

BITS, PILANI- DUBAI
INTERNATIONAL ACADEMIC CITY, DUBAI
I YEAR FIRST SEMESTER- 2010-2011
Comprehensive Exam (Closed book)

Course Title :Chemistry-I

Course No: CHEM C141

Date: 21.12.10

Total Marks: 120

Time: 3 Hrs

Weightage:40%

1. Answer all questions. Part-A, B and C should be answered separately and sequentially
2. Show stepwise calculation indicating the units wherever it is required
3. Useful data: $h = 6.626 \times 10^{-34} \text{ J s}$, $c = 3 \times 10^8 \text{ m/s}$, $m_e = 9.11 \times 10^{-31} \text{ Kg}$.
 $1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}$, $m_p = 1.672 \times 10^{-27} \text{ Kg}$, $1 \text{ a.m.u} = 1.660 \times 10^{-27} \text{ Kg}$, $R = 8.314 \text{ J mol}^{-1} \text{ K}^{-1}$
 $R_H = 109677 \text{ cm}^{-1}$

Question paper contains 3 pages

PART-A

1. (i) Calculate the rate constant for first order reaction having the activation energy $39.3 \text{ kcal mol}^{-1}$ at 300° C and the frequency constant $(A) 1.11 \times 10^{11} \text{ sec}^{-1}$.
(ii) Write the mechanism for unimolecular reactions as suggested by Fredrick Lindemann.
(iii) Mention the methods of studying the kinetics of chemical reactions. [3+4+2M]
2. (i) Give the thermodynamic criteria of spontaneity for exothermic reactions.
(ii) The standard reaction enthalpy of a reaction is $+ 4.80 \text{ kJmol}^{-1}$ for the reaction $\text{H}_2(\text{g}) + \text{Br}_2 \text{ -----} \rightarrow 2\text{HBr}(\text{g})$ at 25°C . Find out the equilibrium constant of the reaction. [3+4M]
3. (i) With a neat sketch explain the working principle of a gas electrode.
(ii) Calculate the emf of the cell
$$\text{Fe} / \text{Fe}^{2+} \quad // \quad \text{Sn}^{2+} / \text{Sn}$$
$$a = 0.6 \quad \quad a = 0.2$$
$$E = - 0.44 \text{ volt} \quad E = + 0.14 \text{ volt}$$
[3+5M]
4. (i) Draw and discuss the Molecular Orbital diagram of NO molecule.
(ii) Mention any four characteristic features of hybridization.
(iii) He_2 molecule does not exist. Justify. [6+4+2M]
5. (i) A diatomic molecule in which the atoms are separated at an equilibrium distance of $13 \times 10^{-11} \text{ m}$ has a rotational constant of $1.78 \times 10^{12} \text{ s}^{-1}$. Calculate the reduced mass of the molecule.
(ii) The transmittance of $0.1 \text{ mol dm}^{-3} \text{ Cu}^{2+}$ ions in aqueous solution in a 5 cm length cell is 30% at 565 nm . Calculate its molar absorption coefficient. What would be the transmittance if the cell length is 1 and 2 cm respectively?
(iii) What is Frank-Condon Principle? [6+4+2M]

PART-B

1. (i) Calculate the number of degrees of freedom(F) in a 2% solution of common salt.
- (ii) The vapour pressure of water at 100°C is 1 atm. What would be the vapour pressure at 90°C ? The enthalpy of vapourization of water in this temperature range is 44.90 kJ/mol .
- (iii) With reference to the phase diagram of carbon dioxide system write the pressure and temperature corresponding to triple point and critical point. **[2+3+3M]**
2. (i) Calculate the molecular weight of a substance of which 0.250g when dissolved in 25g of benzene lowers the freezing point by 0.400 K. K_f for benzene is $5.12\text{ K.kg.mol}^{-1}$.
- (ii) Write the expression for the chemical potential of a solvent and a solute. **[4+4M]**
3. (i) Explain the titration curve for the titration of acetic acid Vs sodium hydroxide. Indicate the stoichiometric point.
- (ii) How will you select an indicator that can be used for the titration of strong acid Vs weak base?
- (iii) Estimate the molar solubility of calcium fluoride in water. ($K_s=4.0\times 10^{-11}$) **[3+2+3M]**
4. (i) What is the minimum uncertainty in the position of a ball of mass 5g that is known to have a speed between 450.000001ms^{-1} and 450.000000ms^{-1} ?
- (ii) What is Photo electric effect and discuss its characteristics?
- (iii) Calculate the wavelength of the line with $n=6$ in the Balmer series of the hydrogen spectrum. **[4+4+4M]**
5. (i) Give the boundary conditions of (a) a particle in a box (b) a particle in a ring.
- (ii) How fast would a particle of mass 1 mg need to travel to have a momentum same as that of a photon of wavelength 300 nm?
- (iii) Atomic radius of Ca is 197 pm while that of Ga is 153 pm. Justify. **[4+6+2M]**

PART-C

- 1.(i) Trimethylammonium hydroxide is a weaker base than tetramethylammonium hydroxide. Justify.
- (ii) Arrange the following compounds in the increasing order of their covalency.
 Ca(OH)_2 , TiCl_4 , NaCl , $\text{Al}_2(\text{PO}_4)_3$
- (iii) Calculate the final volume of one mole of an ideal gas initially at 0°C and 1 atmospheric pressure if it absorbs 4000 J of heat during a reversible isothermal expansion. **[3+3+3 M]**

- 2.(i) The enthalpy of reaction (ΔH) for the formation of ammonia according to the reaction:
 $N_2 + 3H_2 = 2NH_3$ at $27^\circ C$ was found to be $-91.94 kJ$. What will be the enthalpy of reaction (ΔH) at $50^\circ C$? The molar heat capacities at constant pressure and at $27^\circ C$ for N_2 , H_2 and NH_3 are 28.45 , 28.32 and 37.07 joules respectively.
- (ii) One mole of an ideal gas is heated from $100 K$ to $300 K$. Calculate ΔS if (a) the volume is kept constant. (b) the pressure is kept constant. ($C_v = 1.5 R$).
- (iii) What is the reason for inertness of Nitrogen?
- (iv) In the case of water there is a deviation in the value of entropy of vaporization from the value given by Trouton's rule - Why? [4+6+2+3 M]

BITS, PILANI- DUBAI
INTERNATIONAL ACADEMIC CITY, DUBAI
I YEAR FIRST SEMESTER- 2010-2011
TEST- II (Open Book)

Course Title :Chemistry-I

Course No: CHEM C141

Date: 07.11.10

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

$1 \text{ eV} = 1.602 \times 10^{-19} \text{ J}$, $m_p = 1.672 \times 10^{-27} \text{ Kg}$, $1 \text{ a.m.u} = 1.660 \times 10^{-27} \text{ Kg}$

1. (i) Determine the number of possible modes of vibrations in chloro ethene and Carbon disulphide

(ii) Absorption by $^1\text{H}^{35}\text{Cl}$ occurs in the micro wave region and the spacing between the neighbouring lines is 20.89 cm^{-1} . Calculate the internuclear distance in HCl

[5+7M]

2. (i) A particular molecule AB has 87.5% moment of inertia of $^2\text{H}^{131}\text{I}$. The masses of ^2H and ^{131}I are 2.0135 amu and 130.906 amu respectively. At which frequency the $J = 2 \rightarrow 3$ transition occurs for AB and $^2\text{H}^{131}\text{I}$ in . The equilibrium bond length in each case is $1.2 \times 10^{-14} \text{ m}$.

(ii) Which of the following molecules are rotationally active?

(a) HCl (b) CO_2 (c) N_2O (d) O_2

[8+4M]

3. (i) Give any two line broadening process in gaseous samples. Also suggest a method of reducing line broadening when recording the spectrum for gaseous samples.

(ii) Vibrational frequency of $^{127}\text{I}^{81}\text{Br}$ is 266.64 cm^{-1} calculate a) the force constant

b) energy required for transition from $v = 0$ to $v = 1$

[4+8M]

4. (i) Account for the colour of charge transfer complexes with two suitable examples

(ii) Write the possible electronic transitions in

(a) Benzaldehyde (b) 1,3-butadiene (c) n-heptane

[6+6 M]

5. (i) Justify the formation of broad peaks in Electronic spectroscopy.

(ii) A light of wavelength 350nm when passes through 2 mm length of a coloured solution of concentration $0.650 \text{ mmol.dm}^{-3}$, the percentage transmission is 70%. Calculate the molar absorption coefficient of the solution at wavelength 350nm.

Give the results in $\text{cm}^2.\text{mol}^{-1}$.

[4+8 M]

BITS, PILANI-DUBAI
INTERNATIONAL ACADEMIC CITY, DUBAI
I YEAR FIRST SEMESTER, 2010-2011
TEST- 1 (Closed book)

Course Title :Chemistry-I

Date: 26.09.10

Time: 50 min

Course No: CHEM C141

Total Marks:75

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 s, $c = 3 \times 10^8$ m/s, $m_e = 9.11 \times 10^{-31}$ Kg.

$1 \text{ eV} = 1.602 \times 10^{-19}$ J, $m_p = 1.672 \times 10^{-27}$ Kg, $1 \text{ a.m.u} = 1.660 \times 10^{-27}$ Kg

4. This question paper contains 2 pages

- 1.(i) The kinetic energy of an electron is 5×10^{-5} eV. Calculate the wavelength of the wave associated with the electron.
- (ii) The minimum energy required for the photoemission of electrons from the surface of a metal is 4.95×10^{-19} J. Find the K.E. of most energetic photoelectron when the metal is irradiated with radiation of wavelength 2000 \AA .
- (iii) Comment on the nature of Atomic and molecular spectra. [6+6+3M]
2. (i) Write the Schrodinger equation for a single particle moving in one dimension and mention the different terms involved in it.
- (ii) Calculate the minimum uncertainty in the position of a proton that has the speed of 200 kms^{-1} and the uncertainty in its momentum is 0.1 per cent.
- (iii) Based on Born interpretation, mention the boundary conditions for a wave function to be an acceptable wave function. [5+6+4 M]
3. (i) Calculate the energy difference between $n=1$ and $n=2$ levels of a marble of mass 2g, confined in an one-dimensional box of length 0.15 m. What wavelength corresponds to a spectral transition between these levels.
- (ii) Given the atomic masses of H =1.008 a.m.u, Cl=34.98 a.m.u and mean inter nuclear distance of H-Cl in Hydrogen Chloride is 0.13nm. Calculate the moment of inertia of HCl.
- (iii) Mention any two conditions for quantum mechanical Tunnelling.

[7+5+3M]

- 4.(i) Find the force constant of HI bond, where H oscillates towards and away from the stationary I atom. The vibrational frequency of the HI molecule is given to be 2310 cm^{-1} .
- (ii) The frequency of the lines in the Paschen series ($n_1=3$) of the spectrum of atomic hydrogen is $2.7415 \times 10^{14} \text{ Hz}$. Find the principal quantum number of the upper state in the transition ($R_H=109677 \text{ cm}^{-1}$).

[7+8 M]

5.(i) What are allowed and forbidden transitions?

- (ii) To which orbital an electron in the 4p orbital can make spectroscopic transition? Justify.
- (iii) Calculate the probability of finding the electron in a volume of 2 pm^3 located at Bohr's radius (52.9 pm). Given that $\psi = [1/(4\pi a_0^3)]^{1/2} \cdot e^{-r/a_0}$ [4+4+7 M]

BITS, PILANI – DUBAI
INTERNATIONAL ACADEMIC CITY, DUBAI
I YEAR FIRST SEMESTER- 2010-2011
Quiz- II (Closed Book)

Course Title: Chemistry-I
Date: 29.11.10
Time: 20 min

Course No: CHEM C141
Total Marks: 21
Weightage: 7%

Name:	I.D.No.	Section :
-------	---------	-----------

1. What would be the amount of work done when one mole of a gas is allowed to expand from a volume of 1 litre to 10 litres against the constant external pressure of 1 atm. (2M)

2. Write the expression relating enthalpy and internal energy for a perfect gas. (2M)

3. Write the expression for the heat capacity at constant volume. (2M)

4. Five moles of a diatomic ideal gas is allowed to expand isothermally at 25°C from 0.020 to 0.1000 m³. Calculate ΔU if the expansion is performed reversibly. (2M)

5. 5 moles of an ideal gas expand reversibly from a volume of 8dm³ to 80 dm³ at a temperature of 27°C. Calculate the change in entropy. ($R=8.314 \text{ J K}^{-1} \cdot \text{mol}^{-1}$) (3M)

6. Calculate the enthalpy of vapourisation of liquid CCl₄ at its boiling point of 77°C. (2M)

7. Calculate the entropy change in the surrounding, if the reaction enthalpy of a chemical reaction at 25 °C and 1 bar pressure is 29,815 J. (2M)

8. What happens to the free energy of white phosphorous, when it is in atmospheric air? (2M)

B

BITS, PILANI – DUBAI
INTERNATIONAL ACADEMIC CITY, DUBAI
I YEAR FIRST SEMESTER- 2010-2011
Quiz- II (Closed Book)

Course Title: Chemistry-I
Date: 29.11.10
Time: 20 min

Course No: CHEM C141
Total Marks: 21
Weightage: 7%

Name: _____ I.D.No. _____ Section: _____

1. 5 moles of an ideal gas expand reversibly from a volume of 8dm^3 to 80dm^3 at a temperature of 27°C . Calculate the change in entropy. ($R=8.314\text{ J K}^{-1}\cdot\text{mol}^{-1}$) (3M)

2. Calculate the entropy change in the surrounding, if the reaction enthalpy of a chemical reaction at 25°C and 1 bar pressure is 29,815 J. (2M)

3. Calculate the enthalpy of vapourisation of liquid CCl_4 at its boiling point of 77°C . (2M)

4. ΔH_f° of SO_2 (M.Wt 64) is -297.5 kJ/mol . What is the energy required for the decomposition of 6.4 g of SO_2 ? (2M)

5. What is the number of phases in a cup of water containing ice cubes? (2M)

6. Write the expression relating enthalpy and internal energy for a perfect gas. (2M)

7. Five moles of a diatomic ideal gas is allowed to expand isothermally at 25°C from 0.020 to 0.1000 m^3 . Calculate ΔU if the expansion is performed reversibly. (2M)

BITS, PILANI- DUBAI
INTERNATIONAL ACADEMIC CITY, DUBAI
I YEAR FIRST SEMESTER- 2010-2011
QUIZ-1 (Closed book)

Course Title :Chemistry-I

Date: 18.10.'10

Time: 20 min

Course No: CHEM C141

Total Marks: 24

Weightage:8%

-
1. Answer all questions
 2. Question Paper contains 2 pages
 3. Atomic numbers: N-7, I-53, O-8,
-

1. Though Boron is having higher nuclear charge than that of Beryllium, it has lower ionization energy. Why? (2M)

2. What is the general trend of the atomic radius of elements along the period and down the group? (3M)

3. The bond angle in water is 104° instead of the expected 109° for sp^3 hybridization- Justify. (1M)

4. Predict the hybridization and geometry of the following ions, (4M)
(a) NO_2^{2-} (b) IO_3^-

5. Illustrate inter and intra molecular H- bonding with suitable examples. (3M)

6. Arrange the following in the increasing order of polarity and covalency. (2M)
NaBr, NaCl, NaI, NaF
7. Schematically represent the formation of $\pi(2p_y)$ bonding molecular orbital. (2M)
8. Calculate the bond order of NO^+ and O_2^{2-} ions. Indicate their magnetic behavior. (3M)
9. What is the reason for the degeneracy of orbitals of a given subshell? (2M)
10. Write the number of orbitals present in the M shell of an atom (2M)
-
-