

RAMAKRISHNA MISSION VIDYAMANDIRA

(Residential Autonomous College affiliated to University of Calcutta)

B.A./B.Sc. FIRST SEMESTER EXAMINATION, MARCH 2021

FIRST YEAR [BATCH 2020-23]

CHEMISTRY [HONOURS]

Date : 24/03/2021

Time : 11.00 am – 1.00 pm

Paper : I [CC 1]

Full Marks : 50

Group – A

Unit – I

Answer **any one** question :

[1×12]

1. a) If the series limit (shortest wavelength) of Balmer series for hydrogen is 3646 Å, calculate the atomic number of the element, which gives K-series wavelengths down to 0.1 nm. [3]
b) Explain why s orbitals are spherical but p orbitals aren't. [2]
c) Draw and explain the nature of radial probability distribution function for 3s, 3p and 3d orbitals of the H-atom. [3]
d) State Hund's rule and using that deduce ground state term symbol of nd^3 configuration. [3]
e) The value of m_l for a particular orbital is -2, what are the smallest possible values of n and l? [1]
2. a) Establish Bohr's assumption of quantized angular momentum from de Broglie's hypothesis. [2]
b) What is the de Broglie wavelength of an electron that has been accelerated by a potential difference of 500V? (Charge of an electron is 1.602×10^{-19} C and mass of the electron is 9.109×10^{-31} kg) [2]
c) Consider the process of shielding in atoms, using Be as an example. What is being shielded? What is it shielded from? What is doing the shielding? [3]
d) Write down all the term symbols for an ns^1np^1 configuration. [2]
e) What is Stern-Gerlach experiment? What was the conclusion of the experiment and why? [3]

Unit – II

Answer **any one** question :

[1×12]

3. a) pK_a value of $(HO)ClO_n$ decreases with increasing the value of n from zero to three – Explain. [3]
b) What is Lux-Flood concept on acids and bases? Give an example. [3]
c) Which is a stronger base and why? [3]
i) NH_3 , PH_3 and (ii) NH_3 , PF_3
d) What is co-solvating effect? Explain with an example. [3]
4. a) What is gas phase proton affinity? Arrange the following with the increase of Gas phase proton affinity value: F^- , Cl^- , Br^- and I^- . Justify your arrangement. [3]
b) Calculate the pH value in the following cases of an acid-base titration: [3]
i) 24 ml of 0.2 N sodium hydroxide is added to 25 ml of 0.2 N acetic acid
ii) 25 ml of 0.2 N sodium hydroxide is added to 25ml of 0.2N acetic acid
iii) 26 ml of 0.2N sodium hydroxide is added to 25 ml of 0.2N acetic acid

- c) Reactions of a series of substituted pyridine with hydrogen ions show the order of base strength to be 2,6-dimethyl pyridine > 2-methyl pyridine > 2-t-butylpyridine > pyridine, while the reaction with larger acids such as BF₃ or BMe₃ shows the following order of basicity: Pyridine > 2-methyl pyridine > 2,6-dimethyl pyridine > 2-t-butyl pyridine. Explain the difference between these two series. [3]
- d) Rationalize the following data in terms of HSAB theory: [3]
- (i) $\text{CH}_3\text{-CH}_3 + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{OH} + \text{CH}_4$ ($\Delta H = 12 \text{ kcal}$)
- (ii) $\text{CH}_3\text{COCH}_3 + \text{H}_2\text{O} \rightarrow \text{CH}_3\text{COOH} + \text{CH}_4$ ($\Delta H = -13 \text{ kcal}$)

Unit – III

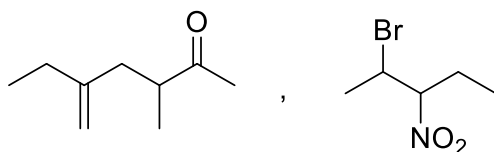
Answer **any one** question : [1×10]

5. a) Balance the following reaction applying Ion-electron method: [3]
 $\text{Cr}_2\text{O}_7^{2-} + \text{SO}_2(\text{g}) \rightarrow \text{Cr}^{3+}(\text{aq}) + \text{SO}_4^{2-}(\text{aq})$ (in acidic medium)
- b) Describe the function of salt bridge in an electrochemical cell. [1]
- c) What would be the electrochemical potential of hydrogen electrode, when it is placed in a solution having pH= 8.0? [2]
- d) Calculate the equilibrium constant for the following reaction: [2]
 $\text{Cu (s)} + 2\text{Ag}^+(\text{aq}) \rightarrow \text{Cu}^{2+}(\text{aq}) + 2\text{Ag (s)}; E^0_{\text{Cell}} = 0.46 \text{ V}$
- e) At 25°C solubility product of AgCl is 1.5625×10^{-10} . At this temperature, calculate solubility of AgCl in water in g/L. [2]
6. a) Explain why in a family of ionic compounds a bromide usually has a low boiling point than chloride. [2]
- b) In case of CaCl₂ and ZnCl₂, which one is expected to be more covalent? [2]
- c) Write the mathematical form of Born–Landé equation. Highlight of its significance. [1+1]
- d) Calculate the lattice enthalpy of KCl from the following data at standard states: Enthalpy of sublimation of K = 89 KJ/mole; Enthalpy of dissociation of chlorine = 244 KJ/ mole; Ionisation energy of K = 425 KJ/mole; Electron gain enthalpy of chlorine = -355 KJ/mole; Enthalpy of formation of KCl = -438 KJ/mole. [2]
- e) In comparison to AgF, AgI has lower solubility in a polar solvent. Explain. [2]

GROUP B

Answer **any one** question : [1×16]

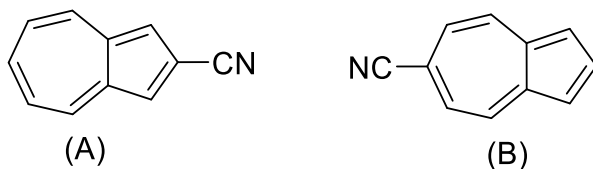
7. a) Write down the IUPAC name for the following molecules: [2]



- b) Draw the orbital picture for : CH₃CH=CH-CN (trans) [2]
- c) Which of the following molecules should have permanent dipole moment?(No explanation needed) [2]
 H₂O, N₂, CO₂, CO, HCHO, CBr₄, p-Hydroxyphenol.

d) Compound (A) has higher dipole moment than compound (B) – explain.

[2]

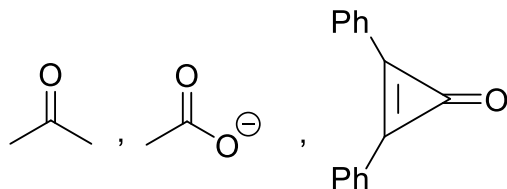


e) Draw the molecular orbital diagram for 1,3,5 – hexatriene and also indicate HOMO and LUMO for the molecule.

[3]

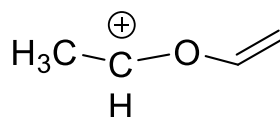
f) Compare the C=O bond distance in the following molecules and explain:

[3]



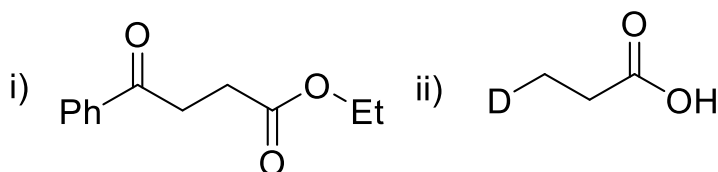
g) Draw the all canonical structures for the following ion and also find out which one should have greater contribution towards the resonance hybrid.

[2]



8. a) Write down the IUPAC name for the following molecules:

[2]



b) Define with examples: bond moment and group moment.

[2]

c) Which compound has the higher dipole moment: Butan-1,2-dione and cyclopentan-1,2-dione.

[2]

d) Which of the following compounds are aromatic, non-aromatic and antiaromatic according to Huckel rule? Explain for individual compound.

[4]

i) p-benzoquinone

ii) cyclooctatratene

iii) cycloheptatrienyl cation

iv) cyclopentadienyl anion.

e) Draw the molecular orbital diagram for 1,3, – pentadienyl radical and also indicate SOMO for the molecule.

[2]

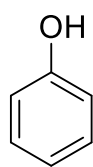
f) Which one is more stable in each of the following pairs; explain with reasons.

[2]

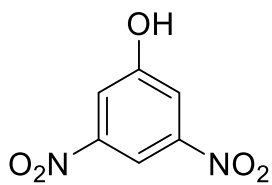


g) Arrange the following molecules in increasing order of acidity with proper explanation:

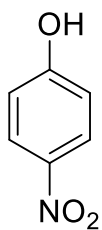
[2]



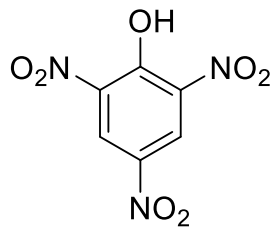
(I)



(II)



(III)



(IV)

_____ x _____