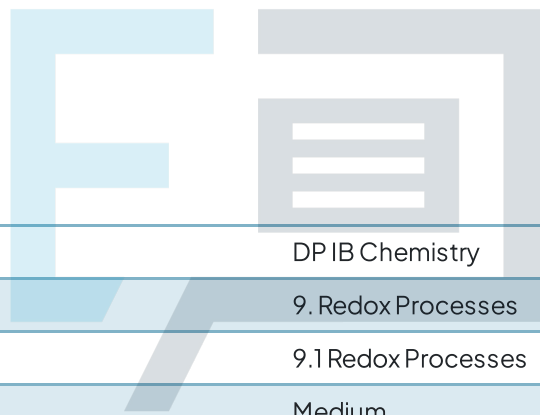




9.1 Redox Processes

Mark Schemes



Course	DP IB Chemistry
Section	9. Redox Processes
Topic	9.1 Redox Processes
Difficulty	Medium

Exam Papers Practice

To be used by all students preparing for DP IB Chemistry SL
Students of other boards may also find this useful

1

The correct answer is **A** because:

- Even in equations with charges, balance the atoms first
- Balance the Cl atoms in the equation
- Then, balance the O and H atoms
- This may take some trial and error - remember to keep checking both sides of the equation
- Check the charges balance and write the full, balanced equation:
 - $3\text{Cl}_2 + 6\text{OH}^- \rightarrow 5\text{Cl}^- + \text{ClO}_3^- + 3\text{H}_2\text{O}$
- The coefficient of p is thus 3, of r is 5 and of s is 1

B, C & D are incorrect because these options do not correctly balance the ec

2

The correct answer is **C** because:

- Chlorine dissolves in water to produce hydrochloric acid and hypochlorous acid
 - $\text{Cl}_2 + \text{H}_2\text{O} \rightarrow \text{HCl} + \text{HOCl}$
- If we analyse the half reactions, we can see that this is a **disproportionation reaction** in which chlorine is both oxidised and reduced
- Oxidation
 - $\frac{1}{2}\text{Cl}_2 + \text{H}_2\text{O} \rightarrow \text{HOCl} + \text{H}^+ + \text{e}^-$ (change in oxidation number Cl: 0 to +1)
- Reduction
 - $\frac{1}{2}\text{Cl}_2 + \text{e}^- \rightarrow \text{Cl}^-$ (change in oxidation number Cl: 0 to -1)

A & D are incorrect because the oxidising power in Group VII halogens **increases as you move up**, with fluorine being the most powerful oxidising agent.

B is incorrect because the reducing power of the halide ions **increases as you move down** due to increasing radius and shielding effects. As iodine is lower than F, Cl and Br, its ions are more powerful reducing agents.

3

The correct answer is **B** because:

- Oxidising agents are substances that oxidise other species, gain electrons and are them
- Write down the oxidation numbers of each species in the reaction



- In equation **B**, Fe^{2+} oxidises $\text{Mg}(0)$ to $\text{Mg}^{2+}(+2)$ and is itself reduced from $\text{Fe}^{2+}(+2)$ to $\text{Fe}(0)$

A, C & D are incorrect because in these reactions, each of the species in bold undergo oxidation so they cannot be acting as oxidising agents.

4

The correct answer is **C** because:

- The oxidation number of oxygen is -2; hydrogen is +1 and chlorine is also +1 so hydrogen and chlorine have the same oxidation number

A is incorrect because in $\text{Mg}(\text{OH})_2$ the oxidation number of magnesium is +2, oxygen is -2 and hydrogen is +1

B is incorrect because in Na_2SO_4 the oxidation number of sodium is +1, sulfur is +6 and oxygen is -2

D is incorrect because in NH_4Cl the oxidation number of nitrogen is -3, hydrogen is +1 and chlorine is -1

5

The correct answer is **A** because:

- Oxidation refers to the **loss of electrons** and reduction refers to the **gain of electrons**: OIL-RIG (oxidation is loss - reduction is gain)
- In the compound NaI, sodium has an oxidation state of +1, and iodine an oxidation state of -1
- Iodine has been oxidised as the number of electrons has decreased as in its elemental form iodine has an oxidation state of 0

B is incorrect because the oxidation state of the SO_4^{2-} ion has not changed

C is incorrect because the oxidation state of the Na^+ ion has not changed

D is incorrect because the oxidation state of the H^+ ion has not changed



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The correct answer is **D** because:

- Oxidation refers to the **loss of electrons** and reduction refers to the **gain of electrons**: OIL-RIG (oxidation is loss - reduction is gain)
- Oxidation numbers in the reactants:
 - Ti in the compound $\text{TiO}_2 = +4$
 - O in the compound $\text{TiO}_2 = -2$
 - Br in the compound $\text{BrF}_3 = +3$
 - F in the compound $\text{BrF}_3 = -1$
- Oxidation numbers in the products:
 - Ti in the compound $\text{TiF}_4 = +4$
 - O in the compound $\text{O}_2 = 0$
 - Br in the compound $\text{Br}_2 = 0$
 - F in the compound $\text{TiF}_4 = -1$
- Oxygen is the only element with an increase in oxidation number from -2 in TiO_2 to 0 in O_2

A is incorrect because the oxidation state of fluorine has not changed

B is incorrect because the oxidation number of bromine decreases in this reaction

C is incorrect because the oxidation state of titanium has not changed

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The correct answer is **A** because:

- Oxidizing agents are substances that oxidize other species, gain electrons and are themselves reduced
- Write down the oxidation numbers of each species in the reaction



- In equation **A**, hydrogen oxidizes Na(0) to Na⁺(+1) and is itself reduced from H(0) to H⁻(-1)

B, C & D are incorrect because hydrogen is acting as a reducing agent in all the other reactions shown; this means that it is losing electrons

8

The correct answer is **C** because:

- In reaction 1 the bromide ions reduce the sulfuric acid to sulfur dioxide gas, this decreases the oxidation state of the sulfur from +6 in the sulfuric acid to +4 in the sulfur dioxide
 - A change in the oxidation state of 2
- In reaction 2 the reduction of sulfuric acid (oxidation state +6) is more complex
 - The first stage is to sulfur dioxide (sulfur oxidation state +4)
 - Then to sulfur (oxidation state 0)
 - And then to hydrogen sulfide (sulfur oxidation state -2)
 - This reaction has a greatest change in oxidation state of 8 (from +6 to -2)
- In reaction 3 there is no change in the oxidation state of sulfur
 - Both hydrogen and potassium have an oxidation state of +1 meaning that the sulfur oxidation state in these compounds is +6

A, B & D are incorrect because these answers do not correspond to the actual changes in oxidation number involved



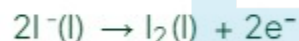
9

The correct answer is **D** because:

- During electrolysis ions are attracted to the oppositely charged electrodes
- Metals ions are positively charged (**cations**), so will be attracted to the negative electrode where they will collect electrons and become neutral atoms



- Non-metals are negatively charged ions (**anions**) and will be attracted to the positively electrode where they give up electrons to become neutral atoms or molecules



A is incorrect because these are the ions, not substances produced in electrolysis

B is incorrect because the substances produced are at the wrong electrodes

C is incorrect because these are the ions that migrate to the electrodes, but they are not the products of the electrolysis

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10

The correct answer is **B** because:

- Electrons are produced at the negative half cell (**anode**) which is zinc in this case
- Electrons flow from the negative half cell to the positive half cell (**cathode**) through the external wire
- These are the half cell reactions which show that electrons flow out of the anode and positive ions are lost from the cathode
 - Anode $\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^{-}$
 - Cathode $\text{Cu}^{2+} + 2\text{e}^{-} \rightarrow \text{Cu}$
- To conserve charge in the half cells,
 - **anions** (negative ions) in the salt bridge flow to the negative half cell to replace the negative charge of the electrons and complete the circuit
 - **cations** (positive ions) in the salt bridge flow to the positive half cell since there is a loss of positive charge from the metal cations becoming metal atoms

A is incorrect because these are the ions are flowing in the wrong direction

C and **D** are incorrect because ions of different charges cannot be both flowing in the same direction towards the half cells

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