C4.2 Mastery Quiz: Extraction of Metals

Mark Scheme

Section A

Qu	Answer	Marks	Supporting information for fix-it tasks
1	B	1	Answering A suggests a misconception that the substance at the top of the reactivity series is the least reactive. *To fix it, model how to annotate this reactivity series by labelling the top as 'most reactive' and the bottom as 'least reactive'. Then ask students to describe how the substances in the reactivity series are organised.* Answering C suggests a misconception that a substance higher up in the series is less reactive. *To fix it, reteach how the reactivity series is arranged and model how to compare reactivities of two substances. Then ask students to write sentences to compare the reactivities of different substances.*
2	B	1	Answering A suggests the misconception that covalent compounds can be electrolysed. *To fix it, recap a comparison the types of boding for covalent and ionic and then ask students to explain why only ionic compounds can be electrolysed.* Answering C suggests the misconception that electrolysis can break down elements. *To fix it, reteach that elements are not charged so cannot conduct electricity when molten. Also recap that electrolysis is for breaking down ionic compounds and that subatomic particles cannot be broken down using electrolysis. Then ask students to describe why only ionic compounds can be broken down using electrolysis.*
3	B	1	Answering A suggests a confusion between oxidation and reduction. *To fix it, ask students to compare oxidation and reduction using the key terms: gain, loss, oxygen, electrons.* Answering C suggests the misconception that 'oxide' is a substance that metals react with. *To fix it, ask students to write out the word equations for the reaction of iron and oxygen, magnesium and oxygen and calcium and oxygen.*
4	A	1	Answering B suggests the misconception that electrolysis has the sole function of extracting metals from their ores. *To fix it, ask students to write a definition of electrolysis.* Answering C suggests the misconception that electrolysis only happens for molten ionic compounds. *To fix it, reteach that*

			both aqueous solutions of ionic compounds and molten ionic compounds can be electrolytes. Then ask students to explain why an ionic compound must be in solution or molten to be electrolysed.
5	B	1	Answering A or C suggests a gap in knowledge that melting and recasting is a possible method to recycle metals. *To fix it, ask students to explain why melting and recasting recycled steel is useful.*
6	C	1	Answering A suggests the misconception that a reaction has taken place, even is the products and reactants are identical. *To fix it, reteach that if the products and reactants are the same then no reaction has taken place and that this the case in A because magnesium is more reactive than carbon. Then ask students to write out the general word equation for the reduction of a metal oxide with carbon and then write example reactions as word equations.* Answering B suggests the misconception that carbon dioxide is used to reduce a metal oxide. *To fix it, ask students to write out the general word equation for the reduction of a metal oxide with carbon and then write example reactions as word equations.*
7	B	1	Answering A suggests a misconception that an inert electrode needs to be reactive to react with ions. *To fix it, recap the definition of the word inert (refer to noble gases and unreactive metals like gold and platinum). Then ask students to explain why an inert electrode is useful for an electrolysis experiment.* Answering C or D suggests a fundamental gap in knowledge that electrodes have to conduct electricity to function. *To fix it, reteach the function of electrodes, using platinum electrodes as an example. Then ask students to state what properties platinum has that makes it a good inert electrode, and explain why.*
8	A	1	Answering B or C suggests a gap in knowledge of how an electrode is represented in a diagram of electrolysis equipment. *To fix it, reteach each part of the equipment shown and what the functions are. Then ask students to sketch this diagram into books and label every part with annotations of functions.*
9	A	1	Answering B suggests a misconception that oxygen is added to a metal oxide for extracting the metal. *To fix it, discuss with student what the key word 'extraction' means and then ask students to explain why iron is extracted from iron oxide.*

			Answering C suggests an inability to apply the reactivity series in this example. *To fix it, ask students to state which is the most and which is the least reactive substance on this reactivity series. Then ask students to explain why carbon can be used to reduce iron oxide but lead cannot.*
10	A	1	Answering B suggests the misconception that it is the negative electrode that wears away during the electrolysis of molten aluminium oxide. *To fix it, reteach that the positive (not negative) electrode is made from carbon and reacts with oxygen to form carbon dioxide so it gradually wears away. Then ask students to sketch diagram of the electrolysis of molten aluminium oxide, labelling all the parts, including an equation for the reaction of the formation of carbon dioxide at the positive electrode.* Answering C suggests the misconception that cryolite makes it more difficult to melt aluminium oxide. *To fix it, reteach that cryolite is added to lower the melting point so that aluminium oxide becomes liquid more easily. Then ask students to explain why cryolite is added to reduce the cost of extracting aluminium from aluminium oxide.*
11	B	1	Answering A suggests the misconception that pure, elemental metal has a charge. *To fix it, ask students to compare elements, ions and ionic compounds.* Answering C suggests misconception that electrolysis causes the separation of different metal atoms. *To fix it, reteach how the process of electrolysis of molten ionic compounds works. Then ask students to explain why iron and aluminium would not be separated in this example.*
12	C	1	Answering A suggests the common misconception that electrolysis not a chemical reaction. *To fix it, reteach that chemical reactions cause the formation of new products from reactants. Then ask students to explain why electrolysis can be considered a chemical change/reaction.* Answering B suggests the misconception that the reduction of a compound is not a chemical reaction. *To fix it, ask students to write out the word equation of the reduction of calcium oxide using sodium and then to explain why this shows a chemical reaction and not a physical change.* Answering D suggests a fundamental gap in knowledge about the definition of chemical reactions/changes. *To fix it, reteach that chemical reactions cause the formation of new products from reactants. Then students should write example word*

			equations from their notes that represent reduction reactions and electrolysis ionic equations.
13	C	1	Answering A or B suggests an inability to link reactivity data to comparing reactivities of metals. *To fix it, model how to analyse these results (e.g. looking for which column has the most ticks to show the most reactions),. Then ask students to use evidence from the table to explain why copper is the least reactive metal here.*
14	A	1	Answering B suggests the common misconception that it is the ion that is formed at the electrode. *To fix it, reteach how Cu is formed in this example by using a diagram of electrolysis.. Then ask students to predict what would be formed at the positive electrode and explain why using the term 'electron(s)'..* Answering C or D suggests the misconception that negatively charged ions are attracted the negative electrode. *To fix it, ask students to write out whether positively or negatively charged ions are attracted to the positive electrode and the negative electrode..*
15	A	1	Answering B suggests a misconception that halogens are formed at the positive electrode because they are more reactive than the metal ion in solution. *To fix it, reteach that at the negative electrode, hydrogen is produced if the metal is more reactive than hydrogen. Then ask students to explain whether silver could be extracted from a solution of silver chloride using electrolysis..* Answering C suggests a fundamental gap in knowledge about the products formed in electrolysis. *To fix it, reteach what happens at the positive and negative electrodes when the ionic compound is in solution. Then ask students to describe what happens at the negative electrode during the electrolysis of sodium chloride solution.*
16 (HT)	A	1	Answering B or C suggests a gap in knowledge that reduction and oxidation happen when acids and metal react. *To fix it, ask students to define a redox reaction, giving an example.*
17 (HT)	B	1	Answering A suggests a confusion of the symbol equation for the reaction and the ionic equation. *To fix it, ask students to describe the difference between a chemical/symbol equation and an ionic equation.* Answering C suggests a confusion of an ionic equation and a half equation. *To fix it, ask students to describe the difference between a half equation and an ionic equation.*

18 (HT)	C	1	Answering A or B suggests a misconception that only some acids contribute a H^+ ion to a half equation. *To fix it, model this thinking by writing out the ionic equations to remind students that acids always have a* H^+ *ion. Then ask students to write out the half equations for the reaction of sodium and hydrochloric acid (HINT – think about which group Na is in)*
19 (HT)	A	1	Answering B suggests the misconception that state symbols are not required for ionic equations. *To fix it, recap the importance of state symbols. Then ask students to explain why we include state symbols in ionic equations.* Answering C suggests the misconception that balancing is not needed for ionic equations. *To fix it, recap why balancing an ionic equation is so important. Then ask students to explain why the half equations written from an unbalanced ionic equation would be incorrect.*
20 (HT)	A	1	Answering B suggests a gap in knowledge about the uses of quarrying and mining. *To fix it, recap when quarrying and mining are used and then ask students to explain why quarrying and mining is carried out.* Answering C suggests the misconception that a less reactive metal can displace a more reactive metal. *To fix it, ask students to look at the reactivity series and explain why silver could not displace copper in this example.*
21 (Chemistry only)	C	1	Answering A suggests the misconception that only air, and not water, is needed for rusting. *To fix it, ask students to briefly plan an investigation to find out whether air and water are needed for an iron nail to rust.* Answering B suggests the misconception that only water, and not air/oxygen is needed for rusting. *To fix it, ask students to briefly plan an investigation to find out whether air and water are needed for an iron nail to rust.*
22 (Chemistry only)	C	1	Answering A or B suggests a gap in knowledge that a more reactive metal is used for both electroplating and sacrificial protection. *To fix it, ask students to explain what might happen if electroplating and* sacrificial protection was carried out using a metal less reactive than iron.

Section B

Qu	Answer	Marks	Supporting information ***Suggestions for fix-it tasks***
1	2+	1	A common error is to simply state positive or +, rather than 2+. *To fix it, ask students to*

			state what the charge on the ion would be if: (a) 1 electron is gained (b) 2 electrons are lost (c) 2 electrons are gained etc.
2	(It has) gained electrons *Allow it has lost oxygen*	1	A common error when answering questions about oxidation and reduction is to limit answers to the gain or loss of oxygen. *To fix it, reteach that it can mean the gain or loss of oxygen, but a more complete and relevant definition is the loss of electrons or the gain of electrons, respectively. Recap OILRIG as an acronym. Then ask students to compare oxidation and reduction of a compound.*
3	(It/gold is very) unreactive (so it found as pure metal in the Earth because it will) not easily react with other substances.	1 1	A common error in this type of explain question is to not include terms such as 'because' or 'this means that'. *To fix it, ask students to rewrite their answer ensuring that they include* 'because' or 'this means that'.
4	Magnesium <u>ions</u> (in the molten magnesium chloride) are attracted to the <u>negative electrode/cathode</u> (because they are positively charged). (At the negative electrode,) magnesium ions <u>gain electrons</u> Or are reduced 2 electrons are gained *(HT only) Allow 3 marks for the correct half equation* *$Mg^{2+} + 2e^- \rightarrow Mg$ (HT only)*	1 1 1 1	A common error in this type of explain question is to not link the initial scientific statement back to the information in the question. *To fix it, ask students to re write their answer using a scientific statement at the start and then link their explanation to information in the question. Underline key information in the question to support this.* Another common error with answering questions about explaining the formation of products in electrolysis, is confusion of the many key terms. *To fix it, look at the glossary or give definitions of: positive electrode, negative electrode, electron, element, ion, electrolysis. And then ask students to explain how zinc is produced from the electrolysis of molten zinc chloride.*
5	<u>Phytomining</u> uses plants to absorb metal compounds (The plants are harvested and) then burned to produce ash that contains metal compounds	1 1 1	A common error here is to be able to state the names of these two methods but there could be an absence of, or lack of detail, in the description. *To fix it, reteach these two processes and then ask students to write their own descriptions again using key words: plants, absorb, burned, bacteria, leachate.*

	<u>Bioleaching</u> uses bacteria to produce leachate solutions (that contain metal compounds).	 1 1 1	
6	$Zn \rightarrow Zn^{2+} + 2e^-$ $2H^+ \rightarrow 2e^- \rightarrow H_2$	1 1	A common error when writing half equations is to not balance them. *To fix it, model, in sequence, how to write out the symbol equation, then the ionic equation and then the half equations.*
7	By reacting with substances in the environment.	1	Students may struggle to explain this and may instead attempt to further describe what corrosion is, perhaps linked to the corrosive hazard symbol. *To fix it, ask students to rewrite their answer but specifically refer to rusting as an example of corrosion.*