**TDC Part II**

**Paper I, Group B**

**Inorganic Chemistry**



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TOPIC:-UNIT -3,

### Stereochemistry of the compounds and complexes

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The stereochemistry of the compounds and complexes of the elements of this series may be summarized groupwise. The elements exhibit different stereochemistry depending on the oxidation state, coordination number and ligand in the particular compound / complex. For example, the stereochemistry of zirconium (Group 4) is tabulated below in Table 2.1.

### Table 2.1: Oxidation states and stereochemistries of zirconiium compounds

|  |  |  |  |
| --- | --- | --- | --- |
| **Oxidation state** | **Coordination number** | **Geometry** | **Examples** |
| Zr0 | 6 | Octahedral | [Zr(bipy)3] |
| Zr3+ | 6 | Octahedral | ZrX3 (X = Cl, Br,I) |
| Zr4+ | 4  6  7  8 | Tetrahedral Octahedral  Pentagonal bipyramidal  Sqnare antiprism Dodecahedral | [ZrCl4], [Zr(CH2C6H5)4]  [ZrF6]2-, [ZrCl6]2-, [Zr(acac)2Cl2] [ZrF7]3-  [Zr(acac)4]  [Zr(C2O4)4]4-, [ZrX4.(diars)2] |

The stereochemistry of niobium (Group 5 element) is being summarized below in Table 2.2.

### Table 2.2: Oxidation states and stereochemistries of niobium compounds

|  |  |  |  |
| --- | --- | --- | --- |
| **Oxidation**  **state** | **Coordination**  **number** | **Geometry** | **Examples** |
| -3 | 5 | Trigonal bipyramidal | [Nb(CO)5]3- |
| -1 | 6 | Octahedral | [Nb(CO)6]- |
| +3 | 6 | Trigonal prism | [NbO2]- |
|  |  | Octahedral | [Nb2Cl9]3- |
|  | 8 | Dodecahedral | [Nb(CN)8]5- |
| +4 | 6 | Octahedral  Distoted pentagonal bipyramidal  Square antiprism Dodecahedral | [NbCl6]2- |
|  |  | K3[NbF7] |
|  | 7 |  |
|  | 8 | [Nb(SCN)4(dipy)2] |
|  |  | K4[Nb(CN)8] |
| +5 | 4 | Tetrahedral | [NbO4]- |
|  | 5  6 | Trigonal bipyramidal  Octahedral | [NbCl5], [Nb(NR2)5]  [NbCl5.OPCl3], [NbCl6]- |

The stereochemistry of molybdenum (Group 6 element) is given below in Table 2.3.

### Table 2.3: Oxidation states and stereochemistries of molybdenum compounds

|  |  |  |  |
| --- | --- | --- | --- |
| **Oxidation state** | **Coordination number** | **Geometry** | **Examples** |
| -2 | 5 | Trigonal bipyramidal | [Mo(CO)5]2- |
| -1 | 6 | Octahedral | [M2(CO)10]2- |
| 0 | 6 | Octahedral | [Mo(CO)6s], [Mo(CO)5I]- |
| +2 | 6 | Octahedral | [Mo(diars)2 X2] [Mo(CNR)7]2+  Mo6Cl12 |
|  | 7 | Capped trigonal prismatic |
|  | 9 | Cluster compound |
| +3 | 6 | Octahedral | [Mo(NCS)6]3-, [MoCl6]3- |
|  | 8 | Dodecahedral | [Mo(CN)7(H2O)]4- |
| +4 | 6 | Octahedral | [Mo(NCS)6]2- |
|  | 8 | Dodecahedral | [Mo(CN)8]4- |
| +5 | 5 | Trigonal bipyramidal | MoCl5 |
|  | 6 | Octahedral | [Mo2Cl10], [MoOCl5]2- |
|  | 8 | Dodecahedral | [Mo(CN)8]3- |
| +6 | 4 | Tetrahedral | [MoO4]2-, [MoO2Cl2] |
|  | 6 | Octahedral | [MoO6], [MoF6] |

The stereochemistry of technetium (Group7 element) is not much explored. Only very few examples of this element are known. Still some of them are given in Table 2.4.

### Table 2.4: Oxidation states and stereochemistries of technitium compounds

|  |  |  |  |
| --- | --- | --- | --- |
| **Oxidation state** | **Coordination number** | **Geometry** | **Examples** |
| 0 | 6 | Octahedral | [Tc2(CO)10] |
| +2 | 6 | Octahedral | [Tc(diars)2Cl2] |
| +3 | 6 | Octahedral | [Tc(diars)2Cl2]+ |
| +4 | 6 | Octahedral | [TcX6]2- |
| +5 | 5  8 | Square pyramidal  Dodecahedral | [TcOX4]-  [M(diars)2Cl4]+ |
| +6 | 6 | Octahedral | [TcF6] |
| +7 | 4 | Tetrahedral | [TcO4]-, [TcO3Cl] |

The stereochemistry of ruthenium (Group 8 element) is being given in Table 2.5.

### Table 2.5: Oxidation states and stereochemistries of ruthenium compounds

|  |  |  |  |
| --- | --- | --- | --- |
| **Oxidation state** | **Coordination number** | **Geometry** | **Examples** |
| -2 | 4 | Tetrahedral | [Ru(CO)4]2- |
| 0 | 5 | Trigonal bipyramidal | [Ru(CO)5], [Ru(CO)3(PPh3)2] |
| +2 | 6 | Octahedral | [RuNOCl5]2-, [Ru(dipy)3]2+ |
| +3 | 6 | Octahedral | [Ru(NH3)5Cl]2+, [Ru(H2O)Cl5]2- |
| +4 | 6 | Octahedral | K2[RuCl6] |
| +5 | 6 | Octahedral | K[RuF6], [RuF5]4 |
| +6 | 4 | Tetrahedral | [RuO4]2- |
|  | 5 | Trigonal | [RuO3(OH)2]2- |
|  | 6 | bipyramidal | [RuF6] |
|  |  | Octahedral |  |
| +7 | 4 | Tetrahedral | [RuO4]- |
| +8 | 4 | Tetrahedral | [RuO4] |

The stereochemistry of rhodium (Group 9 element) has been given in Table. 2.6.

### Table 2.6: Oxidation states and stereochemistries of rhodium compounds

|  |  |  |  |
| --- | --- | --- | --- |
| **Oxidation state** | **Coordination number** | **Geometry** | **Examples** |
| -1 | 4 | Tetrahedral | [Rh(CO)4]- |
| +1 | 3 | Planar | [Rh(PPh3)3]ClO4 |
|  | 4 | Tetrahedral | [Rh(PMe3)4]+ |
|  | 5 | Trigonal bipyramidal | [HRh(PF3)4] |
| +3 | 5 | Square pyramidal | [RhI2(CH3)(PPh3)2] |
|  | 6 | Octahedral | [Rh(H2O)6]3+, [RhCl6]3- |
| +4 | 6 | Octahedral | K2[RhF6] |
| +6 | 6 | Octahedral | [RhF6] |

The stereochemistry of less explored element palladium (group 10) has been given in Table. 2.7.

### Table 2.7: Oxidation states and stereochemistries of palladium compounds

|  |  |  |  |
| --- | --- | --- | --- |
| **Oxidation**  **state** | **Coordination**  **number** | **Geometry** | **Examples** |
| 0 | 3  4 | Planar  Tetrahedral | [Pd(PPh3)3]  [Pd(PF3)4] |
| +2 | 4 | Planar | [Pd(NH3)4]Cl2 |
| +4 | 6 | Octahedral | [PdCl6]2- |

The stereochemistry of silver (Group 11element) is being given below: Table. 2.8.

### Table 2.9: Oxidation states and stereochemistries of silver compounds

|  |  |  |  |
| --- | --- | --- | --- |
| **Oxidation**  **state** | **Coordination**  **number** | **Geometry** | **Examples** |
| +1 | 2 | Linear | Ag(CN) -, Ag(NH ) +  2 3 2 |
|  | 4 | Tetrahedral | [Ag(SCN)4]3-, [Ag(py)4]ClO4 |
|  | 6 | Octahedral | AgCl, AgF, Ag Br, (NaCl |
|  |  |  | structure) |
| +2 | 4 | Planar | [Ag(py)4]2+ |
| +3 | 4 | Planar | [AgF4]- |
|  | 6 | Octahedral | [Ag(IO6)2]7-, [AgF6] |