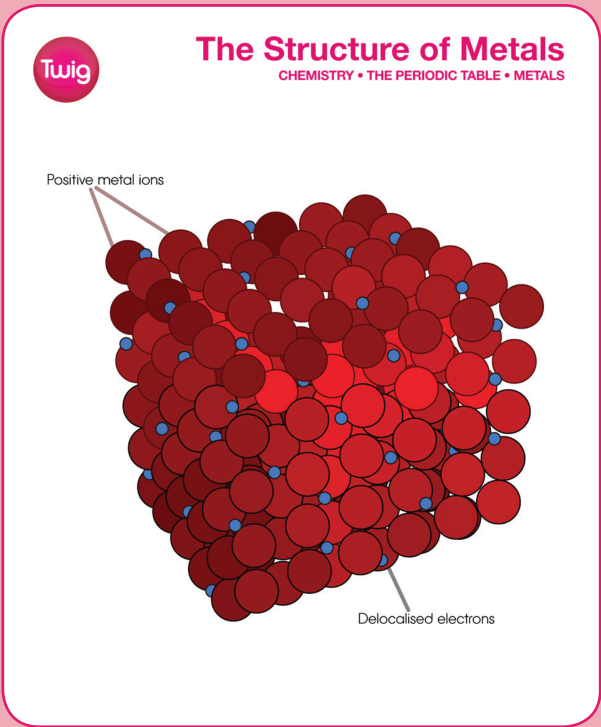
Metals

Section 1: Metals, Metal Extraction and Alloys

• What are the key properties of metals and how can we explain them?

DIAGRAM 01:



21st century life with its computers, mobile phones, cars, aeroplanes and spaceships would be impossible without metals. What is not so obvious is that life on Earth itself depends on their amazing properties.

Metals are:
- **malleable**, which enables them to change shape when squashed or hammered
- **ductile**, so they can be drawn into a wire
- **shiny** when freshly cut
- good **conductors** of heat and electricity

Metals usually have relatively **high melting points** and so are **solids** at room temperature, with the exception of mercury and gallium (which melts in your hand). Metals are made of three-dimensional lattices of positive metal ions surrounded by a 'sea' of negative delocalised electrons. The key to metals' unique properties is that their atoms are held together by metallic bonds, caused by the electrostatic attraction between positive metal ions and the 'sea' of electrons.

The metal ions are tightly packed together, making metals rather dense materials. When a force is applied to a metal, the metal ions can slide over one another. At the same time, the delocalised electrons flow and the metallic bond is re-formed. This is why metals deform, rather than break, when they are squashed.

Metals conduct electricity because, when a potential difference, also called voltage, is applied to a piece of metal, the delocalised electrons can flow, making an electric current. Metals are also good thermal conductors. If metal is heated, the positive ions and the electrons in the metal gain kinetic energy and start moving faster. As the electrons are much lighter than the positive ions, they move much faster and collide with other electrons. This creates kinetic energy in the form of heat, which spreads through the metal and travels away from the heat source. Metals feel cold to the touch because heat is carried away from your hand when your skin makes contact with the metal.

Metals are shiny because light is an electromagnetic wave. It interacts with the delocalised electrons in the metal, setting up electric currents, which cause light to be reflected.

Metal oxides are all bases and they react with acids to make salts and water, for example:

magnesium oxide + sulphuric acid → magnesium sulphate + water

$$MgO(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2O(l)$$

Extension Question

Q1. Explain why metallic sodium is soft and can conduct electricity

In metallic sodium, the positive sodium ions form a three-dimensional lattice. If a force is applied to the metal, the layers of ions slide over each other. At the same time the 'sea' of electrons can flow to its new position, so that the metallic bond between the atoms is maintained. Sodium metal is therefore quite easy to cut, squash or deform.

Sodium atoms have the electron configuration 2,8,1. They can lose their outer electrons, making sodium ions $[2,8]^+$, and in the solid metal the outer electrons merge to form a 'sea' of delocalised electrons. If a potential difference is applied to the piece of sodium, the delocalised electrons move, making an electric current.

• Suggested Films

- Metallic Bonding
- The Elements: Copper
- The Elements: Mercury
- Early Chemistry: Mendeleev's Prophecy
- The Elements: Potassium
- The Elements: Iron
- The Elements: Lead
- The Elements: Uranium
- The Elements: Plutonium
- The Elements: Radium
- The Elements: Sodium

• How can we extract metals from their ores?

The properties of metals make them extremely useful, but to use them we first have to extract them from rocks containing metals or metal compounds, known as metal ores. An ore is a rock from which it is economic to extract a given metal. Although there are tiny amounts of iron in ordinary garden soil, it is not economic to extract such small amounts, so garden soil is not an ore of iron!

Metals vary dramatically in reactivity, from the alkali metals, such as potassium, which react violently with water, to 'noble' metals, such as gold, which are so unreactive that they are used in jewellery. These properties are summed up in the reactivity series with potassium near the top and gold near the bottom. The least reactive metals are found as elements in the Earth's crust. These are known as 'native' metals and include native gold, native silver, native copper and native platinum. They were probably the first metals to be used by human beings for things like tools, weapons and jewellery. However, most metals are not found as native elements: instead they are present in minerals as compounds, combined with oxygen or other non-metals, and we have to use chemical methods to extract them.

For the least reactive metals it may be enough simply to heat the ore in air. Mercury, for example, is extracted by heating mercury sulphide:

mercury sulphide + oxygen → mercury + sulphur dioxide

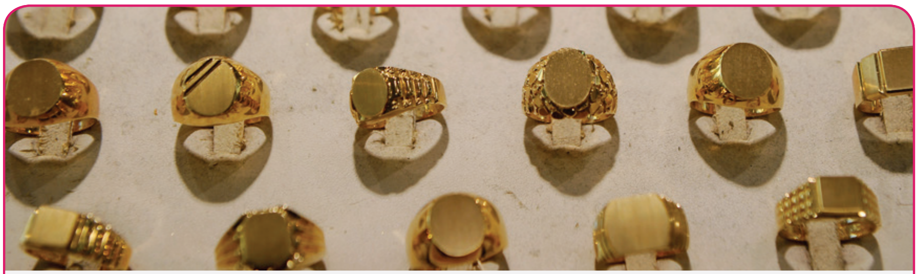
$$HgS(s) + O_2(g) \rightarrow Hg(l) + SO_2(g)$$

For the metals of medium reactivity, such as lead, iron and copper, the ore is heated with a reducing agent, such as carbon or carbon monoxide, which can pull oxygen away from the metal. To make lead, carbon (in the form of coke) is used:

lead oxide + carbon → lead + carbon dioxide

$$2PbO(s) + C(s) \rightarrow 2Pb(s) + CO_2(g)$$

Carbon is behaving as a reducing agent here, pulling oxygen away from lead in lead oxide. To extract the most reactive metals, such as potassium and aluminium, we need to use another technique, electrolysis. Electricity is passed through the molten ore, which conducts electricity because it contains ions which can move freely in the hot liquid. Two rods (called electrodes), one positive and one negative, dip into the molten ore and carry electricity into and out of the molten ore during electrolysis. The metal collects at the negative electrode, the cathode. Electrolysis was only available after 1800, which explains why these metals were discovered much later than gold, iron or copper.



Gold is used in jewellery as it is very unreactive

• Suggested Films

- Reactivity Series
- The Elements: Iron
- The Elements: Copper
- The Elements: Mercury
- The Elements: Lead
- The Elements: Potassium
- The Elements: Gold

Extension Questions

Q2. Why were gold and copper used by human beings long before iron?

Gold and copper are both found as 'native' metals – uncombined with other elements – in many parts of the world. Native iron is much rarer, although it is found in iron meteorites alloyed with nickel. Iron had to be extracted from its ore using carbon (originally in the form of charcoal), requiring the ability to make furnaces hot enough for the extraction to take place.

Q3. Why is aluminium more expensive than iron?

Aluminium is made by the electrolysis of molten aluminium oxide. Electricity is very expensive and this makes aluminium much more costly than iron.

• What are alloys?

Alloys are mixtures of a metal with another element (usually another metal). For example, steel = iron + carbon; bronze = copper + tin; brass = copper + zinc; solder = lead + tin; amalgam = mercury + silver or tin; duralumin = aluminium + copper + other metals. Alloys are typically harder and stronger than pure metals, and all the metals we use in everyday life are actually alloys. In a pure metal the layers of metal ions can slide over one another, but in an alloy the 'new' atoms, which have been introduced, prevent the sliding from taking place so easily.

Alloys have a huge range of applications, with the most important being the various types of steel. All steels contain iron and carbon, but by adding other metals we can change the properties of steel. For instance, the addition of chromium and nickel makes stainless steel which is resistant to rusting. Tungsten steel is very hard, with a high melting point, and is used for drill bits.

In recent years, shape-memory alloys of titanium and nickel, such as nitinol, have been developed. These seem to 'remember' their original shape when heated, because the structure of the alloy changes. For instance, a nitinol dental brace can be made so that once inside the mouth the wires in the brace contract to their original shape, tightening their grip on the teeth and holding them in place.

DIAGRAM 02:

Alloy wheels are lighter than steel wheels, which can increase fuel efficiency

Extension Questions

Q4. What does the term 'carat' in '18 carat gold' mean?

'Carat' is a measure of the purity of gold. 100% pure gold is 24 carat and 75% pure gold is 18 carat. Most jewellery is 18 carat or less, as pure (24 carat) gold is too soft and weak to make jewellery. Because of this, gold is often alloyed with copper or other metals to make it harder and stronger. The colour of the gold changes as more copper is added, making it redder. White gold is made by alloying with nickel or palladium.

Q5. What are alloy wheels?

Alloy wheels are made of alloys of aluminium or magnesium, sometimes mixed with silicon. They are much less dense than steel and are also better thermal conductors. Their low density means that the car is carrying a lower mass, and so may lead to better fuel consumption. Their better thermal conductivity also means that the brakes may also be more efficient than with steel wheels, as heat is produced by friction during braking. However, both aluminium and magnesium corrode more easily than steel, and magnesium is actually flammable, so alloy wheels may not be as practical as steel wheels for the average motorist, and are much more expensive.

Q6. In ancient times, why was bronze used for tools rather than pure copper?

Copper is found as the native metal in rocks and was sometimes used for tools. However, bronze is a much harder and stronger metal than pure copper and, once it became known how to make bronze from copper and tin, it became the metal of choice for arrowheads, helmets and ritual vessels, hence the term 'Bronze Age'.

• Suggested Films

- Metallic Bonding
- Alloys
- Metals in Medicine
- The Elements: Mercury
- The Elements: Aluminium

Q7 Why are alloys not regarded as compounds?

A compound has to have a definite composition, but alloys do not. They are mixtures made by mixing any proportions of the component metals. For example, bronze is made of copper and tin and can be made with any percentage of copper, although it is usually over 80%. Alloys have no definite chemical formula so they cannot be regarded as compounds.

Section 2: Alkali Metals

• What makes the alkali metals a 'group' of elements?

All their atoms have one electron in the outer shell. For example, lithium has the electron configuration 2,1, sodium 2,8,1, and potassium 2,8,8,1. They all lose their outer electron relatively easily to form ions with a single positive charge, such as a lithium ion Li^+ with electron configuration $[2]^+$.

They are all soft metals, silvery when freshly cut, and are stored under oil. They have low densities, some even less dense than water. Their compounds are usually colourless or white. From lithium to caesium they become denser and softer, and their melting points become lower. All the alkali metals are highly reactive, for example, reacting with oxygen to make solid, white ionic oxides:

lithium + oxygen → lithium oxide

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

The alkali metals all react with water, making metal hydroxides and hydrogen gas:

lithium + water → lithium hydroxide + hydrogen gas

$$2Li(s) + 2H_2O(l) \rightarrow 2LiOH(aq) + H_2(g)$$

• Suggested Films

- Alkali Metals
- The Elements: Potassium
- The Elements: Sodium
- The Elements: Magnesium
- What Is An Atom?
- Atom Structure: Electron Shells
- Flame Colours and Fireworks
- Flame Colours and Spectroscopy
- Ionic bonding
- Reactivity Series

The elements become increasingly reactive as you go down the group from lithium to caesium, as the outer electron is lost more and more easily. This is because:

• The outer electron is further from the nucleus in caesium, so less energy is needed to remove the electron so that the reaction can take place.
• There are more full shells of electrons in caesium than lithium, which 'shield' or block the attractive power of the nucleus, therefore the outer electron is lost more easily.

• How are alkali metals extracted?

The alkali metals are extracted by electrolysis of their molten (melted) compounds. Sodium, for instance, can be made by electrolysing molten sodium chloride. The positive metal ions are attracted to the cathode (negative electrode) where they gain electrons (from the electrons that are being passed along wires into the cell) and form sodium atoms:

• Suggested Films

- Alkali Metals
- The Elements: Potassium
- The Halogens
- Hard and Soft Water

At the cathode: $Na^+ + e^- \rightarrow Na$

The sodium atoms collect together making molten sodium, which can be tapped off. At the same time, chloride ions are attracted to the anode (positive electrode) where they lose electrons (they move out of the cell and go round the circuit), forming diatomic molecules of chlorine gas:

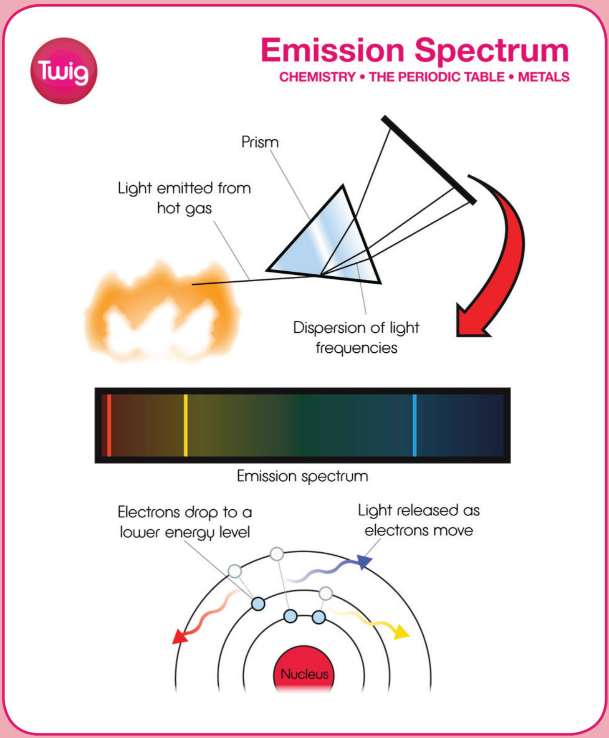
At the anode: $2Cl^- \rightarrow Cl_2 + 2e^-$

Chlorine gas is used for disinfecting swimming pools and for making polymers, such as PVC.

• What causes the flame colours of the alkali metals?

The alkali metals all give characteristic flame colours if they, or their compounds, are heated strongly in a bunsen flame. The colours, which are known as an emission spectrum, are caused by the movement of the outer electrons. The flame colours are: Li = red, Na = yellow, K = lilac, Rb = red, Cs = blue. When the atom is heated, it gains energy and the outer electron 'jumps' from its original energy level E1 to a higher energy level E2. When it falls back to energy level E1 it releases energy in the form of visible light. The colour of the light depends on (E2-E1) the difference between energies of the two energy levels, and this in turn depends on the atomic number of the atom. The atomic number (= number of protons in the nucleus) controls the structure of the atom, and hence decides what the various energy levels are. This is why lithium (with 3 protons in its nucleus) gives a different colour to sodium (with 11 protons in its nucleus).

DIAGRAM 03:



Bright red fireworks contain lithium

• Suggested Films

- Flame Colours and Fireworks
- Flame Colours and Spectroscopy

Extension Question

Q8. Why are compounds of lithium used in fireworks?

Lithium compounds emit red light when heated and so compounds, such as lithium carbonate, are used to make red fireworks.

Section 3: The Transition Metals, Metals in the Living World and Displacement Reactions

• What are the transition metals?

The transition elements are found in the large rectangular block between Groups 2 and 3 in the modern periodic table. They are all strong metals, usually with high melting points (mercury being the exception), and are much less reactive than the Group 1 and Group 2 metals, so, transition metals such as copper, silver, gold and platinum appear relatively low down the reactivity series.

Transition metals typically have coloured compounds and form several different ions. For example, in its compounds, iron exists as both iron(II) ions Fe^{2+} and iron(III) ions Fe^{3+}. These two different ions form two series of compounds: iron(II) compounds (usually green) and iron(III) compounds (usually yellow or brown).

Transition metals usually form several oxides. For example, the two oxides of copper are copper(I) oxide Cu_2O (red) and copper(II) oxide CuO (black). Iron has three different oxides: iron(II) oxide FeO (black), iron(III) oxide Fe_2O_3 (red), and magnetic iron oxide Fe_3O_4 (black).

Transition metal oxides are insoluble in water. Their oxides are all bases, reacting with acids to make solutions of salts and water:

• Suggested Films
- Transition Metals
- Metallic Bonding
- The Elements: Copper
- The Elements: Iron
- The Elements: Mercury
- The Elements: Gold
- The Elements: Silver

• Worksheet Questions
- Questions 1, 2 and 3

copper(II) oxide + sulphuric acid → copper(II) sulphate + water

$$CuO(s) + H_2SO_4(aq) \rightarrow CuSO_4(aq) + H_2O(l)$$


Iron ore

Transition metals and their compounds are often used as catalysts. A few examples include, iron Fe in the Haber process for making ammonia, platinum Pt, rhodium Rh and palladium Pd in catalytic convertors for cars, vanadium pentoxide V_2O_5 for making sulphuric acid, and nickel Ni for hydrogenating vegetable oils to make margarine.

• Why are metals important in the living world?

Life on Earth would impossible without metals. Green plants need magnesium to make chlorophyll for carrying out photosynthesis, calcium is essential for making calcium compounds that make bones and teeth hard and strong, and iron is needed to make the protein haemoglobin, which carries oxygen around the body in our red blood cells, and also another protein myoglobin which binds oxygen in our muscles. Copper plays a role similar to haemoglobin in haemocyanin, which transports oxygen in the blood of molluscs, spiders and lobsters. Zinc is needed to make many enzymes in our bodies work effectively, and cobalt atoms are present in Vitamin B_{12}. Molybdenum and iron are essential for the nitrogenase enzyme used by bacteria in the root nodules of certain plants, to 'fix' atmospheric nitrogen.


Magnesium powder burns with a white flame

Extension Question

Q9. Why is magnesium an essential element for life on Earth?

Magnesium is needed to make chlorophyll, which is needed for green plants to carry out photosynthesis. Without photosynthesis the Earth's atmosphere would have no oxygen. Without green plants, herbivores would have no food, and without herbivores the carnivores would die. Many other chemical processes inside our cells also involve magnesium ions. Without magnesium, life as we know it would be impossible.

• Suggested Films

- The Elements: Oxygen
- The Elements: Magnesium
- Photosynthesis
- The Nitrogen Cycle
- FactPack: Enzymes
- FactPack: How to Make a Human

• What are displacement reactions of metals?

In a displacement reaction a more reactive metal displaces a less reactive metal. For example, iron can displace copper from copper(II) sulphate solution:

iron + copper(II) sulphate → copper + iron(II) sulphate

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

The reactivity series is a useful guide to which displacement reactions will (or will not) take place. Iron is above copper in the reactivity series so we would predict that iron would displace copper. This reaction has been used to recover copper from water seeping out of old copper mines. Iron filings are put in the water, which contains dissolved copper compounds, and copper metal is displaced. Since copper is far more valuable than iron, this process is highly economic, gives off no harmful pollutants, and prevents toxic copper compounds entering the rivers and harming wildlife.

Sodium metal is used to extract titanium by displacement from titanium chloride:

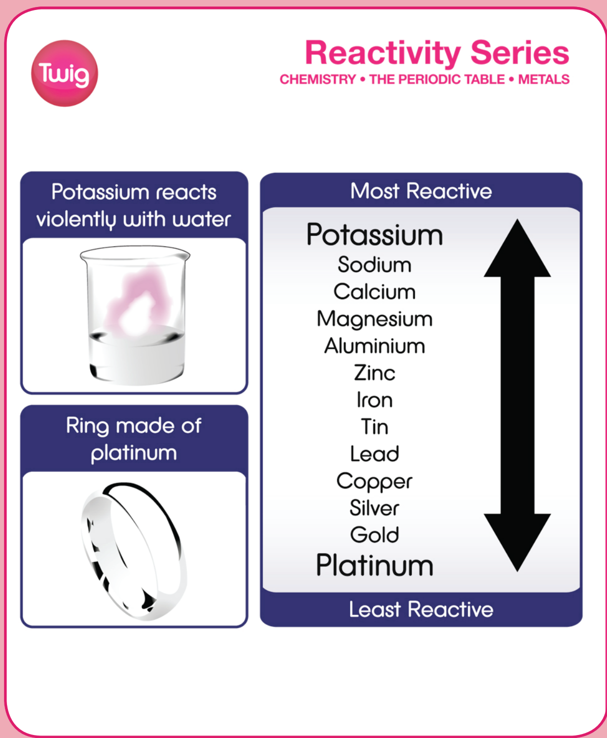
sodium + titanium chloride → titanium + sodium chloride

$$4Na(s) + TiCl_4(l) \rightarrow Ti(s) + 4NaCl(s)$$

• Worksheet Question

- Question 4

DIAGRAM 04:



• Worksheet Questions

Q1. By looking at the properties of other alkali metals, predict the properties of rubidium Rb, which is below potassium in Group 1.

(a) What would rubidium look like? **(b)** Predict the charge on its ion **(c)** How is it stored? **(d)** What colour will its compounds be? **(e)** How you would expect rubidium to react with: **(i)** oxygen gas? **(ii)** chlorine gas? **(iii)** water? **(f)** What might you SEE in a reaction between rubidium and water? **(g)** Suggest how you would expect the reactivity of rubidium to compare with that of potassium?

(a) ______________________

(b) ______________________

(c) ______________________

(d) ______________________

(e)(i) ______________________

(e)(ii) ______________________

(e)(iii) ______________________

(f) ______________________

(g) ______________________

• Worksheet Questions

Q2. A green powder X, which contains only one pure substance, is heated and it turns into a black solid and a colourless gas. The colourless gas turns limewater milky.

(a) Is X an element? How do you know? **(b)** Is the metal in X likely to be a Group 1 metal or a transition metal? How do you know? **(c)** What is the gas? **(d)** If the black powder is heated with hydrogen gas it makes water and a red-brown metal. Suggest the identity of the metal, and hence the identity of X. **(e)** Write an equation for the decomposition of X.

(a) ______________________________

(b) ______________________________ **(c)** ______________

(d) ______________________________

(e) ______________________________

Q3. Complete these word equations, and then write the symbol equations:

(a) potassium + oxygen → **(b)** potassium + water → **(c)** potassium oxide + water →
(d) sodium hydroxide + sulphuric acid → **(e)** sodium hydroxide + nitric acid →
(f) caesium hydroxide + hydrochloric acid → **(g)** francium + chlorine →

(a) ______________________________

(b) ______________________________

(c) ______________________________

(d) ______________________________

(e) ______________________________

(f) ______________________________

(g) ______________________________

• Worksheet Questions

Q4. Use the reactivity series to predict which of these displacement reactions will take place.
If the reaction DOES take place, complete the word equation:

(a) copper + magnesium oxide → **(b)** magnesium + lead(II) oxide →
(c) lead + silver nitrate → **(d)** zinc + copper(II) sulphate →

(a) ______________________

(b) ______________________

(c) ______________________

(d) ______________________

• Worksheet Answers

Q1. By looking at the properties of other alkali metals, predict the properties of rubidium Rb, which is below potassium in Group 1.

(a) What would rubidium look like? **(b)** Predict the charge on its ion **(c)** How is it stored? **(d)** What colour will its compounds be? **(e)** How you would expect rubidium to react with: **(i)** oxygen gas? **(ii)** chlorine gas? **(iii)** water? **(f)** What might you SEE in a reaction between rubidium and water? **(g)** Suggest how you would expect the reactivity of rubidium to compare with that of potassium?

(a) Silvery metal when freshly cut. **(b)** +1. **(c)** Under oil. **(d)** Its compounds are usually white or colourless ionic solids.

(e)(i) Rubidium reacts exothermically with oxygen to make a white solid ionic oxide:

rubidium + oxygen → rubidium oxide

$$4Rb(s) + O_2(g) \rightarrow 2Rb_2O(s)$$

Rubidium oxide reacts exothermically with water to make a strongly alkaline, colourless solution of rubidium hydroxide, which has a pH of 14:

rubidium oxide + water → rubidium hydroxide

$$Rb_2O(s) + H_2O(l) \rightarrow 2RbOH(aq)$$

(e)(ii) Rubidium burns in chlorine gas to make rubidium chloride, a white ionic solid:

rubidium + chlorine → rubidium chloride

$$2Rb(s) + Cl_2(g) \rightarrow 2RbCl(s)$$

(e)(iii) Rubidium reacts violently and exothermically with water, making hydrogen gas and a strongly alkaline solution of rubidium hydroxide:

rubidium + water → rubidium hydroxide + hydrogen gas

$$2Rb(s) + 2H_2O(l) \rightarrow 2RbOH(aq) + H_2(g)$$

(f) Rubidium melts and dissolves with effervescence due to hydrogen gas, which burns with a red flame. The reaction is explosively exothermic and violent.

(g) Rubidium is MORE reactive than potassium as:

(i) its outer electron is further from the nucleus, so the attraction for the nucleus is weaker, making it easier for the electron to be lost;

(ii) there is more shielding by full shells, which also weakens the attraction of the nucleus. [(ii) is actually a much more important factor than (i)].

Hence the outer electron of rubidium is lost more easily than that of potassium, and it is much more reactive than potassium.

• Worksheet Answers

Q2. A green powder X, which contains only one pure substance, is heated and it turns into a black solid and a colourless gas. The colourless gas turns limewater milky.

(a) Is X an element? How do you know? **(b)** Is the metal in X likely to be a Group 1 metal or a transition metal? How do you know? **(c)** What is the gas? **(d)** If the black powder is heated with hydrogen gas it makes water and a red-brown metal. Suggest the identity of the metal, and hence the identity of X. **(e)** Write an equation for the decomposition of X.

(a) X cannot be an element, as it decomposes when heated. Since X is a pure substance (so not a mixture) it must be a compound.

(b) X is a transition metal, because the compound is coloured.

(c) Carbon dioxide.

(d) The metal is copper. The black powder is copper(II) oxide CuO(s). X is copper(II) carbonate $CuCO_3$. Its reaction with hydrogen gas is:

hydrogen + copper(II) oxide → copper + water

$$H_2(g) + CuO(s) \rightarrow Cu(s) + H_2O(l)$$

(e) The thermal decomposition reaction of X is:

Copper(II) carbonate → copper(II) oxide + carbon dioxide

$$CuCO_3(s) \rightarrow CuO(s) + CO_2(g)$$

Q3. Complete these word equations, and then write the symbol equations:

(a) potassium + oxygen → **(b)** potassium + water → **(c)** potassium oxide + water → **(d)** sodium hydroxide + sulphuric acid → **(e)** sodium hydroxide + nitric acid → **(f)** caesium hydroxide + hydrochloric acid → **(g)** francium + chlorine →

(a) potassium + oxygen → potassium oxide

$$4K(s) + O_2(g) \rightarrow 2K_2O(s)$$

(b) potassium + water → potassium hydroxide + hydrogen

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

(c) potassium oxide + water → potassium hydroxide

$$K_2O(s) + H_2O(l) \rightarrow 2KOH(aq)$$

(d) sodium hydroxide + sulphuric acid → sodium sulphate + water

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

(e) sodium hydroxide + nitric acid → sodium nitrate + water

$$NaOH(aq) + HNO_3(aq) \rightarrow NaNO_3(aq) + H_2O(l)$$

(f) caesium hydroxide + hydrochloric acid → caesium chloride + water

$$CsOH(aq) + HCl(aq) \rightarrow CsCl(aq) + H_2O(l)$$

(g) francium + chlorine → francium chloride

$$2Fr(s) + Cl_2(g) \rightarrow 2FrCl(s)$$

• Worksheet Answers

Q4. Use the reactivity series to predict which of these displacement reactions will take place. If the reaction DOES take place, complete the word equation:

(a) copper + magnesium oxide → **(b)** magnesium + lead(II) oxide →
(c) lead + silver nitrate → **(d)** zinc + copper(II) sulphate →

(a) copper + magnesium oxide → no reaction

(b) magnesium + lead(II) oxide → lead + magnesium oxide

(c) lead + silver nitrate → silver + lead(II) nitrate

(d) zinc + copper(II) sulphate → copper + zinc sulphate

• Quizzes

The Transition Metals

Basic

• Which of these is NOT a transition metal?

A – gold
B – mercury
C – silver
D – sodium

• Which of these statements is NOT true of all transition metals?

A – they are solid at room temperature
B – they have coloured compounds
C – they are malleable
D – they have several different oxides

• Copper is used for water pipes because it

A – is very dense
B – conducts electricity
C – does not react with water
D – is very hard

• For which of these purposes are transition metals NOT used?

A – construction
B – coins
C – electrical wiring
D – clothing

Advanced

• When water is added to white anhydrous copper sulphate it turns

A – green
B – red
C – yellow
D – blue

• Which of these statements is NOT true?

A – iron compounds are brown or light green
B – cobalt chloride is red
C – nickel sulphate is red
D – copper salts are blue or green

• White anhydrous copper sulphate can be used to detect the presence of

A – water
B – oxygen
C – nitrogen
D – sulphur

• The two types of copper oxide are

A – pink and yellow
B – blue and white
C – black and green
D – red and black

The Reactivity Series

Basic

- Which of these metals is NOT found as a native metal?

  A – gold

  B – silver

  C – potassium

  D – platinum

- Which of these metals is extracted using electrolysis?

  A – iron

  B – bronze

  C – aluminium

  D – silver

- Copper can be made by heating copper ore with

  A – sodium

  B – charcoal

  C – silver

  D – tin

- Bronze is an alloy made of copper and

  A – gold

  B – silver

  C – tin

  D – iron

Advanced

- Which of these metals is NOT extracted using electrolysis?

  A – potassium

  B – sodium

  C – magnesium

  D – iron

- Charcoal is a form of

  A – copper

  B – ore

  C – carbon

  D – iron

- Which of these is the correct chronological order?

  A – Iron Age, Bronze Age, Copper Age, Stone Age

  B – Stone Age, Bronze Age, Copper Age, Iron Age

  C – Stone Age, Copper Age, Iron Age, Bronze Age

  D – Stone Age, Copper Age, Bronze Age, Iron Age

- Aluminium was not used before 1800 because it

  A – has a high density

  B – is difficult to extract from its ore

  C – reacts violently with water

  D – does not react with other elements

The Alkali Metals

Basic

• Which of these is NOT an alkali metal?

A – lithium
B – magnesium
C – potassium
D – sodium

• Which gas do alkali metals make when they react with water?

A – nitrogen
B – oxygen
C – hydrogen
D – helium

• The least reactive alkali metal is

A – lithium
B – sodium
C – potassium
D – rubidium

• The alkali metals are all stored

A – in glass bottles
B – under oil
C – in plastic bottles
D – under water

Advanced

• The outer shell of alkali metal atoms contains

A – 1 electron
B – 3 electrons
C – 5 electrons
D – 7 electrons

• When potassium reacts with water, the gas it makes burns with a flame which is

A – blue
B – yellow
C – lilac
D – green

• The alkali metals become more reactive as you go down the group because

A – the metals become more dense
B – they have more protons in the nucleus
C – the outer electron is lost more easily
D – there are more neutrons in the nucleus

• Which of these statements about alkali metals is NOT true?

A – they are cut easily with a knife
B – they have high densities
C – their melting points are relatively low

• Answers

The Transition Metals

Basic

• Which of these is NOT a transition metal?

A – gold
B – mercury
C – silver
D – sodium

• Which of these statements is NOT true of all transition metals?

A – they are solid at room temperature
B – they have coloured compounds
C – they are malleable
D – they have several different oxides

• Copper is used for water pipes because it

A – is very dense
B – conducts electricity
C – does not react with water
D – is very hard

• For which of these purposes are transition metals NOT used?

A – construction
B – coins
C – electrical wiring
D – clothing

Advanced

• When water is added to white anhydrous copper sulphate it turns

A – green
B – red
C – yellow
D – blue

• Which of these statements is NOT true?

A – iron compounds are brown or light green
B – cobalt chloride is red
C – nickel sulphate is red
D – copper salts are blue or green

• White anhydrous copper sulphate can be used to detect the presence of

A – water
B – oxygen
C – nitrogen
D – sulphur

• The two types of copper oxide are

A – pink and yellow
B – blue and white
C – black and green
D – red and black

The Reactivity Series

Basic

• Which of these metals is NOT found as a native metal?

A – gold
B – silver
C – potassium
D – platinum

• Which of these metals is extracted using electrolysis?

A – iron
B – bronze
C – aluminium
D – silver

• Copper can be made by heating copper ore with

A – sodium
B – charcoal
C – silver
D – tin

• Bronze is an alloy made of copper and

A – gold
B – silver
C – tin
D – iron

Advanced

• Which of these metals is NOT extracted using electrolysis?

A – potassium
B – sodium
C – magnesium
D – iron

• Charcoal is a form of

A – copper
B – ore
C – carbon
D – iron

• Which of these is the correct chronological order?

A – Iron Age, Bronze Age, Copper Age, Stone Age
B – Stone Age, Bronze Age, Copper Age, Iron Age
C – Stone Age, Copper Age, Iron Age, Bronze Age
D – Stone Age, Copper Age, Bronze Age, Iron Age

• Aluminium was not used before 1800 because it

A – has a high density
B – is difficult to extract from its ore
C – reacts violently with water
D – does not react with other elements

The Alkali Metals

Basic

• Which of these is NOT an alkali metal?

A – lithium

B – magnesium

C – potassium

D – sodium

• Which gas do alkali metals make when they react with water?

A – nitrogen

B – oxygen

C – hydrogen

D – helium

• The least reactive alkali metal is

A – lithium

B – sodium

C – potassium

D – rubidium

• The alkali metals are all stored

A – in glass bottles

B – under oil

C – in plastic bottles

D – under water

Advanced

• The outer shell of alkali metal atoms contains

A – 1 electron

B – 3 electrons

C – 5 electrons

D – 7 electrons

• When potassium reacts with water, the gas it makes burns with a flame which is

A – blue

B – yellow

C – lilac

D – green

• The alkali metals become more reactive as you go down the group because

A – the metals become more dense

B – they have more protons in the nucleus

C – the outer electron is lost more easily

D – there are more neutrons in the nucleus

• Which of these statements about alkali metals is NOT true?

A – they are cut easily with a knife

B – they have high densities

C – their melting points are relatively low