Chemistry: Chapter 18 Salts and neutralization

Combined Science (Chemistry Part): Chapter 18 Salts and neutralization

Sections 18.1−18.3

|!|ELB041818001O|!|

A student tried to prepare a sample of a solid salt by reacting zinc oxide with sulphuric acid in the laboratory, as shown in the diagram below.

The student wrote the following procedures of the experiment in his notebook:

(1) Excess zinc oxide was added to 80.0 cm^3 of 2.0 M sulphuric acid in a beaker.
(2) The mixture was heated for 2 minutes, and was stirred continuously during this time.
(3) The remaining zinc oxide was filtered off.
(4) The filtrate was allowed to cool overnight.

(a) Referring to the above diagram, write down FOUR aspects that are considered unsafe in the laboratory.

(b) Write a full equation for the reaction.

___

(c) Explain why the student heated the reaction mixture in Step (2).

___

(d) The student followed exactly the procedures written in his notebook, but did not obtain any solid salt the next day. Suggest an explanation.

___

[9M]

##

(a) The student did not wear safety spectacles. [1]
The two reagent bottles were not stoppered. [1] The rubber tubing tangled with the bottles, which might easily spill. [1] (In fact, reagent bottles should be stoppered immediately after use and then returned to their original places.)
A beaker was placed too near the edge of the bench. It might easily drop and break. [1]
Too much acid had been used – the 100 cm^3 beaker was almost full and the solution might boil over. (OR a larger beaker should be used.) [1]

(b) $ZnO(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2O(l)$ [1]

(c) To speed up the reaction. [1]

(d) The solution was not concentrated enough (longer heating was necessary in Step (2)). [1] Thus although some solvent had evaporated after one day, the solution was still not yet saturated. [1]

##

|!|ELB0418180002O|!|

A description of the preparation of a pure crystalline sample of hydrated magnesium sulphate is given below.

A 30 cm^3 sample of dilute sulphuric acid is <u>heated</u> gently. A small quantity of magnesium carbonate is added to the hot acid <u>with stirring</u>. More magnesium carbonate is added until it is <u>in excess</u>. The excess magnesium carbonate is filtered off from the magnesium sulphate solution. The filtrate is heated until crystals just start to form, then is left to <u>cool</u>. The crystals are collected and dried between two pieces of filter paper <u>without heating</u>.

(a) Explain the importance of each of the FIVE underlined phrases in the preparation of pure crystalline hydrated magnesium sulphate.

(b) The solubilities of some salts and carbonate are shown in the Tables A and B below.

Table A: Solubility of some salts in water

Salt	**Solubility in water**
Copper(II) nitrate	Soluble
Sodium chloride	Soluble
Lead(II) sulphate	Insoluble
Ammonium chloride	Soluble

Table B: Solubility of some carbonates in water

Carbonate	**Solubility in water**
Copper(II) carbonate	Insoluble
Sodium carbonate	Soluble
Lead(II) carbonate	Insoluble
Ammonium carbonate	Soluble

Name a salt in Table A that can be prepared by using a carbonate and an acid in a way similar to that described for the preparation of hydrated magnesium sulphate. State the names of the starting materials that are needed.

(c) Describe what is observed when aqueous sodium hydroxide is added drop by drop with shaking to aqueous magnesium sulphate.

[9M]

##

(a) The acid is heated so that magnesium carbonate can react with acid faster. [1]
Stirring is done so that magnesium carbonate is uniformly distributed throughout the acid for a fast and complete reaction. [1]
The carbonate is in excess to make sure that all acid has been reacted. [1]
Cool: This allows the filtrate to lose heat and its temperature decreases. The solubility decreases when the temperature decreases. The excessive solute that the cool filtrate cannot retain will form crystals. [1]
Without heating: This is important so that the water of crystallization of the crystal is not removed. [1]

(b) Copper(II) nitrate. [1]
The starting materials are nitric acid and copper(II) carbonate. [2]

(c) When a few drops of sodium hydroxide are added to colourless magnesium sulphate, a white gelatinous precipitate is formed. [1]

##

|!|ELA0418180030|!|

(a) Name FOUR substances which react with dilute sulphuric acid to form zinc sulphate.

(b) (i) Name THREE substances which react with dilute sulphuric acid to form sodium sulphate.

(ii) Explain why you would NOT use sodium in (b)(i).

(c) Name TWO naturally occurring salts.

[6M]

##

(a) Zinc, zinc oxide, zinc hydroxide, zinc carbonate [2]

(b) (i) Sodium hydroxide, sodium carbonate, sodium hydrogencarbonate [2]

(ii) The reaction between sodium and acid is explosive. [1]

(c) Sodium chloride, sodium nitrate (Other answers may be given.) [1]

##

|!|ELA0418180040|!|

For each of the following reactions,

(i) name the salt formed.

(ii) give a full equation for the reaction.

(iii) give an ionic equation for the reaction (if applicable).

(a) magnesium + dilute ethanoic acid

(b) aluminium oxide + dilute sulphuric acid

(c) calcium hydroxide solid + dilute nitric acid

(d) copper(II) carbonate + dilute hydrochloric acid

(e) sodium sulphate solution + lead(II) nitrate solution

(f) sodium + chlorine

[18M]

##

(a) magnesium ethanoate [1]

$Mg(s) + 2CH_3COOH(aq) \rightarrow (CH_3COO)_2Mg(aq) + H_2(g)$ [1]

$Mg(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + H_2(g)$ [1]

(b) aluminium sulphate [1]

$Al_2O_3(s) + 3H_2SO_4(aq) \rightarrow Al_2(SO_4)_3(aq) + 3H_2O(l)$ [1]

$Al_2O_3(s) + 6H^+(aq) \rightarrow 2Al^{3+}(aq) + 3H_2O(l)$ [1]

(c) calcium nitrate [1]

$Ca(OH)_2(s) + 2HNO_3(aq) \rightarrow Ca(NO_3)_2(aq) + 2H_2O(l)$ [1]

$Ca(OH)_2(s) + 2H^+(aq) \rightarrow Ca^{2+}(aq) + 2H_2O(l)$ [1]

(d) copper(II) chloride [1]

$CuCO_3(s) + 2HCl(aq) \rightarrow CuCl_2(aq) + CO_2(g) + H_2O(l)$ [1]

$CuCO_3(s) + 2H^+(aq) \rightarrow Cu^{2+}(aq) + CO_2(g) + H_2O(l)$ [1]

(e) lead(II) sulphate, sodium nitrate [1]

$Na_2SO_4(aq) + Pb(NO_3)_2(aq) \rightarrow PbSO_4(s) + 2NaNO_3$ (aq) [1]

$Pb^{2+}(aq) + SO_4^{2-}(aq) \rightarrow PbSO_4(s)$ [1]

(f) sodium chloride [1]

$2Na(s) + Cl_2(g) \rightarrow 2NaCl(s)$ [1]

No ionic equation can be written. [1]

##

|!|ELA0418180005O|!|

Write full equations to show how you would carry out the following preparations:

(a) zinc sulphate-7-water from zinc oxide

____

(b) potassium sulphate from potassium carbonate

____

(c) silver bromide from sodium bromide

____

(d) barium sulphate from barium carbonate

____

[4M]

##

(a) $ZnO(s) + H_2SO_4(aq) \rightarrow ZnSO_4(aq) + H_2O(l)$;
$ZnSO_4 + 7H_2O \rightarrow ZnSO_4 \cdot 7H_2O$ [1]
(b) $K_2CO_3(aq) + H_2SO_4(aq) \rightarrow K_2SO_4(aq) + CO_2(g) + H_2O(l)$ [1]
(c) $AgNO_3(aq) + NaBr(aq) \rightarrow AgBr(s) + NaNO_3(aq)$ [1]
(d) $BaCO_3(s) + 2HCl(aq) \rightarrow BaCl_2(aq) + CO_2(g) + H_2O(l)$
$BaCl_2(aq) + H_2SO_4(aq) \rightarrow BaSO_4(s) + 2HCl(aq)$ [1]
##

|!|ELA041818006O|!|
Suppose you are going to prepare copper(II) sulphate crystals in the laboratory from copper(II) oxide and sulphuric acid.
(a) List the apparatus you would need.

(b) Describe the method you would use.

[11M]
##
(a) Beaker, heat-resistant mat, Bunsen burner, tripod, wire gauze, spatula, glass rod, evaporating basin, filter funnel, filter paper, filter stand, plastic washbottle [6]
(b) Important points in the method are:
(i) Add excess copper(II) oxide to sulphuric acid. [1]
(ii) Filter to remove excess unreacted copper(II) oxide. [1]
(iii) Boil to concentrate the filtrate (tested with a glass rod). [1]
(iv) Cool the hot concentrated solution to obtain crystals. [1]
(v) Filter, wash and dry the crystals. [1]
##

|!|ELA041818007O|!|
The following passage describes the preparation of a sample of iron(II) sulphate-7-water, $FeSO_4 \cdot 7H_2O$. Read the passage carefully and then answer the following

questions.

Warm about 100 cm^3 of dilute sulphuric acid with an excess of iron filings in a conical flask. Allow the flask to stand until there is no further reaction and then filter. Collect the filtrate in an evaporating dish. Leave the solution to cool and crystallize. Filter off the crystals formed. Dry them between filter papers and store them in a stoppered bottle.

(a) Write down equations for the chemical reactions taking place.

(b) Why is excess iron filings used?

(c) How would you know when no further reaction was occurring?

(d) What is the purpose of the filtration?

(e) Why is the solution not evaporated by the steam bath before it is allowed to crystallize?

(f) Iron forms another well-known sulphate. Write down the formula of the salt.

(g) How would you distinguish between the two sulphates by a simple chemical test?

[9M]

##

(a) $Fe(s) + H_2SO_4(aq) \rightarrow FeSO_4(aq) + H_2(g)$ [1];
$FeSO_4 + 7H_2O \rightarrow FeSO_4 \bullet 7H_2O$ [1]

(b) To ensure that no acid is left; excess acid will contaminate the salt solution. [1]

(c) Evolution of gas bubbles (H_2) stops. [1]

(d) To remove excess iron. [1]

(e) On heating, some iron(II) sulphate will be oxidized by air to produce iron(III) sulphate. [1]

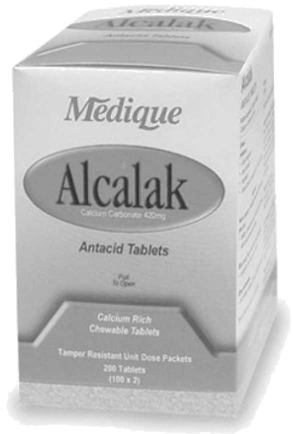
(f) $Fe_2(SO_4)_3$ [1]

(g) Addition of sodium hydroxide solution to their aqueous solutions to give gelatinous precipitates. Iron(II) hydroxide is dirty green, iron(III) hydroxide is reddish brown. [2]

##

Sections 18.4−18.5

|!|ELB041818008O|!|



The following information is found on the label of an antacid sold on the market.

Alcalak Antacid Tablets
Minty Flavour Melts in Your Mouth
Chewable relief for heartburn, sour stomach, acid indigestion and upset stomach.
Directions: The usual adult dose is one tablet to be taken three times a day. (Half for children aged under 11)
Active ingredient: 420 mg calcium carbonate per tablet. Contains no aluminium.
Cautions: Store in a cool and dry place. Protected from light and moisture.

(a) Explain, with an appropriate ionic equation, how the antacid can relieve a sour stomach.

(b) What is the daily limit (in grams) of calcium carbonate that can be taken by a child aged under 11?

(c) In some other antacid tablets, aluminium hydroxide is used as the active ingredient. State the advantage of using aluminium hydroxide.

(d) Suggest ONE reason why antacid tablets should not be exposed to light.

[6M]

##

(a) The antacid reacts and removes excess stomach acid. [1]

$CaCO_3(s) + 2H^+(aq) \rightarrow Ca^{2+}(aq) + H_2O(l) + CO_2(g)$ [1]

(b) Daily limit (in grams) of $CaCO_3$ for an adult

$= \frac{420}{1000} \times 3$ g

= 1.26 g [1]

Daily limit (in grams) of $CaCO_3$ for a child aged under 11

$= \frac{1.26}{2}$ g

= 0.63 g [1]

(c) Aluminium hydroxide neutralizes stomach acid without releasing carbon dioxide gas. [1]

(d) Light may cause chemical decomposition of the antacid tablets. [1]

##

|!|ELA0418180009O|!|

In a science project, Ann and her classmates followed their Biology teacher, Ms Tsui, to visit a farmland. They participated in the preparatory work required before seeding. Ann was assigned to help a farmer to monitor and control soil acidity. She was told that the desirable pH value for soil was within 6 − 7.

The farmer gave a bag of limestone powder to Ann and asked her to put some in a bucket. She was reminded that lumps of limestone should be grounded to powder form before use. Ann was instructed to spray water before applying the limestone powder on the soil. Water is used to activate the limestone reaction since limestone works slowly in dry soil.

(a) How could Ann check if the soil is acidic or not?

____

(b) What is the major chemical in limestone?

____

(c) Write an ionic equation for the limestone reaction.

____

(d) Why is water needed to activate the limestone reaction?

____

(e) Why is limestone used in powder form?

____

(f) Is solid slaked lime (calcium hydroxide) more desirable to be used to lower soil acidity when compared with limestone? Explain your answer.

____

[8M]

##

(a) She could immerse a sample of soil in a beaker of water and then test the resultant solution by pH paper. [2]
(b) Calcium carbonate [1]
(c) $CaCO_3(s) + 2H^+(aq) \rightarrow Ca^{2+}(aq) + H_2O(l) + CO_2(g)$ [1]
(d) Water is a necessary medium for the action of acids. [1]
(e) Powder limestone has a larger surface area in contact with the soil. [1]
(f) No. It is because calcium hydroxide is much more soluble in water than limestone. It is washed away quickly and hence not long lasting. [2]

##

|!|ELA0418180100|!|

Different plants need different pH values in the soil for their best growth.

Plant	**pH range for best growth**
Orchids	4.0–5.0
Oats	4.8–6.3
Azalea	5.0–6.0

Grass	5.5–6.5
Turnips	5.5–7.0
Rice	6.0–6.5
Cabbages	8.0–8.5
Potatoes	8.5–9.0

(a) Many vegetables prefer alkaline soils. Give two examples.

____

(b) What is the ideal pH range of soil for growing rice?

____

(c) In many areas, soil is acidic. Why?

____

(d) How can a farmer raise the pH value of an acidic soil in order to grow vegetables?

____

[5M]

##
(a) Cabbages and potatoes [1]
(b) 6.0–6.5 [1]
(c) This may be due to rotten vegetation, acid rain or use of acidic fertilizers. [2]
(d) He can add powdered limestone or slaked lime to neutralize acids in the soil. [1]
##

|!|ELA041818011O|!|
(a) Liquid waste from factories is often acidic. How can it be treated before disposal?

____

(b) Sometimes, industrial liquid waste is alkaline (e.g. from some dyeing factories). How can it be treated before disposal?

____

(c) Suppose you have spilt some acid from a car battery onto your kitchen table. Which substance from your kitchen cupboard would you use to neutralize the acid?

____

(d) Suppose a little concentrated sulphuric acid is spilt onto your hand while you are doing a chemistry experiment. What should you do?

____

(e) A weak base may be used in antacid tablets (e.g. $Mg(OH)_2$). Explain
(i) why aluminium oxide cannot be used.

___

(ii) why potassium hydroxide cannot be used.

___

[7M]

##

(a) Slaked lime or sodium carbonate can be added to the waste to neutralize the acid. [1]
(b) Sulphuric acid can be added to the waste to neutralize the alkali. [1]
(c) Washing soda (sodium carbonate crystals), or baking soda (sodium hydrogencarbonate) [1]
(d) Immediately wash the affected area with plenty of water. Then report to your teacher. [2]
(e) (i) Al_2O_3, being insoluble even in acidic solution, would not be effective. [1]
(ii) KOH, being corrosive, would damage the gut wall. [1]

##

|!|ELA0418180012O|!|

(a) Give chemical formulae of the following:
(i) Sodium hydroxide

___

(ii) Baking soda

___

(iii) Slaked lime

___

(iv) Limestone

___

(v) Common salt

___

(b) Which of the above substances are
(i) highly soluble electrolytes.

___

(ii) bases.

___

[7M]

##

(a) (i) NaOH [1]

(ii) $NaHCO_3$ [1]

(iii) $Ca(OH)_2$ [1]

(iv) $CaCO_3$ [1]

(v) NaCl [1]

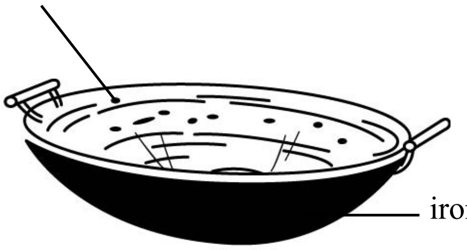
(b) (i) NaOH, $NaHCO_3$, NaCl [1]

(ii) NaOH, $Ca(OH)_2$ [1]

##

|!|ELA041818013O|!|

Some brown solid deposits are sometimes found on iron woks if the woks are not thoroughly dried after washing. These brown substances cannot be washed away with water but can be removed with vinegar.



(a) What are those brown deposits? Under what conditions are they formed?

(b) Write an equation to show how these brown deposits can be removed by vinegar.

(c) Name the type of reaction taking place in (b).

(d) With the help of an equation, explain why cooks usually do not use iron cooking utensils for cooking food with vinegar.

(e) Give the name and the formula of the salt formed when vinegar and baking powder (containing sodium hydrogencarbonate) are mixed.

[7M]

##

(a) Rust (hydrated iron(III) oxide). [1] It is formed from the oxidation of iron in the presence of water and air. [1]

(b) $Fe_2O_3(s) + 6CH_3COOH(aq) \rightarrow 2(CH_3COO)_3Fe(aq) + 3H_2O(l)$ [1]

(c) Neutralization [1]

(d) Iron dissolves slowly in vinegar (acidic solution). [1]

$Fe(s) + 2CH_3COOH(aq) \rightarrow (CH_3COO)_2Fe(aq) + H_2(g)$ [1]

(e) Sodium ethanoate, CH_3COONa [1]

##

|!|ELB0418180140|!|

Angela is helping her mother to purchase antacid tablets. In the supermarket, a shopkeeper recommends two popular brands of antacid to Angela. The information about the two antacids is tabulated as follows:

	Wilson-V	**Gastril**
Mass per tablet	500 mg	400 mg
Active ingredient (by weight)	90% $Mg(OH)_2$	40% $Mg(OH)_2$ 55% $Al(OH)_3$
Number of tablets per bottle	50	70
Price per bottle	\$30	\$35

(a) How many moles of hydroxide ion are there in one tablet of Wilson-V?

(b) What is the cost of Wilson-V tablets in terms of price per mole of hydroxide ions available?

(c) How many moles of hydroxide ion are there in one tablet of Gastril?

(d) What is the cost of Gastril tablets in terms of price per mole of hydroxide ions available?

(e) From the results above, decide which brand of antacid tablets is a better buy.

[14M]

##

(a) Mass of $Mg(OH)_2$ in one tablet of Wilson-V
= 500 mg × 90% = 450 mg [1]
Number of moles of $Mg(OH)_2$ in one tablet of Wilson-V

$$= \frac{\frac{450}{1000}}{(24.3+16.0\times2+1.0\times2)} \text{ mol}$$

$= 7.72 \times 10^{-3}$ mol [1]

Since each formula unit of $Mg(OH)_2$ has 2 hydroxide ions, number of moles of hydroxide ions in one tablet of Wilson-V

$= 7.72 \times 10^{-3} \times 2$ mol

= 0.0154 mol [1]

(b) Price per mole of hydroxide

$$= \frac{\frac{\$30}{50}}{0.0154} \text{ [1]}$$

= \$38.87 per mole [1]

(c) Mass of $Mg(OH)_2$ in one tablet of Gastril

= 400 × 40% = 160 mg [1]

Number of moles of $Mg(OH)_2$ in one tablet of Gastril

$$= \frac{\frac{160}{1000}}{(24.3+16.0\times2+1.0\times2)} \text{ mol}$$

$= 2.74 \times 10^{-3}$ mol [1]

Mass of $Al(OH)_3$ in one tablet of Gastril

= 400 mg × 55% = 220 mg [1]

Number of moles of $Al(OH)_3$ in one tablet of Gastril

$$= \frac{\frac{220}{1000}}{(27.0+16.0\times3+1.0\times3)} \text{ mol}$$

$= 2.82 \times 10^{-3}$ mol [1]

Since each formula unit of $Mg(OH)_2$ has 2 hydroxide ions, and each formula unit of $Al(OH)_3$ has 3 hydroxide ions, number of moles of hydroxide ions in one tablet of Gastril

$= 2.74 \times 10^{-3} \times 2 + 2.82 \times 10^{-3} \times 3$ [1]

= 0.0140 mol [1]

(d) Price per mole of hydroxide ions in Gastril tablets

$$= \frac{\frac{\$35}{70}}{0.0140} \text{ [1]}$$

= \$35.84 per mole [1]

(e) Since the price per mole of hydroxide ions is lower for Gastril tablets, the bottle of Gastril tablets is a better buy. [1]

##