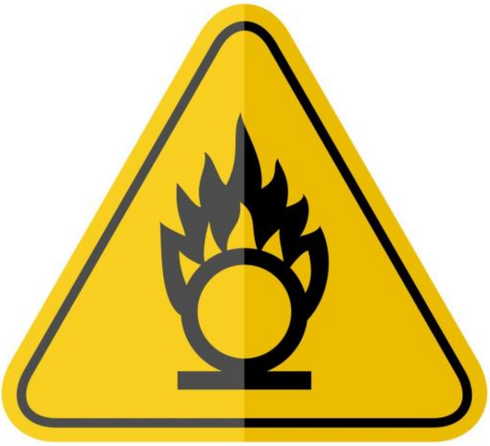
Master

Kirkcaldy High School



Higher Chemistry

Unit 1 - part 3

Oxidising and Reducing Agents

Name: ______________________

Class: ______________________

Teacher: ______________________

Assessment Page

Homework

Homework title	Date	Mark/Total Mark
N5 Formulae + H Redox		**/**

Notes/comments

Check tests

Test title	Date	Mark/Total Mark
Unit 1: Key area 1ci		**/**

Notes/comments

Date: ________________

Redox Reactions

Overarching question(s) for this topic

- How can we identify chemicals that can oxidise and reduce other substances?
- How can we balance complex-ion equations?

Oxidation and Reduction Reactions

Reduction is a **gain** of electrons by a reactant in any reaction.

The **electrons** will appear on the **reactant** side of the reaction

e.g. ion-electron equation: $F_2(g) + \mathbf{2e^-} \rightarrow 2F^-(aq)$

Oxidation is a **loss** of electrons by a reactant in any reaction.

The **electrons** will appear on the **product** side of the reaction

e.g. ion-electron equation: $Li(s) \rightarrow Li^+(aq) + \mathbf{e^-}$

In a **redox** reaction, reduction and oxidation take place at the same time.

e.g. $F_2(g) + Li(s) \rightarrow 2Li^+(aq) + 2F^-(aq)$

which can also be written as:

$F_2(g) + Li(s) \rightarrow 2LiF(aq)$

An **oxidising agent** is a substance that **accepts** electrons, causing another substance to **oxidise**.

Oxidising agents themselves will **reduce**.

In the above example, **fluorine** is acting as an oxidising agent.

A **reducing agent** is a substance that **donates** electrons, causing another substance to **reduce**.

Reducing agents themselves will **oxidise**.

In the above example, **lithium** is acting as a reducing agent.

Uses for oxidising agents

Oxidising agents are widely used because of the effectiveness with which they can kill **fungi** and **bacteria**, and can **inactivate viruses**. The oxidation process is also an effective means of **breaking** down **coloured** compounds, making oxidising agents ideal for use as '**bleach'** for **clothes** and **hair**.

Identifying oxidising and Reducing Agents

You will be given equations that you must identify the oxidation and reduction reactions and the oxidising and reducing agents. You may also write the ion-electron equations for the oxidation and reduction reactions.

Your teacher will show you using these examples:

$$Zn(s) + Cu^{2+}(aq) \rightarrow Zn^{2+}(aq) + Cu(s)$$

You must now use your data booklet to find the charges of the substances, remember only ionic substances will be charged. You will also need to identify spectator ions

$$2Li(s) + CaCl_2(aq) \rightarrow 2LiCl(aq) + Ca(s)$$

$$HgCl_2(aq) + SnCl_2(aq) \rightarrow Hg(l) + SnCl_4(aq)$$

Questions (in your jotter)

With the following equations, write the ion electron equation for the oxidation and reduction reactions and identify the oxidising agent and reducing agent.

1. $2Na(s) + Cl_2(g) \rightarrow 2Na^+(aq) + 2Cl^-(aq)$
2. $Mg(s) + Br_2(l) \rightarrow Mg^{2+}(aq) + 2Br^-(aq)$
3. $Ca(s) + S(s) \rightarrow Ca^{2+}(aq) + S^{2-}(aq)$
4. $2K(s) + I_2(s) \rightarrow 2K^+(aq) + 2I^-(aq)$
5. $Al(s) + 3Cl_2(g) \rightarrow Al^{3+}(aq) + 6Cl^-(aq)$

You may also need to identify the spectator ions in the following equations

6. $Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$
7. $Zn(s) + HCl(aq) \rightarrow ZnCl_2(aq) + H_2(g)$
8. $2AgNO_3(aq) + Cu(s) \rightarrow 2Ag(s) + Cu(NO_3)_2(aq)$
9. $3Ag_2S(aq) + 2Al(s) \rightarrow 6Ag(s) + Al_2S_3(aq)$
10. $H_2(g) + 2Na(s) \rightarrow 2NaH(aq)$

The Electrochemical Series

The electrochemical series represents a series of **reduction** reactions.

The strongest **oxidising agents** are at the **bottom** of the **left-hand column** of the electrochemical series.

The strongest **reducing agents** are at the **top** of the **right-hand column** of the electrochemical series.
An **example** of a reducing agent **not shown** on the electrochemical series is **carbon monoxide.**

Elements with **low electronegativities** tend to form ions by losing electrons and so act as **reducing agents**.

Elements with **high electronegativities** tend to form ions by gaining electrons and so act as **oxidising agents.**

Reaction		
$Li^+(aq) + e^-$	$\rightleftharpoons$	$Li(s)$
$Cs^+(aq) + e^-$	$\rightleftharpoons$	$Cs(s)$
$Rb^+(aq) + e^-$	$\rightleftharpoons$	$Rb(s)$
$K^+(aq) + e^-$	$\rightleftharpoons$	$K(s)$
$Sr^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Sr(s)$
$Ca^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Ca(s)$
$Na^+(aq) + e^-$	$\rightleftharpoons$	$Na(s)$
$Mg^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Mg(s)$
$Al^{3+}(aq) + 3e^-$	$\rightleftharpoons$	$Al(s)$
$2H_2O(\ell) + 2e^-$	$\rightleftharpoons$	$H_2(g) + 2OH^-(aq)$
$Zn^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Zn(s)$
$Cr^{3+}(aq) + 3e^-$	$\rightleftharpoons$	$Cr(s)$
$Fe^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Fe(s)$
$Ni^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Ni(s)$
$Sn^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Sn(s)$
$Pb^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Pb(s)$
$Fe^{3+}(aq) + 3e^-$	$\rightleftharpoons$	$Fe(s)$
$2H^+(aq) + 2e^-$	$\rightleftharpoons$	$H_2(g)$
$S_4O_6^{2-}(aq) + 2e^-$	$\rightleftharpoons$	$2S_2O_3^{2-}(aq)$
$Sn^{4+}(aq) + 2e^-$	$\rightleftharpoons$	$Sn^{2+}(aq)$
$Cu^{2+}(aq) + e^-$	$\rightleftharpoons$	$Cu^+(aq)$
$SO_4^{2-}(aq) + 2H^+(aq) + 2e^-$	$\rightleftharpoons$	$SO_3^{2-}(aq) + H_2O(\ell)$
$Cu^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Cu(s)$
$O_2(g) + 2H_2O(\ell) + 4e^-$	$\rightleftharpoons$	$4OH^-(aq)$
$I_2(s) + 2e^-$	$\rightleftharpoons$	$2I^-(aq)$
$Fe^{3+}(aq) + e^-$	$\rightleftharpoons$	$Fe^{2+}(aq)$
$Ag^+(aq) + e^-$	$\rightleftharpoons$	$Ag(s)$
$Hg^{2+}(aq) + 2e^-$	$\rightleftharpoons$	$Hg(\ell)$
$Br_2(\ell) + 2e^-$	$\rightleftharpoons$	$2Br^-(aq)$
$O_2(g) + 4H^+(aq) + 4e^-$	$\rightleftharpoons$	$2H_2O(\ell)$
$Cr_2O_7^{2-}(aq) + 14H^+(aq) + 6e^-$	$\rightleftharpoons$	$2Cr^{3+}(aq) + 7H_2O(\ell)$
$Cl_2(g) + 2e^-$	$\rightleftharpoons$	$2Cl^-(aq)$
$MnO_4^-(aq) + 8H^+(aq) + 5e^-$	$\rightleftharpoons$	$Mn^{2+}(aq) + 4H_2O(\ell)$
$H_2O_2(aq) + 2H^+(aq) + 2e^-$	$\rightleftharpoons$	$2H_2O(\ell)$
$F_2(g) + 2e^-$	$\rightleftharpoons$	$2F^-(aq)$

Using the electrochemical series

You can use the electrochemical series to identify potential oxidising or reducing agents for specific reactions.

To **oxidise** a specific reaction, the **oxidising agent** must be **below** and to the **left** of the reaction on the electrochemical series.

To **reduce** a specific reaction, the **reducing agent** must be **above** and to the **right** of the reaction on the electrochemical series.

Your teacher will explain the following example

$$SO_3^{2-}(aq) + H_2O(l) \rightarrow SO_4^{2-}(aq) + 2H^+(aq) + 2e^-$$

Which of the following ions could be used to oxidise sulfite ions to sulfate ions?

A $Cr^{3+}(aq)$

B $Al^{3+}(aq)$

C $Fe^{3+}(aq)$

D $Sn^{4+}(aq)$

Questions

1.

$$2I^- (aq) \rightarrow I_2 + 2e^-$$

Which of the following could be used to oxidise iodide ions to iodine?

A Cu(s)

B $Hg^{2+}(aq)$

C $Al^{3+}(aq)$

D $K^+(aq)$

2.

$$Sn^{2+}(aq) + 2e- \rightarrow Sn(s)$$

Which of the following could be used to reduce tin ions to tin metal?

A $Fe^{2+}(aq)$

B Ca(s)

C $Br_2(l)$

D $MnO4^-(aq)$

Balancing complex-ion equations

Complex-ions are ions with multiple elements grouped together. (e.g. IO_3^-, MnO_4^-, $Cr_2O_7^{2-}$). They can undergo redox reactions and must be balanced.

Steps to balancing complex ion equations:

1. Balance the non-oxygen element.
2. Balance the oxygen by adding water molecules to the equation.
3. Balance the hydrogen by adding hydrogen ions (H+) to the equation.
4. Balance the charge.

Your teacher will demonstrate this to you

$$IO_3^- \rightarrow I_2$$

Questions

Balance the following complex ion equations

1. $ClO_3^- \rightarrow Cl_2$
2. $NO_3^- \rightarrow NO$
3. $MnO_4^- \rightarrow Mn^{2+}$
4. $Cr_2O_7^{2-} \rightarrow Cr^{3+}$

Extension questions:
Hodder and Gibson
Blue Chemcord book
SCHOLAR

Past Papers

S & B 1st 20	2015	2016	2017	2018	2019	2021	2022	2023
MC	20	17,18,19	13	18,19	3,4	4	4,5	14
S2	12aii	11bii	9bi	11b	12di	4cii, 6bii	5bi-ii	1biii, 6d

TEAMS: Check Test – Unit 1: Key Area 1ci