4N Acids & Bases Clinic

Name:…… **Date: 6 September 2024**

Reactions involving acids

1 Sodium carbonate reacts with dilute hydrochloric acid at room temperature.
The reactants are $Na_2CO_3(s)$ and $HCl(aq)$.
What are the products formed and their state symbols?

A $Na(s) + H_2O(g) + Cl_2(g) + CO_2(g)$
B $NaCl(aq) + H_2(g) + HCO_3(g)$
C $NaCl(aq) + H_2O(l) + CO_2(g)$
D $Na_2Cl(aq) + HCO_3(aq)$

(C)
[S20/3/7]

2 An incomplete word equation is given.

dilute sulfuric acid + metal ⟶ salt + Q

What is Q?

A hydrogen
B oxygen
C sulfur dioxide
D water

(A)
[S16/3/8]

3 What is missing from the equation below?

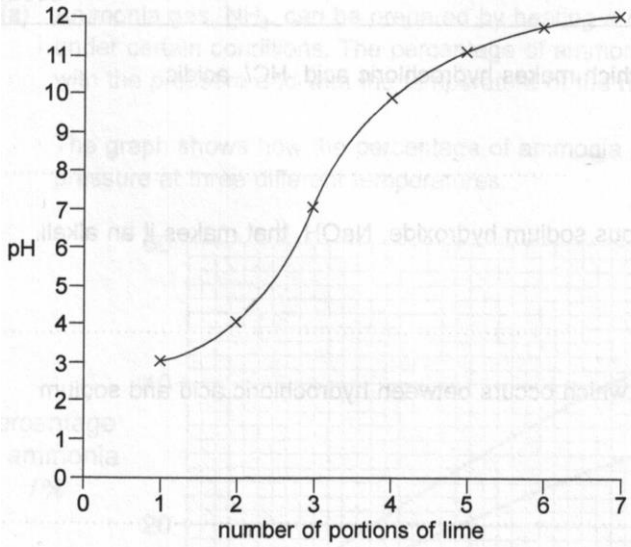
acid + alkali → salt + ...

A carbon dioxide
B hydrogen
C oxygen
D water

(D)
[S13/3/8]

pH scale

4 In an experiment, equal portions of lime are added to **20 cm³** of vinegar.
The graph shows the pH of the vinegar after each portion is added.



How many portions of lime are required to neutralize **40 cm³** of vinegar?

A 3 **B** 6 **C** 8 **D** 14

(B)
[S14/3/9]

5 Soil in a garden has a pH of 6.5.
The pH of the soil is changed by adding calcium hydroxide.
Which plant needs calcium hydroxide to be added to the soil for the plant to grow well?

	plant	pH for optimum growth
A	apple	6.0
B	blackcurrant	7.5
C	potato	5.5
D	strawberry	6.5

(B)
[S15/3/9]

6 A garden has soil with a pH of 6.5. Cabbages grow best in soils with a pH of 7.5. The cabbages grow better when calcium hydroxide is added to the soil in the garden. Which row is correct?

	the soil in the garden is	cabbages grow best in soil that is	calcium hydroxide is
A	weakly acidic	strongly alkaline	alkaline
B	weakly acidic	weakly alkaline	alkaline
C	weakly alkaline	strongly acidic	acidic
D	weakly alkaline	weakly acidic	acidic

(B)
[S16/3/9]

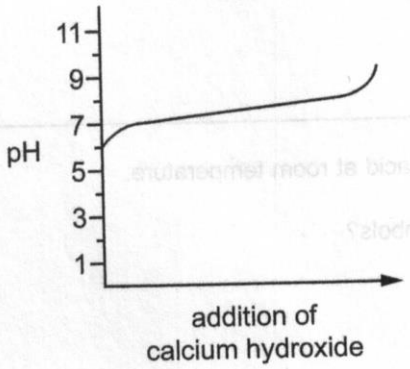
7 Sodium bicarbonate is dissolved in water.
Universal Indicator is added and the colour of the solution is compared to a pH colour chart.
The solution has a pH of 9.
Which statement best describes sodium bicarbonate?

A It is a strong acid.
B It is a strong alkali.
C It is a weak acid.
D It is a weak alkali.

(**D**)
[S17/3/8]

8 Calcium hydroxide is added slowly to acidic soil to reduce the acidity.
The pH of samples of the soil are measured using Universal Indicator.
Which graph shows the change in pH as calcium hydroxide is added to the soil?

A



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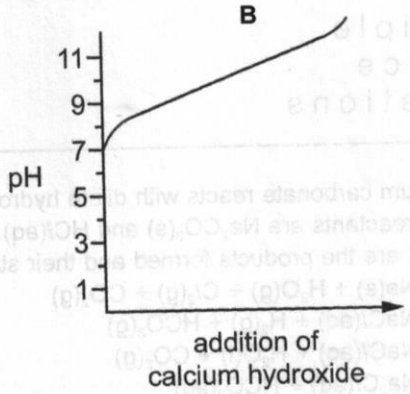

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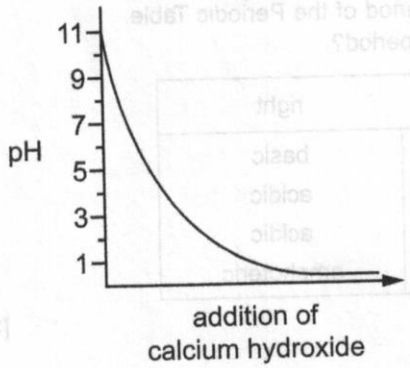

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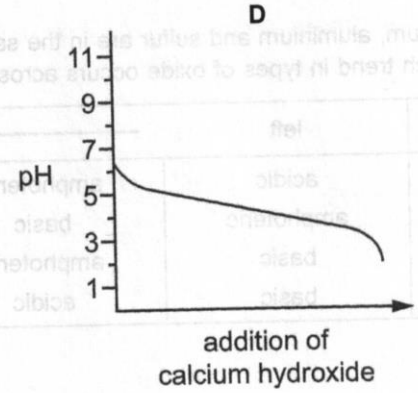


(**A**)
[S20/3/9]

Types of Oxides

9 Element X forms a basic oxide.
What is X?

A a halogen
B a metal
C an acid
D a non-metal

(**B**)
[S13/3/9]

10 When aluminium, carbon and magnesium burn in oxygen, oxides are formed.
Which row identifies the type of oxide that is formed by each one of them?

	aluminium oxide	carbon dioxide	magnesium oxide
A	acidic	basic	amphoteric
B	amphoteric	acidic	basic
C	amphoteric	basic	acidic
D	basic	acidic	amphoteric

(**B**)
[S14/3/8]

11 An oxide of element X dissolves in water to form a solution of pH 5.
Which row is correct for element X?

	type of element	type of oxide
A	metallic	acidic
B	metallic	basic
C	non-metallic	acidic
D	non-metallic	basic

(**C**)
[S15/3/8]

12 The elements, aluminium, sodium and sulfur, are in Period 3 of the Periodic Table.
Which row classifies the oxides of these elements?

	aluminium oxide Al_2O_3	sodium oxide Na_2O	sulfur dioxide SO_2
A	amphoteric	acidic	basic
B	amphoteric	basic	acidic
C	basic	acidic	acidic
D	basic	basic	amphoteric

(**B**)
[S18/3/8]

13 The table shows the reactions of some oxides.

oxide	reaction with hydrochloric acid	reaction with sodium hydroxide
W	salt formed	salt formed
X	salt formed	no reaction
Y	no reaction	salt formed

Which row shows the type of oxides W, X and Y are?

	acidic	amphoteric	basic
A	X	W	Y
B	Y	W	X
C	Y	X	W
D	W	X	Y

(**B**)
[S19/3/8]

14 (a) Write the formula for the ion which makes hydrochloric acid, HCl, acidic.

H^+ [1]

(b) Name the ion present in aqueous sodium hydroxide, NaOH, that makes it an alkali.

Hydroxide [1]

(c) (i) Name the type of reaction which occurs between hydrochloric acid and sodium hydroxide.

Neutralisation [1]

(ii) Name the salt produced in this reaction.

Sodium chloride [1]

(iii) Write the chemical equation for this reaction.

$HCl + NaOH \rightarrow NaCl + H_2O$ [1]

15 Indigestion is caused by having too much hydrochloric acid, HCl, in the stomach.
Tablets called antacids are used to treat indigestion.
One of the chemicals used as an antacid is magnesium hydroxide, $Mg(OH)_2$.

(a) Write a balanced chemical equation to show the reaction between hydrochloric acid and magnesium hydroxide.

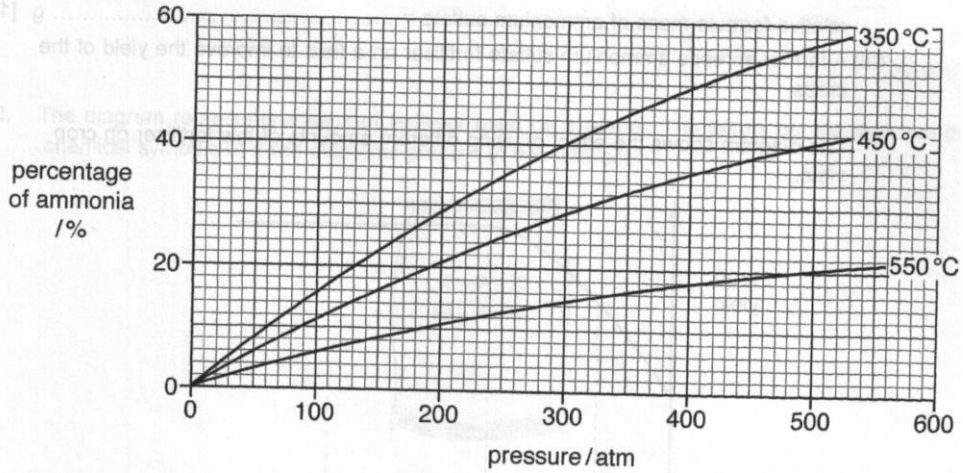
$2HCl + Mg(OH)_2 \rightarrow MgCl_2 + 2\ H_2O$ [2]

(b) What name is given to this type of reaction?

Neutralisation [1]

16 Ammonia gas, NH_3, can be prepared by heating a mixture of hydrogen and nitrogen under certain conditions. The percentage of ammonia gas present in the mixture varies with the pressure and with the temperature of the mixture.

The graph shows how the percentage of ammonia present in the mixture varies with pressure at three different temperatures.



(i) Use the graph to determine the percentage of ammonia present in the mixture at 350 °C and 200 atm.

percentage of ammonia ..... 29 ..... % [1]

(ii) Use the graph to deduce how the percentage of ammonia present in the mixture changes when the temperature is increased but the pressure remains constant.

As temperature increased, the percentage of ammonia decreased. [1]

(b) Much of the ammonia produced industrially is used to make ammonium sulfate, an important fertiliser.

When dissolved in water, the formula of ammonium sulfate may be written as $(NH_4)_2SO_4$ (aq).

(i) State the meaning of the symbol (aq).

aqueous [1]

(ii) Calculate the relative formula mass of ammonium sulfate.

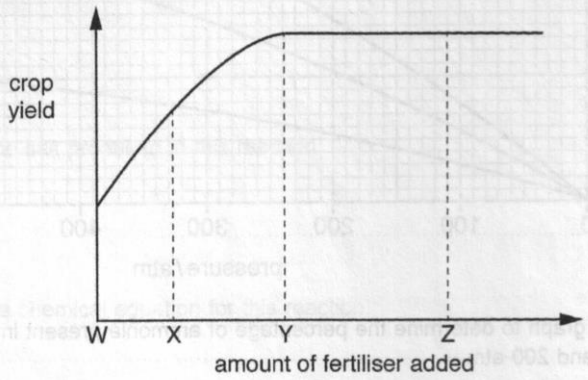
[relative atomic masses, A_r: N, 14; H, 1; S, 32; O, 16]

Mr of $(NH_4)_2SO_4$ = 2[14+4(1)] + 32 + 4(16)
= **132**

relative formula mass of ammonium sulfate = ... g [1]

(iii) A farmer spreads ammonium sulfate fertiliser on a field to improve the yield of the crops.

The diagram shows the effect of using different amounts of this fertiliser on crop yield.



The farmer wants to obtain the highest yield of crop using the least amount of fertiliser.

Which amount, W, X, Y or Z, should the farmer use?

Y

..... [1]

(iv) Another farmer spreads a field with calcium hydroxide.

What is this farmer controlling by the addition of calcium hydroxide to the field?

Controlling / reducing the acidity of soil

..... [1]

(v) On the farm, ammonium sulfate and calcium hydroxide are stored separately.

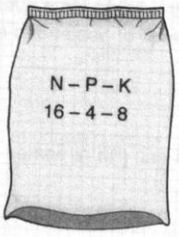
Explain, in terms of the chemistry involved, what would happen if they were allowed to mix.

They will react to form **calcium sulfate, ammonia and water**. [1]

This will make both fertiliser and calcium hydroxide **ineffective** [1]

..... [2]

17 The diagram represents a sack of fertiliser used by a farmer. The letters on the sack are the chemical symbols of three elements present in this fertiliser.



(a) Name all the three elements present in the fertiliser.

Nitrogen, phosphorus, potassium [1]

.....[1]

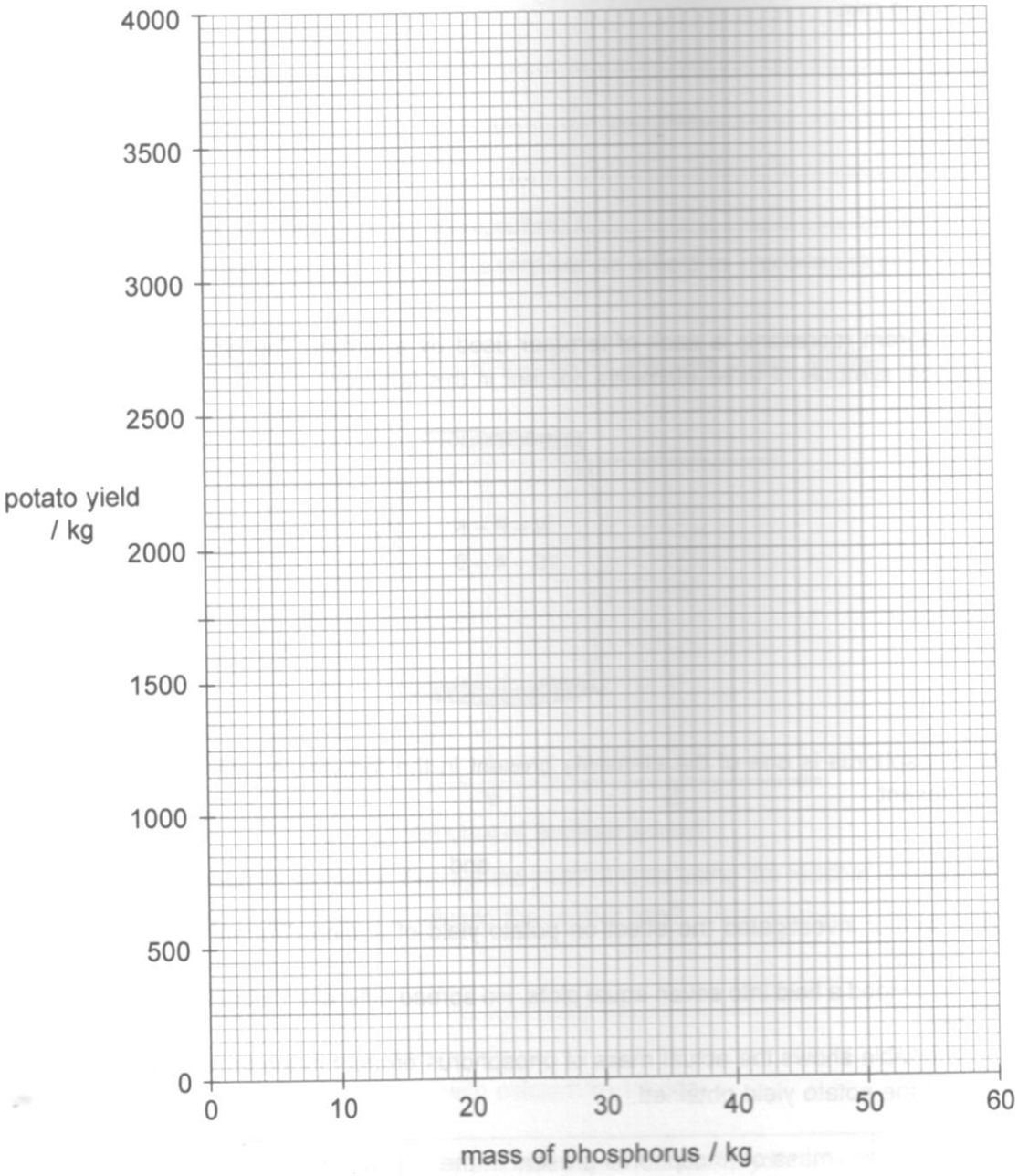
(b) A farmer investigated the effect on potato yield of adding different amounts of fertiliser to the soil.

He divided a field into seven equal plots. He spread different masses of fertiliser across each plot.

The table shows the actual mass of phosphorus present in the fertiliser added to each plot and the potato yield obtained.

plot	mass of phosphorus present in the fertiliser added to the plot / kg	potato yield from the plot / kg
1	0	1300
2	10	2600
3	20	3100
4	30	3400
5	35	3450
6	45	3500
7	55	3500

(i) Plot a graph of these results, marking each point with a cross (x).
Draw a best-fit curve taking into account all the plotted points.

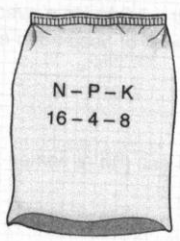


[2]

(ii) Using your graph, give one reason why the farmer decided to add 30 kg of phosphorus to each plot in future years.

30 kg of phosphorus gives ideal maximum potato yield. Increasing mass of phosphorus further will not increase the yield as much.

[1]



(c) The number under each letter on the sack shows the percentage by mass of that element present in the fertiliser.
Each bag contains 50 kg of fertiliser.
Calculate the total number of bags the farmer would have to use to provide one plot with 30 kg of phosphorus.

Mass of phosphorus in each bag = 4% x 50 kg = 2 kg

No. of bags = 30 kg / 2 kg = **15 bags**

number of bags = ... [2]

(d) The farmer has another field in which he plans to grow cabbages. The soil in the field has a pH of 5.5.
Cabbages require the soil to have a pH of 6.5 if they are to grow well.

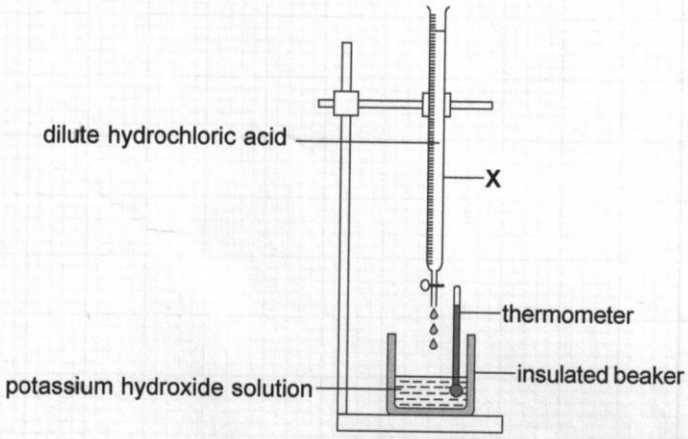
(i) Name the chemical that is often used to spread over fields to raise the pH of the soil.

Calcium hydroxide
..... [1]

(ii) Explain how the chemical named in **d(i)** can bring about this change in pH.

Calcium hydroxide is **alkaline / basic and will neturalise the acid** in soil.
.....
.....
..... [1]

18 The diagram shows the apparatus used to titrate solutions of hydrochloric acid and potassium hydroxide.



(a) Name the piece of apparatus **X**.

burette ..... [1]

(b) 20.0 cm^3 of potassium hydroxide solution is transferred to an insulated beaker. The temperature of this solution is measured and recorded.

A 2.0 cm^3 portion of dilute hydrochloric acid is run into the beaker. The mixture is stirred and the highest temperature reached is measured and recorded.

Seven further 2.0 cm^3 portions of hydrochloric acid are added. Each time the mixture is stirred and the temperature is measured and recorded.

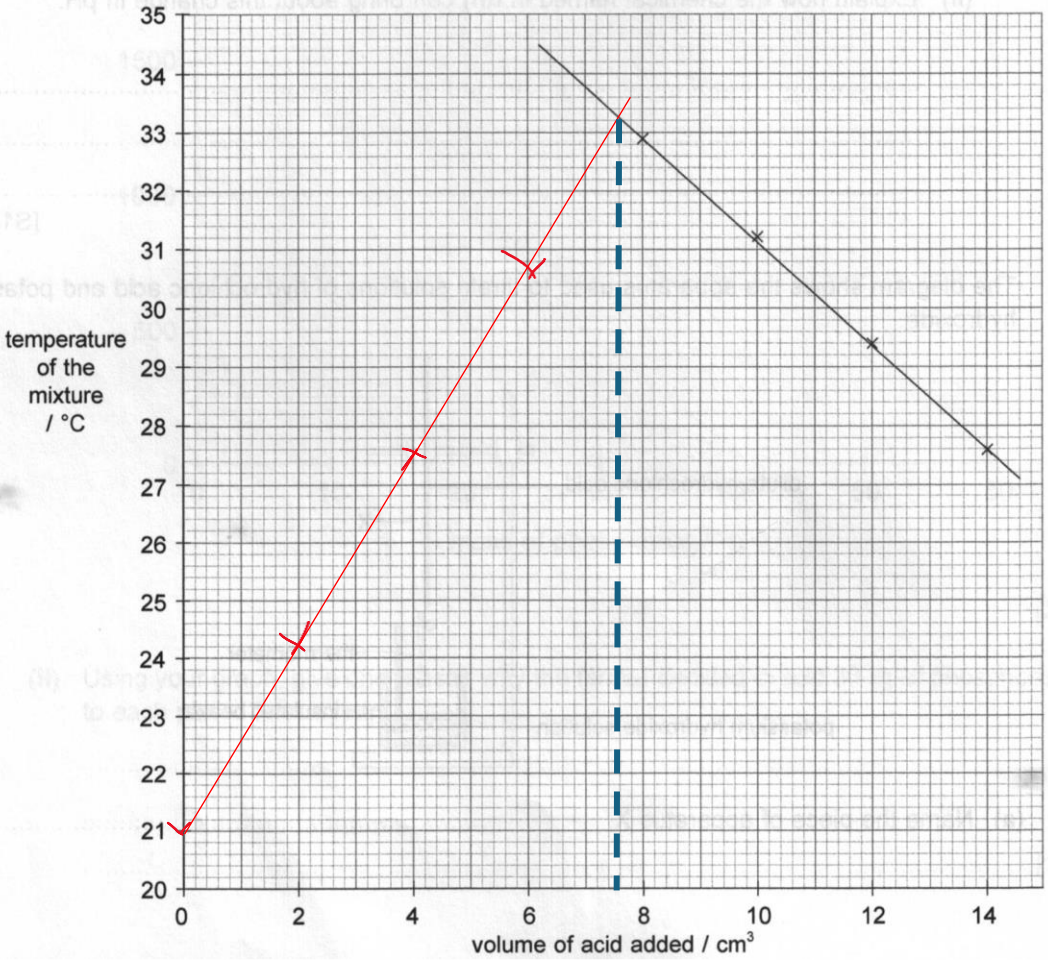
The results for this experiment are shown in the table.

volume of acid added / cm^3	0.0	2.0	4.0	6.0	8.0	10.0	12.0	14.0
temperature of the mixture / °C	21.0	24.2	27.4	30.7	32.9	31.2	29.4	27.6

Four points have been plotted on the grid (on the next page) and a best-fit line has been drawn.

(i) On the grid, plot the remaining four points. Mark each point with a cross (×). [1]

(ii) Draw a best-fit line for these four points. Extend this line to intersect (cross) the line already drawn. [1]



(c) The acid and the alkali exactly neutralise each other at the point where the two graph lines intersect (cross).

(i) From your graph, determine the volume of hydrochloric acid required to exactly neutralise the potassium hydroxide solution.

volume = 7.6 cm^3 [1]

(ii) Using values from your graph, calculate the **rise** in temperature which occurred when the hydrochloric acid exactly neutralised the potassium hydroxide solution.

temperature rise = 33.2 – 21 = **12.2** °C [1]

(iii) Write an ionic equation to show what is meant by the term *neutralisation*.

$H^+ + OH^- \rightarrow H_2O$ [1]

(d) When excess hydrochloric acid is added to potassium hydroxide, the solution changes from alkaline to acidic.

Samples of the solution are taken before and after the addition of excess hydrochloric acid.

Describe a test, that could be carried out on each sample, to show that the solution had changed from alkaline to acidic.

test Add a few drop of Universal Indicator

observation before Indicator was violet / purple

observation after Indicator became red

[2]

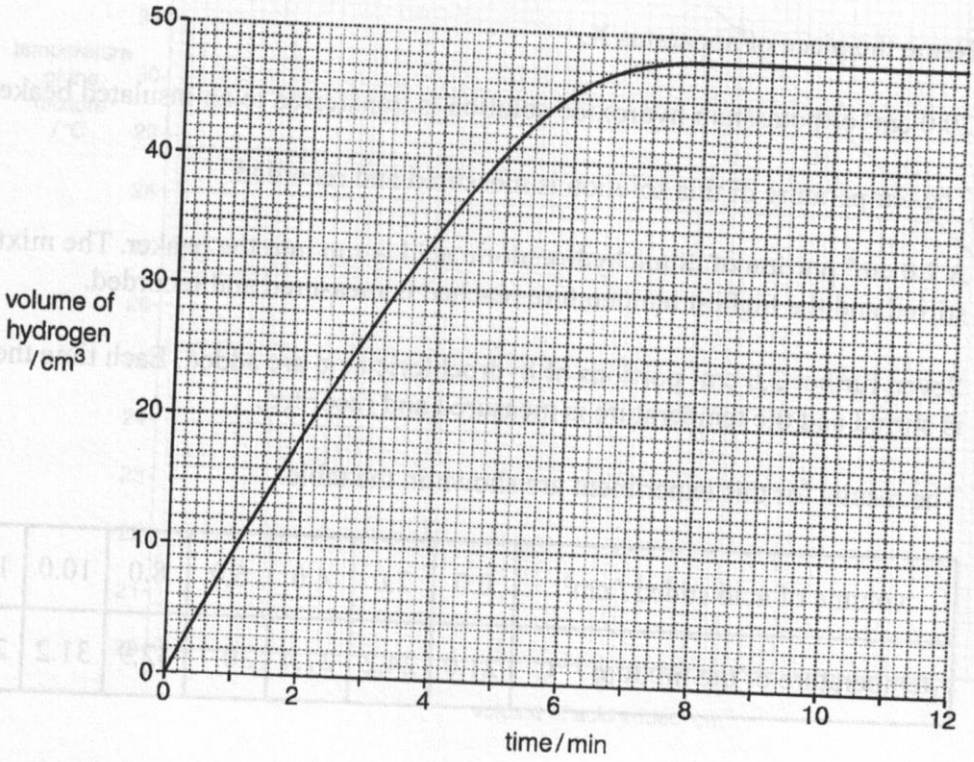
21

Magnesium metal reacts with dilute hydrochloric acid to produce the gas hydrogen.

A student added an **excess** of hydrochloric acid to magnesium in the apparatus shown below.

The gas given off was collected and the total volume of gas was measured every minute.

The results of the student's experiment were plotted and the graph obtained is shown below.



(a) After eight minutes, the reaction stops.

What is the final voume of gas collected?

48 cm^3 [1]

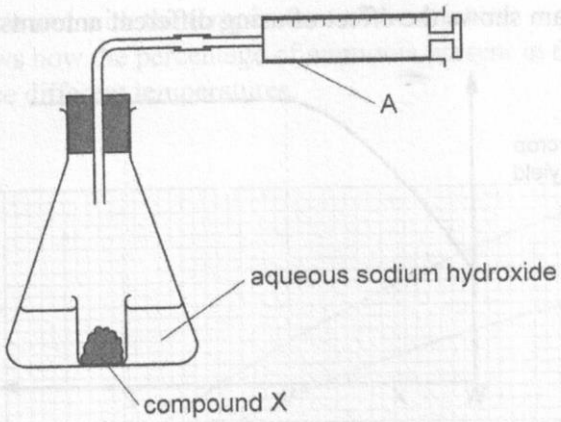
(b) State why reaction stopped.

All magnesium has reacted. [1]

(c) Write a balanced chemical equation for the reaction between magnesium and hydrochloric acid.

$Mg + 2\ HCl \rightarrow MgCl_2 + H_2$ [1]

22 A small container of compound X is added to a flask of aqueous sodium hydroxide.



When the flask is tipped, compound X and aqueous sodium hydroxide mix.
A reaction occurs which releases gaseous ammonia, NH_3.

(a) Name apparatus A which collects the gaseous ammonia.

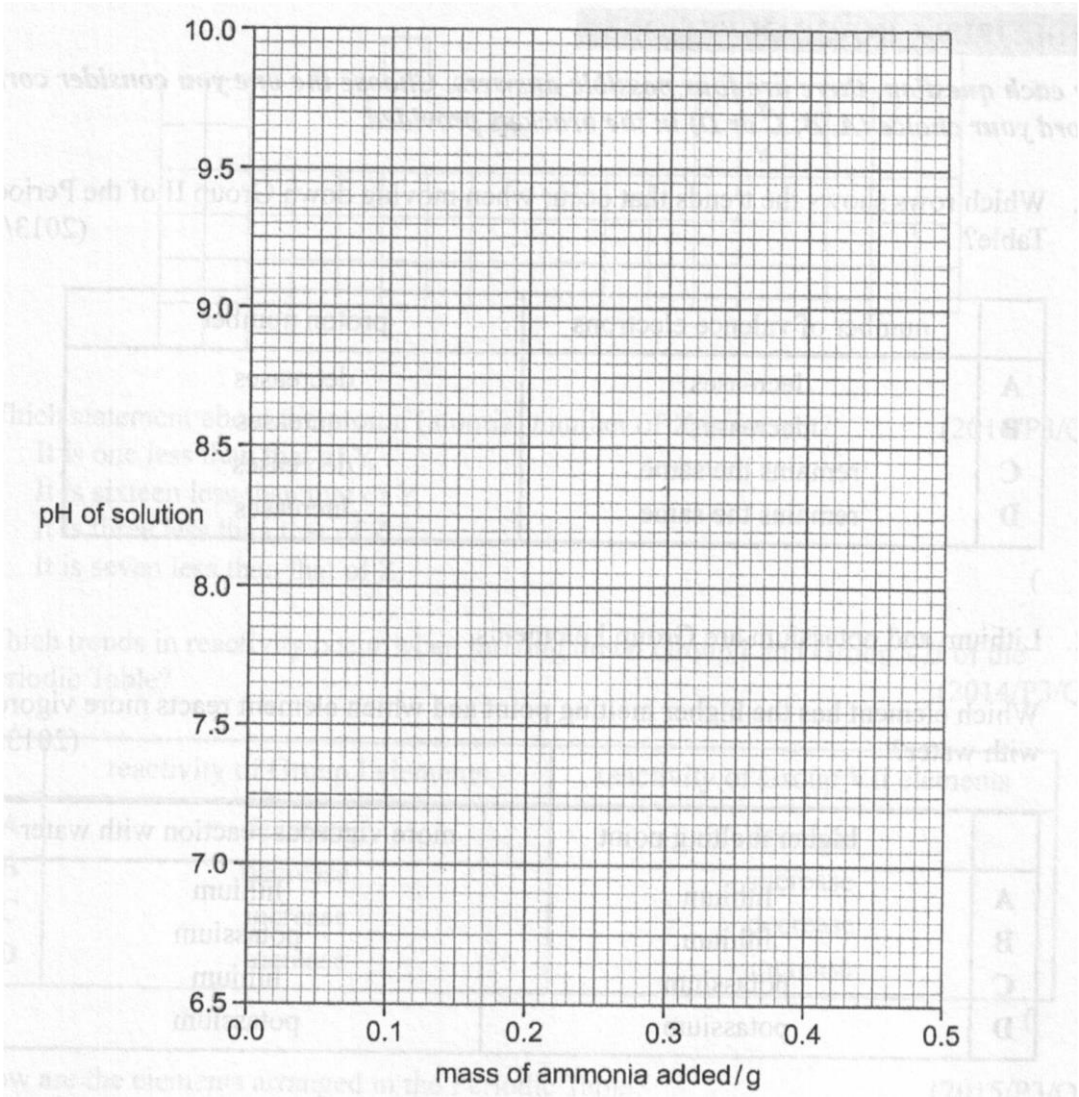
Gas syringe [1]

(b) The ammonia collected in A is added slowly to a flask of water.
The mass of ammonia added and the pH of the resulting solution are measured. The data is shown.

mass of ammonia added /g	pH of solution
0.00	7.0
0.01	8.7
0.05	9.2
0.10	9.4
0.20	9.6
0.30	9.7
0.40	9.8

(i) Plot a graph of pH of solution against mass of ammonia added, marking each point with a cross (x). [1]

(ii) Draw a curved line of best-fit, using all your plotted points. [1]



(iii) Use your graph to predict the pH of solution when 0.03 g of ammonia is added.
Give your answer to **one** decimal place.

..... [1]

(c) Circle the substance that could be added to the aqueous ammonia to neutralise it.

NaOH MgO HCl $CaCl_2$

[1]

(d) When ammonia is heated in oxygen under certain conditions, nitrogen dioxide and water are produced.

(i) Write a balanced equation for this reaction.

$4NH_3 + 7O_2 \rightarrow 4NO_2 + 6H_2O$ [2]