Intermediate 1

Int 1 Chemistry

Section 5

Metals

5LO Section 5: Learning Outcomes

Int 1 Chemistry Unit 2: Everyday Chemistry

LO	Lesson	Text Book	Section 5: Metals Learning Outcome	Int1 Only
1	5.1	p66	Some metals, including gold, silver and copper, are found uncombined in the Earth's crust.	
2	5.1	p66	Most metals are found combined with other elements	
3	5.1 5.2	p67/68	**Some metals, including iron, are extracted from their ores by heating with carbon.**	**Int1**
4	5.3	p69	**Some metals, including aluminium, are extracted from their ores using electricity.**	**Int1**
5	5.4	p71	Metal elements and carbon (graphite) are conductors of electricity and most non- metal elements are non-conductors of electricity.	
6	5.5	p70-72	The specific properties of metals, including density, thermal and electrical conductivity, malleability, strength, are related to their uses.	
7	5.6	p72	An alloy is a mixture of metals, or of metals with non- metals.	
8	5.6	p73/74	Brass, solder and 'stainless' steel are examples of alloys. Metals are alloyed to change their properties for specific uses.	
9	5.7	p78	Metal oxides are produced in the reactions of metals with oxygen.	
10	5.8	p79	**Reactions of metals with water produce hydrogen.**	**Int1**
11	5.10	p80	Reactions of metals with an acid produce hydrogen gas and a salt.	
12	5.9	p81	**Some metals, including copper, silver and gold, do not react with dilute acid.**	**Int1**
13	5.9	p81	**Differences in the reactions give an indication of the reactivity of the metals.**	**Int1**
14	5.10	p79	The test for hydrogen is that it burns with a 'pop'.	
15	5.12	p83	Corrosion is a chemical reaction which involves the surface of a metal changing from an element to a compound.	
16	5.12	p83	Rusting is the corrosion of iron.	
17	5.12	p82	Rusting results in a loss of structural strength.	
18	5.13	p84	Both oxygen (from the air) and water are required for rusting.	
19	5.14	p85	Rust indicator can be used to show the extent of the rusting process (the deeper the blue colour the greater the rusting)	
20	5.14	p85	Acid rain increases the rate of corrosion.	
21	5.14	p85	Salt increases the rate of corrosion	
22	5.15 5.16 5.17	p86-90	Painting, greasing, electroplating, galvanising, tin- plating and coating with plastic give a surface barrier to air and water which can provide protection against corrosion.	
23	5.17	p89	**Iron does not rust when attached to more reactive metals.**	**Int1**
24	5.17	p89	**Zinc (galvanising) and scrap magnesium are used to protect iron.**	**Int1**
25	5.18	p89-90	**Anodising is a process which increases the thickness of the oxide layer on aluminium to provide protection against corrosion.**	**Int1**
26	5.21	p92	In a battery, electricity comes from a chemical reaction.	
27	5.21	p92	Batteries require to be replaced due to the chemicals being used up in the reaction.	
28	5.21	p92	Examples of rechargeable batteries include the lead- acid battery and the nickel-cadmium battery.	
29	5.19	p93	**Electricity can be produced by connecting different metals together, with a solution containing ions, to form a cell.**	**Int1**
30	5.19	p93	**The purpose of the ion solution is to complete the circuit.**	**Int1**
31	5.20	p93	**The voltage between different pairs of metals varies.**	**Int1**
32	5.20	p93	**The voltage is related to the difference in the reactivity of the metals**	**Int1**

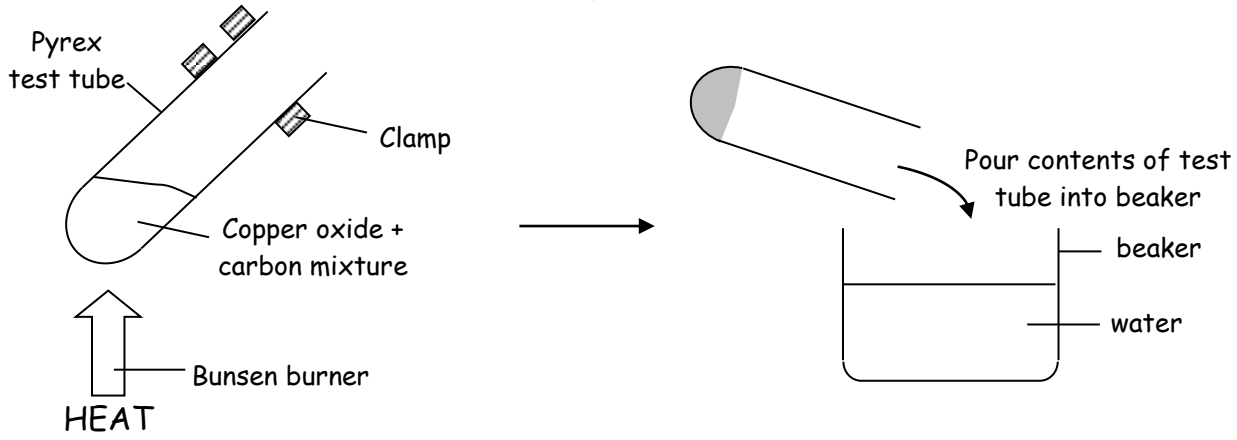
5.1 Making Metals

a) **Copy** the following passage into your jotter

Some metals have been known about for a very long time and their date of discovery is described as pre-historic e.g. gold was used in ancient Egyptian times and before. This is because some metals are found uncombined in the Earth's crust. These metals include gold, silver, copper and mercury.

Most other metals are found combined to other elements. Some of these metal compounds, called ores, can release the metal inside them by heating with carbon, e.g. iron, lead, tin, copper and zinc.

b) **Copy** the following diagram into your jotter



c) **Carry out** the following experiment

1. Collect a clamp stand, *pyrex* test tube, Bunsen burner, heat mat and a beaker of water.
2. Add 1 spatula of the copper ore + carbon mixture to the *pyrex* test tube
3. Clamp the test tube at the correct height for heating with a Bunsen burner. Ensure the test tube is pointing towards the wall and the clamp is fixed high up the test tube
4. Light the Bunsen burner and heat the test tube using a blue flame
5. Empty the contents of the test tube into the beaker. Examine the bottom of the beaker for evidence of copper metal having been formed.

d) **Complete** the following a word equation for the reaction in your jotter.

copper oxide + carbon ⟶ …… + …… ……

5.2 Making Metals II: Blast Furnace

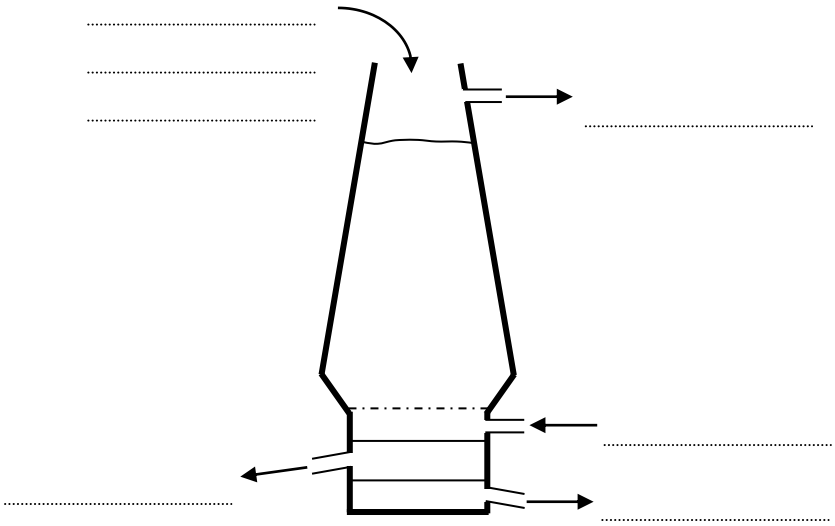
a) **Copy** the following passage into your jotter.

Many metals are made by heating the ore (a compound of the metal) with coke (a pure form of carbon).

Iron metal and its alloy steel are made in large quantities in a blast furnace.

b) **Collect** a copy of the following diagram and **stick** it into your jotter.

Blast Furnace



Iron can be extracted from iron ore in a blast furnace.

The raw materials are **iron ore**, **limestone** and **coke.** They are fed in at the top of the blast furnace. **Hot air** is blown in near the bottom of the furnace. **Molten iron** is removed from the bottom of the furnace. Floating on top of the iron is the **impure molten slag** and this is removed through its own pipe.

c) Use the word bank to **complete** the labels on the above diagram of the blast furnace.

wordbank

hot air	iron ore + limestone + carbon
molten iron	
Molten slag (impurities)	

d) **Write** a word equation for the reaction taking place in a blast furnace.

iron oxide + carbon ⟶ …… + …… ……

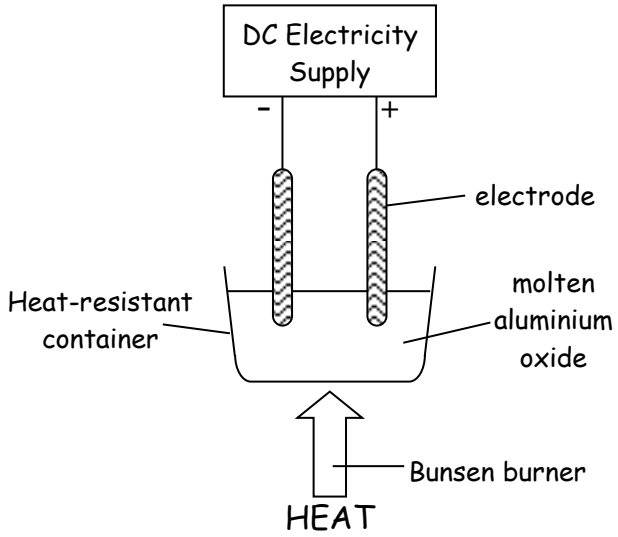
5.3 Making Metals III: Electrolysis

a) **Copy** the following passage into your jotter.

Some metals cannot be made by heating their ores with carbon. Reactive metals like aluminium require more energy to turn the metal ore compound back to the pure metal again.

This process is called <u>electrolysis</u> and the energy needed is supplied by electricity. Aluminium, magnesium, sodium and potassium are made this way.

b) **Copy** the following diagram into your jotter.



word equation

aluminium oxide → aluminium + oxygen

c) **Copy** and **complete** the following table into your jotter.

- Dates of discoveries are found on page 2 of the data booklet.
- Complete the correct column for the method of making each metal.

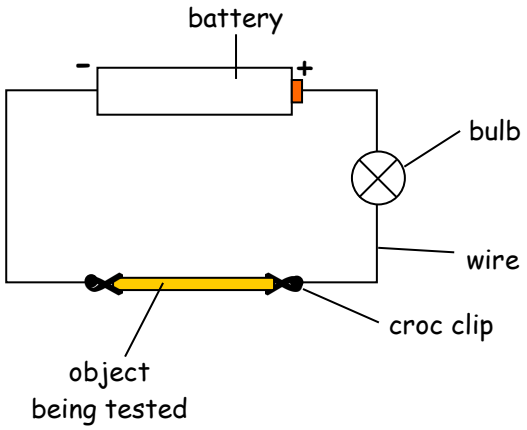
Metal	Date of Discovery	Method to Produce Metal		
		Found uncombined in Earth	Made by heating ore with carbon	Made by molten electrolysis of ore
Gold		✓	✘	✘
Iron				
Magnesium				
Tin				
Aluminium				

5.4 Metals & Electrical Conductivity

a) **Copy** the following passage into your jotter.

All metals conduct electricity. Non-metals do not conduct electricity with the exception of carbon (graphite).

b) **Copy** the following diagram into your jotter.



c) **Copy** the following table into your jotter.

Element	Metal/Non-metal	Conductor/Non-conductor
Aluminium		
Carbon(graphite)		
Copper		
Iron		
Nickel		
Sulphur		
Zinc		
Iodine		
Carbon(charcoal)		

d) **Carry out** electrical conductivity tests to **complete** your table.

- Use page 8 of the data booklet to complete metal/non-metal column

e) **Complete** a PPA write-up sheet for this experiment.

5.5 Properties of Metals

a) **Copy** the following passage into your jotter.

The properties of different metals help to decide what the metal is used for.

b) **Copy** the following table into your jotter and use the following word bank to **complete** your table.

wordbank

malleability	strength	heat conductivity	low density	high melting point	electrical conductivity	resistance to corrosion

Property	Meaning	Example of Use
	Can be beaten/shaped into different shapes	
	The ability to allow electricity flow through it	
	The ability to allow heat energy flow through it	
	The ability to keep the same shape and not bend	
	The ability to withstand high temperatures	
	The amount of a substance in a set volume of that substance	
	The ability to remain a metal and not corrode	

c) **Design** an experiment to test the properties of metals.

- Your teacher will put you into a group
- Your group will be given a property of metals to investigate:
    - Malleability
    - Electrical conductivity
    - Heat conductivity
    - strength
- Design a *fair test* experiment to show how the property you are investigating changes with different metals
    - You must keep all the variables in your experiment the same in a fair test experiment (other than the variable your are investigating)

5.6 Alloys

a) **Copy** the following passage into your jotter.

Metals can be mixed together to form ALLOYS.

- Alloys which are usually made of mixtures of metals conduct electricity, although some alloys can contain some non-metals too.
- Mixing different metals can give alloys different properties compared to the original metals (can have better properties or be cheaper)
- Alloys do not appear on the Periodic Table as they are mixtures. (only pure elements appear on the Periodic Table)

b) **Copy** the following table into your jotter and **complete** the table using the word bank.

wordbank						
solder	bronze	amalgum	brass	cupro-nickel	stainless steel	steel

Alloy	Improved Property of Alloy	Elements in Alloy (No need to learn!)
	Alloy which corrodes slowly and is often used in ornaments	zinc/copper
	Allow with low melting point and is used to join together electrical components and wires	lead/tin
	Alloy with increased strength and is used for building structural frames	iron/carbon
	Alloy used in arrowheads due to increased strength	copper/tin
	Special alloy of steel which is resistant to rusting	iron/nickel/chromium
	Alloy used in tooth fillings	mercury/zinc/silver/ tin/copper
	Alloy used in coins and is harder-wearing than pure metals	copper/nickel

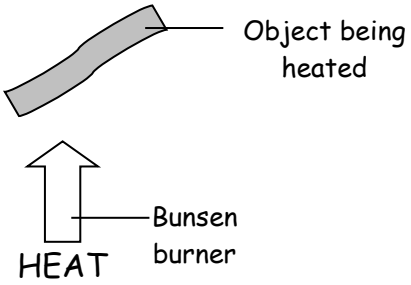
5.7 Reactions of Metals with Oxygen

a) **Copy** the following passage into your jotter.

Metals react with oxygen in air at different rates to form compounds called metal oxides. Metals do not form metal oxides at different rates.

b) **Carry Out** the following experiment.

1. Collect a heat mat, Bunsen burner, a pair of tongs, safety goggles and a beaker of water.
2. Collect each of the three metals
   i. a piece of magnesium ribbon
   ii. an iron nail
   iii. a copper 1p coin
3. Light the Bunsen burner
4. Using the tongs, heat the metals one at a time. **NB**. You must be very careful not to burn yourself or the bench!
5. Once the metal has been heated for a time, place the metal into the beaker of water to cool it down.
6. Record you results in a **table** in your jotter.



<u>Safety Warning</u>

Some of the equipment will be very hot in this experiment. If you are in any doubt, contact your teacher to prevent a nasty burn!

c) **Watch** the teacher cut through some reactive metals.

- Lithium
- Sodium
- Potassium

5.8 Reactions of Metals with Water

a) **Copy** the following passage into our jotter.

Some metals react with water: some quickly, some slowly and some not at all.

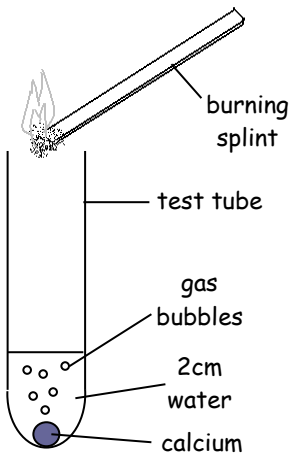
b) **Copy** the following table into your jotter.

Metal	Observation
1. Potassium	
2. Sodium	
3. Lithium	
4. Calcium	
5. Magnesium	

c) **Observe** the reactions of Metals 1-3 with water. (Teacher Demo)

d) **Carry out** the following experiment.

1. Collect a test tube, heat mat, Bunsen burner and a wooden splint
2. Light the Bunsen burner and set to yellow flame (airhole closed)
3. Add water to the test tube to a depth of 2cm.
4. Your teacher will add a piece of calcium metal to your test tube.
5. Observe the reaction in the test tube and identify the gas given off using a burning splint.



e) **Observe** the reaction of magnesium with water. (Set up already)

f) **Complete** your table of results in your jotter for metals 1-5

g) **Answer** the following question in your jotter.

- Which gas is released when reactive metals react with water?

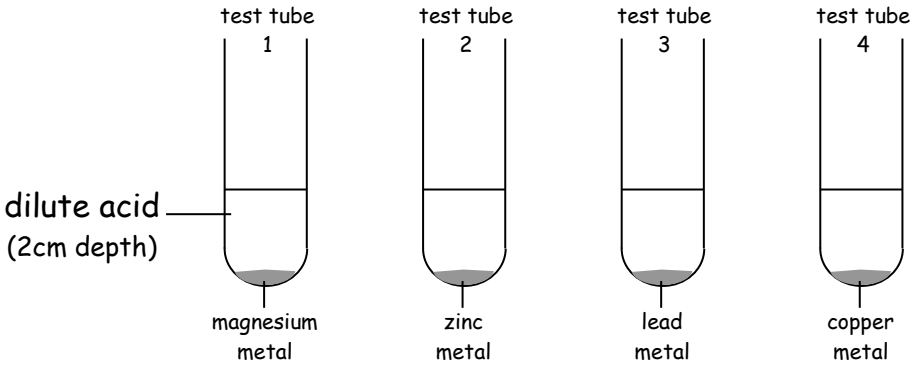
5.9 Reactions of Metals with Acid

a) **Copy** the following passage into your jotter.

Some metals react with dilute metals: some faster than others and some slower.

Some metals do not react with acid, e.g. copper, silver and gold.

b) **Copy** the following diagram into your jotter.



Fair Test

☑ Same volume of acid in each test tube

☑ Same weight of metal in each test test

c) **Copy** the following table into your jotter.

Metal	Observation	Order of Reactivity (Fastest = 1st)

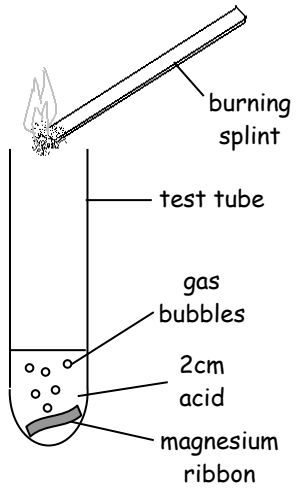
d) **Carry Out** the following experiment.

1. Collect 4 test tubes and a test tube rack.
2. Use a dropper bottle to fill each test tube to a depth of 2cm with dilute acid.
3. Collect a spatula and a tub of magnesium, zinc, lead and copper metals.
4. Add a small spatula of each metal to the appropriate test tubes 1→4. It is best to add magnesium last.
5. Observe the rates of reaction for each test tube and complete your table of results in your jotter,
6. At the end of the experiment, dispose of the metals as shown by your teacher. (i.e. not down the sink!)

e) **Complete** a PPA write-up sheet for this experiment.

5.10 Products of Acids + Metal Reaction

a) **Copy** the following diagram into your jotter.



b) **Carry out** the following experiment.

1. Collect a Bunsen burner, heat mat, wooden splint, test tube, test tube rack and a piece of magnesium ribbon.
2. Light the Bunsen burner and set to the yellow flame. (airhole closed)
3. Use a dropper bottle to fill the test tube with acid to a depth of 2cm.
4. Drop the magnesium ribbon into the acid and test the gas being given off with a burning splint

c) **Copy** and **complete** the following statement into your jotter.

The gas released burns with a …… .

The insoluble gas produced when acids react with a metal is …… .

d) Copy and complete the following word equations into your jotter.

	ACID	+	METAL	⟶	SALT	+	HYDROGEN
1	hydrochloric acid	+	magnesium	⟶	.....	+	.....
2	.....	+	zinc	⟶	zinc nitrate	+	.....
3	.....	+	.....	⟶	lead sulphate	+	hydrogen

5.11 Reactivity Series

a) **Copy** the following into your jotter.

Metals react at different rates from each other. Chemists order metals in a league table of reactivity called the REACTIVITY SERIES.

b) **Collect** a copy of the Reactivity Series and **stick** it into your jotter.

Metal	1st Letter	Mnemonic	My Mnemonic
Potassium	P	**P**lease	
Sodium	S	**S**end	
Lithium	L	**L**ittle	
Calcium	C	**C**harlie	
Magnesium	M	**M**cLean	
Aluminium	A	**A**	
Zinc	Z	**Z**ebra	
Iron	I	**I**f	
Tin	T	**T**he	
Lead	L	**L**eader	
Copper	C	**C**annot	
Mercury	M	**M**ake	
Silver	S	**S**ome	
Gold	G	**G**iant	
Platinum	P	**P**ants	

c) **Complete** your own reactivity series mnemonic on the cut out sheet.

- Collect a piece of scrap paper to get your mnemonic right before transferring your final version to your jotter cut out sheet.

5.12 Corrosion & Rusting

a) **Copy** the following passage into your jotter and **complete** the passage using the word bank.

wordbank

inside	collapse	appearance	physical	iron
surface	remain	strength	chemical	zinc

i. Corrosion is a type of ……*(1)*…… reaction.

ii. Corrosion takes place on the ……*(2)*…… of a metal.

iii. Rusting is the corrosion of ……*(3)*…… metal

iv. As metal rusts, flakes of rust fall off and this leads to a loss of structural ……*(4)*…… and the structure could ……*(5)*…… .

b) Look at this world-famous bridge. It was built in 1890 and hasn't been allowed to completely rusted away.

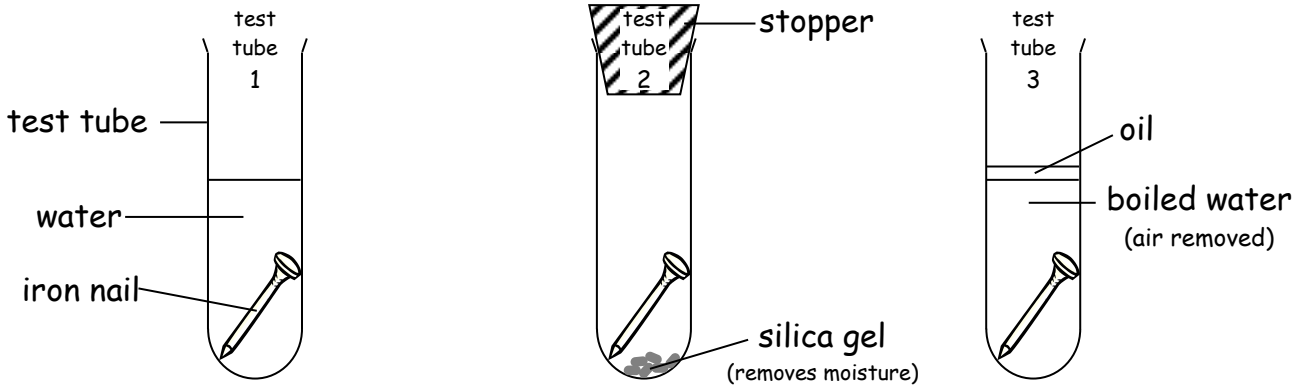
- What is done to prevent the Forth Bridge from completely rusting and then falling down?

5.13 Conditions for Rusting

a) **Copy** the following passage into your jotter.

In order to prevent rusting taking place we must know what conditions and chemicals are required for rusting to take place.

b) **Copy** the following diagram into your jotter.



c) **Copy** the following table into your jotter.

Test Tube	Air/Oxygen Present?	Water Present?	Signs of Corrosion/Rusting
1	✓	✓	Rusting
2	✓	x	No rusting
3	x	✓	No rusting

d) **Copy** the following conclusion into your jotter, leaving spaces for completion once the experiment has completed.

…… and …… are <u>both</u> required for rusting to take place.

e) After a few days, **observe** any rusting in the test tubes and then **complete** your table and conclusion in your jotter.

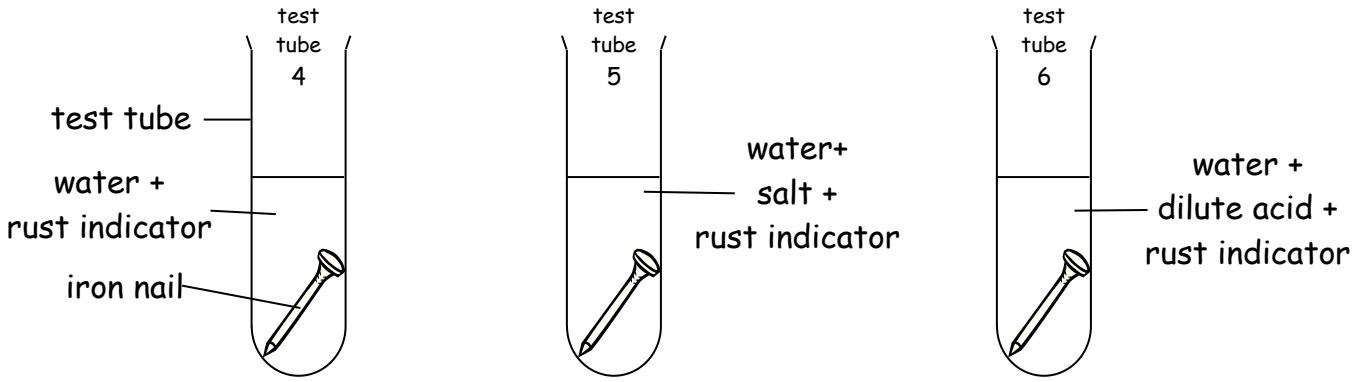
5.14 Speeding Up Rusting

a) **Copy** the following passage into your jotter.

There are two ways to speed up the rate of rusting and corrosion.

i. salt present
ii. acid present

b) **Copy** the following diagram into your jotter.



c) **Copy** the following table into your jotter and **complete** the experiment once you have observed the experiment.

Test Tube	Air Present?	Water Present?	Salt Present?	Acid Present?	Signs of Corrosion/Rusting
4	✓	✓	✗	✗	
5					
6					

d) **Answer** the following questions in your jotter.

1. What colour does rust indicator turn when rust is present?
2. If rusting is heavier, is the colour darker or lighter?
3. Does adding salt speed up or slow down rusting/corrosion?
4. Why might car bodywork rust faster in the winter months of the year?
5. Does adding acid speed up or slow down rusting/corrosion?
6. Where in the environment might acid come from to affect the rate of corrosion of metals?

5.15 Preventing Rusting I: Surface Barrier

a) **Copy** the following passage into your jotter.

Oxygen (from air) and water are both required for rusting/corrosion to take place.

If we can stop oxygen and/or water getting to the metal then we can prevent the metal from rusting/corrosion.

b) **Copy** the following table into your jotter.

Surface Barrier	Method of Protection
	Prevents water getting to metal underneath. Flakes off and needs repainting regularly
	Prevents water getting to metal underneath as it doesn't mix with water
	Prevents water/oxygen getting to metal underneath by forming a complete layer on top but is easily removed.
	Metal is coated is a less-reactive metal. Water/oxygen cannot get to metal underneath if outer tin layer is intact over the whole surface of the metal underneath.

c) **Complete** the table in your jotter using the word bank.

wordbank

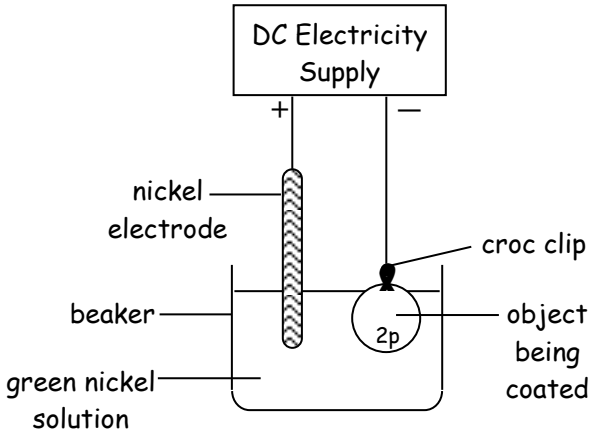
Tin-plating	Painting	Plastic coating	Greasing

5.16 Preventing Rusting II: Electroplating

a) **Copy** the following passage of your jotter

Coating on metal over another metal can be a good way to prevent rusting/corrosion and can be used for other reasons.

b) **Copy** the following diagram into your jotter.



NB.
Object must be attached to the NEGATIVE electrode

c) **Carry** out the experiment to coat metal object in another metal.

- There will be some sets of equipment for you to use around the room.
- Attach your metal object to the positive electrode croc clip and dip it carefully into solution. The metal will gradually coat in nickel metal.

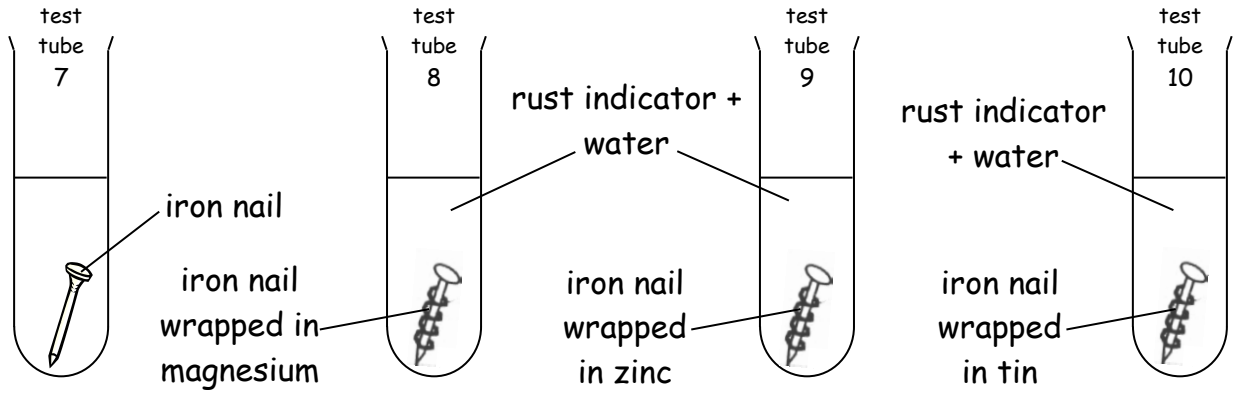
5.17 Preventing Rusting III: Using Other Metals

a) **Copy** the following passage into your jotter.

Iron can be protected from rusting by attaching it to a more reactive metal, e.g. zinc, magnesium, aluminium

Attaching iron to a less reactive metal, e.g. tin, copper, lead will cause the iron to rust quicker.

b) **Copy** the following diagram into your jotter.



c) **Copy** and **complete** the following results table into your jotter.

Test Tube	Nail attached to more reactive metal	Nail attached to less reactive metal	Observation
7	(no metal attached to nail)	(no metal attached to nail)	
8	✓	×	
9			
10			

d) **Complete** your results table from your observations of the experiment.

e) **Copy** and **complete** the following statements into your jotter.

1. Iron is protected by attaching it to a …… reactive metal.
2. Zinc metal attached to iron protects iron from rusting and this is known as …… .
3. An incomplete layer of tin attached to iron speeds up corrosion because tin is …… reactive than iron.
4. …… magnesium metal is used to protect iron in underground pipes and oil rig legs.

5.18 Protecting Aluminium: Anodising

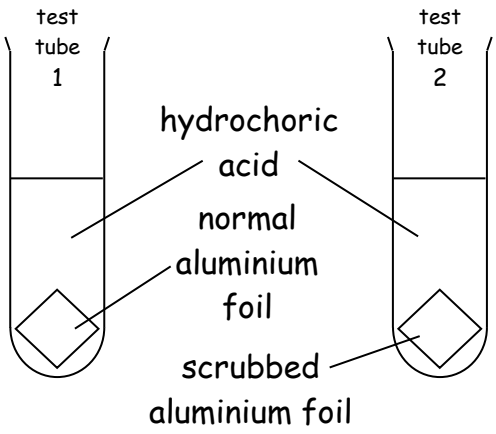
a) **Copy** the following passage into your jotter

Aluminium is a more reactive metal than iron. However, fizzy drinks cans are made of aluminium and they do not corrode like an iron can does.

Aluminium is protected from corrosion by a process called <u>anodising</u>.

b) **Carry Out** the following experiment.

1. Collect 2 pieces of Aluminium foil, a piece of sand paper, 2 test tubes and a test tube rack.
2. Use a dropper bottle to fill each test tube to a depth of 2cm with hydrochloric acid.
3. Use sand paper to rub the outer layer of <u>one</u> piece of aluminium foil.
4. Place both pieces of aluminium foil into different test tubes containing acid.
5. Observe the reaction



c) **Copy** the following passage into your jotter.

Anodising increases the thickness of the oxide layer on the outside of aluminium metal.

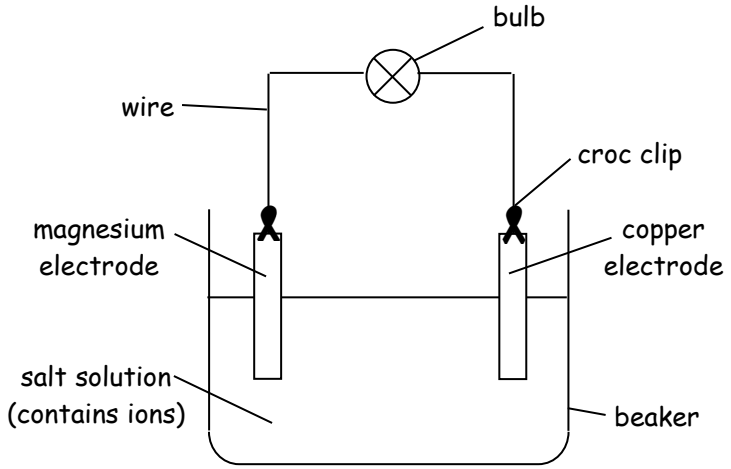
- The outer layer stops oxygen/water getting to the aluminium underneath
- Corrosion is prevented

5.19 Batteries

a) **Copy** the following passage into your jotter.

Metals can be used to make electricity in batteries. But how do batteries work?

b) **Copy** the following diagram into your jotter.



c) **Carry out** the following experiment.

1. Collect a bulb, 2 wires, 2 croc clips, a beaker, magnesium metal and copper metal
2. Attach the bulb to the 2 metals using the wires and the croc clips.
3. Touch the metals together. (nothing should happen!)
4. Collect a beaker of salt solution and place the metals into the beaker, ensuring the metals do not touch.
5. Observe the bulb.

d) **Copy** and **Complete** the following passage in your jotter.

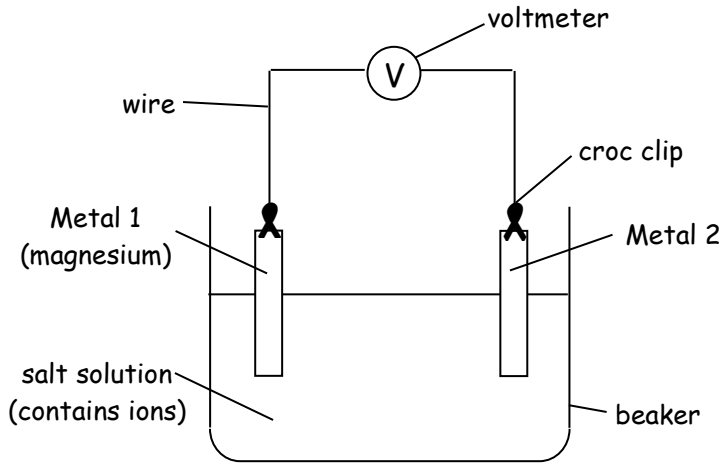
1. The bulb lights up because …… was flowing in the circuit.
2. The purpose of the salt solution (containing ions) is to …… the circuit. The bulb did not light up without the salt (ion) solution.

5.20 Batteries & Voltage

a) **Copy** the following passage into your jotter.

It is possible to buy batteries that are different voltages. Using different metals inside batteries gives different voltages.

b) **Copy** the following diagram into your jotter.



c) **Copy** the following table into your jotter.

Metal 1	Metal 2	Voltage
Magnesium	Copper	
Magnesium	Tin	
Magnesium	Zinc	
Magnesium	Magnesium	

d) **Carry out** the following experiment.

1. Set up the circuit as shown in the diagram.
2. Find the voltage of each metal pair in the table above.

e) **Copy** and **complete** the following passage (use p6 of the data booklet)

1. The combination which gave the largest voltage was …… and …… .
2. On p6 of the data booklet, comparing the gap between the four metals used, the gap between the metals with the largest voltage is the …… .

5.21 Rechargeable Batteries

a) **Copy** the following passage into your jotter.

1. In a battery, electrical energy is produced by a …… reaction.

2. When all the chemicals in a battery are used up, the batteries need to be …… .

3. Constant replacing of batteries is wasteful so …… batteries can be used as an alternate.
   - Nickel-cadmium batteries
   - Lead-acid batteries, used in …… batteries.

b) **Complete** the passage in your jotter by using the word bank.

wordbank			
car	chemical	rechargeable	replaced

Revision
5.22

Access 3 Level Revision Questions

1. Which element is found uncombined in the Earth's crust?

silver or **iron**

2. Which element is a metallic conductor of electricity?

carbon (graphite) or **copper**

3. Which property of copper makes it a good choice for use as wires in cables?

corrosion resistance or **good electrical conductor**

4. An alloy is a

mixture of metals or **pure metal**

5. The melting point of tin metal is

232°C or **2602°C**

6. Which gas is produced when metals react with acid?

nitrogen or **hydrogen**

7. Which gas burns with a "pop" noise?

nitrogen or **hydrogen**

8. Corrosion/rusting of a metal changes the metal into

an element or **a compound**

9. Which substance speeds up rusting?

salt or **grease**

10. Nickel-Cadmium batteries and lead-acid batteries are

rechargeable or **non-rechargable**

11. Name the 2 substances required for rusting/corrosion to occur?

…… and ……

Revision 5.23

Intermediate 1 Level Revision Questions

1. Which element is *not* an electrical conductor?

A. copper B. iron C. carbon (graphite) D. oxygen

2. Which metal is *not* found uncombined in the Earth's crust?

A. gold B. silver C. mercury D. iron

3. Which metal is a solid at 1400°C?

A. nickel B. tin C. gold D. calcium

4. Which of the following is *not* an alloy?

A. brass B. steel C. tin D. bronze

5. Which metal will *not* produce a gas when added to dilute acid?

A. iron B. copper C. magnesium D. zinc

6. The test for hydrogen gas is

A. relights a glowing splint B. burns with a pop C. turns lime water milky D. there is no test for hydrogen

7. Which metal is the most reactive?

A. iron B. magnesium C. silver D. sodium

8. The gas produced by the reaction of acids and metals is

A. hydrogen B. nitrogen C. oxygen D. carbon dioxide

9. The metal used to galvanised zinc is

A. gold B. tin C. magnesium D. zinc

10. Aluminium is *best* protected by

A. anodising B. galvanising C. painting D. electroplating

11. The energy change in a battery is

A. chemical → electrical B. electrical → chemical C. chemical → light D. chemical → sound

12. The purpose of the ion solution in a cell (battery) is

A. to provide energy B. to complete the circuit C. To carry electricity D. To amplify the voltage