مراجعة كيمياء الحديد

مختبر الكيمياء اللاعضوية

مرحلة ثالثة

(التعليم الالكتروني)

صباحي

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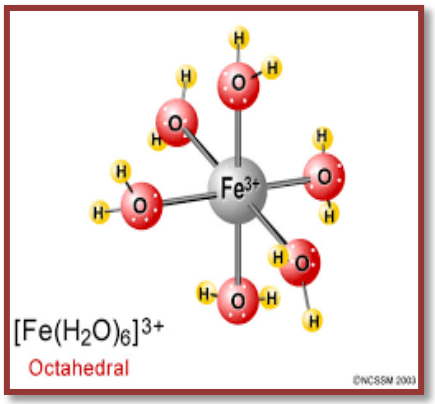
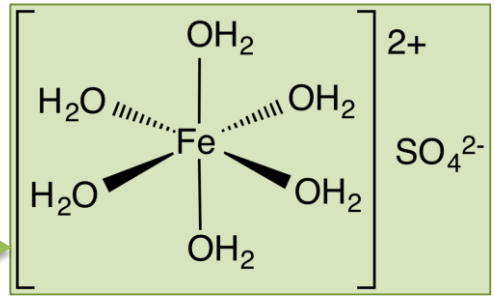
م.م. يسرى جليل

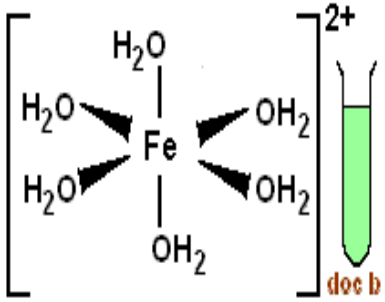
Chemistry of Iron

Ferrous Fe (II) and Ferric Fe(III) form many complexes whose octahedral structure in which the coordination number is six;

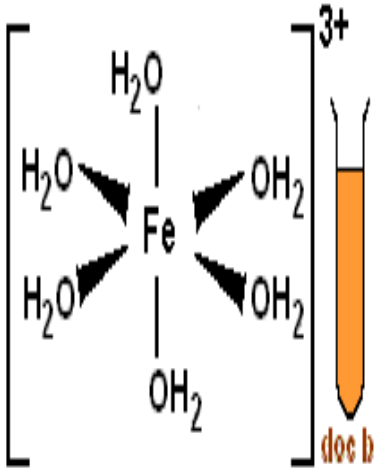


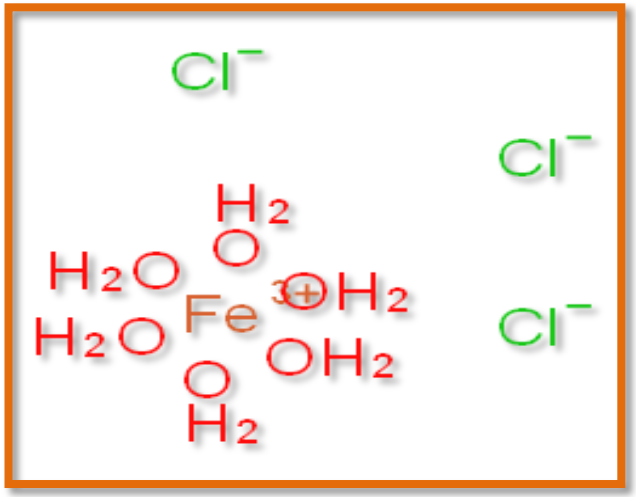
as in aqueous solutions of ferrous salts ($FeSO_4.6H_2O$)the complex ion $[Fe(H_2O)_6]^{2+}$ is formed which is very light greenish blue.





Where as, the complex ion $[Fe(H_2O)_6]^{+3}$ is formed in aqueous solutions of ferric salts ($FeCl_3.6H_2O$).





Preparing a solution of (Fe^{2+}):

Iron solution can be prepared by dissolving ammoniac salt of Iron(II) sulfate $(NH_4)_2SO_4.FeSO_4.6H_2O$ or simple iron sulfate $(FeSO_4.6H_2O)$ in acidic water with H_2SO_4

to form bluish light green solution due to the formation of $[Fe(H_2O)_6]^{2+}$, which can be abbreviated into $(Fe^{2+})$to carry out detection.

$(NH_4)_2SO_4.FeSO_4.6H_2O + H_2O \rightarrow [Fe(H_2O)_6]^{2+}$

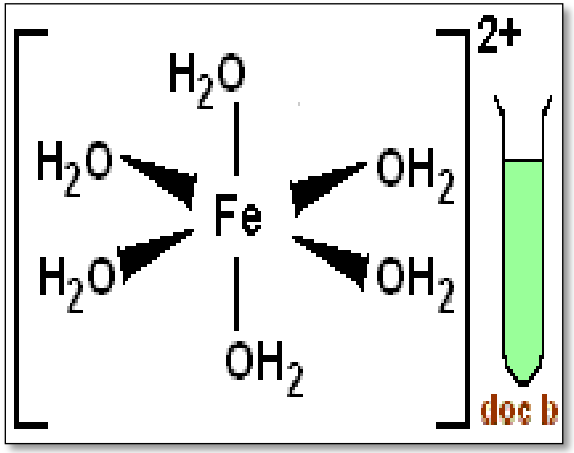
Greenish gray solid — clear bluish light green

$FeSO_4.6H_2O + H_2O \rightarrow [Fe(H_2O)_6]^{2+}$

Light blue solid — clear bluish light green

pH of Aqueous ferrous solution (Fe^{2+}):

Put (10) drops of $[Fe(H_2O)_2]^{2+}$ in a test tube and measure pH by using Litmus paper (the reaction starts before adding H_2SO_4, why?). you will notice that acidic solution is weak due to weak ionization.



Detection of iron (II) (Fe^{2+})

1) Put (10) drops of $[Fe(H_2O)_6]^{2+}$ solution in a test tube, add Potassium Permanganate solution ($KMnO_4$) drop wise, observe the change, and write down your notices.

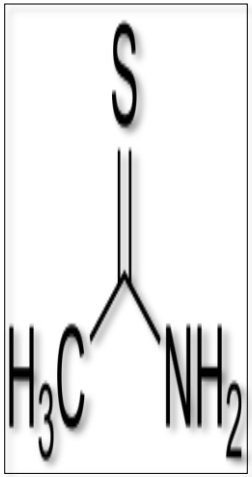
تفاعل كبريتات الحديد الامونياكي
مع برمنغنات البوتاسبوم

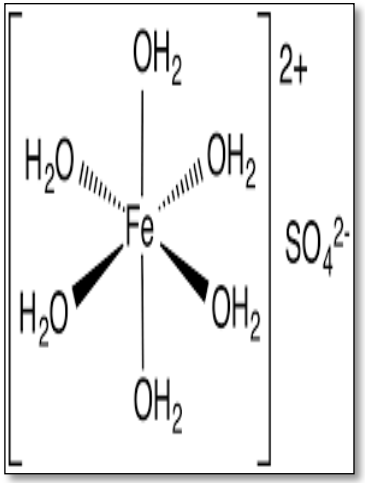
2) Put (10) drops of $[Fe(H_2O)_6]^{2+}$ solution in a test tube, add (2) drops of potassium ferric cyanide solution ($K_3[Fe^{III}(CN)_6]$), you will notice a **dark blue** precipitate , and write down your notices.

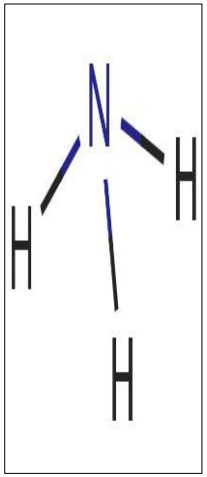
3) Put (10) drops of $[Fe(H_2O)_6]^{2+}$ solution in a test tube, add (2) drops of Potassium ferro cyanide solution ($K_4[Fe^{II}(CN)_6]$), you will notice a <u>white</u> precipitate, and write down your notices (the precipitate will change to **blue** when exposed to air due to oxidation).

4) Put (10) drops of $[Fe(H_2O)_6]^{2+}$ solution in a test tube, add (2) drops of ammonium or Potassium thiocyanate ((NH_4SCN or KSCN), observe the change, and write down your notices.

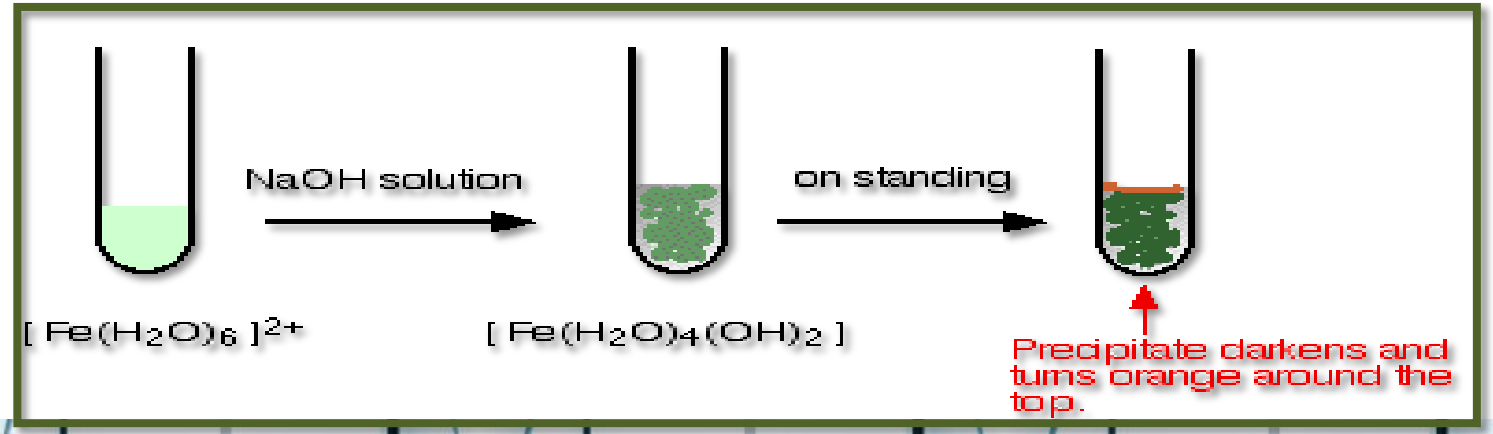
5) Put (10) drops of $[Fe(H_2O)_6]^{2+}$ solution in test tube, add (5) drops of thio acetamide solution (CH_3CSNH_2), observe the change, add (3) drops of concentrated ammonia $NH_3(aq)$, you will notice a <u>black</u> precipitate, and write down your notices.



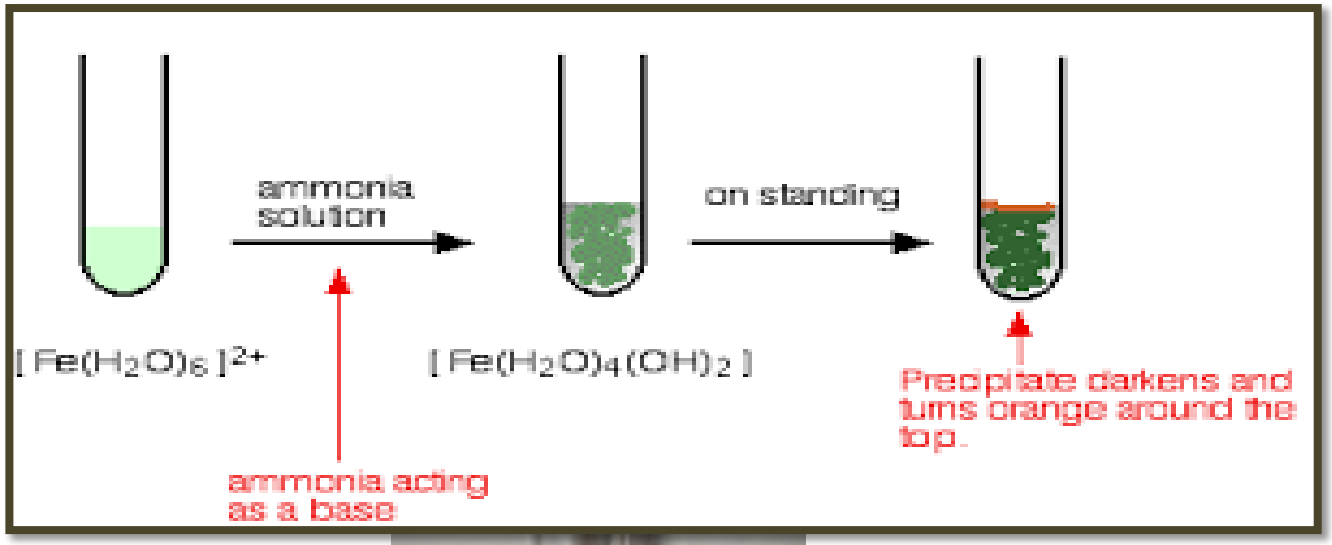


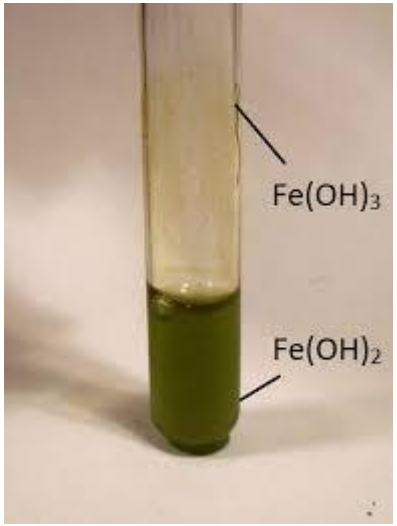


6) Put (10) drops of $[Fe(H_2O)_6]^{2+}$ solution in a test tube, add (2) drops of sodium hydroxide solution (NaOH), you will notice a **blackish green** precipitate, write down your notices.

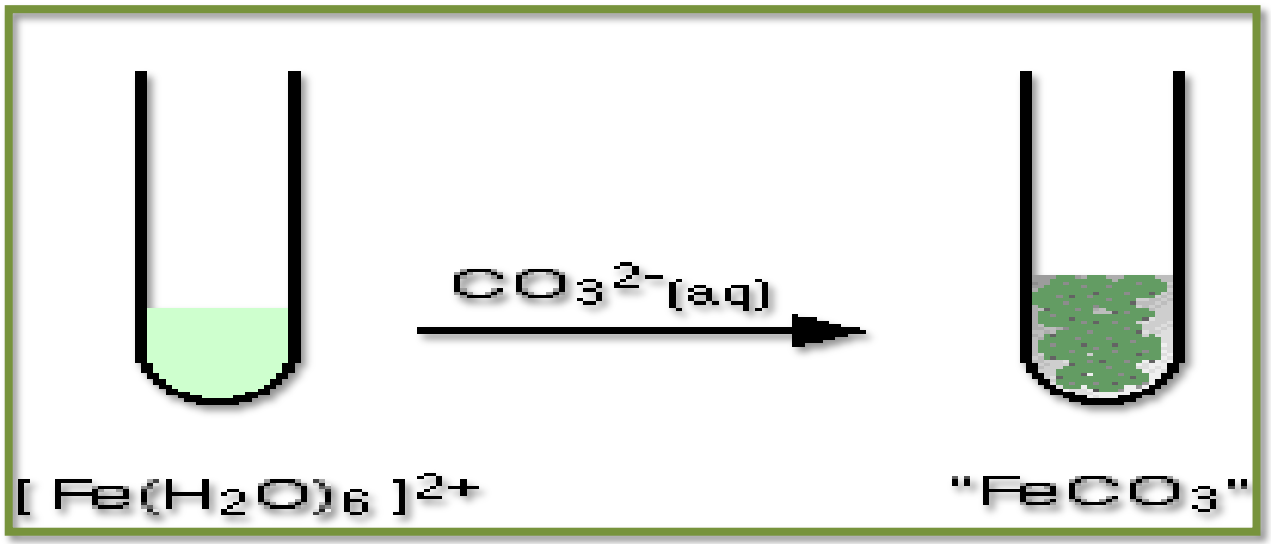


7)Put (10) drops of $[Fe(H_2O)_6]^{2+}$ solution in a test tube, add (2) drops of concentrated ammonia $NH_3(aq)$, you will notice a **blackish green** precipitate, write down your notices.





8) Put (10) drops of $[Fe(H_2O)_6]^{2+}$ solution in a test tube, add (2) drops of sodium carbonates (Na_2CO_3), you will notice a green precipitate, write down your notices.

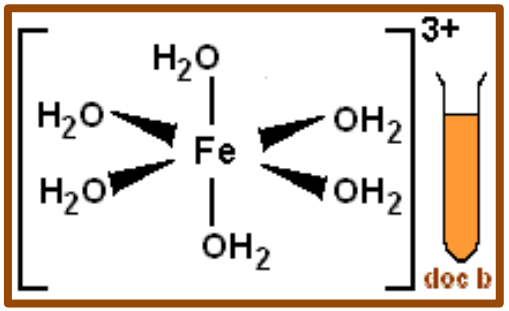


Preparing Solution of (Fe^{3+}):

This solution can be prepared by dissolving ferric chloride salt ($FeCl_3.6H_2O$) in water to form a yellow-orange solution due to formation of the complex ion $[Fe(H_2O)_6]^{3+}$, which can be abbreviated as (Fe^{3+}) to carry out detections.

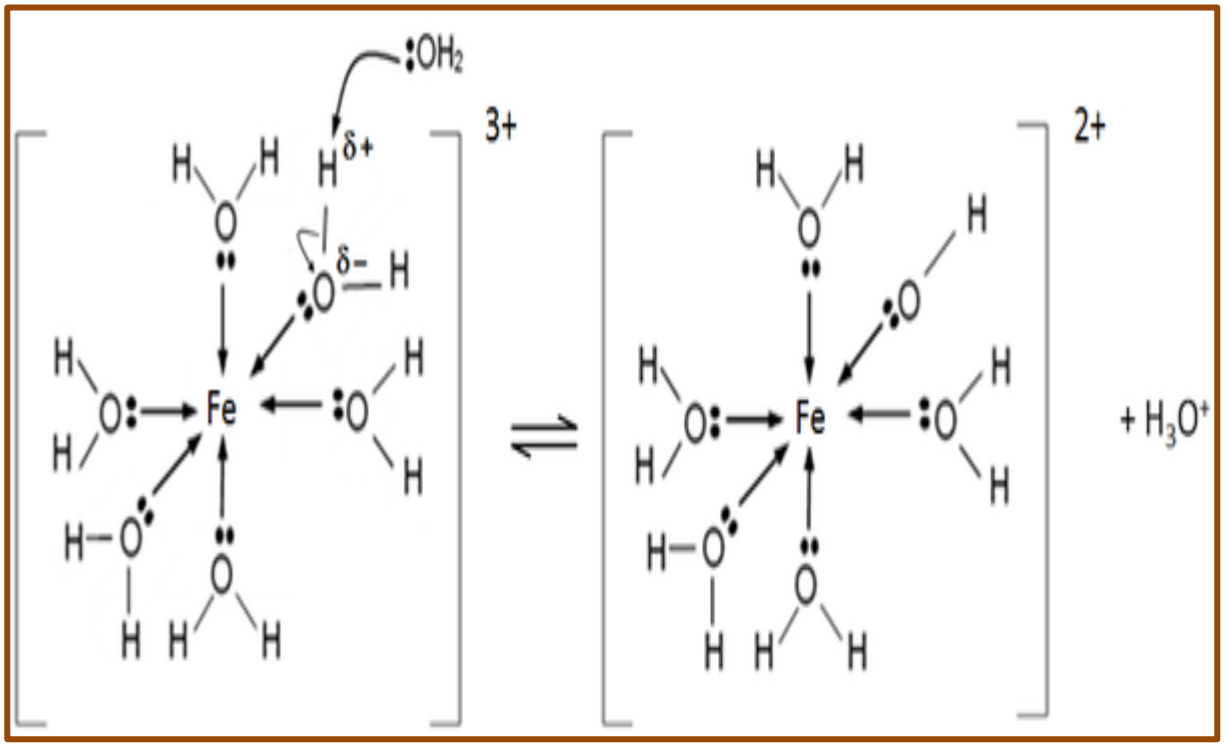
$FeCl_3.6H_2O + H_2O \rightarrow [Fe(H_2O)_6]^{3+}$

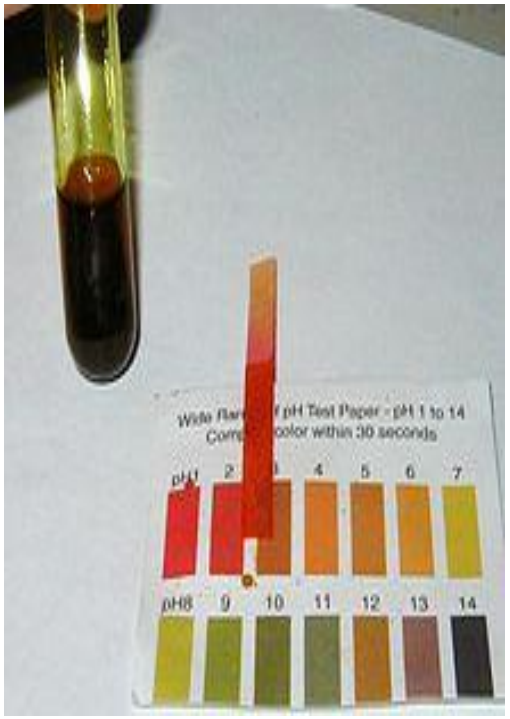
Brown solid — clear orange



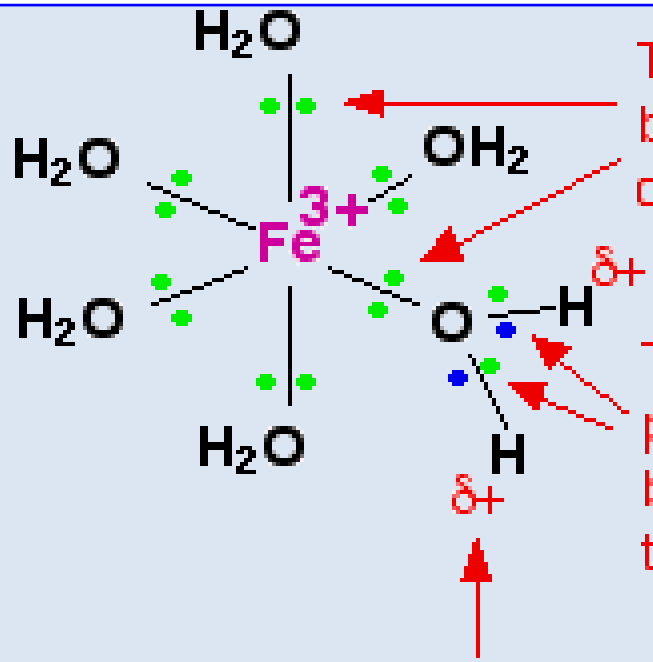
pH of Aqueous ferric solution (Fe^{3+}):

Put (10) drops of $[Fe(H_2O)_6]^{3+}$ solution in a test tube, measure solution pH by using Litmus paper, you will observe that the solution is very acidic due to the previously mentioned ionization.





ممكن تفسير الحامضية على ضوء هذا المخطط



These electron pairs are all being pulled away from the oxygens towards the 3+ ion.

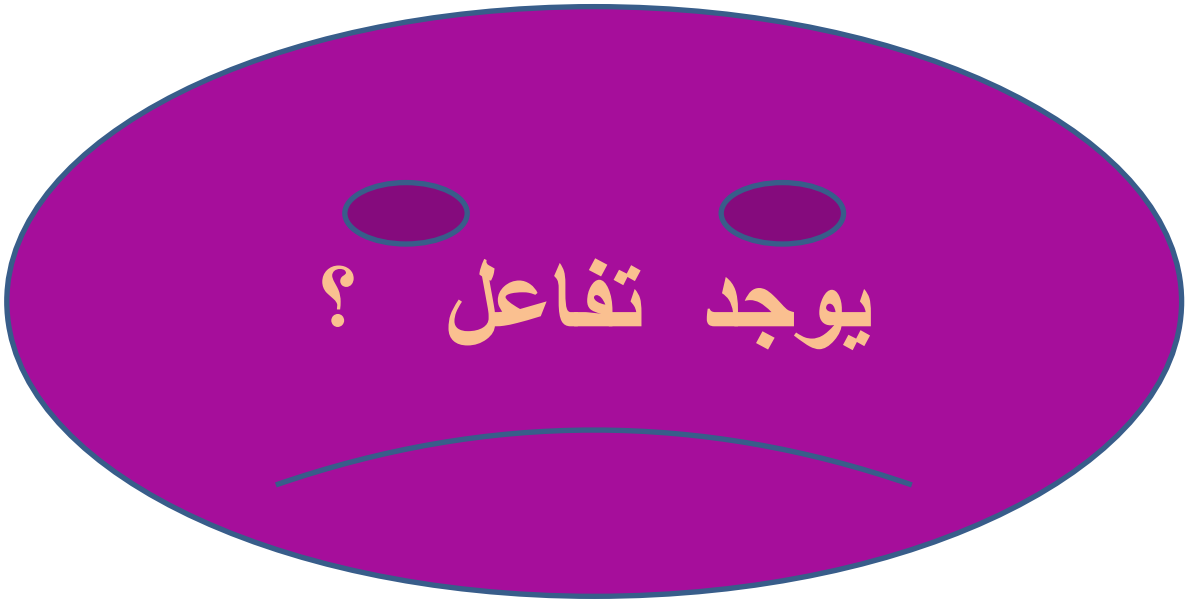
That causes the electron pairs in the O-H bonds to be pulled even closer to the oxygen than normal.

That makes the hydrogen atoms even more positive than they normally are when they are attached to oxygen.

Note: Each oxygen has another lone pair which is left out to avoid even more clutter!

Detection of iron (III) (Fe^{3+})

1)Put (10) drops of $[Fe(H_2O)_6]^{3+}$ solution in a test tube, add Potassium Permanganate solution ($KMnO_4$) drop wise, observe the change, and write down your notices.



test 2) Put (10) drops of $[Fe(H_2O)_6]^{3+}$ solution in a tube, add (5) drops of thioacetamide solution (CH_3CSNH_2), observe the change, add (3) drops of diluted hydrochloric acid HCl, you will notice a down your white yellowish precipitate , write notices.

$$FeCl_3 + H_2S \rightarrow FeCl_2 + HCl + S$$

Oxidation: $H_2S \rightarrow 2H^+ + S + 2e^-$

Reduction: $2Fe^{3+} + 2e^- \rightarrow 2Fe^{2+}$

$$2FeCl_3 + H_2S \rightarrow 2FeCl_2 + 2HCl + S$$

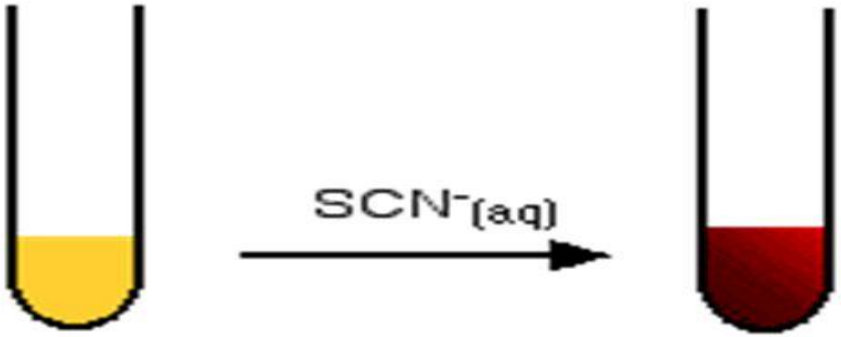
3) Put (10) drops of $[Fe(H_2O)_6]^{3+}$ solution in a test tube, add (2) drops of potassium feeric cyanide solution ($K_3[Fe^{III}(CN)_6]$), you will notice a brown precipitate , write down your notices.

4) Put (10) drops of $[Fe(H_2O)_6]^{3+}$ solution in a test tube, add (2) drops of Potassium ferrocyanide solution ($K_4[Fe^{II}(CN)_6]$), you will notice a blue precipitate, write down your notices.

5) Put (10) drops of $[Fe(H_2O)_6]^{3+}$ solution in a test tube, add (2) drops of ammonium (or Potassium) thiocyanate ((NH_4SCN), you will observe a dark red solution, write down your notices.

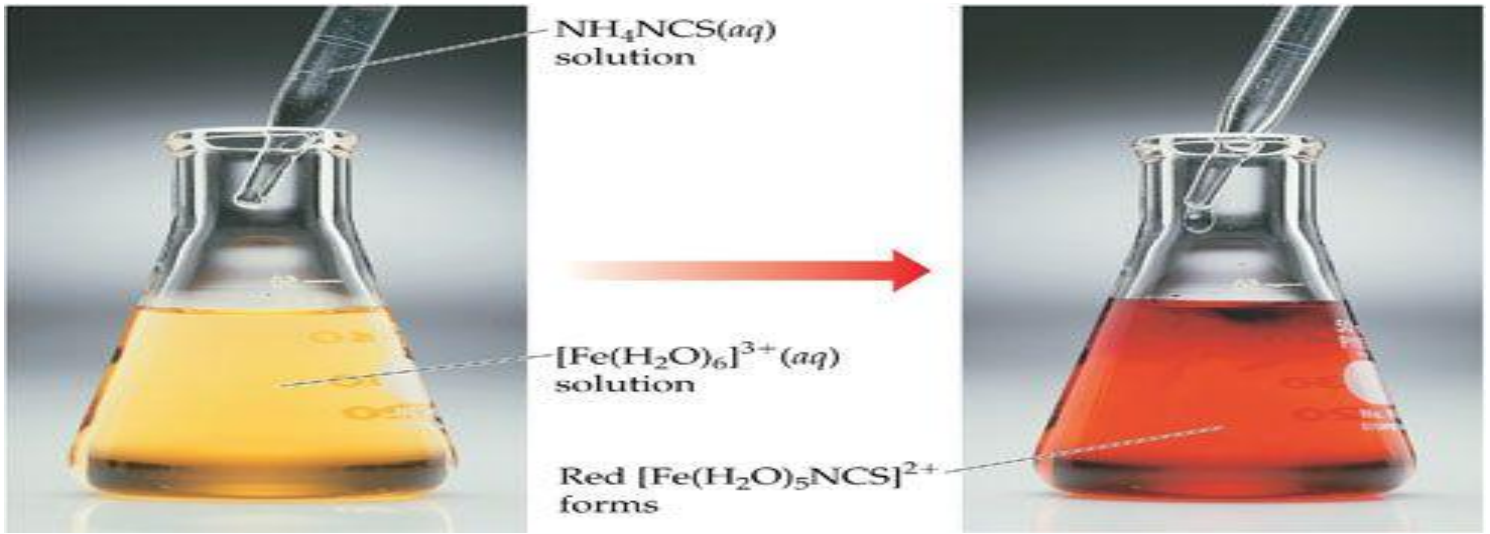
Equilibrium Involving Thiocyanatoiron III Ion

$Fe(H_2O)_6^{3+}$ (Amber) + SCN^{1-} ← → $Fe(SCN)(H_2O)_5^{2+}$ (D. Red)

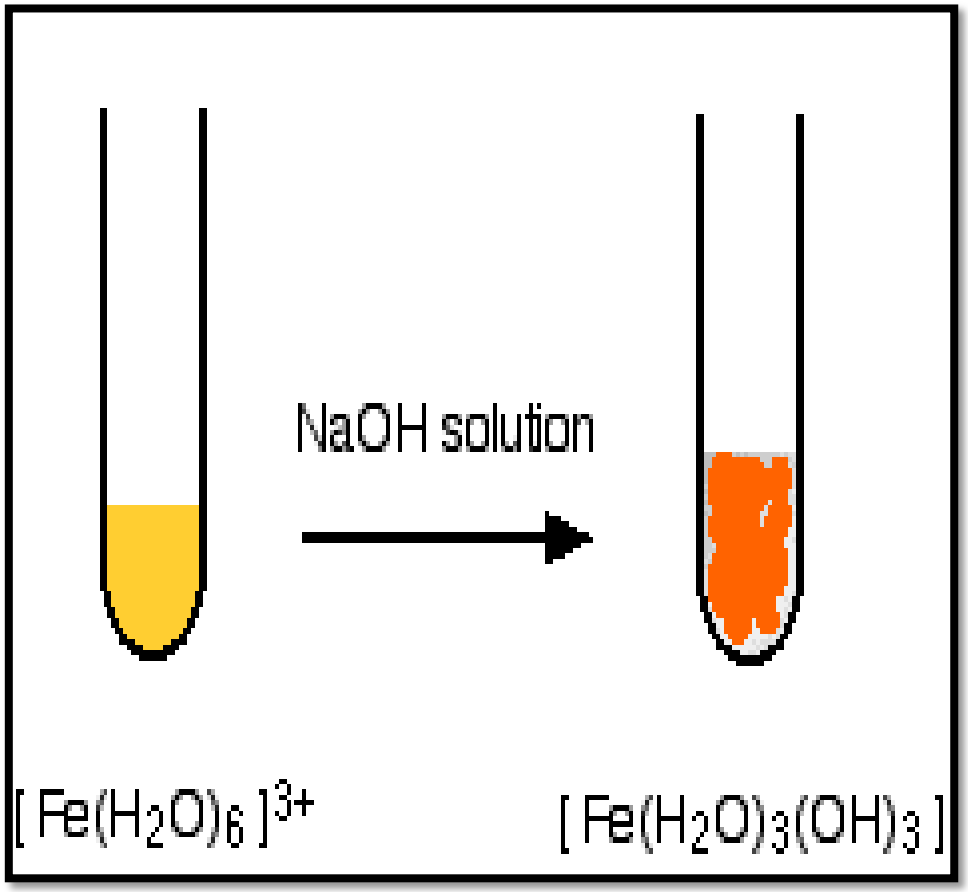


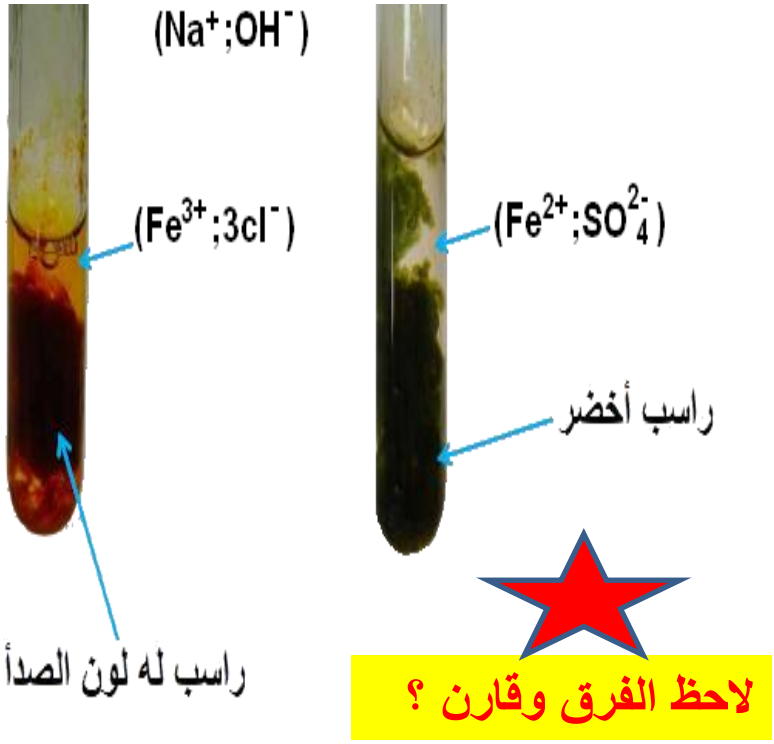
solution containing $[Fe(H_2O)_6]^{3+}$

$[Fe(SCN)(H_2O)_5]^{2+}$

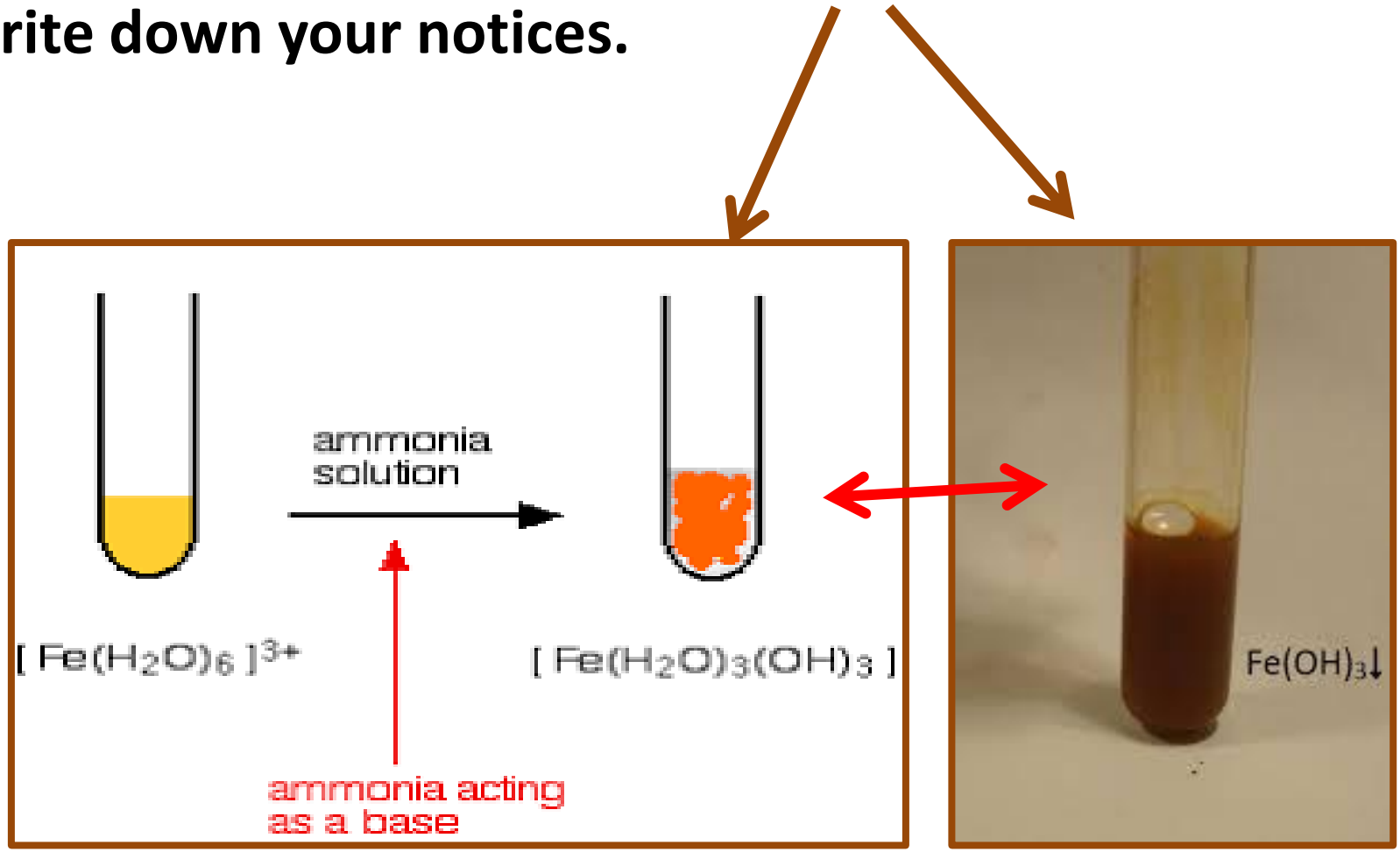


6) Put (10) drops of $[Fe(H_2O)_6]^{3+}$ solution in a test tube, add (2) drops of sodium hydroxide solution (NaOH), you will notice a dark brown precipitate , write down your notices.

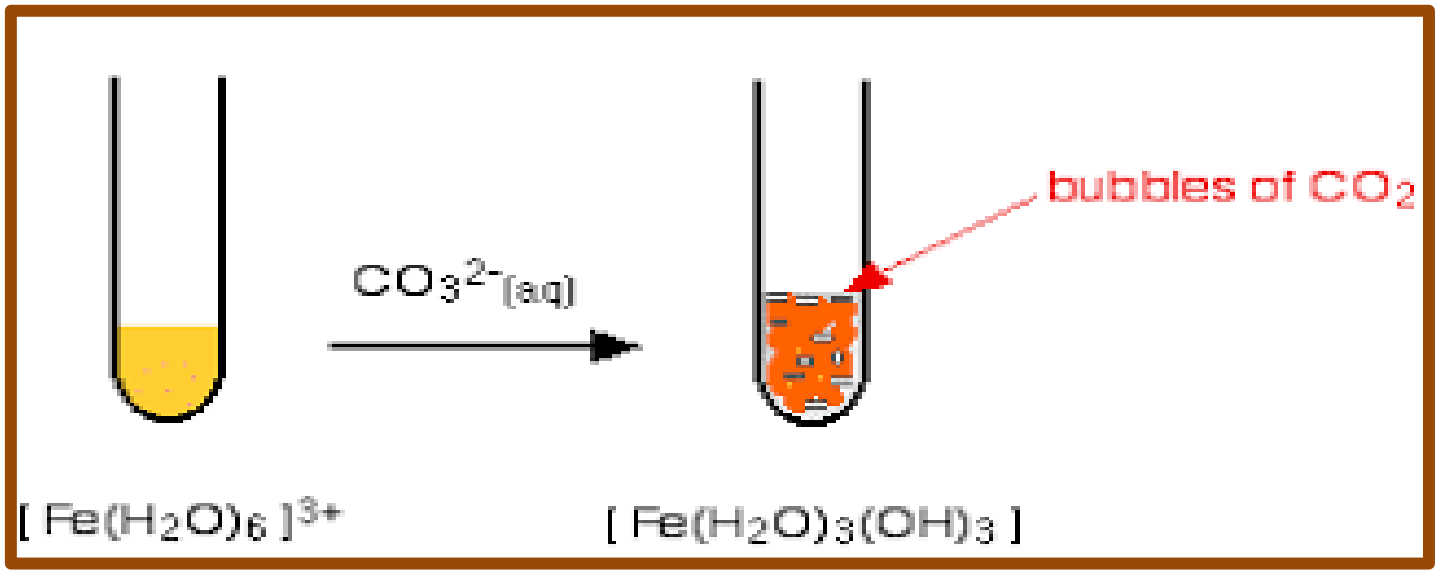




7) Put (10) drops of $[Fe(H_2O)_6]^{3+}$ solution in a test tube, add (2) drops of the concentrated ammonia $NH_3(aq)$, you will notice a dark brown preciptate, write down your notices.



8) **Put (10) drops of $[Fe(H_2O)_6]^{3+}$ solution in a test tube, add (2) drops of sodium carbonates (Na_2CO_3), observe the change, and write down your notices.**



ملاحظات مهمة تبقى معك

Fe^{3+} iron(III)

Add	$[Fe(H_2O)_6]^{3+}$ (aq) violet solution
NaOH (aq) (little) NaOH (aq) (excess) NH_3 (aq) (little) NH_3 (aq) (excess)	Deprotonation reactions– OH^- and NH_3 acting as Lewis bases $Fe(H_2O)_3(OH)_3$ (s) Brown gelatinous precipitate photo
CO_3^{2-} (aq)	Deprotonation reactions – CO_3^{2-} acting as base $Fe(H_2O)_3(OH)_3$ (s) Brown gelatinous precipitate *and* colourless bubbles of CO_2 (g)

Fe^{2+} iron(II)

Add	$[Fe(H_2O)_6]^{2+}$ (aq) green solution
NaOH (aq) (little) NaOH (aq) (excess) NH_3 (aq) (little) NH_3 (aq) (excess)	Deprotonation reactions – OH^- and NH_3 acting as Lewis bases $Fe(H_2O)_4(OH)_2$ (s) Green gelatinous precipitate (turns brown in air) photo
CO_3^{2-} (aq)	$FeCO_3$ (s) precipitation green precipitate

يوجد شيء خطأ حاول تجده ؟

Reaction of iron (iii) ions with sodium hydroxide

$[Fe(H_2O)_6]^{3+}$

A rust brown gelatinous precipitate of iron (iii) hydroxide.

$Fe(OH)_3(H_2O)_{3\,(s)}$

This is insoluble in excess,

$[Fe(H_2O)_6]^{3+} + 3OH^- \rightarrow [Fe(H_2O)_3(OH)_3]_{(s)} + 3H_2O$

A similar reaction occurs with ammonia.

Reaction of iron (ii) ions with sodium hydroxide

$[Fe(H_2O)_6]\ 2+$

A dark green gelatinous precipitate of hydrated iron (ii) hydroxide is formed

$Fe(OH)_2(H_2O)_{4(s)}$

This is insoluble in excess.

$[Fe(H_2O)_6]^{2+} + 2OH^- \rightarrow [Fe(H_2O)_4(OH)_2]_{(s)}$

A similar reaction occurs with ammonia.

Preparation of Sodium ethylenediaminetetraacetatoferrate (III) trihydrate Na [Fe (EDTA)].$3H_2O$:

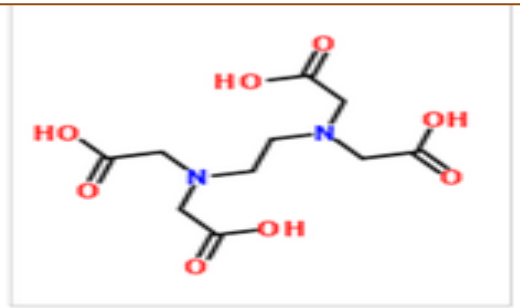
Dissolve (0.4 g) of sodium hydroxide in a beaker consists of (10 mL) of water then add (3.8g) of $Na_2H_2EDTA.2H_2O$ solution to the beaker. Heat the mixture gently until the solid dissolves.

Dissolve (2.5 g) of iron(III) chloride hexa hydrate in (5 mL) of water in other beaker.

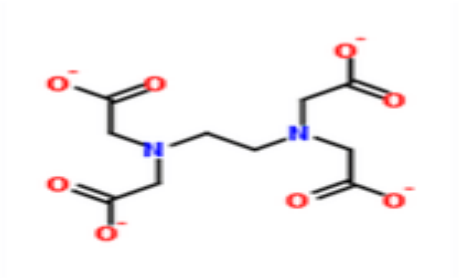
Pour the iron(III) chloride solution into the beaker(step 1), stirr the mixture.

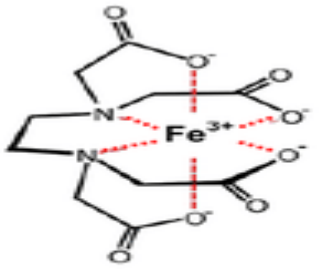
Warm the mixture until the boiling , evaporate gently some of the water until a yellow powder precipitates appears , this may take about five minutes.

Let the mixture cool, collect and filter the precipitate , wash it well with ice-cold water and ethanol , Dry the resulted crystals, weight and calculate the ratio



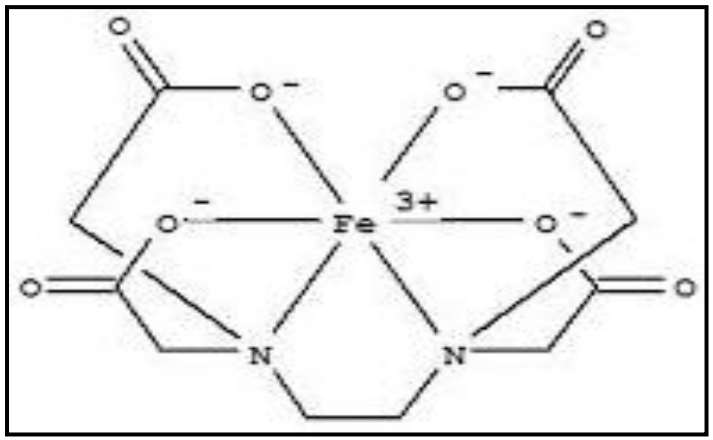
EDTA


$EDTA^{4-}$



$[Fe(EDTA)]^-$

معادلات في التفاعل.. لكن ما هي معادلة التفاعل ألعامة؟



$$EDTA + 4OH^- \rightarrow EDTA^{4-} + 4H_2O$$

$$[Fe(H_2O)_6]^{3+}(aq) + EDTA^{4-}(aq) \rightarrow [Fe(EDTA)]^-(aq) + 6H_2O(l)$$

Questions :

1) What is the benefit of using NaOH?

2) Which of these ligands is a chelate (OH^-, CN^-, and $H_2NCH_2CH_2NH$)?

3) Does this experiment depend on oxidation and reduction principle?

4) Write down this complex preparation equations