Civil Services (Main) Examination, 2002

# CHEMISTRY

## (Paper I)

**Time Allowed : Three Hours** **Maximum Marks : 300**

### QUESTION PAPER SPECIFIC INSTRUCTIONS

*(Please read each of the following instructions carefully before attempting questions)*

There are EIGHT questions divided in two Sections.
Candidate has to attempt FIVE questions in all.
Question Nos. 1 and 5 are compulsory and out of the remaining, any THREE are to be attempted choosing at least ONE question from each Section.
The number of marks carried by a question/part is indicated against it.
Wherever any assumptions are made for answering a question, they must be clearly indicated.
Word limit in questions, wherever specified, should be adhered to.

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## SECTION 'A'

**1.** Answer any three of the following:

**(a)** Discuss the factors that decide the percent ionic character of polar compounds. **20**

**(b)** Resonance is a necessity in VB theory but not so in MO theory – Discuss with reference to nitrite ion. **20**

**(c)** Draw the MO energy level diagram for $O_2$ and discuss the bonding features. **20**

**(d)** Discuss the structures of NaCl and $TiO_2$ (rutile). **20**

**2. (a)** Prove that entropy is a state function. **30**

**(b)** Discuss the entropy of phase transition at the transition temperature and the variation of entropy with temperature. **30**

**3. (a)** Write Schrodinger equation and its solution from Interpret the equation with respect to probability density, eigenvalues and eigenfunctions. **20**

**(b)** Derive Born-Lande equation for the lattice energy of an ionic compound. **20**

**(c)** Explain the construction and functioning of lithium battery and its advantages. **20**

**4. (a)** What are indicator electrodes? Discuss three kinds of metal indicator electrodes. **15**

**(b)** Give the construction and functioning of a liquid ion-exchange electrode and a gas-sensing electrode. **30**

**(c)(i)** What are Miller indices? Discuss their usefulness in expressing the separation of planes. **7**

**(c)(ii)** Calculate the separation of (a) the {123} planes and (b) the {246} planes of an orthorhombic unit cell with a = 0.71 nm, b = 0.93 nm and c = 0.75 nm. **8**

## SECTION 'B'

**5.** Answer any three of the following:

**(a)** Derive the polarographic wave equation and prove that $E$ is approximately equal to $E_{1/2}$. **20**

**(b)** Discuss the various titrations that can be performed in amperometry. **20**

**(c)** Explain in vivo and in vitro fixation of nitrogen. **20**

**(d)** Explain the phosphorescent behaviour of chlorophyll and the significance of cytochromes. **20**

*English version compiled from published transcriptions and cross-checked across sources; not a facsimile of the official UPSC question paper.*



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**6.** **(a)** What is denoted by the quantity 10 Dq? How is it measured? What are the factors that affect the magnitude of 10 Dq? **20**

**(b)** Explain with suitable examples geometrical, optical and linkage isomerisms in co-ordination compounds. **20**

**(c)** Describe the techniques used for the measurement of surface area and types of acidic sites of a catalyst. **20**

**7.** **(a)** Discuss the general features of aprotic solvents and the properties of $BrF_3$. **20**

**(b)** Explain the techniques of stopped-flow and flash photolysis to study the kinetics of a reaction. **20**

**(c)** Compare the electronic configurations, spectral and magnetic properties of actinides with those of lanthanides. **20**

**8.** **(a)** Discuss the formation, structure and properties of metal complexes involving NO. **20**

**(b)** What are fluxional? Discuss their structural aspects with two suitable examples. **20**

**(c)** Explain Debye-Huckel limiting law and the extended Debye-Huckel law. Calculate the ionic strength and the mean activity co-efficient of 1.0 m $mol.kg^{-1}$ $CaCl_2$ (aq) at 25 C. **20**



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