

1. State the full electron arrangement of each of the following transition metals:

- | | | |
|--------------|---------------|--------------|
| (a) copper | (b) Iron | (c) vanadium |
| (d) chromium | (e) manganese | (f) zinc |

2. State the full electron arrangement of the following ions.

- | | | |
|-------------------|-------------------|--------------------|
| (a) copper (I) | (b) Iron(II) | (c) vanadium (III) |
| (d) chromium(III) | (e) manganese(IV) | (f) zinc(II) |

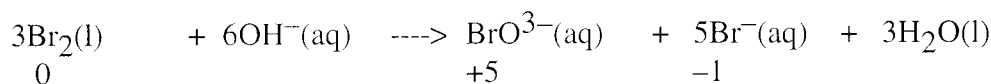
3. Calculate the oxidation number of the transition metal in each of the compounds below.

- | | |
|---------------------|--|
| (a) KMnO_4 | (b) $\text{Na}_2\text{Cr}_2\text{O}_7$ |
| (c) KCrO_4 | (d) NaVO_3 |

4. For each of the changes below calculate the oxidation number of the metal on each side of the equation and hence calculate if the equation represents oxidation or reduction.

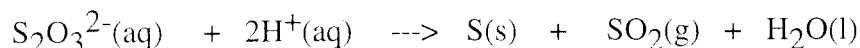
- (a) $\text{MnO}_4^- \rightarrow \text{Mn}^{2+}$
 (b) $\text{Cr}_2\text{O}_7^{2-} \rightarrow \text{Cr}^{3+}$
 (c) $\text{V}^{3+} \rightarrow \text{VO}_3^+$

5. Bromine reacts with hot alkali as follows



In this reaction, the bromine exists in different oxidation states, shown under the equation. In a reaction like this where the oxidation number for an element or an ion changes to give two other oxidation numbers (one being higher and the other lower), the reaction is known as disproportionation.

(a) Study the reaction in which sulphur is precipitated from an acidified solution containing thiosulphate ions.



Determine the three different oxidation numbers for sulphur in this reaction. Show that this is an example of disproportionation.

(b) White copper(I) sulphate powder disproportionates on adding water. What would be seen which would show that two new products had formed?

OXIDATION STATES

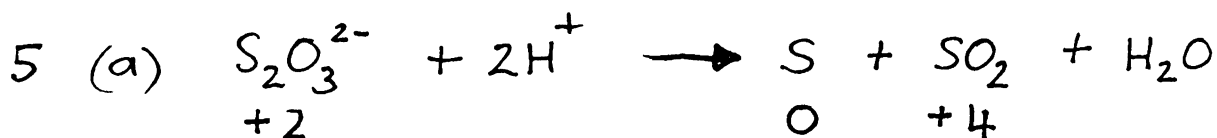
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- electron arrangements.
1. (a) Copper $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^{10}, 4s^1$
 - (b) Iron $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^6, 4s^2$
 - (c) Vanadium $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^3, 4s^2$
 - (d) Chromium $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^5, 4s^1$
 - (e) manganese $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^5, 4s^2$
 - (f) zinc $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^{10}, 4s^2$

- electron arrangements
2. (a) Cu^+ $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^{10}$
 - (b) Fe^{2+} $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^6$
 - (c) V^{3+} $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^2$
 - (d) Cr^{3+} $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^3$
 - (e) Mn^{4+} $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^3$
 - (f) Zn^{2+} $1s^2, 2s^2 2p^6, 3s^2 3p^6 3d^{10}$

3. (a) Mn - +7
- (b) Cr - +6
- (c) Cr - +7
- (d) V - +5

4. (a) +7 to +2 Reduction
- (b) +6 to +3 Reduction
- (c) +3 to +7 Oxidation



- (b) Brown solid of copper metal and a blue solution contain Cu^{2+}

1. For each of the complexes below give
 - (i) The name of the compound
 - (ii) The coordination number of the metal in the complex
 - (a) $[\text{CoBrCl}_3]^-$
 - (b) $[\text{Ni}(\text{H}_2\text{O})_3(\text{NH}_3)]^{2+}$
 - (c) $[\text{Fe}(\text{CN})_6]^{3-}$
 - (d) $[\text{Ti}(\text{H}_2\text{O})_2(\text{NH}_3)_4]^{3+}$
 - (e) $[\text{Pt}(\text{NO}_2)_4]^{4-}$
 - (f) $[\text{Cr}(\text{H}_2\text{O})_2\text{Cl}_2]^+$
 - (g) $[\text{Cu}(\text{NH}_3)_2(\text{H}_2\text{O})_2]^{2+}$
 - (h) $[\text{Cu}(\text{H}_2\text{O})_3\text{Cl}]^+$

2. Name the following compounds:
 - (a) $\text{K}_4[\text{Fe}(\text{CN})_6]$
 - (b) $\text{Na}_2[\text{Pt}(\text{CN})_6]$
 - (c) $\text{K}_2[\text{CuCl}_4]$
 - (d) $\text{Na}_3[\text{CoCl}_6]$

3. What are the formulae of the following complexes:
 - (a) hexaamminechromium(III)
 - (b) trinitrotriammincobalt(III)
 - (c) chloropentaaquachromium(III) ?

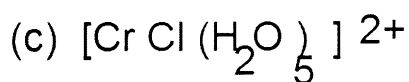
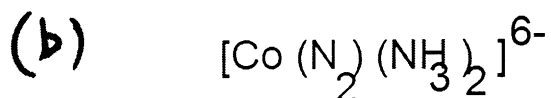
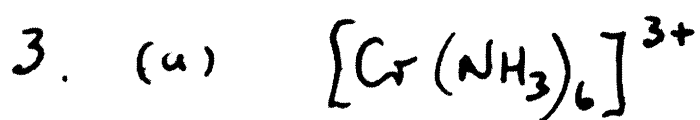
4. An atom with eight d electrons can be written in shorthand as d8.
 - (a) There is only one way of arranging the electrons in a d8 octahedral complex. Show the arrangement on a diagram.
 - (b) How many unpaired electrons are there in a d8 octahedral complex?

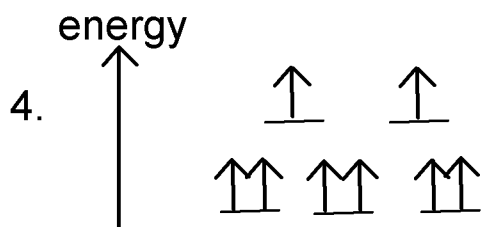
5. The ion $[\text{Ni}(\text{H}_2\text{O})_6]^{2+}$ is present in an aqueous solution of nickel sulphate. When concentrated hydrochloric acid is added to the solution the light green colour changes to a dark green.
 - (a) Calculate the oxidation state and electronic configuration of nickel in the above complex.
 - (b) Explain why the nickel ion is coloured in this complex.
 - (c) Explain why addition of concentrated hydrochloric acid changes the colour of the complex.

This is complex stuff

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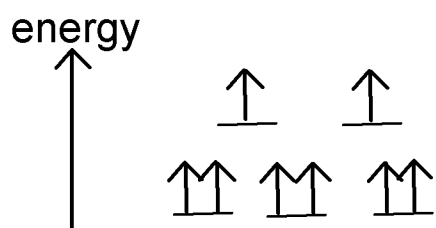
1. (a) Bromotrichlorocobalte(III) (4)
 - (b) Amminetriaquanickel(II) (4)
 - (c) Hexacyanoferrate(III) (6)
 - (d) Tetraamminediaquatitanium(II) (6)
 - (e) Tetranitritoplatinium(0) (4)
 - (f) DIAQUADICHLORO CHROMIUM III (4)
 - (g) DIAMMINE DIAQUA COPPER II (4)
 - (h) TRIAQUA CHLORO COPPER II (4)
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2. (a) POTASSIUM HEXACYANO FERRATE II
 - (b) SODIUM HEXACYANO PLATINATE IV
 - (c) POTASSIUM TETRACHLORO CUPRATE II
 - (d) SODIUM HEXACHLORO COBALTATE III





(b) 2 unpaired electrons

5. Oxidation state of the nickel is 2+ [Ar] 3d⁸



(b) Photons of light of a specific energy are absorbed by d electrons as they move to the higher energy d orbitals. (d to d transitions)

(c) The chloride ligand produces a bigger energy gap between the Split d orbitals. This means that photons absorbed by the electrons as they are promoted will be greater in energy and a different colour will result.