Meden School Curriculum Planning							
Subject	Chemistry	**Year Group**	13	**Sequence No.**		**Topic**	3.2.5 Transition Metals

Retrieval	Core Knowledge	Student Thinking
What do teachers need to **retrieve** from students before they start teaching **new content**?	What **specific ambitious knowledge** do teachers need to teach students in this sequence of learning?	What real life examples can be applied to this sequence of learning to **development of our students thinking, encouraging them to see the inequalities around them** and 'do something about them!'
KS4 Chemistry properties of transition metals, including variable oxidation states, coloured compounds and catalytic uses. A level Chemistry electronic configuration of the d-block elements A level Chemistry shapes of molecules	**3.2.5.1 General Properties of Transition Metals** Transition metal characteristics of elements Ti–Cu arise from an incomplete d sub-level in atoms or ions. The characteristic properties include: • complex formation • formation of coloured ions • variable oxidation state • catalytic activity. A ligand is a molecule or ion that forms a co-ordinate bond with a transition metal by donating a pair of electrons. A complex is a central metal atom or ion surrounded by ligands. Co-ordination number is number of co-ordinate bonds to the central metal atom or ion. **3.2.5.2** H2O, NH3 and Cl− can act as monodentate ligands. The ligands NH3 and H2O are similar in size and are uncharged. Exchange of the ligands NH3 and H2O occurs without change of co-ordination number (eg Co2+ and Cu2+). Substitution may be incomplete (eg the formation of [Cu(NH3)4(H2O)2]2+).	Research uses of transition metals. International market requirements for transition metals. Examine the effects of mining across the globe. Global exploitation of developing countries. Destruction of habitats due to mining.

A level Chemistry Titration calculations	The Cl– ligand is larger than the uncharged ligands NH3 and H2O Exchange of the ligand H2O by Cl– can involve a change of co-ordination number (eg Co2+, Cu2+ and Fe3+). Ligands can be bidentate (eg H2NCH2CH2NH2 and C2O 2–). 4 Ligands can be multidentate (eg EDTA4–). Haem is an iron(II) complex with a multidentate ligand. Oxygen forms a co-ordinate bond to Fe(II) in haemoglobin, enabling oxygen to be transported in the blood. Carbon monoxide is toxic because it replaces oxygen co-ordinately bonded to Fe(II) in haemoglobin. Bidentate and multidentate ligands replace monodentate ligands from complexes. This is called the chelate effect. Students should be able to explain the chelate effect, in terms of the balance between the entropy and enthalpy change in these reactions. Students could carry out test-tube reactions of complexes with monodentate, bidentate and multidentate ligands to compare ease of substitution. Students could carry out test-tube reactions of solutions of metal aqua ions with ammonia or concentrated hydrochloric acid. **3.2.5.3 Shapes of Complex Ions** Transition metal ions commonly form octahedral complexes with small ligands (eg H2O and NH3). Octahedral complexes can display cis–trans isomerism (a special case of E–Z isomerism) with monodentate ligands and optical isomerism with bidentate ligands. Transition metal ions commonly form tetrahedral complexes with larger ligands (eg Cl–). Square planar complexes are also formed and can display cis–trans isomerism. Cisplatin is the cis isomer. Ag+ forms the linear complex [Ag(NH3)2]+ as used in Tollens' reagent. Students understand and draw the shape of complex ions. Students understand the origin of cis–trans and optical isomerism. Students draw cis–trans and optical isomers.	

	Students describe the types of stereoisomerism shown by molecules/ complexes. **3.2.5.4 Formation of Coloured Ions** Transition metal ions can be identified by their colour. Colour arises when some of the wavelengths of visible light are absorbed and the remaining wavelengths of light are transmitted or reflected. d electrons move from the ground state to an excited state when light is absorbed. The energy difference between the ground state and the excited state of the d electrons is given by: $\Delta E = h\nu = hc/\lambda$ Changes in oxidation state, co-ordination number and ligand alter ΔE and this leads to a change in colour. The absorption of visible light is used in spectroscopy. A simple colorimeter can be used to determine the concentration of coloured ions in solution. Students could determine the concentration of a solution of copper(II) ions by colorimetry. Students determine the concentration of a solution from a graph of absorption versus concentration. Students could determine the concentration of a coloured complex ion by colorimetry. **3.2.5.5 Variable Oxidation States** Transition elements show variable oxidation states. Vanadium species in oxidation states IV, III and II are formed by the reduction of vanadate(V) ions by zinc in acidic solution. The redox potential for a transition metal ion changing from a higher to a lower oxidation state is influenced by pH and by the ligand. The reduction of [Ag(NH3)2]+ (Tollens' reagent) to metallic silver is used to distinguish between aldehydes and ketones. The redox titrations of Fe2+ and C2O4 with MnO42– Students should be able to perform calculations for these titrations and similar redox reactions Students could reduce vanadate(V) with zinc in acidic solution. Students could carry out test-tube reactions of Tollens' reagent to distinguish aldehydes and ketones. Students could carry out redox titrations.	

	Examples include, finding: • the mass of iron in an iron tablet • the percentage of iron in steel • the Mr of hydrated ammonium iron(II) sulfate • the Mr of ethanedioic acid • the concentration of H2O2 in hair bleach. **3.2.5.6 Catalysts** Transition metals and their compounds can act as heterogeneous and homogeneous catalysts. A heterogeneous catalyst is in a different phase from the reactants and the reaction occurs at active sites on the surface. The use of a support medium to maximise the surface area of a heterogeneous catalyst and minimise the cost. V2O5 acts as a heterogeneous catalyst in the Contact process. Fe is used as a heterogeneous catalyst in the Haber process. Heterogeneous catalysts can become poisoned by impurities that block the active sites and consequently have reduced efficiency; this has a cost implication. A homogeneous catalyst is in the same phase as the reactants. When catalysts and reactants are in the same phase, the reaction proceeds through an intermediate species. Students should be able to: • explain the importance of variable oxidation states in catalysis • explain, with the aid of equations, how V2O5 acts as a catalyst in the Contact process • explain, with the aid of equations, how Fe2+ ions catalyse the reaction between I− and S2O8 2– • explain, with the aid of equations, how Mn2+ ions autocatalyse the reaction between C2O4 and MnO4 2– Students could investigate Mn2+ as the autocatalyst in the reaction between ethanedioic acid and acidified potassium manganate(VII).	