

OCR (A) Chemistry A-level

Topic 5.3.1 - Transition Elements

Topic 5.3.2 - Qualitative Analysis

Flashcards

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Define a transition element



Define a transition element

A d block element that forms at least one stable ion with partially filled d subshell



Where are the transition metals located in the periodic table?



Where are the transition metals located in the periodic table?

In the middle block from Ti to Cu



What are the 2 elements in d block that are not considered as transition metals?



What are the 2 elements in d block that are not considered as transition metals?

Scandium and zinc



Why is scandium and zinc not considered as transition metals?



Why is scandium and zinc not considered as transition metals?

Scandium only forms Sc^{3+} , where the d orbitals are empty

Zinc only forms Zn^{2+} where the d orbitals are full



What is the noble gas configuration of chromium?



What is the noble gas configuration of chromium?



What is the noble gas configuration of copper?



What is the noble gas configuration of copper?



Which electrons do transition metals lose first when forming ions?



Which electrons do transition metals lose first when forming ions?

4s



What are some characteristic physical properties of transition metals?



What are some characteristic physical properties of transition metals?

- Metallic
- High density
- High melting and boiling point
- Shiny
- Good conductors of heat and electricity



What are the characteristic chemical properties of transition metals (4)?



What are the characteristic chemical properties of transition metals (4)?

- Variable oxidation states → take part in many redox reactions
- Coloured compounds/ions in solution
- Good catalysts
- Form complex ions



In potassium manganate (VII),
what is the oxidation number
of Mn?



In potassium manganate (VII), what is the oxidation number of Mn?

Mn = +7



What are the 2 main ways in which transition metals act as an effective catalyst?



What are the 2 main ways in which transition metals act as an effective catalyst?

- They provide a surface on which reaction can take place
- They change oxidation states to form intermediates required for pathways with lower activation energy



Give some examples of transition metal catalysts and the processes/reactions they catalyse (4)?



Give some examples of transition metal catalysts and the processes/reactions they catalyse (4)?

- Iron - Haber process
- Vanadium (V) oxide - contact process
- Nickel - hydrogenation of alkenes
- Manganese (IV) oxide - decomposition of hydrogen peroxide
- Copper sulfate - hydrogen production



What is a complex ion?



What is a complex ion?

Transition metal ion bonded to one or more ligands by coordinate bonds



Define a ligand



Define a ligand

Molecule or an ion that can donate a pair of electrons to the metal to form a coordinate bond



What is a coordinate bond?



What is a coordinate bond?

A bond in which one of the atom provides both the electrons required for bonding, also known as dative bonding.



What does the coordination number indicate?



What does the coordination number indicate?

The number of coordinate bonds formed between the metal ion and its ligands



What is a mono/unidentate ligand?



What is a mono/unidentate ligand?

A ligand that forms one co-ordinate bond to the central metal ion (one lone pair to donate)



What is a bidentate ligand?



What is a bidentate ligand?

A ligand that forms two coordinate bonds to the central metal ion (2 lone pairs to donate)



What is a multidentate ligand?



What is a multidentate ligand?

A ligand that forms three or more coordinate bonds to the central metal ion



Give some examples of
common monodentate ligands
(4)



Give some examples of common monodentate ligands (4).



Name the most common
bidentate ligand



Name the most common bidentate ligand

ethane-1,2-diamine

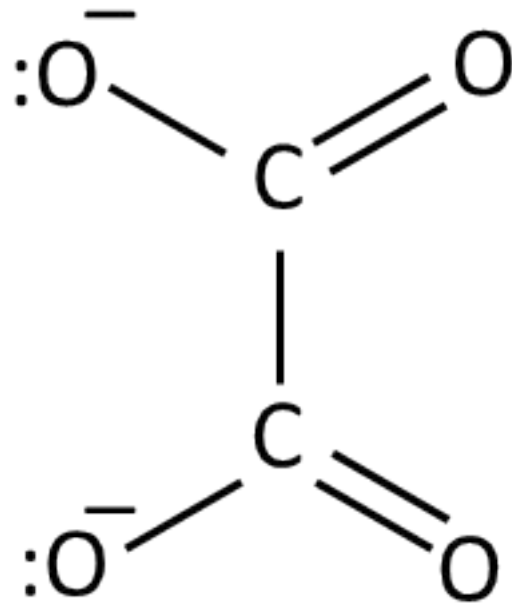


Draw ethanedioate; how many coordinate bonds can it form to a transition metal ion?



Draw ethanedioate; how many coordinate bonds can it form to a transition metal ion?

2 co-ordinate bonds

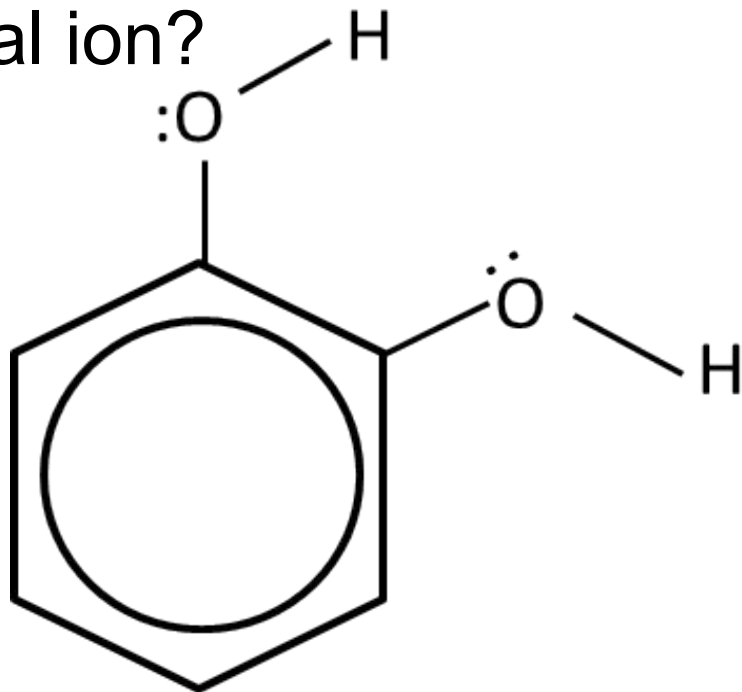


Draw benzene-1,2-diol; how many coordinate bonds can it form to a transition metal ion?



Draw benzene-1,2-diol; how many coordinate bonds can it form to a transition metal ion?

2 coordinate bonds

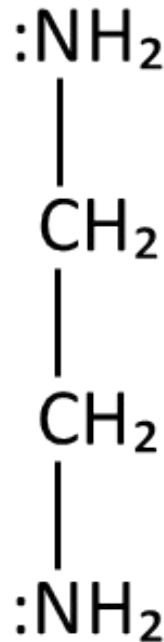


Draw ethane-1,2-diamine.
What is its shortened name?
How many coordinate bonds
does it form?



Draw ethane-1,2-diamine. What is its shortened name? How many coordinate bonds does it form?

2 coordinate bonds, shortened name = en



How many coordinate
bonds does EDTA^{4-} form?



How many coordinate bonds does EDTA^{4-} form?

six



EDTA is a chelating agent,
what does that mean?



EDTA is a chelating agent, what does that mean?

EDTA decreases the concentration of metal ions in the solution by binding to them and forming complex ions

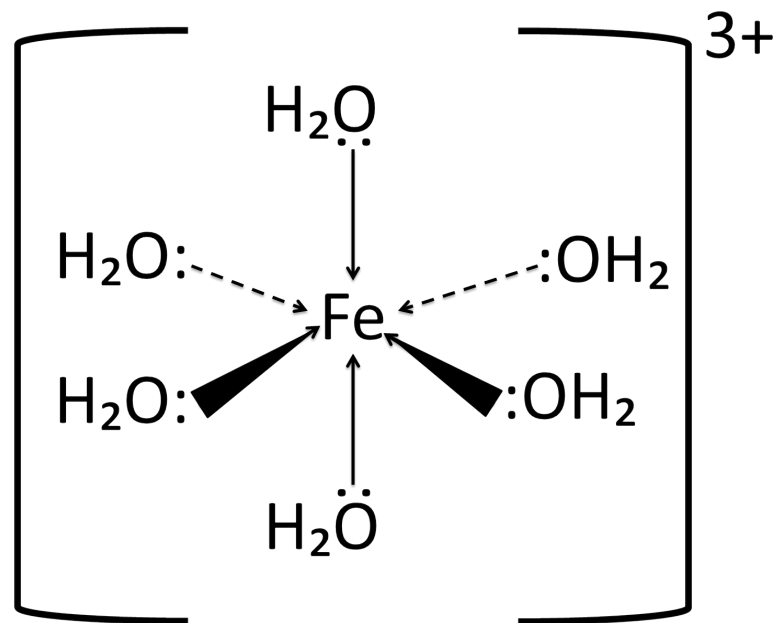


What ion is usually formed when a transition metal compound is dissolved in water? What shape is it? Draw an example



What ion is usually formed when a transition metal compound is dissolved in water? What shape is it? Draw an example

Aqua ion, 6 H_2O ligands around the central metal ion. Octahedral complex ion is formed



If a transition metal ion has 2 ligands, what shape is it usually?



If a transition metal ion has 2 ligands, what shape is it usually?

Linear



If a transition metal ion has 4 ligands, what shape is it usually?



If a transition metal ion has 4 ligands, what shape is it usually?

Tetrahedral



Name an exception to the general rule that ions with 4 ligands is generally tetrahedral. What shape is it?



Name an exception to the general rule that ions with 4 ligands is generally tetrahedral. What shape is it?

Platin is square planar → forms cisplatin



What shape is a complex ion if it has 6 ligands?



What shape is a complex ion if it has 6 ligands?

Octahedral



How can complex ions display
E-Z or cis-trans isomerism?
What shapes of ions does this
apply to?



How can complex ions display E-Z or cis-trans isomerism? What shapes of ions does this apply to?

Ligands differ in the way in which they are arranged in space

2 ligands of the same type can be on the same side of the metal ion (next to each other), which forms the E or cis isomer

2 ligands of the same type can be on opposite sides of the metal ion (not next to each other), which forms the Z or trans isomer

Applies to square planar and octahedral complex ions



What conditions are needed
for a complex ion to display
optical isomerism?



What conditions are needed for a complex ion to display optical isomerism?

Usually applies to octahedral molecules with 2 or more bidentate ligands, so that the mirror images are non-superimposable



What is cis-platin used for?
Describe its mechanism of
action



What is cis-platin used for? Describe its mechanism of action

It is used as an anti-cancer drug

It binds to DNA of fast growing cancer cells and prevents cell division, hence reducing the growth of cancer



Which metal ion is present in a haem group?



Which metal ion is present in a haem group?



What is the coordination number of a haem group?



What is the coordination number of a haem group?

6



What are the ligands in haem group?



What are the ligands in haem group?

4 nitrogen forming the porphyrin ring

1 oxygen

1 globin



Why is CO toxic?



Why is CO toxic?

CO also coordinately bonds to the Fe^{2+} , and bonds more strongly to Fe^{2+} than O_2 . Stops O_2 from bonding to haemoglobin, so O_2 cannot be transported around the body



What colour is $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$
solution?



What colour is $[\text{Cu}(\text{H}_2\text{O})_6]^{2+}$ solution?

Pale blue



What colour is
 $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$ solution?



What colour is $[\text{Cu}(\text{NH}_3)_4(\text{H}_2\text{O})_2]^{2+}$ solution?

Deep blue



What colour is $[\text{CuCl}_4]^{2-}$
solution?



What colour is $[\text{CuCl}_4]^{2-}$ solution?

yellow



What colour is $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$
solution?



What colour is $[\text{Cr}(\text{H}_2\text{O})_6]^{3+}$ solution?

Dark green



What is a precipitation reaction?



What is a precipitation reaction?

A reaction where soluble ions in separate solutions are mixed to form an insoluble compound



What colour is Fe^{2+} 's aqua ion?



What colour is Fe^{2+} 's aqua ion?

Green



What colour is Fe^{3+} 's aqua ion?



What colour is Fe^{3+} 's aqua ion?

Pale brown



What colour is Cr^{3+} 's aqua ion?



What colour is Cr^{3+} 's aqua ion?

violet



What colour is Mn^{2+} 's aqua ion?



What colour is Mn^{2+} 's aqua ion?

Pink



When Cu^{2+} reacts with NH_3 or OH^- , what colour is the precipitate?



When Cu^{2+} reacts with NH_3 or OH^- , what colour is the precipitate?

Blue



When Fe^{2+} reacts with NH_3 or OH^- , what colour is the precipitate?



When Fe^{2+} reacts with NH_3 or OH^- , what colour is the precipitate?

Green



When Mn^{2+} reacts with NH_3 or OH^- , what colour is the precipitate?



When Mn^{2+} reacts with NH_3 or OH^- , what colour is the precipitate?

Brown



When Cr^{3+} reacts with NH_3 or OH^- , what colour is the precipitate?



When Cr^{3+} reacts with NH_3 or OH^- , what colour is the precipitate?

Green



When Fe^{3+} reacts with NH_3 or OH^- , what colour is the precipitate?



When Fe^{3+} reacts with NH_3 or OH^- , what colour is the precipitate?

Brown



What colour is MnO_4^- ?



What colour is MnO_4^- ?

Purple



Write a half equation for the reduction of MnO_4^- to Mn^{2+}



Write a half equation for the reduction of MnO_4^- to Mn^{2+}



Why are redox titrations with transition metal compounds said to be self-indicating?



Why are redox titrations with transition metal compounds said to be self-indicating?

They usually involve a colour change as the metal is changing oxidation state; sometimes an indicator is still needed/useful



What colour is $\text{Cr}_2\text{O}_7^{2-}$?



What colour is $\text{Cr}_2\text{O}_7^{2-}$?

Orange



What colour is Cr^{3+} ?



What colour is Cr^{3+} ?

Green



Write a half equation for the
reduction of $\text{Cr}_2\text{O}_7^{2-}$ to Cr^{3+}



Write a half equation for the reduction of $\text{Cr}_2\text{O}_7^{2-}$ to Cr^{3+} .



Describe how to test for metal ions



Describe how to test for metal ions

- Fill half of the test tube with the sample
- Add aqueous ammonia or sodium hydroxide drop by drop
- Colour of precipitate indicates the ion present



Write the method used to test
for ammonium ions



Write the method used to test for ammonium ions

- Fill half the test tube with sample
- Add sodium hydroxide and warm gently
- Smelly gas is produced; damp red litmus paper turns blue



Why does lime water turn milky in the presence of carbon dioxide?



Why does lime water turn milky in the presence of carbon dioxide?

When carbon dioxide is bubbled in calcium hydroxide (lime water), calcium carbonate precipitate is formed

