Chemistry: Chapter 14 Introduction to acids and alkalis

Combined Science (Chemistry Part): Chapter 14 Introduction to acids and alkalis

Section 14.1

|!|ELB041414001O|!|

Peter is suffering from stomach disorder and the doctor reminds him not to eat any acidic food or drink. He has then joined his mother in a Chinese restaurant and his mother has already ordered some food.

| Chinese dishes | Drinks | Fruits |
|---|---|---|
| Steamed chicken | Tea | Oranges |
| Sweet & sour pork | Cream soda | Pineapples |
| Crab ball with vinegar | Boiled water | |

(a) Identify those acidic food or drinks and state the acid that is probably contained in each of them.

(b) Categorize those acids in part (a) as organic or inorganic acids.

[6M]

##

**(a)**

| Acidic food or drinks | Acid contained |
|---|---|
| Sweet & sour pork, Crab ball with vinegar | Ethanoic acid |
| Tea | Tannic acid |
| Cream soda | Carbonic acid |
| Oranges, Pineapples | Citric acid |

[4]

(b) Organic acid : ethanoic acid, tannic acid, citric acid [1]

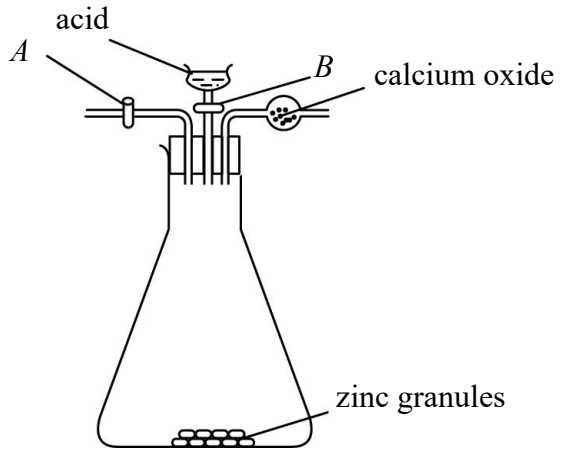
Inorganic acid : carbonic acid [1]

##

Section 14.2

|!|ELB041414002O|!|

The apparatus shown in the diagram below is used to measure the mass of hydrogen gas released when an excess of acid reacts with a known mass of zinc granules.




The apparatus is weighed when it is empty and when it contains zinc granules. Excess acid is put into the tap funnel and the apparatus is weighed again. Tap *B* is opened to add all the acid to the zinc granules. When the reaction is complete, a slow stream of dry air is blown through Tap *A*. The apparatus is then weighed again.

(a) (i) What information can be deduced from the first two weightings?

_____

(ii) Should Tap *A* and Tap *B* be kept open or closed as the reaction takes place?

_____

(iii) Why dry air has to blow through the apparatus?

_____

(iv) What observation indicates the completion of the reaction?

_____

(v) Suggest ONE reason for including the tube of calcium oxide in the apparatus?

_____

(b) Give ONE type of reaction, other than that of an acid on a metal, which leads to the formation of hydrogen gas. Write an equation for the reaction.

_____

[7M]

##

(a) (i) The mass of zinc granules. [1]

(ii) The taps should be kept close to prevent hydrogen gas from escaping through these taps. [1]

(iii) This is to ensure that there is the same amount of air in the flask before and after the experiment. [1]

(iv) All the zinc granules have dissolved and no effervescence. [1]

(v) To absorb any water vapour in the hydrogen gas. [1]

(b) Reaction between alkali metals and water. [1]

E.g. $2Na(s) + 2H_2O(l) \rightarrow 2NaOH(aq) + H_2(g)$ [1]

##

|!|ELA041414003O|!|

For each of the following reactions (if any), write down

(i) a full equation for the reaction.

(ii) an ionic equation for the reaction.

(a) iron + dilute sulphuric acid

_____

(b) copper + dilute sulphuric acid

_____

(c) zinc oxide + dilute hydrochloric acid

_____

(d) solid calcium carbonate + dilute hydrochloric acid

_____

[8M]

##

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

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

(b) No reaction [2]

(c) $ZnO(s) + 2HCl(aq) \rightarrow ZnCl_2(aq) + H_2O(l)$ [1]

$ZnO(s) + 2H^+(aq) \rightarrow Zn^{2+}(aq) + H_2O(l)$ [1]

(d) $CaCO_3(s) + 2HCl(aq) \rightarrow CaCl_2(aq) + CO_2(g) + H_2O(l)$ [1]

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

##

Section 14.3

|!|ELA041414004O|!|

*X* and *Y* are solutions of hydrogen chloride in water and methylbenzene respectively.

(a) Which of the two solutions contains ions?

_____

(b) What are these ions?

_____

(c) Which of the solutions contains molecules of hydrogen chloride?

_____

(d) When lumps of calcium carbonate are added to solution *Y*, the lumps sink to the bottom and there are no signs of reaction. If water is then added, this also sinks to the bottom and carbon dioxide gas begins to bubble off. Explain the observations.

_____

[6M]

##

(a) *X* [1]

(b) $H^+(aq)$, $Cl^-(aq)$ [1]

(c) *Y* [1]

(d) Calcium carbonate and water, having a higher density than methylbenzene, sink to the bottom. Hydrogen chloride in *Y* reacts with water added to form $H^+(aq)$ and $Cl^-$ (aq), i.e. hydrochloric acid. It is the $H^+(aq)$ which reacts with calcium carbonate to liberate carbon dioxide. [3]

##

Section 14.4

|!|ELA041414005O|!|

(a) Baking powder is either sodium hydrogencarbonate or a mixture of sodium hydrogencarbonate and a solid acid. In making cakes, water and a little baking powder is added to flour. The flour paste is then heated in an oven.


(i) Sodium hydrogencarbonate decomposes on heating to give carbon dioxide gas. Write an equation for the change.

(ii) Carbon dioxide may also be liberated by the reaction between sodium hydrogencarbonate and $H^+(aq)$. Write an ionic equation for the change.

(iii) What is the function of the carbon dioxide formed?

(b) 'Fizzy drink' tablets contain a solid acid and sodium hydrogencarbonate. There is effervescence when the tablets are dissolved in water.


Write an ionic equation for the change.

(c) Oven cleaner usually contains solid sodium hydroxide and powdered stone. The sodium hydroxide 'dissolves' grease, which can then be easily washed away. How does the powdered stone help in cleaning?

[5M]

##

(a) (i) $2NaHCO_3(s) \xrightarrow{\text{heat}} Na_2CO_3(s) + CO_2(g) + H_2O(l)$ [1]

(ii) $NaHCO_3(s) + H^+(aq) \rightarrow Na^+(aq) + CO_2(g) + H_2O(l)$ [1]

OR $HCO_3^-(aq) + H^+(aq) \rightarrow CO_2(g) + H_2O(l)$ [1]

(iii) The carbon dioxide formed makes the cakes more 'spongy'. [1]

(b) $H^+(aq) + HCO_3^-(aq) \rightarrow CO_2(g) + H_2O(l)$ [1]

(c) The powdered stone is abrasive: it rubs dirt away. [1]

##

|!|ELA041414006O|!|

Traditional baking powder was composed of a mixture of tartaric acid and bicarbonate of soda (sodium hydrogencarbonate). In making cakes, water and a little baking powder are added to flour. When dissolved in water, the acid and hydrogencarbonate react and liberate carbon dioxide gas. When the bicarbonate of soda is strongly heated, carbon dioxide gas would also be produced which expands, producing bubbles to leaven the mixture.

The percentage by mass of sodium hydrogencarbonate in baking powder can be found by the following steps:

Step 1: Add excess dilute sulphuric acid to 2.00 g of baking powder.

Step 2: Collect the carbon dioxide evolved by a gas syringe.

Step 3: Weigh the carbon dioxide gas collected.

(a) Why should the baking powder be kept in a dry place?

(b) Sodium hydrogencarbonate decomposes to give sodium carbonate, carbon dioxide and water. Write a chemical equation for the decomposition.

(c) (i) Write a chemical equation for the reaction between dilute sulphuric acid and sodium hydrogencarbonate.

(ii) Explain why dilute sulphuric acid added should be in excess.

(iii) If the mass of carbon dioxide collected is 0.64 g, calculate the percentage by mass of sodium hydrogencarbonate in the baking powder.

[8M]

##

(a) When tartaric acid dissolves in water, hydrogen ions would be formed and they react with sodium hydrogencarbonate in baking powder to give carbon dioxide gas. [1]

(b) $2NaHCO_3(s) \rightarrow Na_2CO_3(s) + CO_2(g) + H_2O(l)$ [1]

(c) (i) $H_2SO_4(aq) + 2NaHCO_3(aq) \rightarrow Na_2SO_4(aq) + 2CO_2(g) + 2H_2O(l)$ [1]

(ii) It is to ensure all sodium hydrogencarbonate has completely reacted with the dilute acid. [1]

(iii) $H_2SO_4(aq) + 2NaHCO_3(aq) \rightarrow Na_2SO_4(aq) + 2CO_2(g) + 2H_2O(l)$

Number of moles of carbon dioxide formed = $\frac{0.64}{44.0}$ mol = 0.015 mol [1]

From the equation, mole ratio of $CO_2$ : $NaHCO_3$ = 1 : 1

Number of moles of sodium hydrogencarbonate in baking powder

= 0.015 mol [1]

Mass of sodium hydrogencarbonate in baking powder

= 0.015 × (23.0 + 1.0 + 12.0 + 16.0 × 3) g = 1.26 g [1]

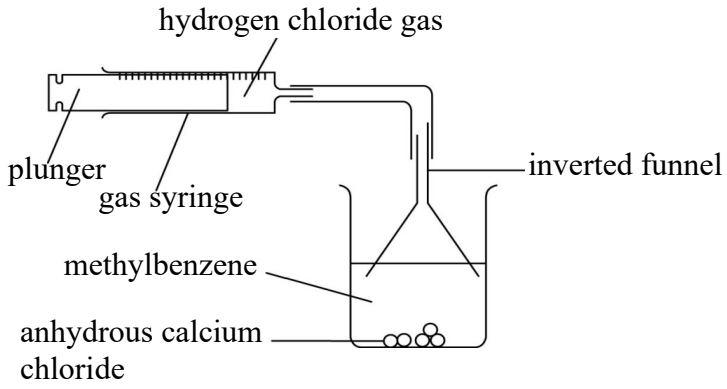
Percentage by mass of sodium hydrogencarbonate in baking powder

= $\frac{1.26}{2.00}$ × 100% = 63.0% [1]

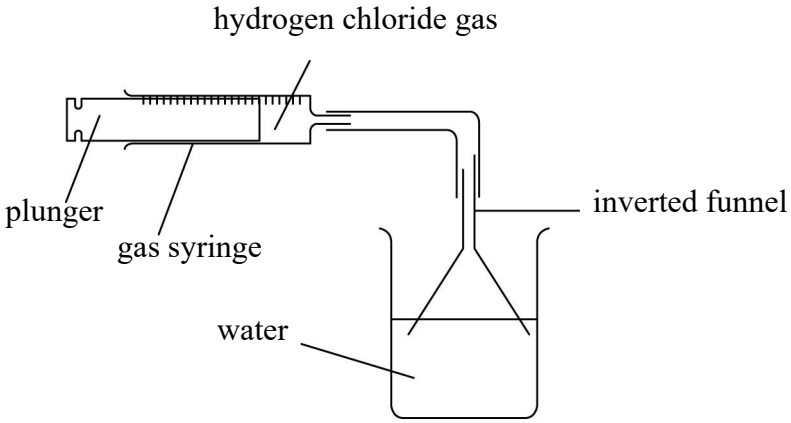
##

|!|ELA041414007O|!|

The following set-ups are to dissolve hydrogen chloride gas in methylbenzene and water respectively.




**Set-up *A***




**Set-up *B***

The properties of the solutions in set-ups *A* and *B* are shown in the following table:

| **Test** | **Hydrogen chloride in methylbenzene (Set-up *A*)** | **Hydrogen chloride in water (Set-up *B*)** |
|---|---|---|
| Electrical conductivity | Poor | Good |
| Action on calcium carbonate | No observable change | Colourless gas bubbles evolved |
| Effect on dry blue litmus paper | ? | ? |

(a) State the function of anhydrous calcium chloride in methylbenzene.

(b) (i) Write a chemical equation for the reaction between calcium carbonate and

the solution in set-up *B*.

(ii) Explain the difference in observations when solid calcium carbonate is added to the solutions formed in above set-ups.

(c) What is/ are the function(s) of the inverted funnel?

(d) Describe what would be observed if dry blue litmus paper is dipped into
(i) hydrogen chloride in methylbenzene.

(ii) hydrogen chloride in water.

[10M]

##

(a) It is a drying agent. It keeps methylbenzene dry and make sure there is no water in methylbenzene. [1]

(b) (i) $2HCl(aq) + CaCO_3(s) \rightarrow CaCl_2(aq) + H_2O(l) + CO_2(g)$ [1]

(ii) In set-up *A*, hydrogen chloride molecules do not ionize to give hydrogen ion, $H^+(aq)$. [1] There is no reaction between hydrogen chloride and calcium carbonate. [1]
In set-up *B*. Hydrogen chloride dissolves in water to give hydrogen ion, $H^+(aq)$, [1] which reacts with calcium carbonate to give carbon dioxide. [1]

(c) To increase surface area for absorption. [1] To prevent sucking back. [1]

(d) (i) There is no observable change. [1]

(ii) It turns blue litmus paper red. [1]

##

Sections 14.5−14.7

|!|ELA041414008O|!|

Sodium hydroxide and calcium hydroxide are common alkalis.

(a) Suggest ONE chemical test which shows that both solutions contain hydroxide

ions. Write an ionic equation for the reaction involved.

(b) Suggest ONE chemical test to distinguish sodium hydroxide solution and calcium hydroxide solution.

(c) Sodium hydroxide is a common alkali, however, it is not used to neutralize excess acid in stomach. Explain briefly.

(d) Suggest ONE suitable chemical for neutralizing the acid in stomach.

(e) Suggest ONE common use of
(i) sodium hydroxide.

(ii) calcium hydroxide.

[9M]

##

(a) Warm the sodium hydroxide solution/ calcium hydroxide solution with the ammonium chloride solution. [1]
They liberate ammonia gas that turns moist red litmus paper blue. [1]
$NH_4^+(aq) + OH^-(aq) \rightarrow NH_3(g) + H_2O(l)$ [1]

(b) Bubble carbon dioxide into the two solutions. [1]
Only calcium hydroxide solution will form a white suspension with carbon dioxide. [1]

(c) Sodium hydroxide solution is corrosive. [1]

(d) Magnesium hydroxide/ aluminium hydroxide [1]

(e) (i) Drain cleaners/ oven cleaners [1]
(ii) Limewater removes sulphur dioxide in flue gases inside scrubber. [1]

##

|!|ELB041414009O|!|

(a) A sodium hydroxide solution has been exposed to air for a long time. When

dilute hydrochloric acid is added to it, colourless gas bubbles are given out. Explain the observation with the help of equations.

(b) For each of the following reactions, write down

(I) the names of the products formed.

(II) a full equation for the reaction.

(III) an ionic equation for the reaction.

(i) dilute sulphuric acid + excess sodium hydroxide solution

(ii) ammonium sulphate solution + sodium hydroxide solution

[8M]

##

(a) Sodium hydroxide solution absorbs carbon dioxide gas from air to form sodium carbonate:

$2NaOH(aq) + CO_2(g) \rightarrow Na_2CO_3(aq) + H_2O(l)$ [1]

The sodium carbonate formed reacts with dilute hydrochloric acid to give colourless bubbles of carbon dioxide gas:

$Na_2CO_3(aq) + 2HCl(aq) \rightarrow 2NaCl(aq) + CO_2(g) + H_2O(l)$ [1]

(b) (i) (I) Sodium sulphate, water [1]

(II) $H_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$ [1]

(III) $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$ [1]

(ii) (I) Sodium sulphate, ammonia, water [1]

(II) $(NH_4)_2SO_4(aq) + 2NaOH(aq) \rightarrow Na_2SO_4(aq) + 2NH_3(g) + 2H_2O(l)$ [1]

(III) $2NH_4^+(aq) + 2OH^-(aq) \rightarrow 2NH_3(g) + H_2O(l)$ [1]

##

Sections 14.8−14.9

|!|ELA041414010O|!|

Name an acid which is

(a) found in our stomach.

_____

(b) found in citrus fruits (e.g. orange).

_____

(c) a gas when pure.

_____

(d) tribasic.

_____

(e) a strong oxidizing agent no matter dilute or concentrated.

_____

[5M]

##

(a) Hydrochloric acid [1]
(b) Citric acid [1]
(c) Hydrochloric acid [1]
(d) Phosphoric acid [1]
(e) Nitric acid [1]

##

|!|ELA041414011O|!|

In school laboratories, chemical wastes such as concentrated acids (e.g. nitric acid $HNO_3(aq)$) produced during practical work are to be stored in special labelled containers. They are then collected and sent to Tsing Yi Chemical Treatment Centre (CWTC) for proper treatment.

(a) Explain why concentrated nitric acid should NOT be poured into the sink in the laboratory.

_____

(b) Explain why concentrated nitric acid should be stored in containers made of plastics instead of metals.

[3M]

##

(a) If concentrated nitric acid is poured into the sink, they may react with the pipes in the wastewater system, causing damage. [1] Besides, it will eventually be discharged into the sea. This would cause serious water pollution. [1]

(b) Concentrated nitric acids would react with metals but NOT with plastics. [1]

##

|!|ELA041414012O|!|

(a) What acid is present in the stomach?

(b) Explain why hydrogen chloride gas appears steamy in moist air.

(c) Is it possible to obtain pure
   (i) carbonic acid.
   (ii) sulphurous acid.
   by evaporating the corresponding aqueous solution? Explain.

(b) The chemical name of aspirin is acetylsalicylic acid. It is an organic acid, soluble in hot water.
   (i) How would you expect an aqueous solution of aspirin to affect the colour of litmus paper?

   (ii) What would you expect to see when baking soda (sodium hydrogencarbonate) is added to an aqueous solution of aspirin?

[6M]

##

(a) Hydrochloric acid [1]

(b) Hydrogen chloride is extremely soluble in water. Thus it fumes in moist air, forming a mist of hydrochloric acid droplets. [1]

(c) No. Pure carbonic acid and sulphurous acid do not exist. On warming, carbon

dioxide and sulphur dioxide are driven out respectively. [2]

(d) (i) It turns blue litmus paper red. [1]

(ii) Effervescence occurs. [1]

##

|!|ELA041414013O|!|

Below is part of a label on a bottle of solid drain cleaner:

**Active Ingredient: Caustic Soda**

Instructions:

1. Put the cleaner into the drain. (Avoid contact with skin)
2. Add two equivalents of water into the drain. (Beware of any irritating fume evolved.)
3. Leave the cleaner solution in the drain for five minutes.
4. Rinse the drain with plenty of water for several minutes.

John is asked to follow the instructions and try to remove any clog in the drain.

(a) Suggest THREE safety precautions John should take when using the solid cleaner.

_____

(b) What is the chemical name of caustic soda?

_____

(c) Suggest what John can do if some cleaner solution is spilled onto his skin.

_____

(d) John knows that glass cleaners are also alkaline in nature. Do you suggest John to use the drain cleaner for glass-cleaning? Explain your answer.

_____

[6M]

##

(a) John should wear plastic gloves, eye goggles and face mask. [3]

(b) Sodium hydroxide [1]

(c) Use a large amount of water to rinse the part of the skin which is in contact with the cleaner solution. [1]

(d) No. Sodium hydroxide solution attacks glass. [1]

##