RS•C

Part 3 Post-16 – Aspects of the platinum group metals (PGM)

Teacher 's notes

This worksheet can stand alone as a teaching and comprehension exercise. It is based on the principles by which the PGM are extracted and separated from a solution of the PGM in 6 mol dm^{-3} hydrochloric acid.

The reading exercise is particularly useful to stretch more able students although the questions are relatively straightforward.

Curriculum links

d-Block elements and ligands, complexes, oxidation numbers, shapes of complexes, redox reactions and use of $E^{\ominus}$.

Level

Post-16 courses.

Timing

60–70 mins.

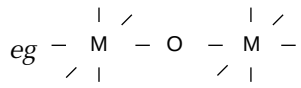
Answers to questions on aspects of the platinum group metals (PGM)

1. a) Molecules or ions which form dative bonds to transition metal ions.

   b) d-Block metal surrounded by ligands.

   c) The number of ligands which surround the metal.

   d) A complex in which two metal atoms are joined via an oxygen atom.



2. One example from a), b) and c) below

   a) $PdCl_4^{2-}$

   $PtCl_4^{2-}$

   b) $[RuCl_6]^{3-}$

   $[RuCl_5(H_2O)]^{2-}$

   $[RuCl_4(H_2O)_2]^{-}$

   $[RuCl_3(H_2O)_3]$

   $[OsCl_6]^{3-}$

   $[OsCl_5(H_2O)]^{2-}$

   $[OsCl_4(H_2O)_2]^{-}$

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$[RhCl_6]^{3-}$

$[RhCl_5(H_2O)]^{2-}$

$[RhCl_4(H_2O)_2]^{-}$

$[IrCl_6]^{3-}$

$[IrCl_5(H_2O)]^{2-}$

$[IrCl_4(H_2O)_2]^{-}$

$[AuCl_4]^{-}$

c) $[RuCl_6]^{2-}$

$[Ru_2OCl_{10}]^{4-}$

$[Ru_2OCl_8(H_2O)_2]^{2-}$

$[OsCl_6]^{2-}$

$[IrCl_6]^{2-}$

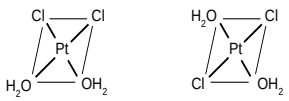
$[PdCl_6]^{2-}$

$[PtCl_6]^{2-}$

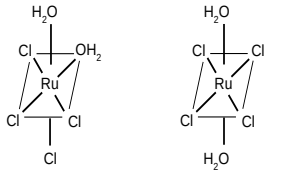
3. a) (i) Octahedral.

(ii) Two octahedra joined by an oxygen bridge as in 1(d).

b)



(cis and trans)



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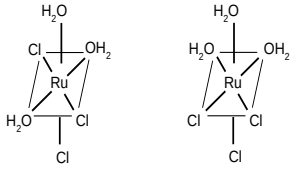

(mer and fac)

4. a) $[RhCl_5(H_2O)]^{2-}$ > *cis* $[RhCl_4(H_2O)_2]^{-}$ > *fac* $[Rh\ Cl_3(H_2O)_3]$ > $[RhCl_6]^{3-}$

b) $[Rh\ Cl_5(H_2O)]^{2-}$ > $[RhCl_6]^{3-}$ > *cis* $[RhCl_4(H_2O)_2]^{-}$ > *fac* $[Rh\ Cl_3(H_2O)_3]$

5. a) $[MCl_4]^{-}$ > $[MCl_6]^{2-}$ because for steric reasons it is harder to pack two bulky mono cations around $[MCl_6]^{2-}$ than one around $[MCl_4]^{-}$.

NB In the organic phase, the species exist as ion pairs with cations packing around the anions. In the aqueous phase, the cations and anions are separate.

b) $[MCl_6]^{2-}$ > $[MCl_5(H_2O)]^{2-}$ due to hydrogen bonding of the water ligand with the water molecules, this complex tends to stay in the aqueous (acid) phase, making it less likely to dissolve in the organic phase.