Topic 12E: **Answers**
Metals (Extensions)

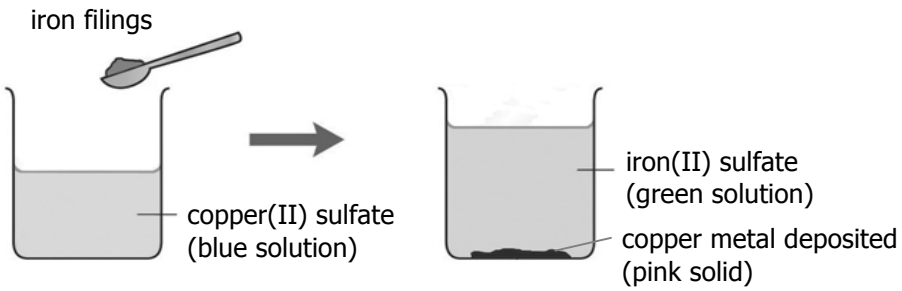
SYLLABUS RELEVANCE & TEXTBOOK CHAPTERS		
O-LEVEL PURE (5072)	✓	Chapter 14
O-LEVEL SCIENCE (5116)	✖	
N-LEVEL SCIENCE (5155)	✖	

Lesson Package & Accompanying Slides Designed by Alex Lee (2008)
Last Modified by Alex Lee (2011)

1. **Reactivity Series Reaction 5: Displacement of Aqueous Salts**

Like halogens, metals can also undergo displacement reactions. **A more reactive metal is able to displace a less reactive metal from its aqueous salt.**

For example, iron is more reactive than copper. Hence, a sample of iron fillings will be able to displace copper from a solution of copper(II) sulfate.



Word Equation:	**iron**	**+**	**copper(II) sulfate**	——→	**iron(II) sulfate**	**+**	**copper**
Chemical Equation:	**Fe (s)**	**+**	**$CuSO_4$ (aq)**	——→	**$FeSO_4$ (aq)**	**+**	**Cu (s)**
Ionic Equation:	**Fe (s)**	**+**	**Cu^{2+} (aq)**	——→	**Fe^{2+} (aq)**	**+**	**Cu (s)**

Observations: **The solution changes from** blue **to** colourless **.**
A brownish-pink **solid forms on the surface of the iron metal.**

(a) For each of the following pairs of reactants, predict if a chemical reaction will take place by indicating 'will react' and 'will not react'.

(i) iron metal + aqueous lead(II) nitrate — will react

(ii) copper metal + aqueous magnesium sulfate — will not react

(iii) zinc metal + aqueous iron(II) chloride — will react

(iv) magnesium metal + aqueous zinc sulfate — will react

(v) lead metal + aqueous calcium chloride — will not react

(vi) calcium metal + aqueous magnesium nitrate — will react

(b) Three samples of metals were each placed in aqueous solutions containing ions of the other two metals. The observations were recorded in the table below.

metal	aqueous cation		
	P^{2+}	Q^{2+}	R^{2+}
P	–	no change	**R** displaced
Q	**P** displaced	–	**R** displaced
R	no change	no change	–

(i) State, with reasons, which of the three metals is the most reactive.

Q. It is able to displace both P and R from their aqueous salts.

(ii) Arrange the three metals in increasing order of reactivity.

R, P, Q

(iii) Arrange the three metals by increasing ease of oxidation.

R, P, Q

(c) For each of the displacement reactions below, construct a chemical equation, construct an ionic equation and state the predicted observations.

(i) A piece of zinc metal is placed into a solution of copper(II) chloride.

Chemical Equation: $Zn\ (s) + CuCl_2\ (aq) \longrightarrow ZnCl_2\ (aq) + Cu\ (s)$

Ionic Equation: $Zn\ (s) + Cu^{2+}\ (aq) \longrightarrow Zn^{2+}\ (aq) + Cu\ (s)$

Observations: Blue solution gradually decolourises. A brownish-pink solid is formed on the surface of the zinc metal.

(ii) A piece of magnesium metal is placed into a solution of iron(II) sulfate.

Chemical Equation: $Mg\ (s) + FeSO_4\ (aq) \longrightarrow MgSO_4\ (aq) + Fe\ (s)$

Ionic Equation: $Mg\ (s) + Fe^{2+}\ (aq) \longrightarrow Mg^{2+}\ (aq) + Fe\ (s)$

Observations: Green solution gradually decolourises. A grey solid is formed on the surface of the magnesium metal.

(ii) A piece of iron metal is placed into a solution of silver nitrate.

Chemical Equation: $Fe\ (s) + 2\ AgNO_3\ (aq) \longrightarrow Fe(NO_3)_2\ (aq) + 2\ Ag\ (s)$

Ionic Equation: $Fe\ (s) + 2\ Ag^{+}\ (aq) \longrightarrow Fe^{2+}\ (aq) + 2\ Ag\ (s)$

Observations: Colourless solution slowly turns green. A grey solid is formed on the surface of the iron metal.

2. **Reactivity Series Reaction 6: Displacement of Metallic Oxides**

Besides displacement from aqueous salts, **a more reactive metal is also able to displace a less reactive metal from its solid oxide**.

For example, when magnesium (a more reactive metal) is heated with a solid sample of iron(III) oxide (the oxide of a less reactive metal), the following reaction occurs:

$$\mathbf{3\ Mg\ (s) + Fe_2O_3\ (s) \longrightarrow 3\ MgO\ (s) + 2\ Fe\ (l)}$$

You will observe that molten iron is obtained as the reaction is very vigorous and there is sufficient heat evolved to melt the metal.

(a) Construct chemical equations for the following oxide displacement reactions:

(i) A sample of zinc fillings are mixed with iron(III) oxide and heated strongly.

$3\ Zn + Fe_2O_3 \rightarrow 3\ ZnO + 2\ Fe$

(ii) Some magnesium strips are heated with powdered zinc oxide.

$Mg + ZnO \rightarrow MgO + Zn$

(iii) A sample of copper is heated with silver oxide.

$Cu + Ag_2O \rightarrow CuO + 2\ Ag$

(b) Samples of four metals, **W**, **X**, **Y** and **Z**, are separately heated with the oxides of the other three metals. The observations are recorded on the table below.

Metal	**Metal Oxide**			
	*oxide of **W***	*oxide of **X***	*oxide of **Y***	*oxide of **Z***
W	–	no reaction	deposits of **Y**	**Observation Q**
X	deposits of **W**	–	deposits of **Y**	deposits of **Z**
Y	no reaction	no reaction	–	no reaction
Z	deposits of **W**	no reaction	deposits of **Y**	–

(i) Which metal is more reactive, **W** or **Z**? Explain how you arrived at your answer.

Z, as it was able to displace W from the oxide of W..

(ii) Predict what Observation **Q**, as indicated in the table above, should be.

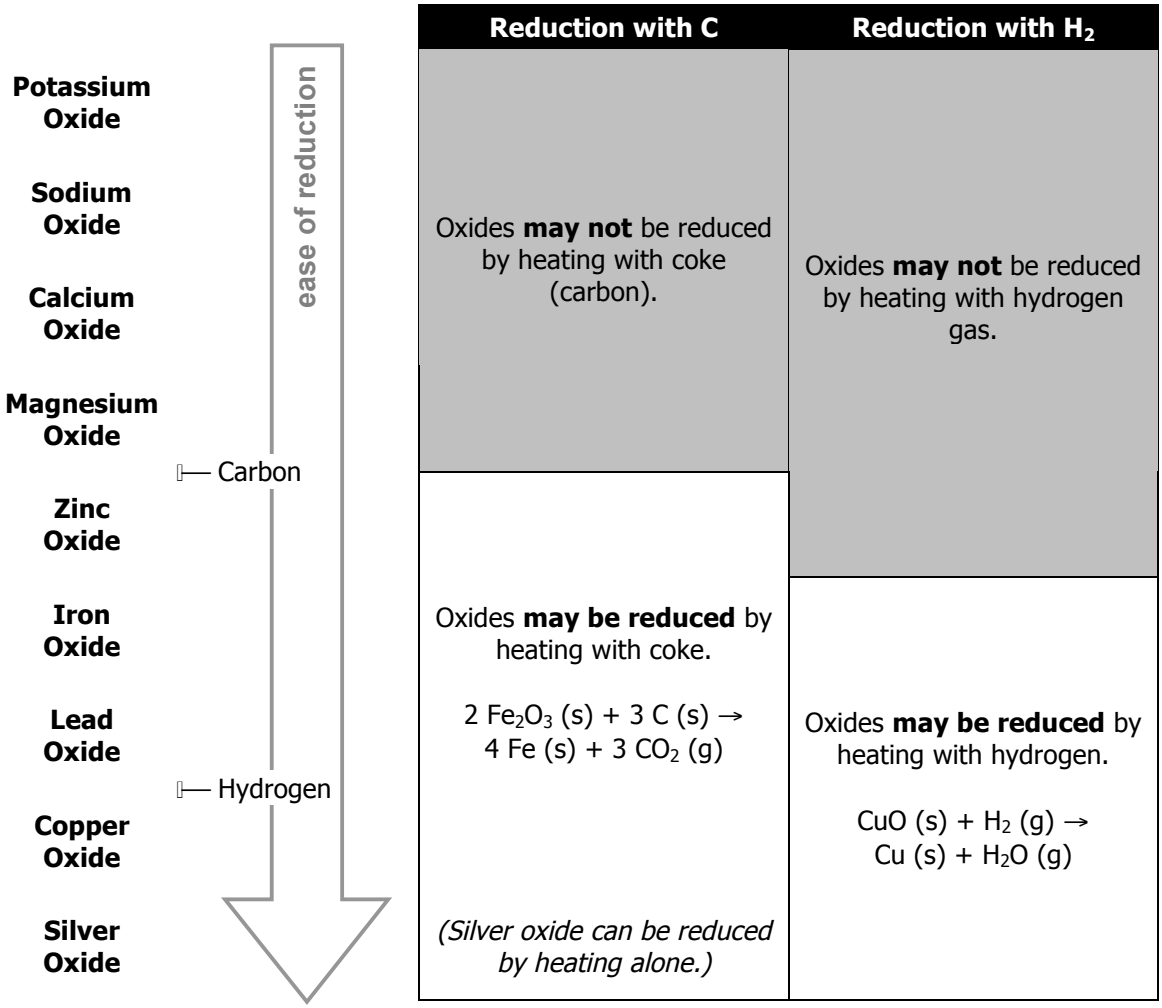
No reaction.

(iii) Arrange the four metals in increasing order of reactivity.

Y, W, Z, X

3. **Reactivity Series Reactions 7 & 8: Reduction by Carbon & Hydrogen**

The reactivity series can also be used to tell the stability of the oxides of the various metals, and to predict their reductions with hydrogen gas (H_2) and coke (carbon, C).



(a) Describe how the following chemical properties differ as we move down the reactivity series, from potassium to silver.

(i) ability to react with water and acids

Reactivity decreases as we move down the reactivity series.

(ii) ease of reduction of metal oxide by heating with carbon and hydrogen

Ease of reduction increases as we move down the reactivity series.

(b) Which of the above oxides may be reduced by carbon but not hydrogen?

Zinc oxide

4. **Summary of Reactivity Series Reactions**

With the exception of the displacement reactions, below summarizes all the reactions that we learn this chapter. You would observe that, as we move down the reactivity series, there is a lower tendency for the metals to react but a higher tendency for the metallic compounds to react.

		K	Na	Ca	Mg	Zn	Fe	Pb	Cu	Ag
Reactions of Elements	*oxidation reaction with cold water*	✓	✓	✓	✓					
	oxidation reaction with hot steam	✓	✓	✓	✓	✓	✓			
	oxidation reaction with dilute acid	✓	✓	✓	✓	✓	✓	✓		
	heating in the presence of oxygen	✓	✓	✓	✓	✓	✓	✓	✓	
Reactions of Compounds	*thermal decomposition of carbonates*			✓	✓	✓	✓	✓	✓	✓
	reduction of metal oxide with carbon					✓	✓	✓	✓	✓
	reduction of metal oxide with hydrogen						✓	✓	✓	✓

(a) Four unknown metals, **A**, **B**, **C** and **D**, were subject to various tests as shown:

Metal	*effect of metal in cold, dilute hydrochloric acid*	*effect of heating oxide of metal with carbon*	*effect of strongly heating metal carbonate*
A	vigorous effervescence	reduced to the metal	carbon dioxide evolved
B	no visible change	reduced to the metal	carbon dioxide evolved
C	vigorous effervescence	no visible change	no visible change
D	vigorous effervescence	no visible change	carbon dioxide evolved

(i) Which of the above four metals, **A**, **B**, **C** or **D**, is most likely to be sodium? State the key piece of information that led you to this conclusion.

C. Its carbonate is unable to be thermally decomposed.

(ii) Arrange the four metals in order of decreasing ease of oxidation.

C, D, A, B

(b) An unknown metal **M** reacts with steam to form compound **N**. Upon heating compound **N** in a stream of hydrogen, metal **M** is reformed, together with a colourless liquid **O**.

(i) Identify metal **M** and compound **N**.

Metal **M**: **iron** Compound **N**: **iron(II) oxide**

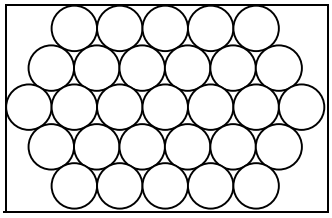
(ii) Construct a chemical equation for the reaction between **N** and hydrogen.

$FeO + H_2 \longrightarrow Fe + H_2O$

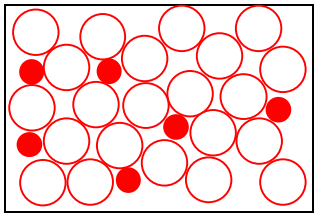
5. **Iron: Types of Steel Alloy**

Steel is an alloy of iron. Its main constituent, other than iron, is usually carbon.

(a) Below shows a diagram representing the structure of pure iron. In the spaces provided, draw the structure for steel.



Iron



Steel

Use your diagram to explain the differences in texture between iron and steel.

In iron, the particles are more regularly arranged than in steel, and are hence able to slide over each other more easily. As such, iron has a more malleable and ductile texture, while steel has a harder/stronger texture.

(b) Complete the table below which compares the different types of steel.

Name	Composition	Properties	Uses
Mild Steel	Carbon (≈0.25%) Iron	Softer, more easily shaped. Able to absorb impact.	Car bodies Machinery
High Carbon Steel	Carbon (≈1.50%) Iron	Strong, but brittle. Unable to absorb impact.	Knives and cutting tools Hammers
Stainless Steel	Chromium (~10%) Nickel or Carbon Iron	No visible corrosion, maintaining a shiny appearance (luster).	Chemical plants Cutlery Surgical instruments

(c) Briefly describe the relationship between the percentage of non-iron content in steel, and the physical properties of the steel.

The higher the percentage of non-iron content, the stronger and less malleable/ductile the texture of steel.

(d) Is steel a compound or a mixture? State one reason to justify your answer.

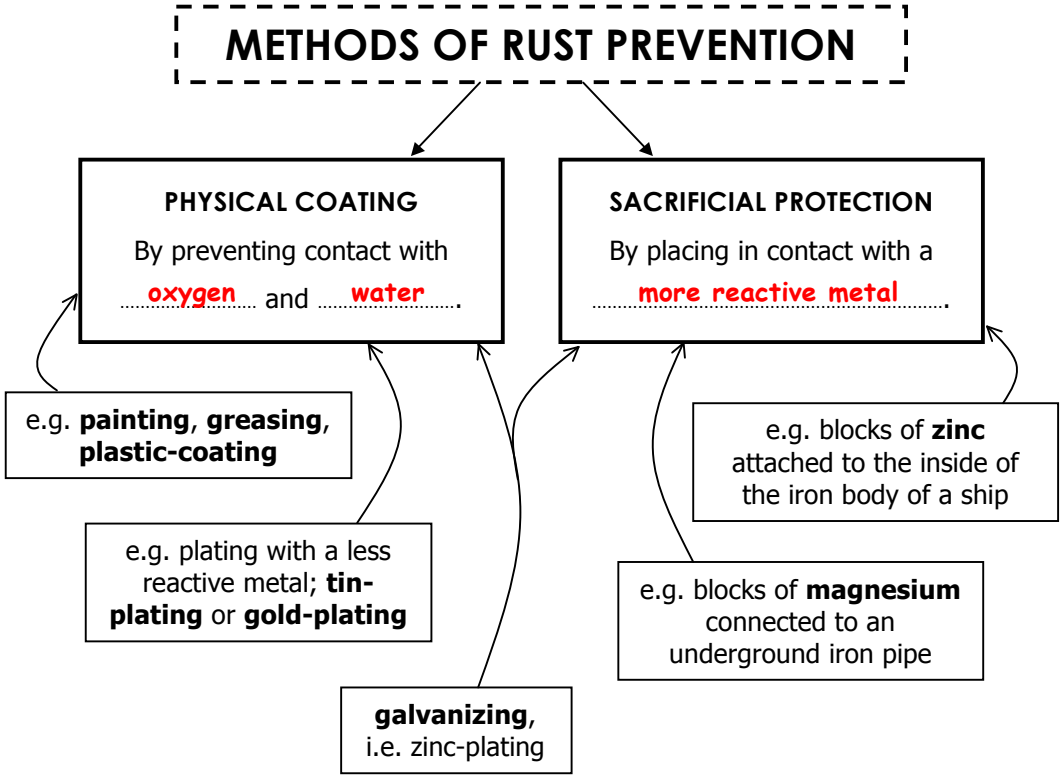
Mixture. The best evidence for this is in the variable composition of steel.

Compounds have a fixed composition of elements.

6. **Iron: Prevention of Rusting**

Rusting is a highly undesirable phenomenon. Besides the poor aesthetic appeal with the reddish-brown iron(III) oxide produced, rusting also wears down the strength of the iron material, making it more prone to breakage and other forms of damage.

As such, we examine several methods of rust prevention.



(a) One method of rust prevention is by **using a physical coating** around an iron object, such as painting or greasing.

(i) Explain how this method prevents an iron object from rusting.

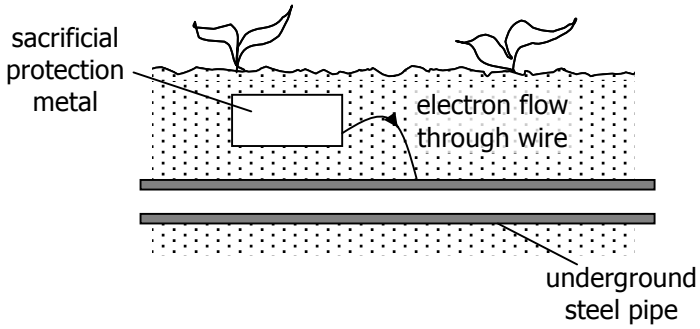
It prevents the iron object from coming in contact with air and moisture, hence rusting may not occur.

(ii) Outline the key advantages and disadvantages of this method of rust prevention.

Advantages: low-cost, easy to apply and does not require much maintenance (unless coating is damaged)

Disadvantages: the iron beneath the physical coating will rust once the coating is scratched or damaged as contact with air and water is possible

(b) Another method of rust prevention is by placing a more reactive metal in contact with the iron object, i.e. sacrificial protection. One example of the use of sacrificial protection of iron is in underground water pipes.



(i) Explain how this method prevents an iron object from rusting.

The more reactive metal gives electrons to the iron object, hence being oxidised/corroding in place of iron.

(ii) State the two metals that are commonly used for sacrificial protection.

magnesium and zinc

(iii) Outline the key advantages and disadvantages of this method of rust prevention.

Advantages: continues to be effective against rust even if scratched; easy to replace a single block of magnesium instead of entire surface

Disadvantages: more costly; requires regular replacement of the sacrificial metal

(c) Iron sheets, used for roofing, are often protected against rust through galvanizing.

(i) Define what is meant by galvanizing.

Plating/coating an iron or steel object with zinc.

(ii) Galvanizing protects an iron object from rusting in two ways. What are these two ways?

Zinc forms a physical coating around the iron object, preventing contact with air and moisture. At the same time, zinc readily donates electrons to the iron object, hence corroding/oxidising in place of the iron.

(ii) State an advantage of galvanizing over other forms of plating, e.g. tin plating.

In galvanizing, even if the zinc layer is scratched, the iron beneath it will still be protected from rusting by sacrificial protection, unlike tin-plating.

Self-Designed Summary

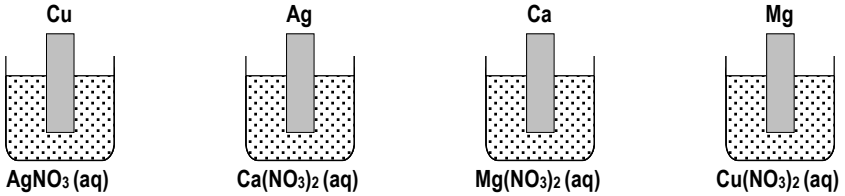
Supplementary Questions

1. Small pieces of each of the five metals were added to aqueous solutions of five metal nitrates. The results are tabulated in the table below.

		Metal				
		Cu	**Mg**	**Ni**	**Ag**	**Sn**
Solution	$Cu(NO_3)_2$	✗	✓	✓	✗	✓
	$Mg(NO_3)_2$	✗	✗	✗	✗	✗
	$Ni(NO_3)_2$	✗	✓	✗	✗	✗
	$AgNO_3$	✓	✓	✓	✗	✓
	$Sn(NO_3)_2$	✗	✓	✓	✗	✗
TOTAL ✓s			4			

   (a) Fill in the total number of ticks in each column in the table above. Hence arrange the five metals in increasing order of reactivity.
   (b) (i) Give two observations made when magnesium is added to aqueous copper(II) nitrate.
   (ii) Construct a balanced chemical equation, including state symbols, for this reaction.
   (iii) Suggest two ways by which the rate of reaction between magnesium and copper(II) nitrate may be increased.

2. The following experiment was set up.



   (a) (i) In which beaker was there no reaction?
   (ii) Construct an equation, including state symbols, for the reaction in the first beaker.
   (b) The experiment was repeated. Zinc strips were used instead of the metal strips in all four beakers. In which beakers would you expect to see a reaction?

3. When iron fillings are placed in aqueous copper(II) sulfate solution,
   A copper(II) hydroxide is precipitated.
   B copper powder is formed.
   C iron(II) sufate is precipitated.
   D there is no reaction.

4. When sodium is placed in aqueous iron(II) chloride, which of the following does **not** occur?
   A A green precipitate is formed.
   B The temperature of the solution drops.
   C Bubbles of gas are observed.
   D The solution decolourises.

5. Several mixtures of metals and their oxides were heated together. The following reactions were obtained.

   (i) Oxide of **X** + **W** ⟶ no reaction
   (ii) Oxide of **W** + **Y** ⟶ no reaction
   (iii) Oxide of **Z** + **Y** ⟶ Oxide of **Y** + **Z**
   (iv) Oxide of **Z** + **W** ⟶ Oxide of **W** + **Z**

   The arrangement showing the metals in order of increasing reactivity is
   A W, X, Y, Z **B Z, Y, W, X** **C Z, W, Y, X** **D Y, X, W, Z**

6. Metals **W**, **X**, **Y** and **Z** were placed in salt solutions as shown in the table.

Metal	Result of Placing Metal in Solution of			
	Salt of **W**	Salt of **X**	Salt of **Y**	Salt of **Z**
W	no reaction	**X** displaced	**Y** displaced	no reaction
X	no reaction	no reaction	no reaction	no reaction
Y	no reaction	**X** displaced	no reaction	no reaction
Z	**W** displaced	**X** displaced	**Y** displaced	no reaction

The metals, arranged in increasing order of reactivity, are:
A **Z, Y, X, W** **B** **Y, W, Z, X** **C** **Z, W, Y, X** **D** **Y, X, W, Z**

7. Strips of metal **M** were dipped into solutions of zinc nitrate and lead(II) nitrate. A metallic deposit appeared on both strips. What could metal **M** be?
A lead **B** iron **C** copper **D** magnesium

8. The metal chromium liberates hydrogen from dilute hydrochloric acid although it does not react with cold water. Crystals of lead appear when a piece of chromium is placed in lead(II) nitrate solution. Which of the following gives the order of decreasing reactivity of the three metals?
A calcium, chromium, lead
B chromium, calcium, lead
C calcium, lead, chromium
D chromium, lead, calcium

9. When nickel and iron were put separately into solutions of salts of metals **X**, **Y** and **Z**, some observations were made and tabulated in the table below.

	$\mathbf{X}^{2+}$ (aq)	$\mathbf{Y}^{2+}$ (aq)	$\mathbf{Z}^{2+}$ (aq)
Nickel	**X** displaced	no reaction	no reaction
Iron	**X** displaced	**Y** displaced	no reaction

The correct order of decreasing reactivity of the five metals is
A **X**, Ni, Fe, **Y**, **Z** **B** **Z**, Fe, **Y**, Ni, **X** **C** **Z**, Fe, Ni, **Y**, **X** **D** **Z**, **Y**, Fe, Ni, **X**

10. The information below concerns three metals, **X**, **Y** and **Z**.
(i) the oxide of X is decomposed by heat to the element X
(ii) the carbonate of Y is not decomposed by heat
(iii) the oxide of Z is not decomposed by heat, but its carbonate decomposes

In order of decreasing reactivity, the three elements should be arranged as
A **Y, Z, X** **B** **Y, X, Z** **C** **X, Y, Z** **D** **X, Z, Y**

Supplementary Questions (Answers)

Question 1

(a) 1, 4, 3, 0, 2; Ag, Cu, Sn, Ni, Mg

(b) (i) The solution turns from blue to colourless; a pinkish-brown deposit of copper is seen.

(ii) $Mg\ (s) + Cu(NO_3)_2\ (aq) \longrightarrow Mg(NO_3)_2\ (aq) + Cu\ (s)$

(iii) Using a higher concentration of copper(II) nitrate; using smaller pieces of magnesium; conducting the experiment at a higher temperature.

Question 2

(a) (i) The second beaker.

(ii) $Cu\ (s) + 2\ AgNO_3\ (aq) \longrightarrow Cu(NO_3)_2\ (aq) + 2\ Ag\ (s)$

(b) The first and fourth beakers only. (The second and third beakers would not react.)

Multiple-Choice Questions

3 B 4 B 5 A 6 C 7 D 8 A 9 B 10 A

Lecture Slides

Metals (Extensions)

Anglo-Chinese School (Barker Road)

CHEMISTRY
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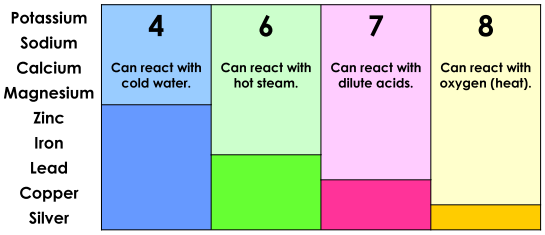
Chapter Overview

In This Chapter, We Will Learn …

1. Displacement Reactions
2. Reduction of Metal Oxides
3. Iron: Types of Steel
4. Iron: Rust Prevention

Reactivity Series – A Continuation

- In the previous tutorial, we had learnt four reactions in relation to the reactivity series:



Reactivity Series – A Continuation

- In this chapter, we shall look at four more reactions in relation to the reactivity series of metals:
  - displacement of aqueous salts
  - displacement of solid oxides
  - reduction of a metal oxide by carbon
  - reduction of a metal oxide by hydrogen

Displacement from Aqueous Solution

- Previously, we learnt that a more reactive halogen can displace a less reactive halogen from its salt.
- The same is true for metals. **A more reactive metal can displace a less reactive metal from its aqueous salt.**

$$Fe\ (s) + CuSO_4\ (aq) \longrightarrow FeSO_4\ (aq) + Cu\ (s)$$

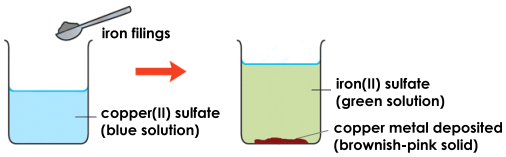
Iron | Copper(II) Ion | Iron(II) Ion | Copper

What is the ionic equation for the above reaction?

$$Fe\ (s) + Cu^{2+}\ (aq) \longrightarrow Fe^{2+}\ (aq) + Cu\ (s)$$

Displacement from Aqueous Solution

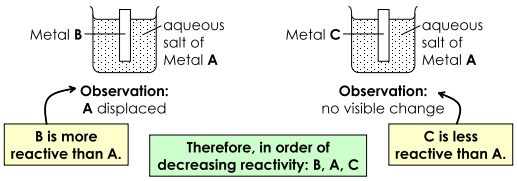
- Displacement reactions are typically accompanied by a visible change.



- In the above reaction, the solution changes from **blue to green**, while a **brownish-pink solid** forms on the surface of the iron metal.

Displacement from Aqueous Solution

- Displacement reactions can also be **used to test for the order of reactivity** for several unknown metals.
- We can determine the order of reactivity of three metals, **A**, **B** and **C**, as follows:



Displacement of Metals

- Besides displacement from aqueous salts, a more reactive metal is also able to displace a less reactive metal from its **solid oxide** by heating. For example:

$$3\ Mg\ (s) + Fe_2O_3\ (s) \longrightarrow 3\ MgO\ (s) + 2\ Fe\ (l)$$

- The iron formed is molten due to the heat involved.

Reduction of Oxides

- **The more reactive the metal, the more stable the oxide it forms.** Hence it is harder to reduce the oxide back into a metal again.
- For example, calcium is a more reactive metal than zinc. Therefore, it is harder to reduce calcium oxide than zinc oxide.
- We shall examine the reduction of these metal oxides with carbon and with hydrogen.

Reduction of Oxides

	Reduction by Carbon (5)	Reduction by Hydrogen (4)
Potassium, Sodium, Calcium, Magnesium	Unable to be reduced.	Unable to be reduced.
Zinc, Iron, Lead, Copper, Silver	Reduced to form **metal** and **carbon dioxide**. $2\ ZnO + C \longrightarrow 2\ Zn + CO_2$	Reduced to form **metal** and **water vapour**. $PbO + H_2 \longrightarrow Pb + H_2O$

Reactivity Series – A Summary

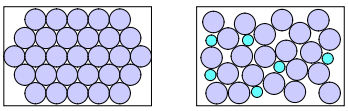
- Below shows all the reactions (except displacement) learnt this chapter.

		K	Na	Ca	Mg	Zn	Fe	Pb	Cu	Ag	
Reactions of Elements	reaction with cold water	✓	✓	✓	✓						4
	reaction with hot steam	✓	✓	✓	✓	✓	✓				6
	reaction with dilute acid	✓	✓	✓	✓	✓	✓	✓			7
	heating in oxygen	✓	✓	✓	✓	✓	✓	✓	✓	✓	8
Reactions of Compounds	decomposition of carbonates	7		✓	✓	✓	✓	✓	✓	✓	
	reducing oxide with carbon	5				✓	✓	✓	✓	✓	
	reducing oxide with hydrogen	4					✓	✓	✓	✓	

- You would notice that the most reactive metals form the most stable compounds!

Iron: Alloys (Steel)

- Steel is an alloy consisting mainly of **iron**, with small traces of other elements such as **carbon**.



- In iron, the particles are **more regularly arranged** than in steel, and are able to **slide over each other more easily**. As such, iron has a **more malleable and ductile texture**, while steel has a harder/stronger texture.

Iron: Alloys (Steel)

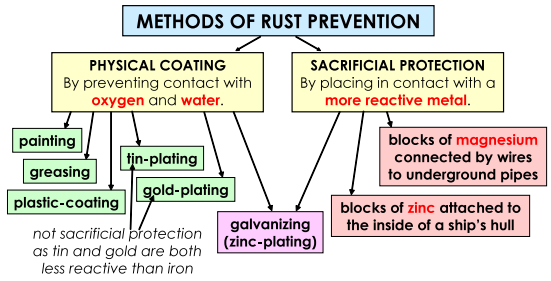
- The composition of steel determines whether it is brittle, or malleable and ductile.
- Steel which is still relatively malleable and ductile (known as '**mild steel**') is able to be crushed upon impact - e.g. used for car bodies.
- Steel which is very hard and brittle (known as '**high carbon steel**') is able to withstand very large impact, but will shatter if tested beyond its threshold.

Iron: Alloys (Steel)

Name	Composition	Properties	Uses
Mild Steel	Carbon (≈0.25%) Iron	Softer, more easily shaped. Able to absorb impact.	Car bodies Machinery
High Carbon Steel	Carbon (≈1.50%) Iron	Strong, but brittle. Unable to absorb impact.	Knives and cutting tools Hammers
Stainless Steel	Chromium (≈10%) Nickel or Carbon Iron	No visible corrosion, maintaining a shiny appearance (luster).	Chemical plants Cutlery Surgical instruments

Iron: Rust Prevention

- There are two main ways to prevent rusting:



Iron: Rust Prevention

Using A Physical Coating

- ***Prevents an iron object from coming in contact with air and moisture, hence rusting may not occur.***
- Examples:
  - painting
  - greasing
  - plastic-coating
  - tin or gold plating

Images: http://www.usplasticcoatings.com/plastic_coatings_services.htm(Plastic-Coated Tools)
http://www.chromeprosplating.com/uploads/CPP/chrome_wheel_plating.jpg (Chrome Plating)

Iron: Rust Prevention

Using A Physical Coating

- **Advantage**: low-cost, easy to apply, does not require much maintenance (unless coating is damaged)
- **Disadvantage**: the iron beneath the physical coating will rust once the coating is scratched or damaged, as contact with air and water is now possible

Image: http://farm2.static.flickr.com/1201/1465388628_16d701a378.jpg

Iron: Rust Prevention

Sacrificial Protection

- ***By connecting to a more reactive metal, the more reactive metal gives electrons to the iron object, hence being oxidised/corroding in place of iron.***
- The two metals commonly used for sacrificial protection are **magnesium** and **zinc**.

used for underground pipes

used for ship bodies

Image: http://www.westcoastcorrosion.com/service%20cathodic%20protection.htm

Iron: Rust Prevention

Sacrificial Protection

- **Advantage**: continues to be effective against rust even if scratched; easy to replace a single block of zinc or magnesium instead of recoating entire surface
- **Disadvantage**: more costly; requires regular replacement of the sacrificial metal

Iron: Rust Prevention

Galvanizing

- ***Refers to plating of an iron or steel object with zinc.***
- Protects an iron object from rusting in two ways:
  - Zinc **forms a physical coating** around the iron object, **preventing contact with air and moisture**.
  - Zinc readily **donates electrons** to iron object, hence **corroding/oxidising in place of the object**.

Image: http://www.pacificgalv.com/galvprocess.html

Iron: Rust Prevention

Galvanizing

- **Advantage**: Even if the zinc layer is scratched, the iron beneath will still be protected by sacrificial protection.
- This is unlike tin-plating or gold-plating, where tin and gold are less reactive and hence are unable to provide sacrificial protection.

Images: http://www.manufacturer.com/trade/i1115980/Galvanized+Corrugated+Sheets.html (Galvanized Sheets)
http://www.salterspiralstair.com/galvanized_spiralstairs.html (Galvanized Steel Stairs)

Iron: Rust Prevention