Experiment worksheet answers

4.1 Synthesis and decomposition reactions can be represented by equations

Pages 90–91 and 200

Experiment 4.1A: Direct synthesis with a ‘pop’

Discussion

1 What evidence was there that water was formed in the reaction?

Water can be seen to condense on the inside of the test tube that ‘popped’.

2 Write a chemical equation for the reaction that occurred, ensuring that no atoms are created or destroyed in the process.



3 Why do you think that heat was required to start the reaction?

Many chemical reactions require energy (in the form of heat) to break the initial bonds within the molecule. In this case the lit match was needed to break the bonds of the hydrogen gas.

4 Apart from synthesis, in what other ways could this reaction be classified? (Hint: think about energy involved in this reaction)

Heat and light were produced. Therefore, this reaction is exothermic.

Experiment worksheet answers

4.1 Synthesis and decomposition reactions can be represented by equations

Pages 90–91 and 201

Experiment 4.1B: Decomposing a carbonate

Discussion

1 What evidence is there that copper(II) oxide was formed in the reaction?

Copper carbonate is a green-coloured powder. When it is heated, it becomes a black powder that is similar in appearance to copper oxide.

2 What evidence is there that a gas was given off in the reaction?

Sometimes, a gas can be seen to be given off.

3 Write a chemical equation for the reaction that occurred, including state symbols.



4 Apart from decomposition, what other ways could this reaction be classified?

This is an endothermic reaction.

Further investigation

How could you redesign this experiment to provide evidence that it is carbon dioxide gas that is produced in the reaction? Write an experimental method, including labelled diagrams, and list any additional equipment you will need. Show your design to your teacher and, if it is safe, try your method using copper(II) carbonate and then repeat using calcium carbonate.

There are two ways students can test for carbon dioxide:

1 Bubbling carbon dioxide through limewater will make the latter milky. Limewater is calcium hydroxide. When carbon dioxide is added, insoluble calcium carbonate is formed.

2 Placing a lit splint into the test tube with carbon dioxide will make the splint go out.

Experiment worksheet answers

4.1 Synthesis and decomposition reactions can be represented by equations

Pages 90–91 and 202

Experiment 4.1C: Electrolysis

Discussion

1 What evidence was there that copper was formed in the reaction?

A shiny copper layer formed over one of the carbon electrodes indicates that copper was created from the copper sulfate.

2 Considering the structure of the copper sulfate, describe the:

• role of the water in the process

Water dissolves the ionic compound, allowing the ions to conduct electricity.

• role of the electric circuit

The electrical circuit provides the energy to drive the electrolysis reaction.

• reason that the copper was only found on one of the carbon electrodes.

Copper forms over the electrode that has attracted the positive copper ions.

3 Do you think that a usable amount of copper could be produced this way? If not, what changes would need to be made to the set-up to produce more copper?

Only a small amount of copper can be produced in this set up because once copper covers the electrode, it prevents the reaction from occurring further. For usable amounts of copper to be produced, the copper would need to be removed from the electrode regularly to enable the reaction to proceed.

Conclusion

Provide evidence from your results to support your answer.

Decomposition reaction.

Experiment worksheet answers

4.2 Acid reactions depend on strength and concentration

Pages 92–93 and 203

Experiment 4.2: Acid titrations

Discussion

1 When you tested the pH of the two acids, you used the same concentration (0.1 M).

a Why were they compared at the same concentration?

So that the concentration was controlled and any variation that occurred was a result of the strength of the acid.

b Why did they have a different pH?

Hydrochloric acid is able to release a hydrogen ion more easily than ethanoic acid. pH is a measure of how easily the acid can release the hydrogen ion.

c What can be concluded about the strength of ethanoic acid compared with the strength of hydrochloric acid?

Hydrochloric acid was stronger than ethanoic acid.

2 Compare the number of drops of sodium hydroxide used to neutralise each acid. Is this what you expected? Explain using your results.

Students’ results will reflect their results.

3 Write a balanced equation for each neutralisation reaction.





4 The pop test is the standard test for hydrogen gas. The ‘pop’ sound is a mini-explosion due to the combustion of hydrogen gas in air, which is a very exothermic (heat producing) reaction.

The equation for the reaction is: 

a Did your tests confirm that hydrogen gas was produced?

Yes

b Was there a difference in how fast the reactions with the two different acids occurred? If so, suggest why.

Yes. Strong acids and more concentrated acids are more likely to release a hydrogen ion and therefore form the product water at an increased rate.

5 Write a balance chemical equation for the reaction between the two acids and the magnesium ribbon.



Conclusion

1 What do you know about neutralisation reactions?

They form water and a metal salt.

2 What do you know about reactions between metals and acids?

They form hydrogen gas.

3 What do you know about the difference between strength and concentration of acids?

Strength is an indication of how readily the acid releases a hydrogen ion. Concentration is an indication of how many acid molecules there are. Increased strength or concentration increases the rate of a reaction.

Experiment worksheet answers

4.3 The solubility rules predict the formation of precipitates

Pages 94–95 and 204

Experiment 4.3: Precipitation reactions

The expected results of these reactions are:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | NaCl | NaOH | Na2SO4 | Na2CO3 |
| Ca(NO3)2 | – | Ca(OH)2 | – | CaCO3 |
| Cu(NO3)2 | – | Cu(OH)2 | – | CuCO3 |
| Mg(NO3)2 | – | Mg(OH)2 | – | MgCO3 |
| AgNO3 | AgCl | Ag(OH) | – | Ag2CO3 |
| CuSO4 | – | Cu(OH)2 | – | CuCO3 |

Note: the solubility of some of these solutions (e.g. Ca(OH)2 and Mg(OH)2) is dependent on their concentration, because small amounts will dissolve in water.

Discussion

1 The sets of compounds tested included a range of anions: NO3–, OH–, CO32–, Cl– and SO42–. Of these, which:

a did not form any precipitates?

All nitrates and sulfates were soluble.

b only formed precipitates with one or two cations?

Chloride ions and bromide ions formed a precipitate with silver cations only.

2 The sets of compounds tested included a range of cations: Na+, Ag+, Cu2+, Ca2+ and Mg2+. Of these, which:

a did not form any precipitates?

Potassium did not form any precipitates. (Depending on their concentration, magnesium and calcium may not have formed any precipitates.)

b formed precipitates with only one or two anions?

Calcium, copper, magnesium and iron only formed some precipitates.

3 Did the precipitation reactions you observed match those predicted from Table 4.1? Discuss why or why not.

Students’ results will vary.

4 Write balanced chemical equations for the reactions between:

a silver nitrate and sodium chloride



b magnesium nitrate and sodium hydroxide.



5 Why is it important not to touch the tip of the dropper bottles on the top of the solution already on the plastic sleeve?

Touching the end of the droppers on the plastic sleeve may contaminate the solution in the dropper. A precipitate will form that may affect the dropper or the results of the experiment.

6 What other factors may affect the outcome of these precipitation reactions?

Some solutions may have a partial solubility. The concentrations of the solutions may affect the results. Many senior chemistry students need to memorise the rules of solubility when they go on to further study. This can be encouraged early on using a range of memory tools.

Experiment worksheet answers

4.4 Combustion reactions between hydrocarbons and oxygen produce carbon dioxide, water and energy

Pages 96–97 and 205

Experiment 4.4: Combustion of wire wool

Discussion

1 Was this reaction an exothermic or endothermic reaction?

Exothermic as heat and light is produced.

2 Was there any change in the mass of reactants and products? Explain your observation.

Yes. The iron reacts with oxygen in the atmosphere to form iron oxide. This will increase the mass.

3 Write a worded equation for this reaction.

iron (wire wool) + oxygen → iron oxide

4 Write a balanced chemical reaction for this reaction.



Conclusion

What do you know about the oxidation of wire wool?

The iron forms bonds with oxygen to form iron oxide.

Experiment worksheet answers

4.5 Polymers are long chains of monomers

Pages 98–99 and 206

Experiment 4.5: Polymerisation of casein

Discussion

1 What are the reactants used?

casein

2 What are the products produced?

casein polymer

3 What changes have taken place?

The acid in the vinegar changes the shape of the casein molecules so that they are able to join together into a long polymer.

4 Is the polymer you created a thermoplastic or thermoset plastic? How could you test this?

Thermosetting. It does not melt or change shape when heated. This could be tested with a Bunsen burner.

5 State a use for this polymer and what properties make it suitable for that use.

Casein plastic can be used to make buttons. These would not change shape under an iron.

Experiment worksheet answers

4.6 Temperature, concentration, surface area and stirring affect reaction rate

Pages 100–103 and 207

Experiment 4.6A: Effect of temperature on reaction rate

Expected results

The higher the temperature, the faster the reaction.

Experiment worksheet answers

4.6 Temperature, concentration, surface area and stirring affect reaction rate

Pages 100–103 and 208

Experiment 4.6B: Factors affecting reaction rate

Discussion

1 Write a balanced chemical equation for the chemical reaction.



2 Describe the relationship between your independent variable and dependent variable as shown by your graph.

Students’ results will vary according to the inquiry they chose.

3 Is the hypothesis supported by the results?

Students’ results will vary.

4 Name two possible sources of error in your experiment. How could you improve the quality of the evidence that was obtained in the experiment?

Students’ results will vary.

Experiment worksheet answers

4.7 Catalysts increase the rate of a reaction

Pages 104–105 and 209

Exeriment 4.7: Using a catalyst

Expected results

The test tube with no manganese dioxide has no reaction. The test tube with manganese dioxide and hydrogen peroxide fizzes and bubbles rapidly.

Discussion

1 Was there any evidence of reaction in the test tube in which manganese dioxide was not added?

There should be no reaction visible. It is important to emphasise to students that although they saw no reaction occurring, this does not mean there was no reaction at all. It was just too slow to observe.

2 Would you say that the manganese dioxide acted as a catalyst in this reaction? Justify your answer.

When manganese dioxide was present, the reaction occurred much faster even though the manganese dioxide did not appear to be used in the reaction. These are the characteristics of a catalyst.