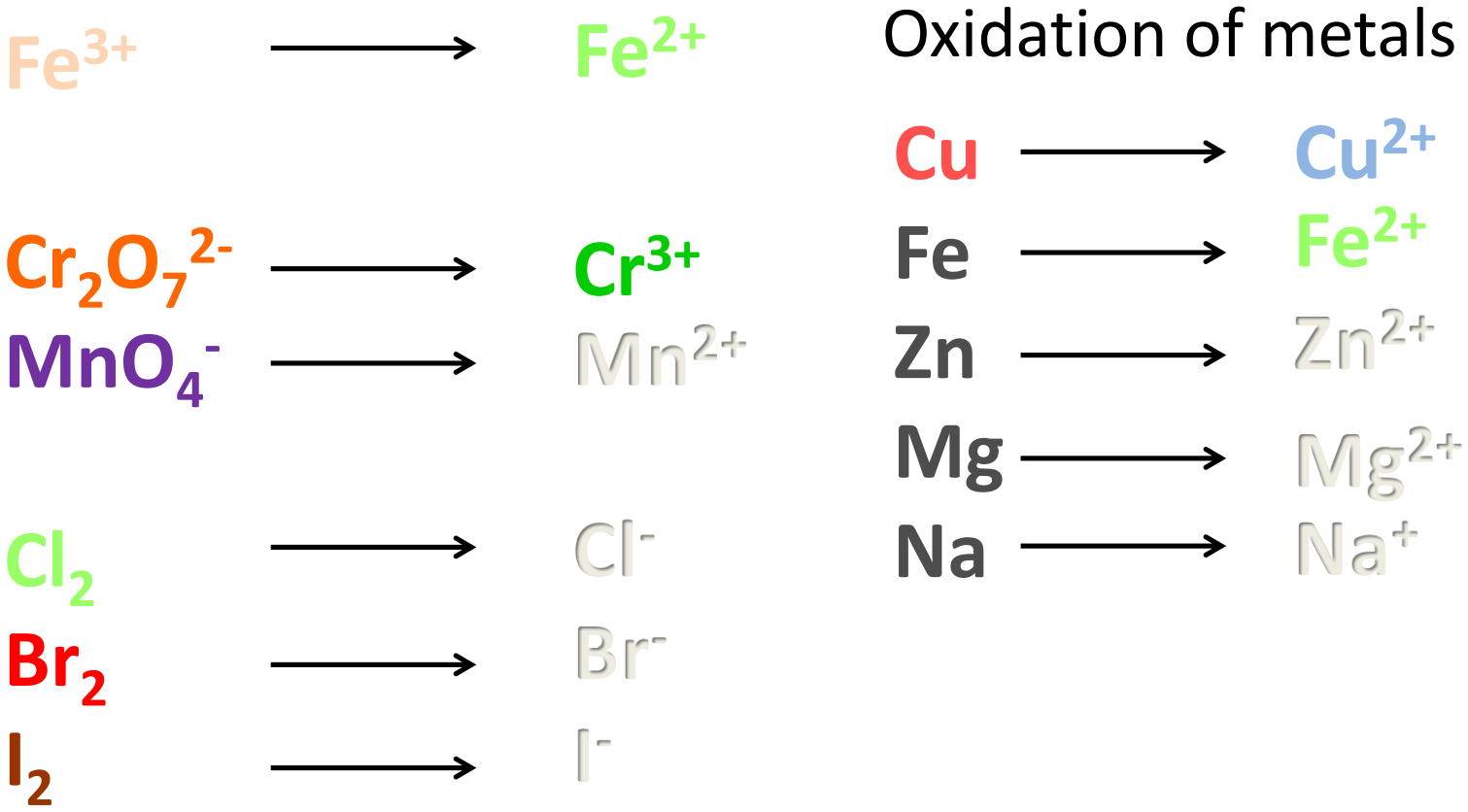
Colours in common redox reactions



Oxidation of metals

CHEM 2.7 Assessment

For A: link one colour to one species
identify one species oxidised or reduced and link to electron transfer or oxidation number

For M: link colour change to product and reactant for one half equation
write balanced half equation
identify half equation as oxidation or reduction linked to electron transfer or oxidation number

For E: link all colour changes to all species
write both balanced half equations and a full equation
identify both half equations as oxidation or reduction linked to electron transfer or oxidation number

Finding products from reactants

What are the products that would be produced from the following reactants?

Use your SciPad pg 67 or the resource sheet to help you

Mg	**Mg^{2+}**
Cu^{2+}	**Cu**
blue	**pink/orange**
I^-	**I_2**
H^+	**H_2**
$Cr_2O_7^{2-}$	**Cr^{3+}**
orange	**green**
MnO_4^-	**Mn^{2+}**
purple	**colourless**

Writing observations

When we write observations they must give the colour of the reactants and the products and linked to the species involved.

For example: Zn^{2+} ions reacting with Fe^{2+} ions

Reactants:	Zn^{2+}	Products:	Zn
	Fe^{2+}		Fe^{3+}

Colourless Zn^{2+} ions were added to pale green Fe^{2+} ions. A pale orange solution forms due to the Fe^{3+} and a silvery/grey solid is produced which is Zn.

Putting it all together

Write down the following chemical reactions, leaving a decent space between each one.

Copper metal reacting with zinc sulfate

Hydrochloric acid reacting with iron metal

Acidified potassium dichromate solution reacting with sodium chloride solution

Acidified potassium permanganate solution reacting with potassium bromide solution

Putting it all together

We are going to:
Identify the chemical formula of the reactants
Identify the chemical formula of the products
Write expected observations
Write half equations
Write full equations
Identify species oxidised and reduced
Link species oxidised and reduced to electron transfer or oxidation number
Identify the oxidant and reductant

Putting it all together

For example: Copper nitrate solution reacting with potassium iodide solution.

Identify the chemical formula of the reactants **Cu^{2+} and I^-**
Identify the chemical formula of the products **Cu and I_2**
Write expected observations
Write half equations **$Cu^{2+} + 2\ e \rightarrow Cu$ and $2\ I^- \rightarrow I_2 + 2\ e$**
Write full equations **$Cu^{2+} + 2\ I^- \rightarrow Cu + I_2$**
Identify species oxidised and reduced **Cu^{2+} reduced, I^- oxidised**
Link species oxidised and reduced to electron transfer or oxidation number
Identify the oxidant and reductant **Cu^{2+} oxidant, I^- reductant**

Identifying reactants

Write down the chemical formula of the reactants in the following reactions.

Copper metal reacting with zinc sulfate **Cu and Zn^{2+}**

Hydrochloric acid reacting with iron metal **H^{+} and Fe**

Potassium dichromate solution reacting with sodium chloride solution **$Cr_2O_7^{2-}$ and Cl^{-}**

Potassium permanganate solution reacting with potassium bromide solution

MnO_4^{-} and Br^{-}

Identifying products

Write down the chemical formula of the <u>products</u> in the following reactions.

Copper metal reacting with zinc sulfate **Cu^{2+} and Zn**

Hydrochloric acid reacting with iron metal **H_2 and Fe^{2+}**

Acidified potassium dichromate solution reacting with sodium chloride solution **Cr^{3+} and Cl_2**

Acidified potassium permanganate solution reacting with potassium bromide solution

Mn^{2+} and Br^-

Writing observations

Write down the expected observations from the following reactions linked to the species involved.

Copper metal reacting with zinc sulfate

Pink/brown Cu strip was added to colourless Zn^{2+} solution. The solution turns blue (Cu^{2+}) and a silvery/grey deposit of Zn is formed.

Hydrochloric acid reacting with iron metal

Silvery/grey Fe strip was added to colourless H^{+} solution. Bubbles are produced (H_2) and the solution remains colourless (Fe^{2+}).

Writing observations

Write down the expected observations from the following reactions linked to the species involved.

Acidified potassium dichromate solution reacting with sodium chloride solution

Colourless Cl^- solution is added to orange $Cr_2O_7^{2-}$ solution. A green solution is formed (Cr^{3+}), the pale green Cl^- can not be seen.

Acidified potassium permanganate solution reacting with potassium bromide solution

Colourless Br^- solution is added to purple MnO_4^- solution. An orange/red solution is formed (Br_2), and the Mn^{2+} is colourless.

Writing half equations

Write down the half equations from the following reactions.

Copper metal reacting with zinc sulfate $Cu \rightarrow Cu^{2+} + 2\ e$

$Zn^{2+} + 2\ e \rightarrow Zn$

Hydrochloric acid reacting with iron metal $2\ H^{+} + 2\ e \rightarrow H_2$

$Fe \rightarrow Fe^{2+} + 2\ e$

Acidified potassium dichromate solution reacting with sodium chloride solution $Cr_2O_7^{2-} + 14\ H^{+} + 6\ e \rightarrow 2\ Cr^{3+} + 7\ H_2O$

$2\ Cl^{-} \rightarrow Cl_2 + 2\ e$

Acidified potassium permanganate solution reacting with potassium bromide solution $MnO_4^{-} + 8\ H^{+} + 5\ e \rightarrow Mn^{2+} + 4\ H_2O$

$2\ Br^{-} \rightarrow Br_2 + 2\ e$

Writing full equations

Write down the full equations from the following reactions.

Copper metal reacting with zinc sulfate $Cu + Zn^{2+} \rightarrow Cu^{2+} + Zn$

Hydrochloric acid reacting with iron metal $2\ H^{+} + Fe \rightarrow H_2 + Fe^{2+}$

Acidified potassium dichromate solution reacting with sodium chloride solution $Cr_2O_7^{2-} + 14H^{+} + 6\ Cl^{-} \rightarrow 2\ Cr^{3+} + 7\ H_2O + 3\ Cl_2$

Acidified potassium permanganate solution reacting with potassium bromide solution

$2\ MnO_4^{-} + 16\ H^{+} + 10\ Br^{-} \rightarrow 2\ Mn^{2+} + 8\ H_2O + 5\ Br_2$

Species oxidised and reduced

Identify the species oxidised and the species reduced from the following reactions.

Copper metal reacting with zinc sulfate **Cu oxidised**
Zn^{2+} reduced

Hydrochloric acid reacting with iron metal **H^+ reduced**
Fe oxidised

Acidified potassium dichromate solution reacting with sodium chloride solution **$Cr_2O_7^{2-}$ reduced**
Cl^- oxidised

Acidified potassium permanganate solution reacting with potassium bromide solution **MnO_4^- reduced**
Br^- oxidised

Species oxidised and reduced

Give a reason for your decision (either electron transfer or oxidation numbers).

Copper metal reacting with zinc sulfate

Cu lost electrons as they are on the right hand side of the half equation. Zn^{2+} gained electrons as they are on the left hand side of the half equation. Oxidation is loss of electrons and reduction is gain of electrons.

Hydrochloric acid reacting with iron metal

The oxidation number of H decreased from +1 in H^+ to 0 in H_2. The oxidation number of Fe increased from 0 in Fe to +2 in Fe^{2+}. Oxidation is increase in oxidation number, reduction is decrease in oxidation number.

Species oxidised and reduced

Give a reason for your decision (either electron transfer or oxidation numbers).

Acidified potassium dichromate solution reacting with sodium chloride solution

Cl^- lost electrons as they are on the right hand side of the half equation. $Cr_2O_7^{2-}$ gained electrons as they are on the left hand side of the half equation. Oxidation is loss of electrons and reduction is gain of electrons.

Acidified potassium permanganate solution reacting with potassium bromide solution

The oxidation number of Mn decreased from +7 in MnO_4^- to +2 in Mn^{2+}. The oxidation number of Br increased from -1 in Br^- to 0 in Br_2. Oxidation is increase in oxidation number, reduction is decrease in oxidation number.

Oxidants and reductants

Identify the oxidants and reductants from the following reactions.

Copper metal reacting with zinc sulfate **Cu reductant**
Zn^{2+} oxidant

Hydrochloric acid reacting with iron metal **H^+ oxidant**
Fe reductant

Acidified potassium dichromate solution reacting with sodium chloride solution **$Cr_2O_7^{2-}$ oxidant**
Cl^- reductant

Acidified potassium permanganate solution reacting with potassium bromide solution **MnO_4^- oxidant**
Br^- reductant

Do now:

Write down the ions that are going to react in a redox reaction when copper nitrate solution is added to potassium iodide solution.

Cu^{2+} and I^-

Write down the products that will be formed as a result of this redox reaction.

Cu and I_2

Get your homework out

Observing redox reactions

For example: Copper nitrate solution reacting with potassium iodide solution.

Identify the chemical formula of the reactants **Cu^{2+} and I^-**
Identify the chemical formula of the products **Cu and I_2**
Write expected observations
Write half equations **$Cu^{2+} + 2\ e \rightarrow Cu$ and $2\ I^- \rightarrow I_2 + 2\ e$**
Write full equations **$Cu^{2+} + 2\ I^- \rightarrow Cu + I_2$**
Identify species oxidised and reduced **Cu^{2+} reduced, I^- oxidised**
Link species oxidised and reduced to electron transfer or oxidation number
Identify the oxidant and reductant **Cu^{2+} oxidant, I^- reductant**

Lab today

We are going to go through the reactions as a class.

We will carry each reaction out and then do what we started doing yesterday:

- Identify the chemical formula of the reactants
- Identify the chemical formula of the products
- Write the observations linked to reactants and products
- Write half equations
- Identify species oxidised and reduced
- Link species oxidised and reduced to electron transfer or oxidation number
- Identify the oxidant and reductant

Reaction 1

Add 1 cm depth hydrogen peroxide (H_2O_2) and 1 cm depth sulphuric acid (H_2SO_4) in a test tube. Add drops of potassium iodide (KI) until a change is observed

Reactants: H_2O_2 H_2SO_4 KI

I^- and H_2O_2

Products: I_2 and H_2O

Observations: A colourless H_2O_2 solution had colourless H_2SO_4 added. Then colourless I^- solution was added. A yellow solution formed, this is a result of I_2 being produced. Water is also formed, this is colourless.

Half equations: $H_2O_2 + 2\ H^+ + 2e \rightarrow 2\ H_2O$ and $2I^- \rightarrow I_2 + 2\ e$

Oxidised: I^- is oxidised, because it loses electrons. Oxidation is loss of electrons. Reduced: H_2O_2 is reduced because it gains electrons. Reduction is gain in electrons.

Reaction 2

Add 1 cm depth potassium dichromate ($K_2Cr_2O_7$) and 1 cm depth sulphuric acid (H_2SO_4) in a test tube. Add drops of hydrogen peroxide (H_2O_2) until a change is observed

Reactants: $Cr_2O_7^{2-}$ and H_2O_2 and H_2SO_4

Products: Cr^{3+} and O_2

Observations: An orange solution ($Cr_2O_7^{2-}$) had colourless H_2SO_4 added. Colourless solution of H_2O_2 was added. A green solution formed which is Cr^{3+} and bubbles of O_2 were seen.

Half equations:

$Cr_2O_7^{2-} + 14H^+ + 6\ e \rightarrow 2\ Cr^{3+} + 7H_2O$ and $H_2O_2 \rightarrow O_2 + 2\ H^+ + 2\ e$

Oxdised: H_2O_2 ON of O is -1 and O_2 ON of O is 0 so increase in ON is oxidation

Reduced: $Cr_2O_7^{2-}$ ON of Cr is +6 and Cr^{3+} ON of Cr is +3 o decrease in ON is reduction

Do now:

What is the reactant in the following species?

Eg $KMnO_4$: The species reacting is MnO_4^- **Mn^{2+}**

$K_2Cr_2O_7$	**$Cr_2O_7^{2-}$**	**Cr^{3+}**
$FeSO_4$	**Fe^{2+}**	**Fe^{3+} or Fe**
KI	**I^-**	**I_2**
H_2SO_4	**H^+**	**H_2**
$Zn(NO_3)_2$	**Zn^{2+}**	**Zn**

What would be produced in the redox reaction?