too reactive in water to use in displacement reactions.

4 a copper sulfate + iron → iron sulfate + copper

b magnesium chloride + zinc → no reaction

c iron sulfate + magnesium → magnesium sulfate + iron

d zinc chloride + silver → no reaction

e zinc chloride + iron → no reaction

5 Potassium is very reactive in water and if used in solutions of salts it would be very dangerous.

Topic 5.2 Using the reactivity series and displacement reactions

Exercise 5.2 Using the reactivity series

1 a The metal is more reactive than iron and copper but less reactive than magnesium.

b aluminium or zinc

c Accept any metal above copper in the reactivity series such as iron, zinc or magnesium.
Accept any metal above zinc such as magnesium.

2 a Zinc is more reactive than iron so the zinc combines with the chlorine in the iron chloride and forms zinc chloride and leaves iron metal.

b zinc + iron chloride → zinc chloride + iron

c Iron can be displaced by zinc because zinc is more reactive. Copper is even less reactive than iron so zinc will displace copper from a solution of copper chloride.

d Zinc is less reactive than magnesium so it cannot displace magnesium from a solution of magnesium chloride.

3 a Aluminium and iron oxide are mixed in a container over the rail that needs to be welded. This reaction produces so much heat energy that the displaced iron melts. The molten iron produced can be shaped and used to join the rails together. For the iron oxide and aluminium to react they have to be ignited and this is done using another exothermic reaction. (Credit naming the reaction between magnesium powder and barium nitrate, but it is the idea of using an exothermic reaction to start the main reaction that is needed here, rather than the details.)

b This method is used because it produces enough energy to melt the iron, and is possible to do when the work has to be done away from an electricity supply.

c aluminium + iron oxide → aluminium oxide + iron

4 a carbon

b Iron ore is heated in the blast furnace with carbon in the form of coke. The carbon displaces the iron from the iron oxide and molten iron is produced.

c iron oxide + carbon → iron + carbon dioxide

d It is above iron in the reactivity series. (Accept any more specific suggestion provided it is not above aluminium.)

Topic 5.3 Salts

Exercise 5.3A Which acid is used to make which salt?

1 Hydrochloric acid — HCl — chlorides
Sulfuric acid — H_2SO_4 — sulfates
Nitric acid — HNO_3 — nitrates

2 magnesium chloride: hydrochloric acid;
magnesium nitrate: nitric acid;
magnesium sulfate: sulfuric acid.

3 NaCl: sodium chloride;
$CuSO_4$: copper sulfate;
$CuCl_2$: copper chloride;
KNO_3: potassium nitrate

4 citrates

Exercise 5.3B Making salts

1 Place some zinc metal into dilute nitric acid. When it has stopped reacting, put your solution into an evaporating basin and heat it gently to evaporate off the water and produce crystals of zinc nitrate.

2 zinc + nitric acid → zinc nitrate + hydrogen

3 Silver is much less reactive than zinc and will not react with dilute sulfuric acid.

4 Potassium is far too reactive; there would be an explosive reaction if potassium metal were placed in dilute sulfuric acid.

5 a It is important because harmful fumes will be given off from the acid.

b copper oxide + sulfuric acid → copper sulfate + water

6 a magnesium + nitric acid → magnesium nitrate + hydrogen

b copper oxide + nitric acid → copper nitrate + water

c zinc + hydrochloric acid → zinc chloride + hydrogen

d zinc + sulfuric acid → zinc sulfate + hydrogen

Exercise 5.3C Practical steps for making salts

1 Copper chloride cannot be made by reacting copper with dilute sulfuric acid because, to make a chloride, you would need to use hydrochloric acid and copper is unreactive and does not react with any dilute acid.

2 The first step is to react copper oxide with sulfuric acid. Excess copper oxide is added to sulfuric acid in a beaker. This is heated gently and stirred constantly. When a colour change (to blue) is seen, you should stop heating. Safety precautions: wear safety glasses, as you are using acid; do not boil the acid mixture, as harmful fumes are given off.

The second step is to filter the mixture. The excess copper oxide is left in the filter paper and the filtrate is a solution of copper sulfate. No additional safety precautions need to be taken.

The third step is to evaporate the water from the copper sulfate solution by heating it gently in an evaporating basin. When small crystals form, or the solution starts to spit, stop heating and allow the rest of the water to evaporate slowly. Safety precautions: wear safety glasses and take care as the hot solution may spit and burn you.

Credit labelled diagrams that help to explain the above method.

Topic 5.4 Other ways of making salts

Exercise 5.4A Preparing copper chloride

1 The copper carbonate reacts with the acid and carbon dioxide gas is given off. Credit any mention of the formation of copper chloride or water.

2 (unreacted) copper carbonate

3 A solution of copper chloride: credit `a mixture of water and copper chloride'. (Learners should recognise that water and the salt are present.)

4 Place the filtrate in an evaporating basin and heat it to evaporate off the water and leave the crystals.

5 When the solution is being heated it tends to spit, and this can burn.

6 They should wear safety glasses to prevent damage to their eyes; take special care when close to the evaporating dish; turn off the heat when the solution begins spitting.

7 copper carbonate + hydrochloric acid → copper chloride + water + carbon dioxide

Exercise 5.4B Preparing potassium chloride

1 hydrochloric acid

2 The list should include: measuring cylinder, beaker (credit conical flask), hydrochloric acid, burette, stand, universal indicator solution, safety glasses.

3 Put on safety glasses. First add a drop of universal indicator solution to the potassium hydroxide in the beaker, which turns blue. Set up the burette and fill with acid. Add acid, a little at a time, to the potassium hydroxide, and swirl the beaker to mix the contents.

4 When they see the universal indicator solution turn from blue to green.

5 Add charcoal to the neutral solution to remove the colour. Then the solution should be filtered to remove the pieces of charcoal.

6 potassium hydroxide + hydrochloric acid → potassium chloride + water

7 $KOH + HCl \rightarrow KCl + H_2O$

Exercise 5.4C Mystery substances

1 carbon dioxide
2 hydrogen
3 salts
4 sulfuric acid
5 a solution of copper chloride (accept any chloride of a metal below iron on the reactivity series)
6 hydrochloric acid
7 zinc carbonate
8 iron
9 magnesium
10 zinc sulfate + sulfuric acid → zinc sulfate + carbon dioxide + water
11 iron + copper chloride → iron chloride + copper

(Accept another chloride as the reactant, provided it is below iron on the reactivity series.)

12 magnesium + hydrochloric acid → magnesium chloride + hydrogen

Topic 5.5 Rearranging atoms

Exercise 5.5A What happens to the atoms and the mass when chemicals react?

1 The magnesium atoms should be coloured green and oxygen atoms red.
2 a The magnesium atoms should be coloured green, chlorine atoms yellow and hydrogen atoms left blank.
  b magnesium chloride
3 a The answer to each of the four questions is 2.
  b yes
4 a Oxygen atoms should be coloured red and the hydrogen atoms left blank.
  b The number of hydrogen atoms in the reactants is **the same as** the number of hydrogen atoms in the products.
  c The number of oxygen atoms in the reactants is **the same as** the number of oxygen atoms in the products.
5 24 g
6 80 g (Accept a figure less than 80 g with an explanation that some carbon dioxide will be lost to the atmosphere.)

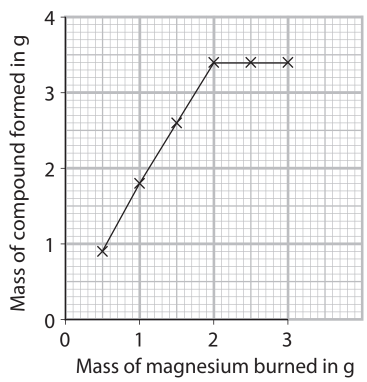
Exercise 5.5B Before and after the reaction

1 calcium, chlorine, hydrogen, oxygen and carbon
2 The particle diagram should show a molecule of sulfur dioxide: a light circle representing the sulfur atom, touching two dark circles representing the oxygen atoms.
sulfur + oxygen → sulfur dioxide;
$S + O_2 \rightarrow SO_2$
3 a magnesium, carbon and oxygen
  b carbon and oxygen
  c from the hydrochloric acid
  d from the hydrochloric acid
4 45 g
5 25 g of magnesium will be present in the magnesium sulfate
6 The term conservation of mass means that all of the atoms present at the start of a reaction are still there at the end. No elements are destroyed and no elements are created, so the mass of the products is the same as the mass of the reactants.
7 250 g
8 zinc + sulfuric acid → zinc sulfate + hydrogen
9 a No, he has not made a mistake.
  b One of the products is hydrogen gas. Since Arun used a beaker without a lid, this gas has escaped into the air. This accounts for the apparent loss of mass.
10 When scientists get an unexpected result in an experiment they should repeat the experiment several times to ensure the unexpected result is not a mistake.

Exercise 5.5C Investigating burning magnesium

1 The volume of oxygen used, the time taken to transfer the deflagrating spoon, the time taken to light the magnesium.
2 magnesium + oxygen → magnesium oxide

3 Credit: axes the correct way round and correctly labelled, including units; suitable choice of scale; points plotted accurately and joined appropriately.



4 The greater the mass of magnesium burned, the greater the mass of product formed. However, this is only true of masses of magnesium up to 2.0 g; above this the mass of the product does not change.

5 The mass of the product formed stays the same at these masses because the magnesium has used up all the (limited supply of) oxygen available. Some of the magnesium may not have been burnt.

6 a There are a number of movements of things into and out of the gas jar, and so chances to spill magnesium or the product. Also, there is a good chance that some oxygen will be lost from the gas jar as the deflagrating spoon is transferred. The lighting of the magnesium would need to be done quickly. If some magnesium had not burned it would need to be separated from the product.

b The burning magnesium should not be looked at directly. The deflagrating spoon will get hot so will need to cool down before the mass of the product can be measured.

Unit 6 Sound and space

6.1 Loudness and pitch of sound

Exercise 6.1A Comparing sound waves

1 A

2 A

3 D

4 C

5 B

6 C

Exercise 6.1B Drawing sound waves

1 Wave spacing should be the same; height of the peaks and the depth of the troughs should increase equal and opposite about the mid-line.

2 Wave spacing should decrease so there are more waves (still evenly spread) on the grid; height and depth should stay the same.

3 Wave spacing should increase so there are fewer waves (still evenly spread) on the grid; height and depth should decrease equal and opposite about the mid-line.

Exercise 6.1C Understanding sound waves

1 a 0.5 mm

b 250; unit Hz

2 loudness decreases, pitch increases

3 a sound is higher pitched (accept one octave higher)

b double the frequency / twice as fast / twice as many in the same period of time

c double the frequency / twice as fast / twice as many in the same period of time

Topic 6.2 Interference of sound

Exercise 6.2A Reinforcing sound

1 The sound becomes louder.

2 D

3 The sound waves reinforce.

Exercise 6.2B Cancelling and reinforcing

1 a The pitch **stays the same**.
The loudness **increases**.

b Arun hears nothing / no sound.

2 a A wave drawn with peaks aligned with the original wave; it must cross the mid-line at the same points as the original wave; it need not be the same amplitude as the original.

b A wave drawn with peaks aligned to the troughs of the original wave; it must cross the mid-line at the same points as the original wave; it must be the same amplitude as the original.