Answers to worksheet questions

Chapter 5

Worksheet 5.1

1 **a** All acids are ***substances that contain hydrogen***.
b When an acid is dissolved in water it results in an excess of ***hydrogen ions, H^+***.
c When an alkali dissolves in water it results in an excess of ***hydroxide ions, OH^-***.
d When an acidic solution reacts with an alkaline solution, ***H^+ and OH^- ions combine to form water***.
e The reaction between an acid and an alkali is called ***neutralisation***.

2 **a** **i** An acid is a proton donor / a substance which when dissolved in water has an excess of H^+ ions / turns blue litmus red / has a pH less than 7.
ii A base is a proton acceptor / a substance which when dissolved in water has an excess of OH^- ions / turns red litmus blue / has a pH higher than 7.
iii An alkali is a base that dissolves in water.
iv A salt is a substance made by the neutralisation of an acid with a base (alkali).
b When acids and bases react, the reaction is called ***neutralisation***. This can be summarised as acid + base → ***salt*** + water.

Bases are ***metallic*** compounds such as oxides or hydroxides. Bases such as magnesium hydroxide are used in medicines to cure ***indigestion***.

Hydrogencarbonates or carbonates can also be used to react with acids to relieve their effects; they are sometimes referred to as ***antacids***.

3 **a** Substances which change colour according to whether they are in acidic or alkaline solutions are ***called indicators***.
b When a substance dissolves in water it forms a solution which may be ***acidic, neutral or alkaline***.
c The pH scale is ***used to show how acidic or alkaline a solution is***.
d When non-metal oxides dissolve in water, their solutions are often ***acidic, with a pH less than 7***.
e When metal oxides dissolve in water, their solutions are ***alkaline, with a pH greater than 7***.

Worksheet 5.2

1 **a** zinc oxide + hydrochloric acid → ***zinc chloride*** + ***water***
b magnesium oxide + sulfuric acid → ***magnesium sulfate*** + ***water***
c copper carbonate + nitric acid → ***copper nitrate*** + ***water*** + ***carbon dioxide***
d sodium carbonate + ethanoic acid → ***sodium ethanoate*** + ***water*** + ***carbon dioxide***
e ammonium chloride + sodium hydroxide → ***sodium chloride*** + ***ammonia*** + ***water***

2 **a** potassium hydroxide + sulfuric acid → potassium sulfate + water
$2KOH + H_2SO_4 \rightarrow K_2SO_4 + 2H_2O$
b lithium hydroxide + hydrochloric acid → lithium chloride + water
$LiOH + HCl \rightarrow LiCl + H_2O$
c sodium hydroxide + nitric acid → sodium nitrate + water
$NaOH + HNO_3 \rightarrow NaNO_3 + H_2O$

d potassium hydroxide + ethanoic acid → potassium ethanoate + water
$KOH + CH_3COOH \rightarrow CH_3COOK + H_2O$

e rubidium hydroxide + nitric acid → rubidium nitrate + water
$RbOH + HNO_3 \rightarrow RbNO_3 + H_2O$

3 Stages would be:

- React excess copper(II) oxide with dilute sulfuric acid.
- Stir and heat the mixture in a conical flask using a Bunsen burner, tripod and gauze.
- Filter off the excess black solid and collect the blue solution in another conical flask.
- Concentrate the solution by heating in an evaporating basin.
- Leave to stand and cool slowly to form crystals.
- Filter off the crystals and dry between filter papers.

Worksheet 5.3

1 **a** He was protesting against the tax on salt imposed by the British – it was a move towards independence.

b People need an intake of salt to stay healthy / salt was used to preserve meat.

c NaCl

d Salt crystals are obtained by heating the solution to concentrate it and then allowing the solution to cool to form crystals; or salt formed by evaporation, leave the solution to stand to allow all the water to evaporate.

2 **a** **iii** = a mixture of sodium ions and chloride ions in water

b **i** calcium sulfate

ii $CaSO_4 + \boldsymbol{2H_2O} \rightarrow CaSO_4.2H_2O$

iii hydration

iv $Ca(OH)_2 + \boldsymbol{H_2SO_4} \rightarrow CaSO_4 + \boldsymbol{2}H_2O$

Worksheet 5.4

1 **a** All acids produce ***hydrogen*** gas when they react with metals.

b All acids produce ***carbon dioxide*** gas when they react with carbonates.

c Weak acids such as ***ethanoic acid*** react more slowly than strong ones.

2

Acid	Other reactant	Salt produced	Other product(s)
hydrochloric acid	magnesium	***magnesium chloride***	***hydrogen***
nitric acid	copper carbonate	***copper nitrate***	***carbon dioxide + water***
sulfuric acid	magnesium	***magnesium sulfate***	***hydrogen***
sulfuric acid	iron	***iron(II) sulfate***	***hydrogen***
hydrochloric acid	zinc	zinc chloride	***hydrogen***
sulfuric acid	sodium carbonate	sodium sulfate	***carbon dioxide + water***
hydrochloric acid	calcium hydroxide	***calcium chloride***	***water***
ethanoic acid	***sodium hydroxide***	sodium ethanoate	water
nitric acid	ammonia solution	***ammonium nitrate***	***water***

Worksheet 5.5

1

Acid	Formula	Alkali	Formula
hydrochloric acid	*HCl*	sodium hydroxide	*NaOH*
sulfuric acid	H_2SO_4	ammonia solution	NH_4OH
ethanoic acid	CH_3COOH	limewater	$Ca(OH)_2$
nitric acid	HNO_3		

2 All the acids contain hydrogen.

3 All the alkalis contain oxygen and hydrogen.

4 The formula of the hydrogen ion is H^+.

5 The formula of the hydroxide ion is OH^-.

6 $H^+(aq) + OH^-(aq) \rightarrow H_2O$

Worksheet 5.6

1 **a** oven cleaner, pH 12
b lemon juice, pH 2
c A neutral solution has a pH of 7.

2 orange

3 **a** pH 8 or 9
b neutralisation
c water

4 **a** citric acid (also have ascorbic acid or vitamin C)
b The lemon juice (pH 2) is 100× stronger as an acid than the orange juice (pH 4); each pH unit represents a difference of 10× in strength / it is a logarithmic scale (like the Richter scale for earthquakes, for instance).

Worksheet 5.7

1

Name of solid	Formula	Reaction with acid	Cost per gram / pence
magnesium carbonate	$MgCO_3$	fizzes	16.0
calcium carbonate	$CaCO_3$	*fizzes*	11.0
magnesium hydroxide	$Mg(OH)_2$	*does not fizz*	7.5
aluminium hydroxide	$Al(OH)_3$	does not fizz	22.0

2 $Mg(OH)_2 + 2HCl \rightarrow MgCl_2 + 2H_2O$

3 **a** The tablet was ground to a powder and placed in a flask with a known volume of water and a few drops of methyl orange added as indicator.

The acid of known concentration was added from a burette / a known volume at a time / the mixture was swirled to ensure good mixing / acid was added in this way with good mixing until the indicator just changed colour.

The experiment was repeated using information from the first experiment to obtain an accurate value for the acid needed to completely react with the tablet.

The experiment was repeated for other tablets.

b The acid concentration must be the same so that a direct comparison can be made between the values obtained from the experiments.

4

Solid	Mass of solid to neutralise 20 cm^3 of acid / g	Cost / pence
magnesium carbonate	0.7	*11.2*
calcium carbonate	1.2	*13.2*
magnesium hydroxide	0.6	*4.5*
aluminium hydroxide	0.4	*8.8*

5 A tablet of magnesium hydroxide would appear to be the most cost-effective tablet and has the advantage of not producing a gas as it neutralises the acid. In practice, commercial tablets often contain more than one of these compounds.