

Total number of printed pages-8

1 (Sem-4/FYUGP) CHE 41 MJ

2026

CHEMISTRY

(Major)

Paper : CHE4400104MJ

(Inorganic Chemistry-I)

Full Marks : 45

Time : 2 hours

*The figures in the margin indicate
full marks for the questions.*

1. Answer the following questions as directed :

$$1 \times 5 = 5$$

- (i) Predict the symmetry point group of H_2S molecule.
- (ii) Write the electronic configuration of Fe in $[Fe(CN)_6]^{4-}$ in terms of t_{2g} and e_g in an octahedral field when $\Delta_o < P$.
- (iii) Write the most stable oxidation state in each of Cu , Ag and Au ?
- (iv) Which of the following elements does not show disproportion reaction?
 - (a) Mn
 - (b) Cu
 - (c) Cl
 - (d) K
- (v) How many α and β particles will be released when ${}_{92}U^{238}$ successfully disintegrates to be transformed to ${}_{82}Pb^{206}$?

2. Answer **any five** from the following questions :

$$2 \times 5 = 10$$

- (i) Draw all the symmetry elements present in ammonia molecule.

- (ii) What is John Teller effect? Give the splitting of d orbitals in z -in and z -out pattern of distortion.

- (iii) What is zone refining? Which type of substances is purified by it?

- (iv) $FeSO_4$ solution is always prepared in dilute sulphuric acid. Explain.

- (v) Write the nuclear reaction involved in carbon dating.

- (vi) Actinoids have greater tendency to form complexes than actinoids. Explain.

- (vii) Calculate the bond order of $[Re_2Cl_8]^{2-}$ and give its magnetic property.

- (viii) Why is +3 the common oxidation state for lanthanides?

- (ix) The tendency of a metal ion to form compounds of high coordination numbers decreases across the first-row transition elements. Explain.

- (x) Show that $1 \text{ amu} = 1.66 \times 10^{-27} \text{ Kg}$
 $= 913.5 \text{ MeV}$ of energy.

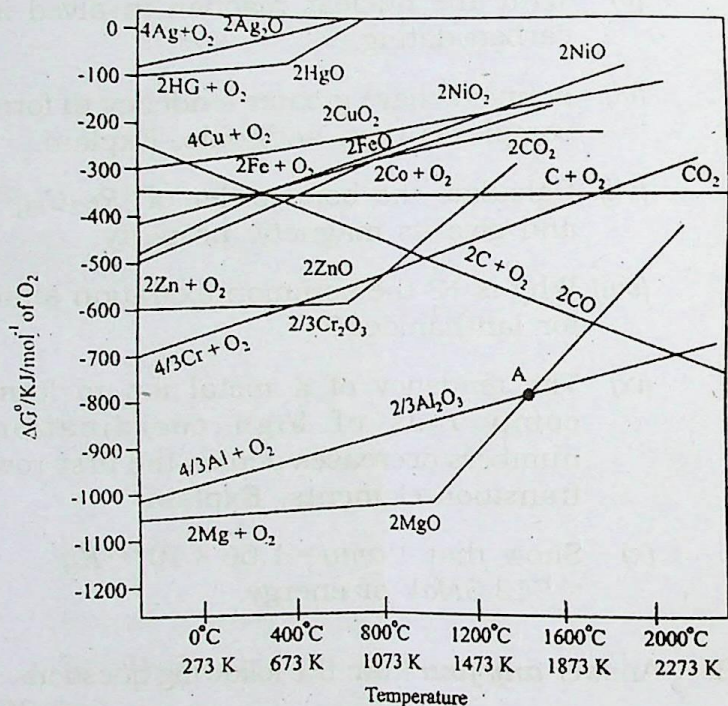
3. Answer **any four** from the following questions :

$$5 \times 4 = 20$$

- (i) Find all the symmetry elements in an O_h point group.

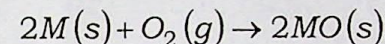
(ii) Calculate CFSE in terms of Δ_0 and P for high spin and low spin octahedral complexes of $Fe(II)$ and $Co(II)$. Predict whether the complexes will be paramagnetic or diamagnetic.

(iii) Consider the following Ellingham diagram for oxides and answer the following questions :



(a) What does the slope of the lines represent?

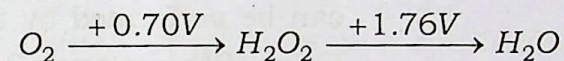
(b) $\Delta G^\circ = RT \ln K$. What is the expression for K for the general reaction :



(c) At what temperature can carbon reduce zinc oxide?

$$1+2+2=5$$

(iv) (a) Using the Latimer diagram of oxygen given below :



Draw the Frost diagram of oxygen. From these diagrams indicate (a) which is the most stable species, and (b) which species would undergo disproportionation?

(b) The mass defect for ${}^7N^{14}$ was found to be $0.112 amu$. Calculate the binding energy per nucleon.

$$3+2=5$$

(v) (a) State why the elements of the second transition series show properties which are more similar to those of the third transition series than the first transition series.

- (b) Discuss the principles of extraction of nickel from its ore.

2+3=5

- (vi) (a) Half life period of a radioactive element is 1×10^{-6} sec. How long will it take for 90% disintegration?

- (b) What is a symmetry operation? How many symmetry operations can be performed by the operator C_3 on BF_3 molecule?

3+2=5

- (vii) (a) Square planar d^8 paramagnetic complexes are extremely rare. Account for this observation with a crystal field argument.

- (b) The second ionization energy of Cu and Cr are sufficiently high. Explain why.

3+2=5

- (viii) How many oxides of vanadium are known? Give preparation, properties and uses V_2O_5 .

2+3=5

4. Answer **any one** from the following questions:

10

- (i) (a) Why are transition metals capable of showing variable oxidation state? Give a brief description of stable and unstable oxidation states of V, Cr, Mn and Fe.

1+4=5

- (b) Describe Mond's process to purify Nickel.

5

- (ii) (a) What is an improper rotational axis of symmetry (S_n)? Give an example of a molecule with centre of inversion (i).

- (b) Give the factors affecting the magnitude of Δ_0 .

- (c) Define electrolytic reduction with an example.

- (d) Explain autoxidation with an example.

- (e) La^{4+} ion does not exist. Explain.

2×5=10

- (iii) (a) Discuss the bonding in an octahedral molecule with the help of molecular orbital theory considering σ -bond only.

5

- (b) Will Hg_2^{2+} ion disproportionate in aqueous solution into Hg^{2+} and Hg^0 ? Given that

$$E^0(Hg_2^{2+}/Hg^0) = 0.7960V$$

$$E^0(Hg^{2+}/Hg_2^{2+}) = 0.9110V$$

$$E^0(Hg^{2+}/Hg^0) = 0.8535V$$

5

- (iv) (a) Derive integrated form of equation for the decay of radioactive element. Deduce the expression for $t_{1/2}$. 3+2=5

- (b) Discuss the ion exchange method of separation of lanthanides.

5