RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College under University of Calcutta)

FIRST YEAR

B.A./B.SC. FIRST SEMESTER (July – December) 2014

Mid-Semester Examination, September 2014

Date : 15/09/2014 **CHEMISTRY (Honours)**

Time : 11 am – 1 pm Paper : I Full Marks : 50

[Use a separate answer book for each group]

Group – A

(*Answer **Question No. 1 or 2** and **Question No. 3 or 4***)

1. a) A mixture of gas in a container of volume, V, composing of n_1, n_2, n_3 etc. no. of different gas molecules exerts the pressure, P at the T temperature. Show from kinetic theory of gas that—

$$P = P_1 + P_2 + P_3 + ...,$$

where P_1, P_2, P_3 etc are the partial pressures exerted by the different gas molecules, respectively, at same temperature. [2]

b) i) Write the gas distribution function for velocity and explain the terms involved. [2]

ii) When does the 1D velocity distribution curve for gas molecules flatten? [2]

c) Find out the molar specific heat for BF_3 molecule, according to law of equipartition of energy. [No need to describe the law] [2]

2. a) The time required for a molecule to travel one meter is 1/C. Calculate the average time required for the molecules to travel one meter. [3]

b) Compare the a 1D and 3D velocity and speed distribution curves respectively at a temperature T. Cite the important features. [2]

c) Suppose that at some initial time all the molecules in container have same translational energy, $2{\cdot}0\times10^{-21}$J. As time passes, the energies are distributed in Maxwellian way. Write down the expression for average energy. Also compute the final temperature of the system. [3]

3. a) 1 mol of gas in a leak proof cylinder fitted with a piston is allowed to expand — (i) isothermally, (ii) adiabatically. State the type of the system in each case as isolated/closed/open. Give reasons. [2]

b) 2 mol of an ideal gas, initially at 400K, expands reversible following the condition PV^2 = constant till the temperature falls to 300K. Calculate, W, Q and ΔU for the process. Given $\bar{C}_V = \frac{5}{2}R$. [3]

c) Show that work is not a state function, it is a path function. [3]

4. a) Prove that PV^γ = constant for an ideal gas undergoing reversible, adiabatic expansion or compression. [3]

b) 1 mol of an ideal gas expands in two stages from (P_1, V_1, T) to (P_2, V_2, T). For the first stage the opposing pressure is P' and $P_1 > P' > P_2$ and for the second stage, the opposing pressure is P_2. Show that for maximum work, $P' = \sqrt{P_1P_2}$ and find out $|W_{max}|$. [3]

c) Show that : $C_P - C_V = \left[V - \left(\frac{\partial H}{\partial P}\right)_T\right]\left(\frac{\partial P}{\partial T}\right)_V$. [2]

Group – B

(*Answer **Question No. 5 or 6** and **Question No. 7 or 8***)

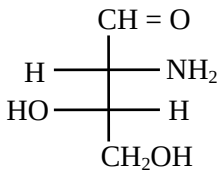
5. a) The C–H bond length of fluoromethane is shorter than those of methane —explain. [2]

b) Draw orbital picture of H_2C = CH–CN indicating hybridisation state of C and N atoms. [2]

c) Arrange the following bond length in order of decreasing value with reason C–C, C–H, C=C, C–Cl and C–Br. [2]

d) Between ∠FCF and ∠HCH bond angles in CH_2F_2 which one is smaller? Explain. [2]

6. a) Indicate whether the following pairs of compounds are identical, enantiomers or diastereomers. Justify your answer. [6]

i) 

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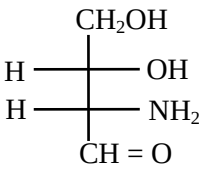
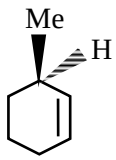


ii) 

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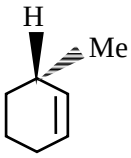
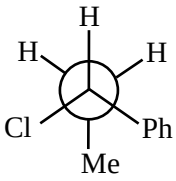


iii) 

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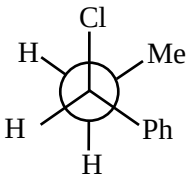
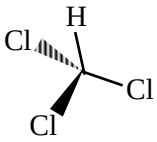
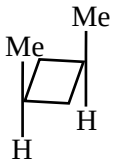


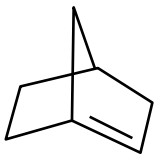
b) Indicate the symmetry elements present in the following compounds. [2]

i) 

; (ii) 

7. a) Predict the relative order of C–C bond lengths in propane, propene and propyne with explanation. [2]

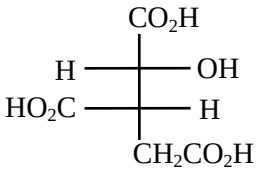
b) Why does the following structure not exist? [2]

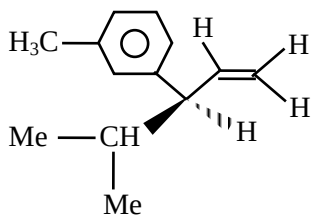


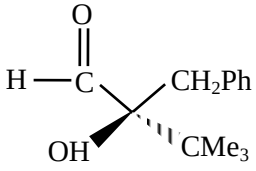
c) Give approximate bond angles each atom except hydrogen of $H_3C – CH = N – CH_3$. [2]

d) Which one of chloroacetic acid and β -chloropropionic acid is stronger? [2]

8. a) Assign configurational designation (R/S) at the chiral centres of the following compounds. [3]

i) 

ii) 

iii) 

b) Write the structure of the following compounds as directed. [3]

i) D – 2 – butylmethyl ether (Fischer projection)
ii) L – phenylalanine (Fischer projection)
iii) Erythro – 3 – bromo – 2 – butanol (Newman)

c) Give Example of the following : [2]
i) A meso compound having three chiral cemtres.
ii) A molecule having S_2 – axis of symmetry.

Group – C

(*Answer **Question No. 9 or 10** and **Question No. 11 or 12***)

9. a) Compare and contrast between 4f block elements and 5f block elements. [2]
b) Calculate using Slater's rule the effective nuclear charge on 4S and 3d electron of Bromine atom. [2]
c) Explain why at room temperature (~ 30°C) metallic Galium is liquid. [2]
d) Amongst $MgCO_3$ and $CaCO_3$ which is thermally more stable and why? [2]
e) Write down the I.U.P.A.C name with symbol with atomic number 107 and 109. [1]

10. a) Write notes on Lanthanide contraction, its causes and consequences. [2]
b) Why do 'd' block elements exhibit variable valency? [1]
c) Lithium Carbonate is soluble in alcohol where as other alkali metal carbonates do not —Explain. [2]
d) Explain the stability of Auride ion with respect to Cupride ion. [1]
e) Compare and contrast between (**any one**) : [2]
i) Beryllium and Aluminium
ii) Boron and Silicon
f) It is hard to separate Zircorium and Haufmium. [1]

11. a) $\Psi(r)$ for the 1S orbital in a hydrogen atom has a very high value at r = 0. But the plot of radial density vs 'r' passes through zero at r = 0 and has a maximum at 0·53Å. Explain. [3]
b) The ground state electronic configuration of Cu is $[Ar]3d^{10}4S^1$ but not $[Ar]3d^9 4S^2$. Explain. [2]
c) What is the minimum uncertainty in the velocity of an electron if we want to locate it within 0·01Å of the first Bohr radius in a hydrogen atom? [2]
d) Write down the values of m_ℓ for 'ℓ' = 1, and explain their significance. [2]

12. a) Establish the Bohr's Quantum Restriction from de Broglie concept. [2]
b) Discuss the penetrating power of the different orbitals (s,p,d,f) in the light of wave mechanical model. [2]
c) Determine the ground state term symbol for Cu-atom. [2]
d) The 1^{st} 1P values of He and Li are 24·5 ev and 5·4 ev respectively. Calculate the Z* value and screening constant for the outer most electron in the He and Li. [3]

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