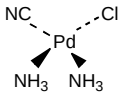
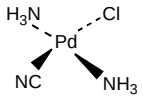
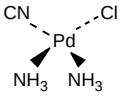
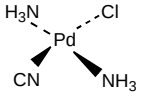
CH1012 Tutorial 4 Answers

1.





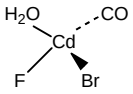




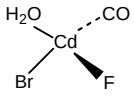
geometric cis trans

cis – linkage isomer trans – linkage isomer

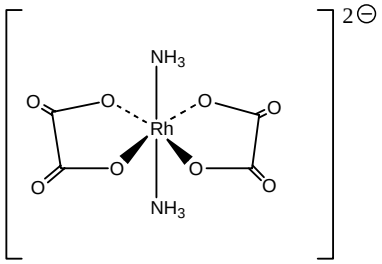
optical

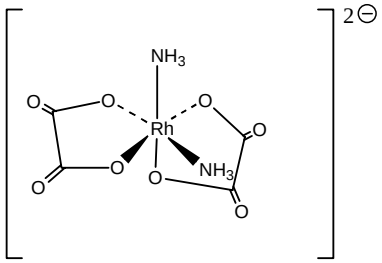


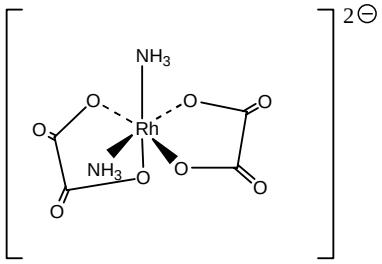
(S)



(R)







geometric trans cis

cis – optical isomer

2. Assign the oxidation state of carbon in the following compounds: $C_{diamond}$ $NaHCO_3$ C_2F_2

0 -1 = C +1 –(3*-2) +1

(by defn.) C = +IV

3. Determine if the following reactions are redox or metathesis reactions, explain your decision.

For <u>redox</u> reaction(s) identify the oxidised and reduced species.

(i) $2Ca(s) + O_2(g) \rightarrow 2CaO(s)$ - redox

0 0 +2 -2

Ca is oxidised O is reduced

(ii) $Ca(OH)_2(s) + H^+(aq) \rightarrow Ca^{2+}(aq) + H_2O$ - metathesis

driving force formation of the weak electrolyte water.

4. Balance the following redox equation in acidic solution, show all the steps in your working.

$$MnO_4^-(aq) + H_2O_2(aq) \rightarrow Mn^{2+}(aq) + O_2(g)$$

$$2(MnO_4^- + 8H^+ + 5e^- \rightarrow Mn^{2+} + 4H_2O)$$

$$5(H_2O_2 \rightarrow O_2 + 2H^+ + 2e^-)$$

$$2MnO_4^- + 16H^+ + 5H_2O_2 \rightarrow 2Mn^{2+} + 5O_2 + 8H_2O + 10H^+$$

$$2MnO_4^-(aq) + 5H_2O_2(aq) + 6H^+(aq) \rightarrow 2Mn^{2+}(aq) + 8H_2O(l) + 5O_2(g)$$

5. What is the **spectrochemical series** and how does this series help us understand the colour of transition metal complexes?

The spectrochemical series is a ranking of ligands in relation to the ability of the ligand to split the energy of the d-orbitals (the crystal field splitting energy Δ), weak field ligands show a small splitting and strong field ligands a large splitting.

$Cl^- < F^- < OH^- < H_2O < NH_3 <$ en $< NO_2^- < CN^- < CO$

weak field, small Δ strong field, large Δ

long λ absorbed short λ absorbed

The crystal field splitting energy Δ results from the increase in the energies of the dz^2 and dx^2-y^2 orbitals of the 5 x d orbitals as ligands approach the isolated metal ion (where all 5 orbital are of the same energy).
The triply degenerate set of orbitals at lower energy is called the t_{2g} set and the doubly degenerate set e_g .
The energy separating the t_{2g} and e_g sets is called the crystal splitting energy Δ.
Light absorption occurs in the TM complexes as an electron is excited from the t_{2g} to e_g sets of orbitals.
Ligands influence the size of Δ and therefore the colours of the complexes.
The spectrochemical series then effectively relates the colour of complexes to the field strength of the ligands and the size of Δ.