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PAGE 2 EXAMPLES

Fe [Ar] 4s² 3d⁶

Cu [Ar] 4s¹ 3d¹⁰

Fe³⁺ [Ar] 3d⁵

Cu⁺ [Ar] 3d¹⁰

Sc [Ar] 4s² 3d¹

Cu²⁺ [Ar] 3d⁹

Sc³⁺ [Ar]

Zn [Ar] 4s² 3d¹⁰

V [Ar] 4s² 3d³

Zn²⁺ [Ar] 3d¹⁰

V²⁺ [Ar] 3d³

Cr [Ar] 4s¹ 3d⁵

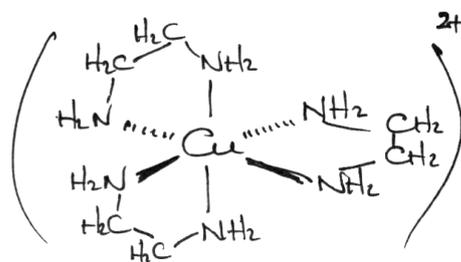
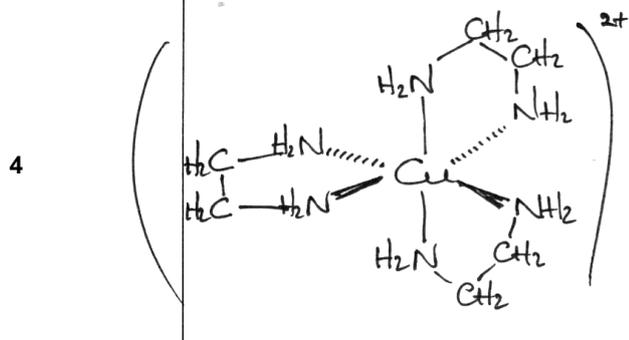
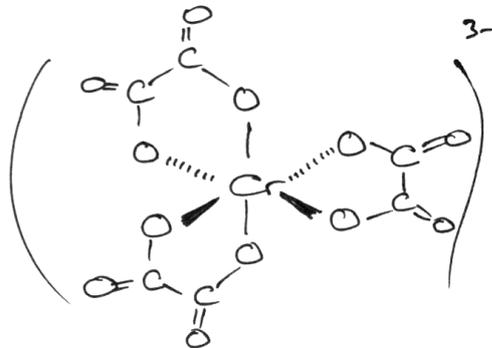
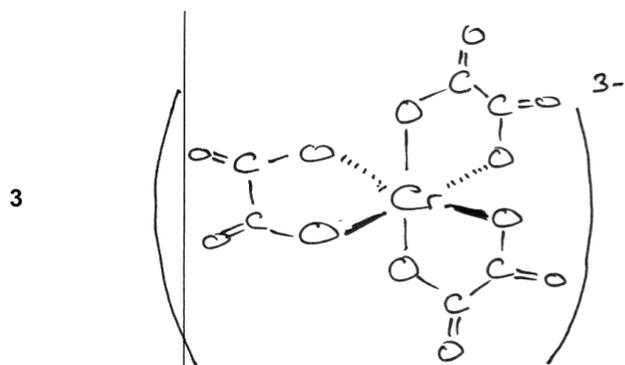
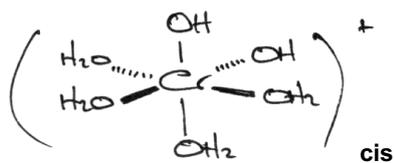
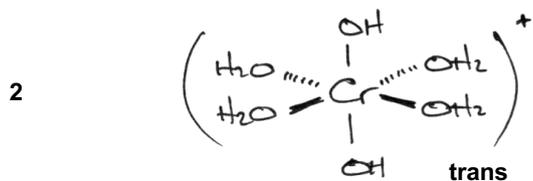
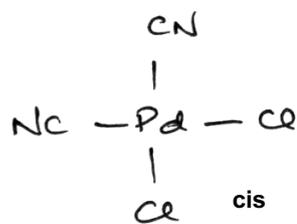
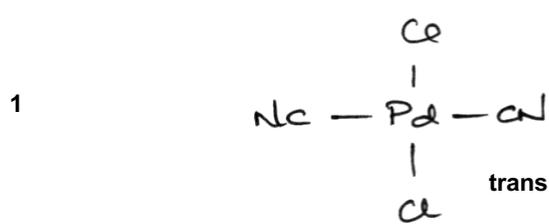
metal	atom	Common ions		Transition metal?
Sc	Sc [Ar] 4s ² 3d ¹	Sc ³⁺ [Ar]		Yes
Cu	Cu [Ar] 4s ¹ 3d ¹⁰	Cu ⁺ [Ar] 3d ¹⁰	Cu ²⁺ [Ar] 3d ⁹	Yes
Zn	Zn [Ar] 4s ² 3d ¹⁰	Zn ²⁺ [Ar] 3d ¹⁰		No

TASK 1 – Drawing complexes

Formula	$[\text{Ag}(\text{CN})_2]^-$	$[\text{Cr}(\text{NH}_3)_6]^{3+}$	$[\text{Ni}(\text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2)_3]^{2+}$
Sketch			
Shape	linear	octahedral	octahedral
Bond angles	180°	90°	90°
Metal oxidation state	+1	+3	+2
Co-ordination number	2	6	6
Ligand(s)	CN^-	NH_3	$\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2$

Formula	$[\text{Co}(\text{NH}_2\text{CH}_2\text{CH}_2\text{NH}_2)_2\text{Cl}_2]^+$	$[\text{Pt}(\text{NH}_3)\text{Cl}_3]$	$[\text{Fe}(\text{C}_2\text{O}_4)_3]^{3-}$
Sketch			
Shape	octahedral	square planar	octahedral
Bond angles	90°	90°	90°
Metal oxidation state	+3	+2	+3
Co-ordination number	6	4	6
Ligand(s)	$\text{H}_2\text{NCH}_2\text{CH}_2\text{NH}_2, \text{Cl}^-$	NH_3, Cl^-	$\text{C}_2\text{O}_4^{2-}$

TASK 2 – Drawing pairs of complexes that are isomers



TASK 3 – Substitution reactions

- 1**
- a) Ligand(s) replaced by other ligand(s)
 - b) 1, 2, 4, 5, 6, 7
 - c) 5
 - d) Cl^- too big so cannot fit 6 around metal
 - e) 3, 4, 5, 6
- 2**
- a) 4-
 - b) $[\text{Pb}(\text{H}_2\text{O})_6]^{2+} + \text{EDTA}^{4-} \rightarrow [\text{Pb}(\text{EDTA})]^{2-} + 6\text{H}_2\text{O}$
 - c) ΔH negligible as similar number and type of bonds broken / formed
 ΔS positive as go from 2 to 7 particles
 ΔG (very) negative and therefore reaction feasible
 - d) ΔG (very) positive and therefore reaction not feasible.

TASK 4 – Coloured complexes

- 1 a) d orbitals have different energy, visible light absorbed, for electrons to be excited from lower to higher d orbitals, colour seen consists of those colours not absorbed
 b) oxidation state, ligand, co-ordination number, shape; they affect the size of the energy gap between the d orbitals and so the wavelength of visible light absorbed

2 a) $\Delta E = hv = \frac{hc}{\lambda}$

b) absorbs orange light, what is left gives blue colour

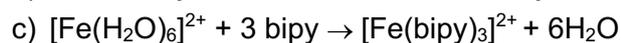
c) $2.21 \times 10^{-19} \text{ J}$, 133 kJ mol^{-1}

d) $4.19 \times 10^{-19} \text{ J}$, 252 kJ mol^{-1}

e) Different ligand, therefore different energy gap between higher and lower d orbitals, therefore different wavelength of visible light absorbed

- 3 a) ligand = particle that forms a co-ordinate bond to a metal ion,
 bidentate = ligand that forms two co-ordinate bonds to metal ion

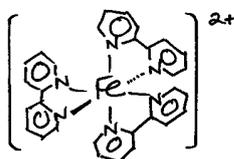
b) to intensity the colour as colour is very faint



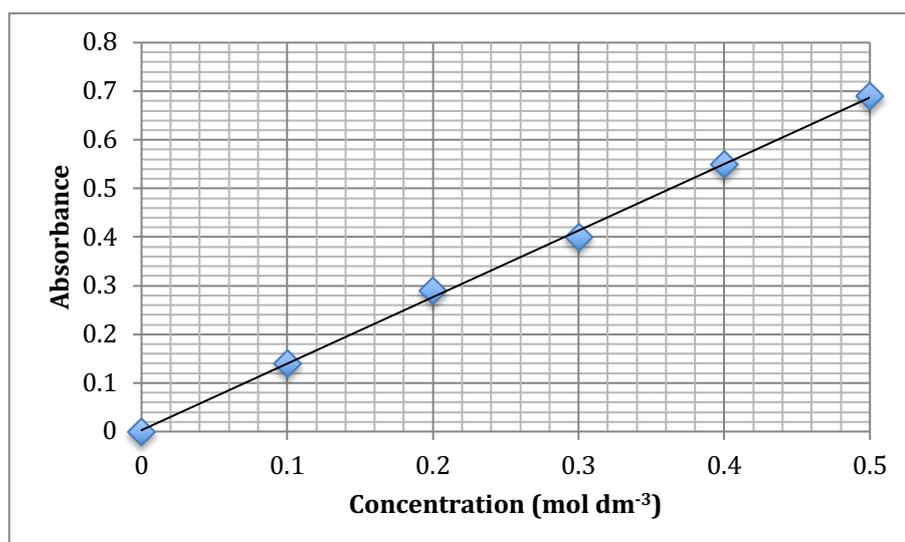
d) octahedral

e) 6

f)



g)



h) 0.15 mol dm^{-3}

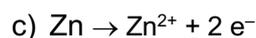
TASK 5 – Variable oxidation states



b) ligands



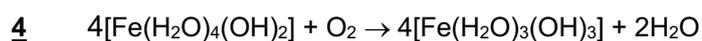
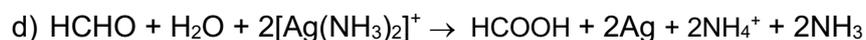
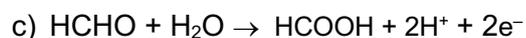
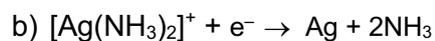
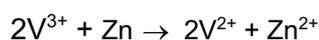
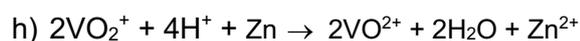
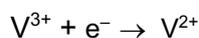
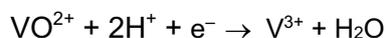
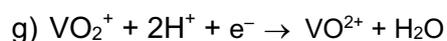
b) reducing agent



d) easier to reduce transition metal in acid



f) to prevent reaction with oxygen



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e.g.1 $\text{mol KMnO}_4 = 0.0200 \times 25.45/1000 = 0.000509$
 $\text{mol Fe}^{2+} \text{ in } 25 \text{ cm}^3 = 5 \times 0.000509 = 0.002545$
 $\text{mol Fe}^{2+} \text{ in } 250 \text{ cm}^3 = 0.02545$
 $\text{mass Fe} = 0.02545 \times 55.8 = 1.42 \text{ g}$
 $\% \text{ Fe} = 100 \times 1.42/1.51 = 94.0\% \text{ (3sf)}$

e.g.2 $\text{mol KMnO}_4 = 0.00300 \times 27.75/1000 = 0.00008325$
 $\text{mol C}_2\text{O}_4^{2-} \text{ in } 25 \text{ cm}^3 = 2.5 \times 0.00008325 = 0.0002081$
 $\text{mol C}_2\text{O}_4^{2-} \text{ in } 250 \text{ cm}^3 = 0.002081$
 $\text{mass H}_2\text{C}_2\text{O}_4 = 0.002081 \times 90.0 = 0.187 \text{ g}$
 $\% \text{ H}_2\text{C}_2\text{O}_4 = 100 \times 0.187/2.34 = 8.00\% \text{ (3sf)}$

TASK 6 – Redox titrations

1 $\text{mol KMnO}_4 = 0.0200 \times 24.3/1000 = 0.000486$
 $\text{mol Fe}^{2+} = 5 \times 0.000486 = 0.00243$
 $[\text{Fe}^{2+}] = 0.00243 / (20.0/1000) = 0.122 \text{ mol dm}^{-3} \text{ (3sf)}$

2 $\text{mol KMnO}_4 = 0.0200 \times 25.00/1000 = 0.000500$
 $\text{mol Fe}^{2+} = 5 \times 0.000500 = 0.00250$
 $\text{mass Fe} = 0.0250 \times 55.8 = 0.1395 \text{ g}$
 $\% \text{ Fe} = 100 \times 0.1395/3.00 = 4.65\% \text{ (3sf)}$

3 $\text{mol KMnO}_4 = 0.0100 \times 43.85/1000 = 0.0004385$
 $\text{mol Fe}^{2+} \text{ in } 25 \text{ cm}^3 = 5 \times 0.0004385 = 0.002193$
 $\text{mol Fe}^{2+} \text{ in } 500 \text{ cm}^3 = 0.002193 \times 20 = 0.04385$
 $M_r = \frac{277.8}{0.04385} = 6337.2$
 $M_r \times \text{H}_2\text{O} = 277.8 - 151.9 = 125.9$
 $x = 125.9/18.0 = 7 \text{ (nearest integer), } M_r = 126 \text{ (3sf)}$

4 a) reaction is between two negative ions so is slow
b) Mn^{2+} produced in reaction acts as catalyst to increase rate
c) $\text{mol KMnO}_4 = 0.0200 \times 27.50/1000 = 0.000550$
 $\text{mol C}_2\text{O}_4^{2-} \text{ in } 25 \text{ cm}^3 = 2.5 \times 0.000550 = 0.001375$
 $\text{mol C}_2\text{O}_4^{2-} \text{ in } 250 \text{ cm}^3 = 0.01375$
 $M_r = \frac{146.2}{0.01375} = 10632.4$
 $M_r \times \text{H}_2\text{O} = 146.2 - 128.1 = 18.0$
 $n = 18.0/18.0 = 1 \text{ (nearest integer), } M_r = 146 \text{ (3sf)}$

5 mol $\text{KMnO}_4 = 0.00133 \times 32.50/1000 = 0.00004323$
 mol Fe^{2+} in $25 \text{ cm}^3 = 5 \times 0.00004323 = 0.0002161$
 mol Fe^{2+} in $250 \text{ cm}^3 = 0.0002161 \times 10 = 0.002161$
 mass Fe = $0.002161 \times 55.8 = 0.121 \text{ g}$
 % Fe = $100 \times 0.121/0.940 = 12.8\%$ (3sf)

6 a) $\text{FeC}_2\text{O}_4 \cdot n\text{H}_2\text{O} : \text{MnO}_4^- = 1 : 0.6$
 b) mol $\text{KMnO}_4 = 0.0200 \times 28.50/1000 = 0.000570$
 mol $\text{FeC}_2\text{O}_4 \cdot n\text{H}_2\text{O}$ in $25 \text{ cm}^3 = 5/3 \times 0.000570 = 0.000950$
 mol $\text{FeC}_2\text{O}_4 \cdot n\text{H}_2\text{O}$ in $250 \text{ cm}^3 = 0.00950$
 $M_r = \frac{1.71}{0.00950} = 180.0$
 $M_r \times \text{H}_2\text{O} = 180.0 - 143.8 = 36.2$
 $x = 36.2/18.0 = 2$ (nearest integer), $M_r = 180$ (3sf)

7 mol $\text{KMnO}_4 = 0.0150 \times 22.65/1000 = 0.0003398$
 mol Fe^{2+} in $25 \text{ cm}^3 = 5 \times 0.0003398 = 0.001699$
 mol Fe^{2+} in $250 \text{ cm}^3 = 0.001699 \times 10 = 0.01699$
 $M_r = \frac{8.492}{0.01699} = 499.9$
 $M_r \times \text{H}_2\text{O} = 499.9 - 284.0 = 215.9$
 $x = 215.9/18.0 = 12$ (nearest integer), $M_r = 500$ (3sf)

8 Fe^{2+} only mol $\text{KMnO}_4 = 0.0200 \times 15.0/1000 = 0.0003000$
 mol Fe^{2+} in $25 \text{ cm}^3 = 5 \times 0.0003000 = 0.001500$
 $\text{Fe}^{2+} + \text{Fe}^{3+}$ mol $\text{KMnO}_4 = 0.0200 \times 19.0/1000 = 0.0003800$
 mol $\text{Fe}^{2+} + \text{Fe}^{3+}$ in $25 \text{ cm}^3 = 5 \times 0.0003800 = 0.001900$
 Fe^{3+} mol $\text{Fe}^{3+} = 0.001900 - 0.001500 = 0.000400$
 $[\text{Fe}^{2+}] = 0.001500 / (25.0/1000) = 0.0600 \text{ mol dm}^{-3}$ (3sf)
 $[\text{Fe}^{3+}] = 0.000400 / (25.0/1000) = 0.0160 \text{ mol dm}^{-3}$ (3sf)

9 mol $\text{KMnO}_4 = 0.0100 \times 26.50/1000 = 0.000265$
 mol Fe^{2+} in $20 \text{ cm}^3 = 5 \times 0.000265 = 0.001325$
 mol Fe^{2+} in $500 \text{ cm}^3 = 0.001325 \times 25 = 0.03313$
 mass Fe = $0.03313 \times 55.8 = 1.85 \text{ g}$
 % Fe = $100 \times 1.85/13.2 = 14.0\%$ (3sf)

10 Acid-base titration to find moles of $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ only

$$\text{mol NaOH} = 0.100 \times 17.35/1000 = 0.001735$$

$$\text{mol H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O in } 25 \text{ cm}^3 = \frac{1}{2} \times 0.001735 = 0.0008675$$

$$\text{mol H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O in } 250 \text{ cm}^3 = 0.008675$$

Redox titration to find total moles of $\text{H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O}$ and $\text{K}_2\text{C}_2\text{O}_4 \cdot x\text{H}_2\text{O}$

$$\text{mol KMnO}_4 = 0.0200 \times 24.85/1000 = 0.000497$$

$$\text{mol C}_2\text{O}_4^{2-} \text{ in } 25 \text{ cm}^3 = 2.5 \times 0.000497 = 0.001243$$

$$\text{mol C}_2\text{O}_4^{2-} \text{ in } 250 \text{ cm}^3 = 0.01243$$

$$\text{mol of C}_2\text{O}_4^{2-} \text{ from K}_2\text{C}_2\text{O}_4 \cdot x\text{H}_2\text{O} = 0.01243 - 0.008675 = 0.00375$$

$$\text{Mass of H}_2\text{C}_2\text{O}_4 \cdot 2\text{H}_2\text{O in } 250 \text{ cm}^3 = 0.008675 \times 126.0 = 1.093 \text{ g}$$

$$\text{Mass of K}_2\text{C}_2\text{O}_4 \cdot x\text{H}_2\text{O in } 250 \text{ cm}^3 = 1.78 - 1.093 = 0.687 \text{ g}$$

$$M_r = \frac{0.687}{0.00375} = 183.2$$

$$0.00375$$

$$M_r x \text{H}_2\text{O} = 183.2 - 166.2 = 17.0$$

$$x = 17.0/18.0 = 1 \text{ (nearest integer), } M_r = 183 \text{ (3sf)}$$

11 a) $\text{mol KMnO}_4 = 0.0200 \times 16.9/1000 = 0.000338$

$$\text{mol Fe}^{2+} \text{ in } 25 \text{ cm}^3 = 5 \times 0.000338 = 0.00169$$

$$\text{mol Fe}^{2+} \text{ in } 250 \text{ cm}^3 = 0.00169 \times 10 = 0.0169$$

b) $\text{mol EDTA}^{4-} = 0.100 \times 17.6/1000 = 0.00176$

$$\text{mol Fe}^{3+} \text{ in } 25 \text{ cm}^3 = 0.00176$$

$$\text{mol Fe}^{3+} \text{ in } 250 \text{ cm}^3 = 0.0176$$

c) $\text{mol original Fe}^{3+} + \text{Fe} = 0.0176$

$$\text{mol original Fe} = 0.0169$$

$$\text{mol original Fe}^{3+} = 0.0176 - 0.0169 = 0.0007$$

$$\% \text{ rusted iron} = 100 \times \frac{0.0007}{0.0176} = 4.0\% \text{ (sf is very arguable!)}$$

Page 24 - Reaction of metal aqua ions with NaOH(aq)

aqua ion	reaction	observation	equation
$\text{Fe}(\text{H}_2\text{O})_6^{2+}$	add some OH^-	green solution → green precipitate	$[\text{Fe}(\text{H}_2\text{O})_6]^{2+} + 2\text{OH}^- \rightarrow [\text{Fe}(\text{H}_2\text{O})_4(\text{OH})_2] + 2\text{H}_2\text{O}$
	add XS OH^-	no visible reaction	–
$\text{Cu}(\text{H}_2\text{O})_6^{2+}$	add some OH^-	blue solution → blue precipitate	$[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 2\text{OH}^- \rightarrow [\text{Cu}(\text{H}_2\text{O})_4(\text{OH})_2] + 2\text{H}_2\text{O}$
	add XS OH^-	no visible reaction	–
$\text{Fe}(\text{H}_2\text{O})_6^{3+}$	add some OH^-	orange solution → brown precipitate	$[\text{Fe}(\text{H}_2\text{O})_6]^{3+} + 3\text{OH}^- \rightarrow [\text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3] + 3\text{H}_2\text{O}$
	add XS OH^-	no visible reaction	–
$\text{Al}(\text{H}_2\text{O})_6^{3+}$	add some OH^-	colourless solution → white precipitate	$[\text{Al}(\text{H}_2\text{O})_6]^{3+} + 3\text{OH}^- \rightarrow [\text{Al}(\text{H}_2\text{O})_3(\text{OH})_3] + 3\text{H}_2\text{O}$
	add XS OH^-	no visible reaction	$[\text{Al}(\text{H}_2\text{O})_3(\text{OH})_3] + \text{OH}^- \rightarrow [\text{Al}(\text{H}_2\text{O})_2(\text{OH})_4]^- + \text{H}_2\text{O}$

Page 25 - Reaction of metal aqua ions with $\text{NH}_3(\text{aq})$

aqua ion	reaction	observation	equation
$\text{Fe}(\text{H}_2\text{O})_6^{2+}$	add some NH_3	green solution → green precipitate	$[\text{Fe}(\text{H}_2\text{O})_6]^{2+} + 2\text{NH}_3 \rightarrow [\text{Fe}(\text{H}_2\text{O})_4(\text{OH})_2] + 2\text{NH}_4^+$
	add XS NH_3	no visible reaction	–
$\text{Cu}(\text{H}_2\text{O})_6^{2+}$	add some NH_3	blue solution → blue precipitate	$[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 2\text{NH}_3 \rightarrow [\text{Cu}(\text{H}_2\text{O})_4(\text{OH})_2] + 2\text{NH}_4^+$
	add XS NH_3	no visible reaction	$[\text{Cu}(\text{H}_2\text{O})_4(\text{OH})_2] + 4\text{NH}_3 \rightarrow [\text{Cu}(\text{H}_2\text{O})_2(\text{NH}_3)_4]^{2+} + 2\text{H}_2\text{O} + 2\text{OH}^-$
$\text{Fe}(\text{H}_2\text{O})_6^{3+}$	add some NH_3	orange solution → brown precipitate	$[\text{Fe}(\text{H}_2\text{O})_6]^{3+} + 3\text{NH}_3 \rightarrow [\text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3] + 3\text{NH}_4^+$
	add XS NH_3	no visible reaction	–
$\text{Al}(\text{H}_2\text{O})_6^{3+}$	add some NH_3	colourless solution → white precipitate	$[\text{Al}(\text{H}_2\text{O})_6]^{3+} + 3\text{NH}_3 \rightarrow [\text{Al}(\text{H}_2\text{O})_3(\text{OH})_3] + 3\text{NH}_4^+$
	add XS NH_3	no visible reaction	–

Page 25 - Reaction of metal aqua ions with Na₂CO₃(aq)

aqua ion	reaction	observation	equation
Fe(H ₂ O) ₆ ²⁺	add some CO ₃ ²⁻	green solution → green precipitate	$[\text{Fe}(\text{H}_2\text{O})_6]^{2+} + \text{CO}_3^{2-} \rightarrow \text{FeCO}_3 + 6\text{H}_2\text{O}$
Cu(H ₂ O) ₆ ²⁺	add some CO ₃ ²⁻	blue solution → blue-green precipitate	$[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + \text{CO}_3^{2-} \rightarrow \text{CuCO}_3 + 6\text{H}_2\text{O}$
Fe(H ₂ O) ₆ ³⁺	add some CO ₃ ²⁻	orange solution → brown precipitate & gentle bubbles	$2[\text{Fe}(\text{H}_2\text{O})_6]^{3+} + 3\text{CO}_3^{2-} \rightarrow 2[\text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3] + 3\text{H}_2\text{O} + 3\text{CO}_2$
Al(H ₂ O) ₆ ³⁺	add some CO ₃ ²⁻	colourless solution → white precipitate & gentle bubbles	$2[\text{Al}(\text{H}_2\text{O})_6]^{3+} + 3\text{CO}_3^{2-} \rightarrow 2[\text{Al}(\text{H}_2\text{O})_3(\text{OH})_3] + 3\text{H}_2\text{O} + 3\text{CO}_2$

Page 26 – Acid-base character of metal hydroxide precipitates

add excess acid		metal hydroxide	add excess alkali	
observation	equation		observation	Equation
green ppt → green solution	$[\text{Fe}(\text{H}_2\text{O})_4(\text{OH})_2] + 2\text{H}^+ \rightarrow [\text{Fe}(\text{H}_2\text{O})_6]^{2+}$	[Fe(H ₂ O) ₄ (OH) ₂]	no visible reaction	–
blue ppt → blue solution	$[\text{Cu}(\text{H}_2\text{O})_4(\text{OH})_2] + 2\text{H}^+ \rightarrow [\text{Cu}(\text{H}_2\text{O})_6]^{2+}$	[Cu(H ₂ O) ₄ (OH) ₂]	no visible reaction	–
brown ppt → violet solution	$[\text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3] + 3\text{H}^+ \rightarrow [\text{Fe}(\text{H}_2\text{O})_6]^{3+}$	[Fe(H ₂ O) ₃ (OH) ₃]	no visible reaction	–
white ppt → colourless solution	$[\text{Al}(\text{H}_2\text{O})_3(\text{OH})_3] + 3\text{H}^+ \rightarrow [\text{Al}(\text{H}_2\text{O})_6]^{3+}$	[Al(H ₂ O) ₃ (OH) ₃]	white ppt → colourless solution	$[\text{Al}(\text{H}_2\text{O})_3(\text{OH})_3] + \text{OH}^- \rightarrow [\text{Al}(\text{H}_2\text{O})_2(\text{OH})_4]^-$

Page 26 – Substitution with similar sized ligands e.g. NH₃(aq)

aqua ion	reaction	observation	equation
Fe(H ₂ O) ₆ ²⁺	add excess NH ₃	green solution → green precipitate	$[\text{Fe}(\text{H}_2\text{O})_6]^{2+} + 2\text{NH}_3 \rightarrow [\text{Fe}(\text{H}_2\text{O})_4(\text{OH})_2] + 2\text{NH}_4^+$
Cu(H ₂ O) ₆ ²⁺	add excess NH ₃	blue solution → blue precipitate → deep blue solution	$[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 4\text{NH}_3 \rightarrow [\text{Cu}(\text{H}_2\text{O})_2(\text{NH}_3)_4]^{2+} + 4\text{H}_2\text{O}$
Fe(H ₂ O) ₆ ³⁺	add excess NH ₃	orange solution → brown precipitate	$[\text{Fe}(\text{H}_2\text{O})_6]^{3+} + 3\text{NH}_3 \rightarrow [\text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3] + 3\text{NH}_4^+$
Al(H ₂ O) ₆ ³⁺	add excess NH ₃	colourless solution → white precipitate	$[\text{Al}(\text{H}_2\text{O})_6]^{3+} + 3\text{NH}_3 \rightarrow [\text{Al}(\text{H}_2\text{O})_3(\text{OH})_3] + 3\text{NH}_4^+$

Page 27 – Substitution with bigger ligands e.g. Cl⁻(aq)

aqua ion	reaction	observation	equation
Fe(H ₂ O) ₆ ²⁺	add excess Cl ⁻	green solution → yellow solution	$[\text{Fe}(\text{H}_2\text{O})_6]^{2+} + 4\text{Cl}^- \rightarrow [\text{FeCl}_4]^{2-} + 6\text{H}_2\text{O}$
Cu(H ₂ O) ₆ ²⁺	add excess Cl ⁻	blue solution → yellow solution	$[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 4\text{Cl}^- \rightarrow [\text{CuCl}_4]^{2-} + 6\text{H}_2\text{O}$
Fe(H ₂ O) ₆ ³⁺	add excess Cl ⁻	orange solution → yellow solution	$[\text{Fe}(\text{H}_2\text{O})_6]^{3+} + 4\text{Cl}^- \rightarrow [\text{FeCl}_4]^- + 6\text{H}_2\text{O}$
Al(H ₂ O) ₆ ³⁺	add excess Cl ⁻	colourless solution → colourless solution	$[\text{Al}(\text{H}_2\text{O})_6]^{3+} + 4\text{Cl}^- \rightarrow [\text{AlCl}_4]^- + 6\text{H}_2\text{O}$

TASK 9 – REACTIONS OF INORGANIC COMPLEXES

- | | | |
|-----------|---|---|
| <u>1</u> | blue solution → blue precipitate
no further reaction with excess | $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 2\text{OH}^- \rightarrow [\text{Cu}(\text{H}_2\text{O})_4(\text{OH})_2] + 2\text{H}_2\text{O}$ |
| <u>2</u> | colourless solution → white precipitate
no further reaction with excess | $[\text{Al}(\text{H}_2\text{O})_6]^{3+} + 3\text{NH}_3 \rightarrow [\text{Al}(\text{H}_2\text{O})_3(\text{OH})_3] + 3\text{NH}_4^+$ |
| <u>3</u> | green solution → green precipitate
no further reaction with excess | $[\text{Fe}(\text{H}_2\text{O})_6]^{2+} + \text{CO}_3^{2-} \rightarrow \text{FeCO}_3 + 6\text{H}_2\text{O}$ |
| <u>4</u> | orange solution → brown ppt & bubbles
3CO ₂
no further reaction with excess | $2[\text{Fe}(\text{H}_2\text{O})_6]^{3+} + 3\text{CO}_3^{2-} \rightarrow 2[\text{Fe}(\text{H}_2\text{O})_3(\text{OH})_3] + 3\text{H}_2\text{O} + 3\text{CO}_2$ |
| <u>5</u> | orange(or violet) solution → yellow solution
no further reaction with excess | $[\text{Fe}(\text{H}_2\text{O})_6]^{3+} + 4\text{Cl}^- \rightarrow [\text{FeCl}_4]^- + 6\text{H}_2\text{O}$ |
| <u>6</u> | colourless solution → white precipitate
white precipitate → colourless solution | $[\text{Al}(\text{H}_2\text{O})_6]^{3+} + 3\text{OH}^- \rightarrow [\text{Al}(\text{H}_2\text{O})_3(\text{OH})_3] + 3\text{H}_2\text{O}$
$[\text{Al}(\text{H}_2\text{O})_3(\text{OH})_3] + \text{OH}^- \rightarrow [\text{Al}(\text{H}_2\text{O})_2(\text{OH})_4]^- + \text{H}_2\text{O}$ |
| <u>7</u> | blue solution → blue precipitate
blue precipitate → deep blue solution
2OH ⁻ | $[\text{Cu}(\text{H}_2\text{O})_6]^{2+} + 2\text{NH}_3 \rightarrow [\text{Cu}(\text{H}_2\text{O})_4(\text{OH})_2] + 2\text{NH}_4^+$
$[\text{Cu}(\text{H}_2\text{O})_4(\text{OH})_2] + 4\text{NH}_3 \rightarrow [\text{Cu}(\text{H}_2\text{O})_2(\text{NH}_3)_4]^{2+} + 2\text{H}_2\text{O} + 2\text{OH}^-$ |
| <u>8</u> | pink solution → blue solution
no further reaction with excess | $[\text{Co}(\text{H}_2\text{O})_6]^{2+} + 4\text{Cl}^- \rightarrow [\text{CoCl}_4]^{2-} + 6\text{H}_2\text{O}$ |
| <u>9</u> | green solution → green precipitate
no further reaction with excess | $[\text{Fe}(\text{H}_2\text{O})_6]^{2+} + 2\text{OH}^- \rightarrow [\text{Fe}(\text{H}_2\text{O})_4(\text{OH})_2] + 2\text{H}_2\text{O}$ |
| <u>10</u> | colourless solution → colourless solution
no further reaction with excess | $[\text{Zn}(\text{H}_2\text{O})_6]^{2+} + 4\text{Cl}^- \rightarrow [\text{ZnCl}_4]^{2-} + 6\text{H}_2\text{O}$ |
| <u>11</u> | colourless solution → white precipitate
no further reaction with excess | $[\text{Zn}(\text{H}_2\text{O})_6]^{2+} + \text{CO}_3^{2-} \rightarrow \text{ZnCO}_3 + 6\text{H}_2\text{O}$ |