Answers to worksheet questions

Chapter 8

Worksheet 8.1

1 The metals of Group I in the Periodic Table are called the ***alkali*** metals. They are a family of very ***reactive*** metals. They tarnish rapidly in air, but are ***shiny*** when freshly cut. They conduct heat and ***electricity*** well but are ***soft***, have low densities and ***low*** melting and boiling points.

2 **a** lithium + oxygen → lithium oxide

$4Li(s) + O_2(g) \rightarrow 2Li_2O(s)$

b

Metal	Reaction with water
lithium	*floats and fizzes steadily*
sodium	*melts and skates around on surface*
potassium	*melts, skates around on surface and gas catches fire*

c potassium + water → potassium hydroxide + hydrogen

$2K(s) + 2H_2O(l) \rightarrow 2KOH(aq) + H_2(g)$

Worksheet 8.2

1 **a** **i** tungsten **ii** sodium **iii** tungsten

b they all conduct electricity

c mercury

d because it has a very high melting point

e It would sink because it is denser than mercury.

2

Property	Alkali metals	Transition metals
reactivity	*very reactive*	*less reactive*
density	*can float on water*	*sink in water*
melting and boiling point	*low*	*high*
colour of salts	*colourless*	*often coloured*

3 Metals have many ***properties*** that make them useful. Most metals react with other substances such as ***air*** and ***water***. Because of this, most metals are found combined with other elements as ***ores***. The method used to extract the metal depends on how ***reactive*** it is. Moderately reactive metals can be extracted by ***reducing*** the oxide with ***carbon***. The most reactive metals must be extracted by ***electrolysis***. Some metal compounds react with acids – they are called ***bases***. When an acid reacts with a base, a ***salt*** is formed.

Worksheet 8.3

1 Zinc will displace copper from a solution of copper sulfate, and magnesium will displace zinc from a solution of zinc sulfate.

a zinc + copper sulfate → zinc sulfate + copper
magnesium + zinc sulfate → magnesium sulfate + zinc

b $Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$
$Mg(s) + ZnSO_4(aq) \rightarrow MgSO_4(aq) + Zn(s)$

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

d They are redox reactions because there is exchange of electrons / some atoms are losing electrons while some ions are gaining them.

e copper < zinc < magnesium

2 When a more reactive metal is dipped in a solution containing a less reactive metal, a ***displacement*** reaction takes place.

An example of this type of reaction is when a piece of ***zinc*** is dipped in ***copper*** sulfate solution, where the ***more*** reactive metal displaces the less reactive from solution. Studying these reactions helps us to draw up a ***reactivity*** series of the metals.

3 **a** All three metals became the negative electrode.

b A > C > B (> copper)

c **i** A and B: 2.0 V

ii B and C: 0.2 V

d **i** A is the negative terminal.

ii C is the negative terminal.

Worksheet 8.4

1 **a** Copper is being deposited on the surface of the zinc electrode.

b The copper ions that make the solution blue are being discharged to form the copper on the zinc electrode so the solution goes colourless.

c The reaction is an exothermic reaction so the temperature rises.

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

3 $Cu^{2+}(aq) + 2e^- \rightarrow Cu(s)$

4 Electrons move from the zinc atoms to the copper ions.

5 The zinc reacts with the acid and dissolves, and bubbles of hydrogen gas are given off.

6 There is no reaction between copper and the acid.

7 **a** The electrons flow from zinc to copper in the external circuit.

b The zinc electrode gets smaller / shrinks / loses mass.

c The zinc electrode becomes negatively charged.

d The zinc electrode could be changed for a more reactive metal, magnesium, for example / the copper electrode could be changed for a less reactive metal, silver, for example.

e **i** anode: the zinc electrode
cathode: the copper electrode

ii These charges on the electrodes are the opposite way round to those in an electrolytic cell.

Worksheet 8.5

1 1 mole ZnS = 65 + 32 = 97 g

$2ZnS$	$+ 3O_2$	$\rightarrow$	$2ZnO$	$+ 2SO_2$
2 moles			2 moles	
194 g			162 g	
194 tonnes			162 tonnes	

ZnO	$+ C$	$\rightarrow$	Zn	$+ CO$
1 mole			1 mole	
81 g			65 g	
162 tonnes			130 tonnes	

2 The zinc evaporates from the mixture in the furnace and is condensed in the upper part of the furnace.

3 SO_2 is reacted with oxygen to make sulfur trioxide. This is then dissolved in water to make sulfuric acid.
$2SO_2 + O_2 \rightleftharpoons 2SO_3$
$SO_3 + H_2O \rightarrow H_2SO_4$

4 $2CuS + 3O_2 \rightarrow 2CuO + 2SO_2$

5 $2CuO + C \rightarrow 2Cu + CO_2$

6 carbon dioxide and water

7 copper

8 anode: the impure copper
cathode: pure copper

Worksheet 8.6

Most reactive ⟶ **Least reactive**

magnesium > aluminium > zinc > iron > copper

	Aluminium	Copper	Iron	Magnesium	Zinc
Aluminium sulfate		no reaction	no reaction	✓	no reaction
Copper sulfate	✓		✓	✓	✓
Iron sulfate	✓	no reaction		✓	✓
Magnesium sulfate	no reaction	no reaction	no reaction		no reaction
Zinc sulfate	✓	no reaction	no reaction	✓	

$3Mg + Al_2O_3 \rightarrow 3MgO + 2Al$
$Mg\,(s) + Zn^{2+}(aq) \rightarrow Mg^{2+}(aq) + Zn(s)$

Worksheet 8.7

1 **a** A and D

b In B there is no oxygen – it has been boiled out of the water.
In C there is no water – the drying agent (calcium chloride) removes any water.

2 Rusting would be fastest in **D** because salt water promotes rusting.

3 by sacrificial protection / blocks of a more reactive metal than iron (magnesium or zinc) are attached to the hull or legs / these blocks are corroded in preference to the iron

4 **a** by making the cutlery out of stainless steel (containing chromium)

b by galvanising the car body and by painting