cell at 298K when $E^\circ_{Al/Al^{3+}}$ and $E^\circ_{Fe^{2+}/Fe}$ are –1.66V and –0.44V respectively.

[2+4+4M]

PART-C

1. (i) Estimate the wavelength of electrons that have been accelerated from rest through a potential difference of 5.00 kV.

(ii) The work function of Caesium is 3.10 eV . Can the light of wavelength 720 nm eject electrons from the metal ?

(iii) Write the Schrodinger equation for a particle of mass m in one dimensional box.

[4+4+2M]

2. (i) List the factors favourable for polarization and covalency .

(ii) The frequency of one of the lines in the Paschen series of the spectrum of atomic hydrogen is 2.7415×10^{14} Hz. Identify the principal quantum number of the upper state in transition.

(iii) Write the possible values of l and m_l, if n = 3.

[4+4+2M]

3. (i) Calculate the work done for isothermal expansion of 14 g of N_2 gas from 10 dm^3 to 30 dm^3 at 32°C .

(ii) Calculate the standard enthalpy of sublimation of ice at 0°C from its standard enthalpy of fusion at 0°C(7.5 kJ mol^{-1})and the standard enthalpy of vapourization of water at 0 C (49.65kJ mol^{-1}).

(iii) How can we achieve maximum expansion work ?

[4+2+4M]

4. (i) Calculate the heat of reaction given below

$C + \frac{1}{2}O_2 \rightarrow CO$ $\quad \Delta H = ?$

$C + O_2 \rightarrow CO_2$ $\quad \Delta H = -393.5$ kJ

$CO + \frac{1}{2}O_2 \rightarrow CO_2$ $\quad \Delta H = -282.0$ kJ

(ii) The enthalpy of sublimation of Cs is 226 kJ mol^{-1} .Calculate the energy that must be supplied as heat at constant pressure to convert 6.0 g of solid Cs metal to a gas Cs^{3+} ions and electrons at 25°C (IE_1 =376kJmol^{-1}, IE_2= 2420 kJmol^{-1} IE_3= 3300 kJmol^{-1}, Molar mass of Cs = 132.91)

[6+4M]

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BITS PILANI -DUBAI CAMPUS,KNOWLEDGE VILLAGE ,DUBAI
I YEAR FIRST SEMESTER, 2006-2007

Name of the student :
ID No & Sec :

QUIZ -II (Closed Book)

Course Title :Chemistry I | Course No:CHEMUC141
Date: 5.12.2006 | Total Marks:30
Time:30 min | Weightage:10%

1. For multiple choice questions tick and underline the correct answer.
2.Overwriting will be taken as a wrong answer.
3.Useful data : R= 8.314 J $K^{-1}mol^{-1}$,atomic masses : H = 1 , O = 16 .
4.Question paper contains 3 pages & Each question carries 2 marks .
5.Steps not required for numericals.

1.In an isothermal expansion of an ideal gas
(a) q = 0 (b) w = 0 (c) $\Delta V = 0$ (d) $\Delta U = 0$

2. In the free expansion of a perfect gas the work done (w) by the system is equal to

_____ .

3. Calculate the maximum work done in expanding 16g of oxygen at 300 K and occupying a volume of 5 dm^3 isothermally until the volume becomes 25 dm^3.

4. In an adiabatic process ,which of the following is true?

(a) q = +w (b) q= 0 (c) $\Delta U = q$ (d) $p\Delta V = 0$

5. Caculate the amount of heat necessary to raise 213.5 g of water from 25 °C to 100° C. Molar heat capacity of water is 18 cal $mol^{-1} K^{-1}$.

6. Find the standard enthalpy change for the reaction

$$CO_{2(g)} + H_{2(g)} \text{ ----------} \rightarrow CO_{(g)} + H_2O_{(g)}$$

Given that ΔH_f° for $CO_{2\,(g)}$ $CO_{(g)}$ and $H_2O_{(g)}$ as –393.5, –110.5 and –241.8KJ mol^{-1} respectively.

7. Calculate the enthalpy change($\Delta \mathbf{H}$) of the following reaction.

$$2C_2H_{2(g)} + 5O_{2(g)} \text{ ----------} \rightarrow 4\,CO_{2(g)} + 2H_2O_{(g)}$$

Given: Average bond energies of various bonds i.e, C-H, C≡C, O=O, C=O, O–H as 414, 810, 499, 724, 460 kJ mol^{-1} respectively.

8. For a gaseous reaction

$$2A_{2(g)} + 5B_{2(g)} \text{ ----------} \rightarrow 2A_2B_{5(g)}$$

at 27°C the heat change at constant pressure is found to be –50160J. Calculate the value of internal energy change (ΔU).

9. Among o-nitro benzoic acid & p-nitro benzoic acid which will have higher boiling point-Why?

10. According to Fajans' rule of polarization a _____ cation and a _____ anion favour covalency.

11. Absorption spectrum in UVregion results from

(a)increase in vibrational energy (b) electronic excitation

(c)decrease in rotational energy (d) increase in potential energy

12. Mention any two charge transfer acceptors

13. List all the possible electronic transitions for acetone

14. The electronic transition which accomplishes shortest wavelength absorption is

_____ .

15. Mention any two applications of CD spectra.

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BITS PILANI -DUBAI CAMPUS,KNOWLEDGE VILLAGE ,DUBAI
I YEAR FIRST SEMESTER 2006-2007

Test –2 (Open book)
Course Title :Chemistry I (CHEM UC141)

Date: 19.11.2006
Time: 50 min

Total Marks:60
Weightage:20%

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

1.(i)Draw the MO energy level diagram for fluorine molecule, clearly labeling all the orbitals and and showing the electronic arrangements in the molecular orbitals.Calculate the bond order and state whether this molecule is diamagnetic or paramagnetic.

(ii)Arrange the following molecular species in increasing order of their stability

O_2, O_2^{2-}, O_2^{+}, O_2^{2+}, O_2^{-}

(iii) The carbonyl group typically absorbs infrared radiation at around 1700 cm^{-1}. Estimate the force constant for the C = O bond .The atomic masses are $^{12}C = 1.99 \times 10^{-26}$ Kg $^{16}O = 2.66 \times 10^{-26}$ Kg.

(iv)How many normal modes of vibrations are there in water molecule.Represent the different modes of vibration of water molecule.

(6+4+6+4M)

2.(i) Find the state of hybridization of the central atom in the following species
ICl_3, ClO_4^-

(ii) Draw the orbital model of ethane molecule showing the scheme of overlap & types of bonds formed.

(iii)Which of the following molecules can have a pure rotational spectrum?

NH_3, Br_2, HBr, N_2, NO, PCl_5, H_2

(iv) 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. (H = 1.008 g mol^{-1} and Br = 79.92 g mol^{-1}).

(5+5+4+6M)

3. (i) In the MO diagram of Nitrogen molecule, why $\sigma 2p_z$ orbitals are raised in energy when compared to $\Pi 2p_x$ and $\Pi 2p_y$ orbitals ?

(ii) Calculate the frequency of rotational raman transition from J = 0 to 1 of HCl molecule if the bond length is 135pm (mass of the H atom is 1.67×10^{-27} Kg and mass of Cl atom is 5.807×10^{-26}Kg)

(iii) Give the conditions for the Linear Combination of Atomic Orbitals and draw the shapes for the formation of $\sigma 2p_z$ and $\Pi 2p_y$ bonding molecular orbitals.

(iv) Give any four differences between infra red spectra and Raman spectra.

(4+6+6+4M)

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BITS PILANI -DUBAI CAMPUS,KNOWLEDGE VILLAGE ,DUBAI
I YEAR FIRST SEMESTER 2006-2007

TEST- 1 (Closed book)

Course Title :Chemistry-I **Course No:CHEM UC141**
Date:1.10.2006 **Total Marks:60**
Time: 50 min **Weightage:20%**

1.Answer all questions
2.Show stepwise calculation indicating the units wherever it is required
3.Useful data : h =6.626 x 10^{-34} J sec,c = 3 x 10^{8} m/sec, 1eV = 1.602 x 10^{-19} J ,
Mass of electron = 9.110 x 10^{-31} Kg
4.Question paper has 2 pages

1.(i) The threshold wavelength for photo-electric emission in tungsten is 230 nm. What wavelength of incident light must be used in order to eject electrons with a maximum velocity of 5 x 10^{5} m/s ?

(ii) An electron is confined to a molecule of length 10 Å .Calculate its lowest irremovable energy in eV.What is the minimum excitation energy from this state?

(iii) Give any two applications of Scanning Tunnelling Microscopy.

(iv) Name any 4 experiments to show that Laws of classical mechanics failed to account for the observed behaviour of microscopic particles.

(7+6+3+4 M)

2.(i) A certain photochemical reaction is found to require 9 x 10^{-19} J energy per water molecule. Calculate the number if photons (per water molecule) of light with wavelength of 2.21x 10^{-6} m that is required to initiate the reaction.

(ii) Assume that a new material developed made it possible to use it as a filament at 4000°C instead of 2500°C. By what factor the power output of a lamp that used the new material increase.

(iii) The force constant of O-H is 516 Nm^{-1}. The atomic masses of O^{16} and H^{1} is 26.6 x 10^{-27}kg and 1.67 x 10^{-27} kg respectively . From the above data calculate the vibrational frequency in cm^{-1}.

(iv) Give the expression that is important for the interpretation of vibrational (infrared) spectroscopy.

(5+5+6+4M)

P.T.O

3. (i) Write the mathematical expression for the debroglie matter wave.

(ii) Write the wave functions for an electron in a hydrogen atom and for a particle free to oscillate to and fro.

(iii) Mention the cyclic boundary conditions for a particle travelling on a circular path of radius r.

(iv) What is the uncertainity of momentum if the uncertainity in position of an electron is one?

(v) Estimate the minimum uncertainity in the speed of an electron in a hydrogen atom taking its diameter at 156pm

(vi) Calculate the energy in eV required to excite an electron from level $m_l = +2$ to the the next higher level of an cyclic aromatic molecule as a ring diameter 300pm and the electron as a particle that moves only along the perimeter of the ring.

(2+2+4+2+3+7 M)

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