2020
CHEMISTRY
[HONOURS]
Paper : I

Full Marks : 75 Time : 4 Hours

The figures in the right-hand margin indicate marks.
Candidates are required to give their answers in their own words as far as practicable.

GROUP–A
(Marks : $37\frac{1}{2}$)

1. Answer any **three** questions: 1×3=3
   a) Why lithium carbonate has lower thermal stabilisation than hydrated lithium perchlorate? Both CO_3^{2-} and ClO_4^- have wide difference in size with respect to lithium ion.
   b) Why F_2 is gaseous whereas I_2 is solid in room temperature?
   c) Calculate the exchange energy of Pt in ground state. [k=exchange energy constant]
   d) Write expression for energy of an energy level of hydrogen like atom according to Bohr's model. Mention the meaning of each term.
2. Answer any **three** questions: 2×3=6
   a) Write down the radial wave function of 3s hydrogenic orbital. Indicate the number of radial nodes.

   b) Comment on the Schotky defects exhibited by AgBr and AgCl.
   c) Discuss on the lattice defect in ZnO crystals.
   d) Compare the uncertainties of a proton and an electron in a 1Å box. [mass of proton=1.6726219×10^{-27} kg and mass of electron=9.10938356×10^{-31} kg]
   e) Comment on the relative ionic radii of S^{2-} and Cl^- using slater's rule.
3. Answer any **three** questions: 6×3=18
   a) i) Discuss the importance of H-bonding in biological systems with reference to two examples of your choices.
      ii) The hydration energies of F^- and K^+ are –121 kcal/mole and –77 kcal/mole respectively although they have the same ionic radius–Explain this difference in hydration energy. 4+2
   b) i) Arrange the following ions in order of increasing ionic radii.

$$Na^+, Mg^{2+}, Al^{3+}, O^{2-}, F^-.$$

      ii) Differentiate between zinc blende and wurtzite structures. 2+4

c) i) It is very difficult to separate Nb and Ta chemically from each other—Explain this statement.

ii) Why the melting point of KCl is much higher than AgCl although the sizes of K^+ and Ag^+ are almost the same.

iii) State and explain Pauli exclusion principle. 2+2+2

d) Write a note on Fajan's rule. 6

e) Define Schottky defect and derive an expression for the number of Schottky defects present in an ionic crystal. 2+4

4. Answer any **one** question: 10×1=10

a) i) Explain why the alkali metals are weakly paramagnetic using band theory.

ii) CdS has a band gap of 2.4 eV. Comment on its colour.

iii) Give two main features of each of the structures perovskite, itmehite and spinel to differentiate.

iv) Calculate the Z_{eff} experieneed by 3s and 3d electron of Mn.

v) What will be largest and smallest wave length of Paschen series of H atom? (R_H=109700 cm^{-1}). 2+2+2+2+2=10

b) i) The energy of an excited H-atom is – 3.4eV. Calculate the angular momentum of the electron according to Bohr's theory [Given: $m_e=9.1\times10^{-31}$ kg, $R_H=1.09\times10^7 m^{-1}$, $h=6.626\times10^{-34}$ Js, $c=3\times10^8 m\ s^{-1}$]

ii) Explain why electron affinity of Mn^{3+} is greater than Fe^{3+}?

iii) Explain why CsF assumes rock salt structure rather than CsCl structure, although the radius ratio value corresponds to coordination no. 8.

iv) Give of one example of hydrogen bond that is essential to form important biological molecular assembly.

4+2+2+2=10

[General Proficiency : $\frac{1}{2}$]

GROUP–B

(Marks : $37\frac{1}{2}$)

5. Answer any **three** questions: 1×3=3

a) Draw the structure of peroxo-disulphuric acid.

b) Complete the following transformation:

$$^{210}_{84}Po \rightarrow ? + ^{4}_{2}He + ?$$

c) Complete the following reaction:

$$HClO_4 + HF \rightarrow$$

d) What do you mean by surface acid?

6. Answer any **three** questions: 2×3=6

a) The B–F bond lengths in BF_3 are shorter than in $H_3N \rightarrow BF_3$ — Explain.

b) How urea will behave in water, liquid ammonia and in anhydrous H_2SO_4?

c) 1 gm radium-226 is placed in a sealed tube. How much helium will be evolved in 60 days? ($t_{1/2}$=1590 years).

d) Compare the basicity of trimethylammonium hydroxide and tetramethyl ammonium hydroxide in water with explanation.

e) In presence of *cis*-diol, H_3BO_3 can be successfully titrated with NaOH— Explain.

7. Answer any **three** questions: 6×3=18

a) i) Draw the nutralisation curve when a weak acid is titrated with a weak base.

ii) What will be the effect on acidity when $CuSO_4$ is added to an aqueous solution of $(NH_4)_2SO_4$.

iii) What are per acids? Draw the structures of persulphate and perchlorate anious. Justify their nomenclature. 1+2+1+(1+1)=6

b) i) Give the names, formulae and structural features of different kind of silicates.

ii) The difference in atomic radii between Sn and Pb is less than the difference in atomic radii between Ge and Sn. – Explain. 4+2=6

c) i) Give a brief description of determination of age by radiocarbon dating.

ii) Define buffer capacity. 4+2=6

d) i) How many fissions are required to produce 600 MW power with an efficiency of 30%? Average energy per fision in 200 MeV.

ii) Aqueous solutions of $KHSO_4$ and K_2SO_4 are mixed in the ratio 1:2 the pH of the

solution is 2.30. Calculate pKa of HSO_4^-. 3+3=6

e) i) Differentiate between spallation and fission reactions.

ii) "The radionuclides with n/p ratio above the stability ratio emit β particles rather than neutrons"– Explain.

iii) Why SiO_2 is solid whereas CO_2 is gaseous? 2+2+2=6

8. Answer any **one** question: 10×1=10

a) i) Write a short note on phosphazenes.

ii) What are the common ores of uranium? Discuss the methodology for extraction of uranium from one of its ore.

iii) What do you understand by magic numbers? 4+4+2

b) i) Give a comparative account of the nuclear binding energy curve and packing fraction curve. What information are available from these curves?

ii) Write a short note on oxidizing behaviour of perborate.

iii) Why boron nitride is called inorganic graphite? 4+4+2

(General Proficiency : $\frac{1}{2}$)

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