Name:	Target Grade:	Actual Grade:

BRIGHT CULTURE

ACID AND BASES
MCQ and STRUCTURED QUESTIONS

READ THESE INSTRUCTIONS FIRST

INSTRUCTIONS TO CANDIDATES

1. Find a quiet, comfortable spot free place from distractions.

2. Spend one minute on each mark.

3. Time yourself for every single question.

4. Every chapter has their own question types. Ensure that you know the different question type for each chapter.

5. Make a conscientious effort to remember your mistakes, especially in terms of answering techniques. E.g Take a picture for the mistakes that you made, keep it in a photo album, and revise it over and over again.

6. Highlight question types that you tend to keep making mistakes and review them nearing exams.

7. Always review the common questions and question type that you tend to make mistakes nearing exams.

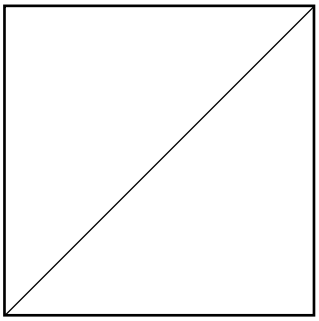
8. During exams, classify the question type and recall what you have learnt, how you need to analyse the questions for the different question type, what you need to take note of and answer with the correct answering techniques!

✨ **Wishing you all the best for this test!**

You've got this!

💡 **With lots of love,**
Bright Culture 💛

MARKS



If you are struggling in this paper, means you need to work harder!

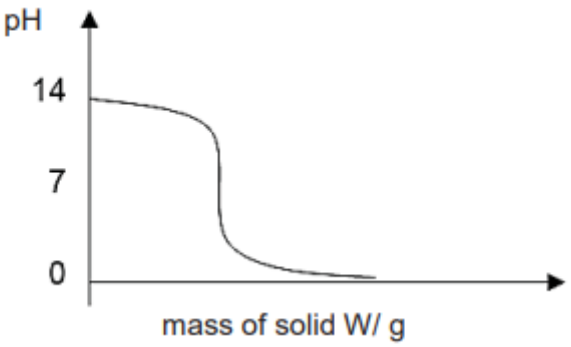
If you need any professional guidance and further advice on how to advance, feel free to WhatsApp us at 91870820 or find us at [www.bright-culture.com/.](http://www.bright-culture.com/) We are committed to connect you to your future to reach your goals.

ACID AND BASES MCQ
Paper 1

1. In which of the following do both gases change the colour of damp red litmus paper?

A ammonia and chlorine
B ammonia and sulfur dioxide
C carbon dioxide and chlorine
D carbon dioxide and sulfur dioxide

2. Solid W is gradually added to solution X. The changes in pH are shown on the graph.



What are W and X?

	solution X	solid W
A	nitric acid	insoluble metal oxide
B	hydrochloric acid	soluble metal oxide
C	aqueous ammonia	soluble non-metal oxide
D	sodium hydroxide	soluble non-metal oxide

3. Which of the following results is obtained when 100 cm^3 of 0.500 mol/dm^3 dilute sulfuric acid is added to 60.0 g of granular solid lead(II) carbonate?

A No visible reaction.
B Colourless solution with effervescence is produced.
C Colourless solution with white precipitate
D A colourless solution with white precipitate, effervescence and granular remains

4. Two unlabelled bottles contain colourless solutions. One of which was sodium carbonate solution and the other was sodium chloride solution.

Which solution when added to a sample from each bottle would most readily identify the bottles?

A ammonia
B hydrochloric acid
C lead(II) nitrate
D sodium hydroxide

5. Four statements about hydroxide, OH^- ions are made.

- It reacts with hydrogen ions to form water.
- It reacts with aqueous iron(III) sulfate to form a green precipitate.
- It migrates to the cathode in electrolysis of an aqueous solution.
- Its solution gives an alkaline gas when warmed with aqueous ammonium chloride.

How many statement(s) is/ are correct?

A 1 only
B 2 only
C 3 only
D 4 only

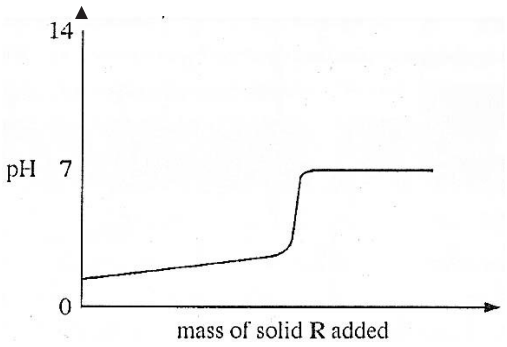
6. A sample of flue gas from the power station is bubbled into different solutions and the results are shown in the table.

solution	observation
acidified potassium manganate (VII)	purple solution turns colourless
acidified potassium iodide	colourless solution turns brown
red litmus solution	turns blue
blue litmus solution	turns red

Which are the possible gases present in the sample?

A sulfur dioxide gas and chlorine gas
B chlorine gas, hydrogen gas and carbon monoxide gas
C ammonia gas, sulfur dioxide and oxygen gas
D ammonia gas, nitrogen monoxide gas and oxygen gas

7. Solid R is gradually added to aqueous solution S. The changes in pH are shown in the graph below.

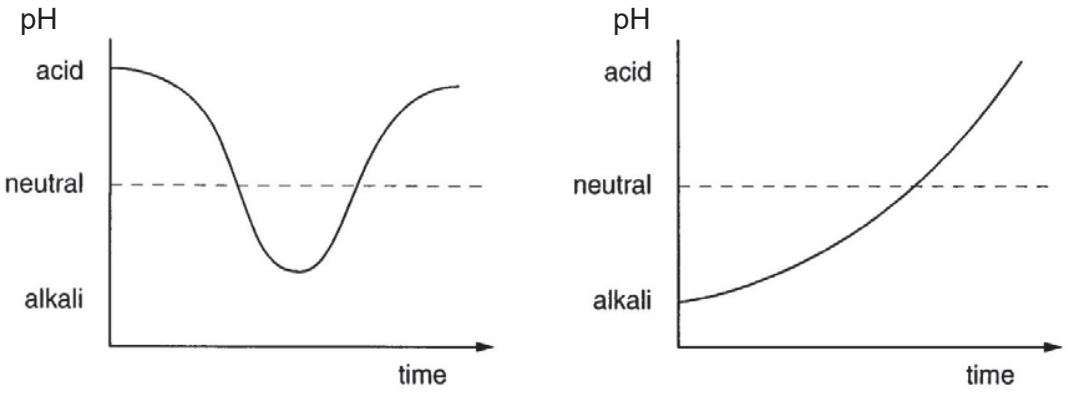


What are R and S?

	R	S
A	insoluble metal oxide	hydrochloric acid
B	insoluble non-metal oxide	sodium hydroxide
C	soluble metal oxide	hydrochloric acid
D	soluble non-metal oxide	sodium hydroxide

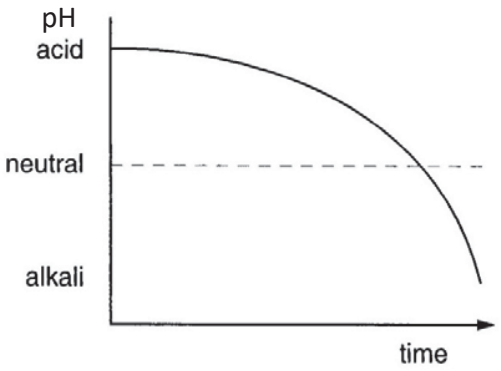
8. The mouth contains saliva which is a weak alkali. When sweets containing sugar are eaten, bacteria in the mouth change the sugar into acids.

Which graph best shows how the acidity in the mouth changes during and after the eating of sweets?

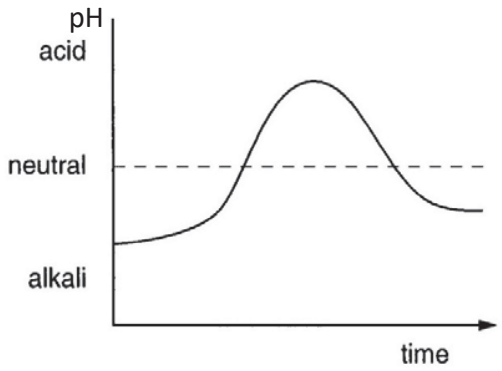


A

B



C



D

9. Three elements **X**, **Y** and **Z** belong to the same period in the Periodic Table. The properties of their oxides are given below.

oxide of **X:**	soluble in both nitric acid and aqueous sodium hydroxide
oxide of **Y:**	insoluble in water and aqueous sodium hydroxide but dissolves readily in nitric acid
oxide of **Z:**	changes acidified potassium manganate(VII) from purple to colourless

Based on the statements above, arrange **X**, **Y** and **Z** in order of <u>decreasing</u> atomic number in the Periodic Table.

A **X**, **Y**, **Z**
B **Y**, **X**, **Z**
C **Z**, **X**, **Y**
D **Z**, **Y**, **X**

10. Which one of the following elements burns in excess oxygen to form a neutral oxide?

A carbon
B sulfur
C calcium
D hydrogen

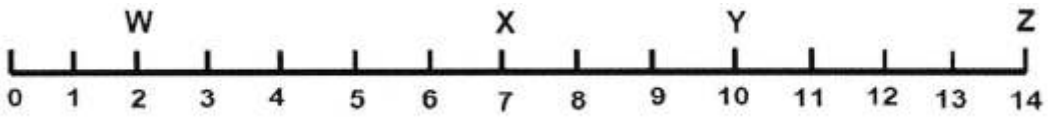
11. The following are some statements about dilute sulfuric acid.

I. It forms a red solution when universal indicator is added to it.
II. It can conducts electricity when a power source is added to it.
III. It can dissociate in water to form two different types of ions.
IV. It can dissolve copper(II) oxide in order to form a blue solution.

Which two statements confirm the acidic nature of the solution?

A I and III
B I and **IV**
C II and **IV**
D III and **IV**

12. Solutions **W**, **X**, **Y** and **Z** are placed on the pH scale as shown.



Which of the letters from **W** to **Z** matches the correct solutions?

	nitric acid	toothpaste	sodium hydroxide	suqar solution
A	**W**	**X**	**Y**	**Z**
B	**W**	**Y**	**Z**	**X**
C	**Y**	**X**	**Z**	**W**
D	**Z**	**W**	**X**	**Y**

13. Which of the following correctly classifies the different oxides?

	Amphoteric oxide	**Basic oxide**	**Neutral oxide**
A	$Al2O_3$	ZnO	CO
B	Al_2O_3	SiO_2	H2O
C	PbO	CuO	NO
D	V_2O_5	Al_2O_3	SO_2

14. Nitrogenous fertilizer such as ammonium nitrate is used to increase crop yield.
Which substance can be added to increase pH of the acidic soil without causing a loss of nitrogen?

A calcium carbonate
B calcium hydroxide
C magnesium hydroxide
D magnesium sulfate

15. The pH of an aqueous solution of hydrochloric acid is 2.
What will be the pH of the acid after the addition of 10.0 g of sodium chloride?

A 2
B 5
C 7
D 9

16. Which row in the table correctly shows the properties of 0.100 mol/dm^3 hydrochloric acid when compared with 0.100 mol/dm^3 ethanoic acid?

	pH	conductivity	Rate of reaction with magnesium
A	lower	lower	slower
B	higher	higher	faster
C	lower	higher	faster
D	higher	lower	slower

17. Consider the three reactions below.

- reaction between nitric acid and calcium hydroxide
- ethane burning in air
- reaction between ethanoic acid and ethanol

A student made three statements about the three reactions above.

1 carbon dioxide is produced in all reactions
2 water is produced in all reactions
3 a salt is produced in all reactions

Which statement(s) is/are true?

A 2 only
B 1 and 2 only
C 2 and 3 only
D 1, 2 and 3

Apply past knowledge to past knowledge to new situations 8

18. Methylamine, CH_3NH_2, has very similar chemical properties to ammonia, NH_3. Methylamine reacts with hydrogen chloride to form a white crystalline salt, methylammonium chloride.

$$CH_3NH_2 + HCl \rightarrow CH_3NH_3^+Cl^-$$

A sample of methylammonium chloride is heated with aqueous sodium hydroxide. What are the products?

A ammonia, sodium chloride and water
B ammonia, sodium hydrogen carbonate and sodium chloride
C methylamine, hydrogen chloride and water
D methylamine, sodium chloride and water

ACID AND BASES STRUCTURRED QUESTIONS

Paper 2 Section A

1. Fig. 2.1 shows the structures of various compounds, **A**, **B**, **C**, **D**, **E** and **F**.

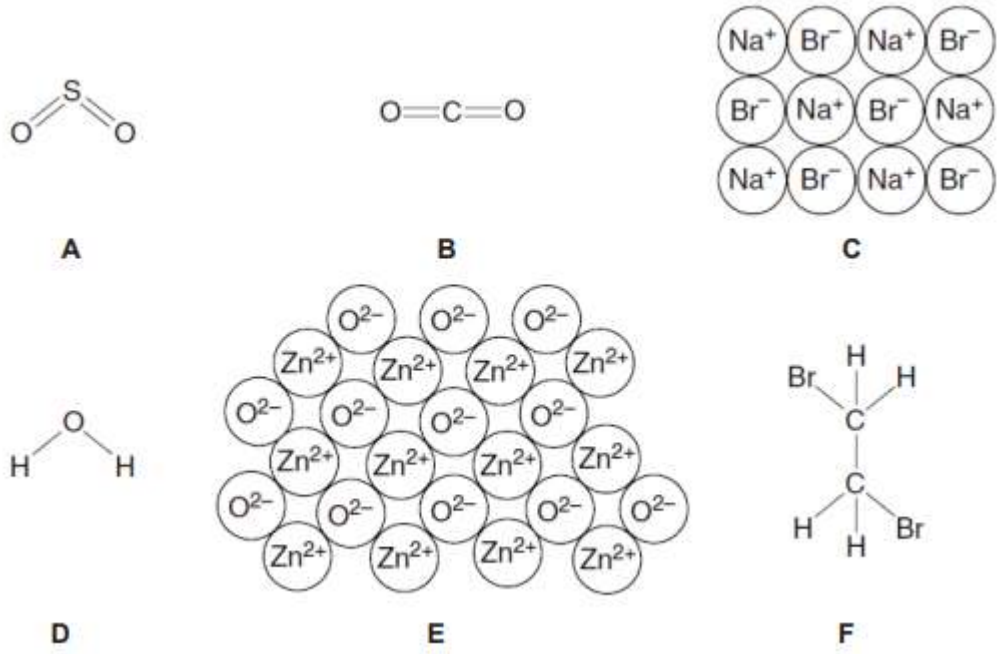


Fig. 2.1

a. Use the letters **A** to **F** to answer the following.
Each compound may be used once, more than once or not at all.

i. Which compound is most likely to contribute to acid rain?

ii. Which compound is an amphoteric oxide?

iii. Which two of these compounds have giant structures?

iv. Which compound when molten, releases a reddish brown gas at the anode during electrolysis?

b. State the empirical formula of compound **F**.

[Total: 5]

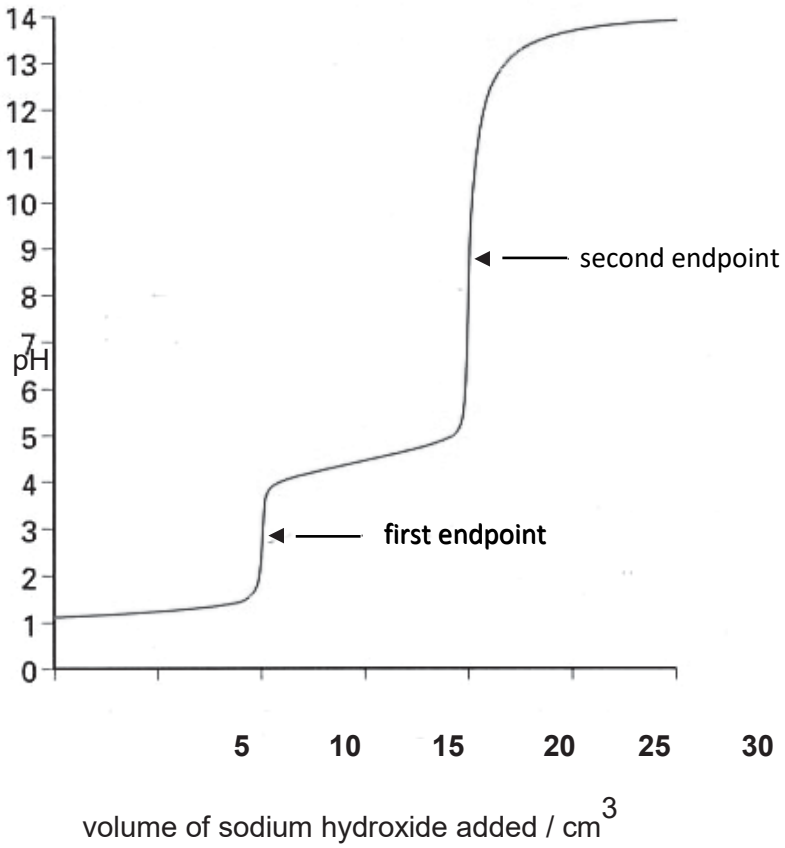
Paper 2 Section B

1. Different experiments were set up to investigate the reactions of sulfuric acid.

25.0 cm^3 of 0.10 mol/dm^3 sulfuric acid was transferred to a conical flask and sodium hydroxide was added from a burette.

After each addition of sodium hydroxide, the pH of the solution was recorded using a pH probe attached to a data logger.

The display from the data logger shows the results below. The pH curve has two endpoints, which resulted because H_2SO_4 undergoes two stages of ionisation in water to produce hydrogen sulfate ions, and sulfate ions respectively.



(a) (i) Sulfuric acid ionises in water in two stages. In stage I, it ionises to produce HSO_4^- ions.

$$H_2SO_4\ (aq) \rightarrow HSO_4^-\ (aq) + H^+\ (aq)$$

Write an equation to show the second stage of ionisation of HSO_4^- in water.

……[1]

(ii) State the chemical formula and name of the salt formed at the first endpoint.

chemical formula ……

chemical name ……..……..…..[2]

(iii) H_2SO_4 is completely neutralised when the second endpoint is reached.

Use the information from the pH curve to calculate the concentration of sodium hydroxide used in the experiment.

[3]

(b) Describe how you would show that iron(II) sulfate rather than iron(III) sulfate is formed when iron is dissolved in dilute sulfuric acid.

……

……

……[2]

(c) In an experiment, hydrated iron(II) sulfate was gently heated to constant mass, leaving behind anhydrous iron(II) sulfate.

The following table shows the results obtained.

mass of hydrated salt at the start	27.8 g
mass of anhydrous salt at the end	15.2 g

Use the results to work out the empirical formula of the hydrated iron(II) sulfate used in this experiment.

[2]

[Total: 10]

2. **(a)** Citric acid is a white crystalline powder with formula $C_5H_7O_5COOH$

Two samples of 0.1 mol/dm^3 citric acid was prepared, one in water and the other in propanol. It was noticed that when the acid dissolved in water, the solution felt cold.

Dissociation of citric acid in water: $C_5H_7O_5COOH \rightarrow C_5H_7O_5COO^- + H^+$

A piece of magnesium ribbon was added to each of the two solutions. The results are summarised in Table 11.1

Table 11.1

solution	action on magnesium ribbon
citric acid in water	slow but steady formation of gas bubbles
citric acid in propanol	no reaction

(i) What type of energy change takes place when citric acid was dissolved in water?

[1]

(ii) Explain the **observations** for the reaction between a solution of citric acid in water and magnesium.

[2]

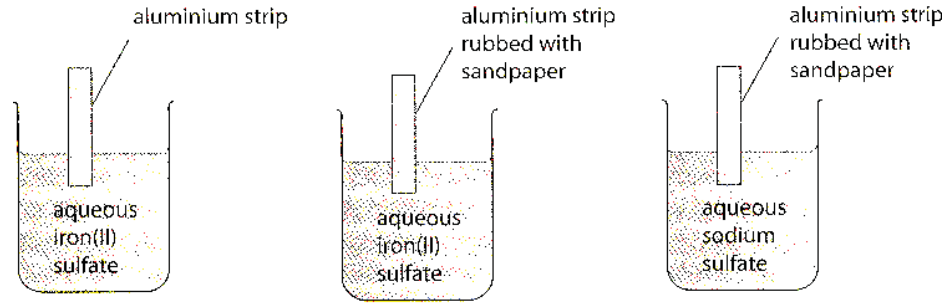
(iii) Write a balanced chemical equation to show the reaction between magnesium and citric acid in water.

[1]

(iv) Explain why there was no reaction between magnesium and a solution of citric acid in propanol.

[1]

(b) Fig 11.2 shows three experiments involving aluminium that were set up in the laboratory.



Experiment 1 **Experiment 2** **Experiment 3**

Fig 11.2

(i) Explain why a reaction occurred in Experiment **2** but not in **1**.

[3]

(ii) State and explain the observation(s) if any, that will be seen in Experiment **3**.

[2]

[Total: 10 marks]

3. Read the information below about the oxides of elements in Period 3 of the Periodic Table.

Elements and their oxides

The table below show the properties of the oxides formed by elements in Period 3.

element	formula of oxide	melting point of oxide/°C	boiling point of oxide/°C
Na	Na_2O	1132	1950
Mg	MgO	2852	3600
Al	Al_2O_3	2072	2977
Si	SiO_2	1600	2230
P	P_4O_6	24	173
	P_4O_{10}	340	360
S	SO_2	-72	-10
	SO_3	17	45
Cl	Cl_2O	-121	2
	Cl_2O_7	-92	82

(a) Describe the pattern for the ratio of each metallic element to oxygen across period 3. Include ratios in your answer.

[1]

(b) Account for the melting and boiling points of the oxides formed by elements in Period 3 in terms of structure and bonding.

[2]

(c) Suggest a reason for the difference in the melting and boiling points between the two oxides of sulfur.

[2]

(d) The table below shows the variation of atomic and ionic radius across Period 3.

element	atomic radius/nm	simple ion	ionic radius/nm	number of electron shells in simple ion
Na	0.191	Na^+	0.102	
Mg	0.160	Mg^{2+}	0.072	
Al	0.130	Al^{3+}	0.054	
Si	0.118	*	-	-
P	0.110	P^{3-}	0.212	
S	0.102	S^{2-}	0.184	
Cl	0.099	Cl^-	0.181	
Ar	0.095	-	-	-

*Si does not form simple ions and thus the data is omitted from the table

(i) Complete the table above to show the number of shells of electrons in the ions of period 3 elements.[1]

(ii) Use the information from the table to explain the difference between the radii of anions and cations in the same period. [2]

(iii) Suggest why there is no value stated for the ionic radius of argon. [1]

4 Aqueous ammonia, NH_3, is used to make many different water-soluble fertilisers.

(a) Draw a 'dot and cross' diagram to show the bonding in ammonia.

Show only the outermost electrons.

[2]

(b) Ammonium nitrate is an example of a water-soluble fertiliser that can be made.

(i) Name a suitable acid that can be used to make ammonium nitrate from aqueous ammonia.

…… [1]

(ii) Hence, write a balanced chemical equation with state symbols for the formation of ammonium nitrate.

……[2]

(c) Farmers sometimes need to add calcium hydroxide to the soil for their crops to grow well.

(i) Explain why calcium hydroxide is added to soil by farmers.

……

…… [1]

(ii) With the aid of a suitable ionic equation, explain why adding both calcium hydroxide and ammonium nitrate to the soil at the same time is not recommended.

ionic equation .... …..….…..…..…..…..…..…..…..…..…

explanation …..……..…..…..…..

……………………………………………………………………………

…………………………………………………………………………… [3]

[Total: 9 marks]

5 **(a)** Antacid tablets are ingested to provide relief for gastric pains. Antacid tablets containing magnesium carbonate are seldom used nowadays. Instead, magnesium hydroxide is usually used as the active ingredient. Based on the reactions involved, suggest one reason why magnesium hydroxide is preferred to magnesium carbonate. [1]

____

____

(b) Irene took some tablets containing magnesium hydroxide to relieve stomach pains caused by excess hydrochloric acid present in the gastric juice.
Write a chemical equation for the above reaction. [1]

____

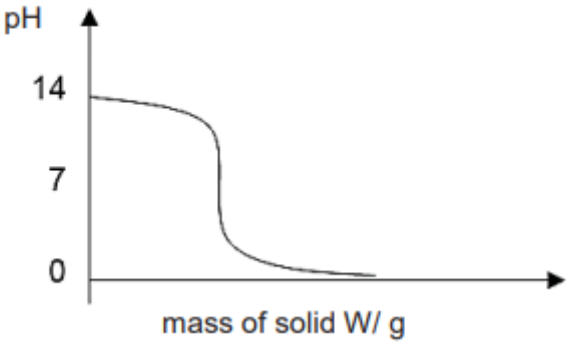
ANSWER TO ACID AND BASES

Paper 1

1 In which of the following do both gases change the colour of damp red litmus paper?

A ammonia and chlorine
B ammonia and sulfur dioxide
C carbon dioxide and chlorine
D carbon dioxide and sulfur dioxide

2 Solid W is gradually added to solution X. The changes in pH are shown on the graph.



What are W and X?

	solution X	solid W
A	nitric acid	insoluble metal oxide
B	hydrochloric acid	soluble metal oxide
C	aqueous ammonia	soluble non-metal oxide
D	sodium hydroxide	soluble non-metal oxide

3 Which of the following results is obtained when 100 cm^3 of 0.500 mol/dm^3 dilute sulfuric acid is added to 60.0 g of granular solid lead(II) carbonate?

A No visible reaction.
B Colourless solution with effervescence is produced.
C Colourless solution with white precipitate
D A colourless solution with white precipitate, effervescence and granular remains

4 Two unlabelled bottles contain colourless solutions. One of which was sodium carbonate solution and the other was sodium chloride solution.

Which solution when added to a sample from each bottle would most readily identify the bottles?

A ammonia
B hydrochloric acid
C lead(II) nitrate
D sodium hydroxide

5 Four statements about hydroxide, OH^- ions are made.

- It reacts with hydrogen ions to form water.
- It reacts with aqueous iron(III) sulfate to form a green precipitate.
- It migrates to the cathode in electrolysis of an aqueous solution.
- Its solution gives an alkaline gas when warmed with aqueous ammonium chloride.

How many statement(s) is/ are correct?

A 1 only
B 2 only
C 3 only
D 4 only

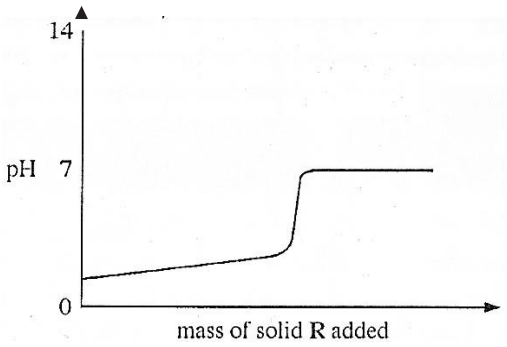
6 A sample of flue gas from the power station is bubbled into different solutions and the results are shown in the table.

solution	observation
acidified potassium manganate (VII)	purple solution turns colourless
acidified potassium iodide	colourless solution turns brown
red litmus solution	turns blue
blue litmus solution	turns red

Which are the possible gases present in the sample?

A sulfur dioxide gas and chlorine gas
B chlorine gas, hydrogen gas and carbon monoxide gas
C ammonia gas, sulfur dioxide and oxygen gas
D ammonia gas, nitrogen monoxide gas and oxygen gas

7 Solid R is gradually added to aqueous solution S. The changes in pH are shown in the graph below.

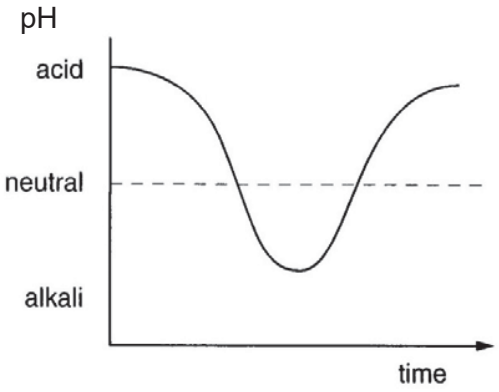


What are R and S?

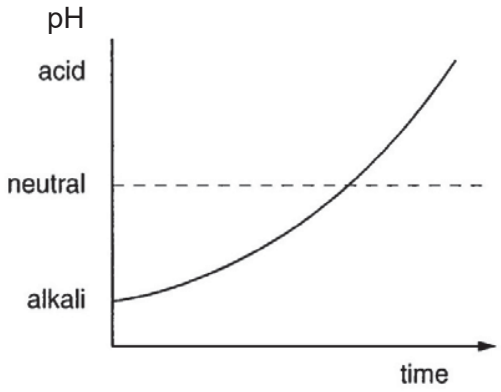
	R	S
A	insoluble metal oxide	hydrochloric acid
B	insoluble non-metal oxide	sodium hydroxide
C	soluble metal oxide	hydrochloric acid
D	soluble non-metal oxide	sodium hydroxide

8 The mouth contains saliva which is a weak alkali. When sweets containing sugar are eaten, bacteria in the mouth change the sugar into acids.

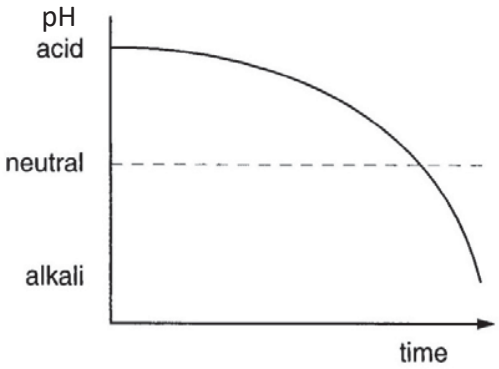
Which graph best shows how the acidity in the mouth changes during and after the eating of sweets?



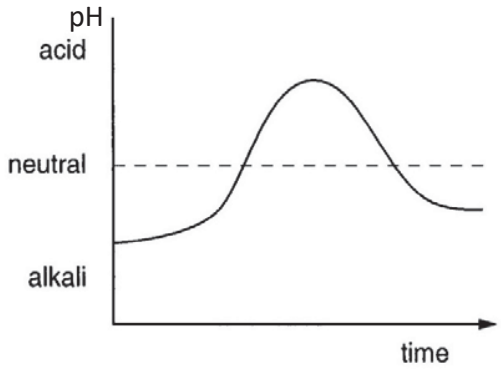
A



B



C



D

9 Three elements **X**, **Y** and **Z** belong to the same period in the Periodic Table. The properties of their oxides are given below.

oxide of **X:**	soluble in both nitric acid and aqueous sodium hydroxide
oxide of **Y:**	insoluble in water and aqueous sodium hydroxide but dissolves readily in nitric acid
oxide of **Z:**	changes acidified potassium manganate(VII) from purple to colourless

Based on the statements above, arrange **X**, **Y** and **Z** in order of decreasing atomic number in the Periodic Table.

A **X**, **Y**, **Z**
B **Y**, **X**, **Z**
C **Z**, **X**, **Y**
D **Z**, **Y**, **X**

10 Which one of the following elements burns in excess oxygen to form a neutral oxide?

A carbon
B sulfur
C calcium
D hydrogen

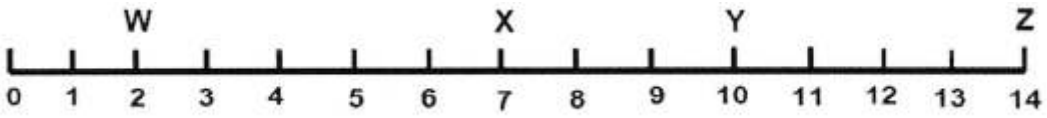
11 The following are some statements about dilute sulfuric acid.

I It forms a red solution when universal indicator is added to it.
II It can conducts electricity when a power source is added to it.
III It can dissociate in water to form two different types of ions.
IV It can dissolve copper(II) oxide in order to form a blue solution.

Which two statements confirm the acidic nature of the solution?

A I and III
B I and **IV**
C II and **IV**
D III and **IV**

12 Solutions **W**, **X**, **Y** and **Z** are placed on the pH scale as shown.



Which of the letters from **W** to **Z** matches the correct solutions?

	nitric acid	toothpaste	sodium hydroxide	sugar solution
A	**W**	**X**	**Y**	**Z**
B	**W**	**Y**	**Z**	**X**
C	**Y**	**X**	**Z**	**W**
D	**Z**	**W**	**X**	**Y**

13 Which of the following correctly classifies the different oxides?

	Amphoteric oxide	**Basic oxide**	**Neutral oxide**
A	$Al2O_3$	ZnO	CO
B	Al_2O_3	SiO_2	H2O
C	PbO	CuO	NO
D	V_2O_5	Al_2O_3	SO_2

14 Nitrogenous fertilizer such as ammonium nitrate is used to increase crop yield.
Which substance can be added to increase pH of the acidic soil without causing a loss of nitrogen?

A calcium carbonate
B calcium hydroxide
C magnesium hydroxide
D magnesium sulfate

15 The pH of an aqueous solution of hydrochloric acid is 2.
What will be the pH of the acid after the addition of 10.0 g of sodium chloride?

A 2
B 5
C 7
D 9

16 Which row in the table correctly shows the properties of 0.100 mol/dm^3 hydrochloric acid when compared with 0.100 mol/dm^3 ethanoic acid?

	pH	conductivity	Rate of reaction with magnesium
A	lower	lower	slower
B	higher	higher	faster
C	lower	higher	faster
D	higher	lower	slower

17 Consider the three reactions below.

- reaction between nitric acid and calcium hydroxide
- ethane burning in air
- reaction between ethanoic acid and ethanol

A student made three statements about the three reactions above.

4 carbon dioxide is produced in all reactions
5 water is produced in all reactions
6 a salt is produced in all reactions

Which statement(s) is/are true?

A 2 only
B 1 and 2 only
C 2 and 3 only
D 1, 2 and 3

Apply past knowledge to past knowledge to new situations 8

18 Methylamine, CH_3NH_2, has very similar chemical properties to ammonia, NH_3. Methylamine reacts with hydrogen chloride to form a white crystalline salt, methylammonium chloride.

$$CH_3NH_2 + HCl \rightarrow CH_3NH_3^+Cl^-$$

A sample of methylammonium chloride is heated with aqueous sodium hydroxide. What are the products?

A ammonia, sodium chloride and water
B ammonia, sodium hydrogen carbonate and sodium chloride
C methylamine, hydrogen chloride and water
D methylamine, sodium chloride and water

ANSWERS FOR ACID AND BASES STRUCTURRED QUESTIONS

Paper 2 Section A

1 Fig. 2.1 shows the structures of various compounds, **A**, **B**, **C**, **D**, **E** and **F**.

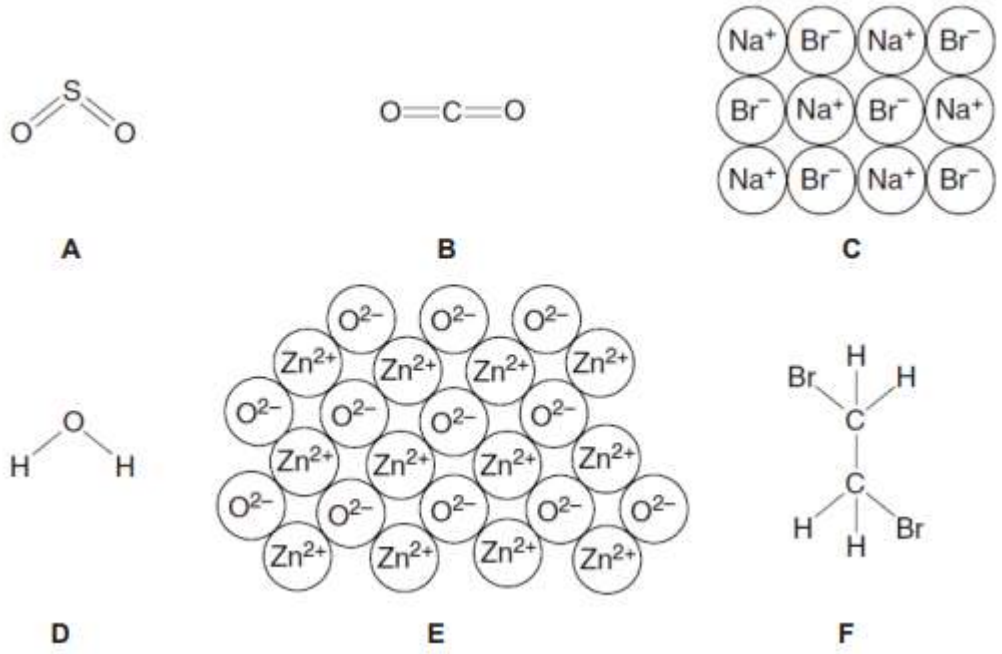


Fig. 2.1

a. Use the letters **A** to **F** to answer the following.
Each compound may be used once, more than once or not at all.

i. Which compound is most likely to contribute to acid rain?

A [1]

ii. Which compound is an amphoteric oxide?

E[1]

iii. Which two of these compounds have giant structures?

C & E [1]

iv. Which compound when molten, releases a reddish brown gas at the anode during electrolysis?

C [1]

b. State the empirical formula of compound **F**.

CH_2Br

[Total: 5]

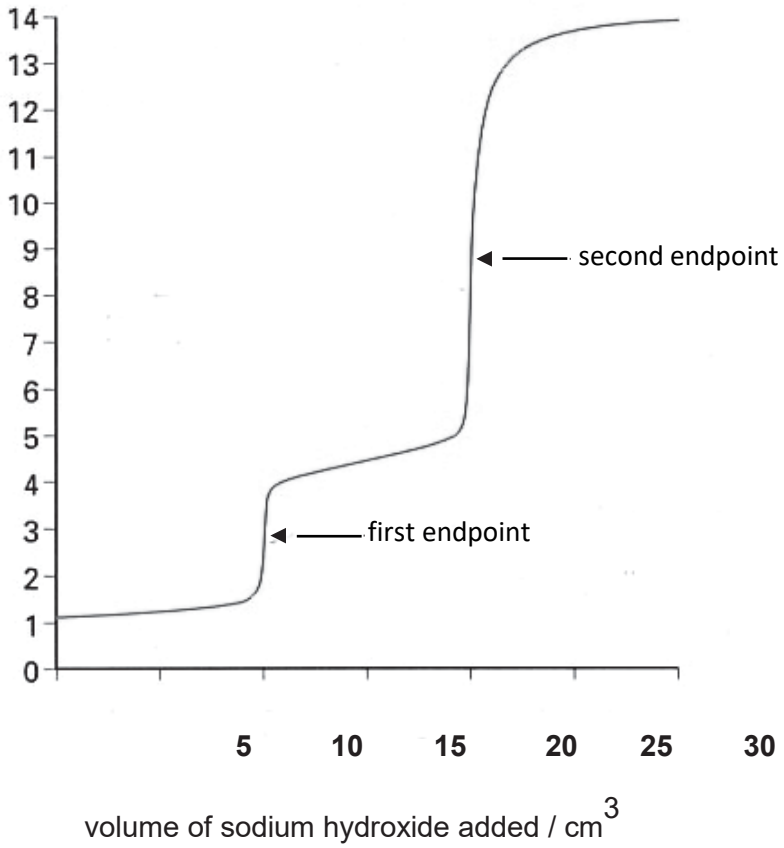
Paper 2 Section B

1 Different experiments were set up to investigate the reactions of sulfuric acid.

25.0 cm^3 of 0.10 mol/dm^3 sulfuric acid was transferred to a conical flask and sodium hydroxide was added from a burette.

After each addition of sodium hydroxide, the pH of the solution was recorded using a pH probe attached to a data logger.

The display from the data logger shows the results below. The pH curve has two endpoints, which resulted because H_2SO_4 undergoes two stages of ionisation in water to produce hydrogen sulfate ions, and sulfate ions respectively.



(a) (i) Sulfuric acid ionises in water in two stages. In stage I, it ionises to produce HSO_4^- ions.

$$H_2SO_4\ (aq) \rightarrow HSO_4^-\ (aq) + H^+\ (aq)$$

Write an equation to show the second stage of ionisation of HSO_4^- in water.

$HSO_4^-\ (aq) \rightarrow (aq)\ SO4^{2-}\ (aq)$ [1]

(ii) State the chemical formula and name of the salt formed at the first endpoint. chemical formula $NaHSO_4$ [1]

chemical name sodium hydrogensulfate [1]

(iii) H_2SO_4 is completely neutralised when the second endpoint is reached.

Use the information from the pH curve to calculate the concentration of sodium hydroxide used in the experiment.

No. of mol H_2SO_4
= (25.0/1000) x 0.10
= 0.0025 mol [1]

$H_2SO_4 + 2NaOH \rightarrow Na_2SO_4 + 2H_2O$
From equation,
1 mol H_2SO_4: 2 mol NaOH
0.0025 mol H_2SO_4:0.005 mol NaOH [1]

Concentration of NaOH
= 0.005 / (20.0/1000)
= 0.250 mol/dm^3 [1] [3]

(b) Describe how you would show that iron(II) sulfate rather than iron(III) sulfate is formed when iron is dissolved in dilute sulfuric acid.

Add 2 to 3 drops, and then, excess of NaOH solution [1].
If a dirty green precipitate that is insoluble in excess NaOH is formed, iron (II) sulfate is formed. [1]

(c) In an experiment, hydrated iron(II) sulfate was gently heated to constant mass, leaving behind anhydrous iron(II) sulfate.

The following table shows the results obtained.

mass of hydrated salt at the start	27.8 g
mass of anhydrous salt at the end	15.2 g

Use the results to work out the empirical formula of the hydrated iron(II) sulfate used in this experiment.

compound	$FeSO_4$	H_2O
mass/g	15.2	27.8 – 15.2 = 12.6
no. of moles	15.2 / 152 = 0.1 mol	12.6 / 18 = 0.7 mol
simplest ratio	0.1 / 0.1 = 1	0.7 / 0.1= 7

Empirical formula is **$FeSO_4.7H_2O$**. 1m for simplest ratio
1m empirical formula

[2]
[Total: 10]

2 **(a)** Citric acid is a white crystalline powder with formula $C_5H_7O_5COOH$

Two samples of 0.1 mol/dm^3 citric acid was prepared, one in water and the other in propanol. It was noticed that when the acid dissolved in water, the solution felt cold.

Dissociation of citric acid in water: $C_5H_7O_5COOH \rightarrow C_5H_7O_5COO^- + H^+$

A piece of magnesium ribbon was added to each of the two solutions. The results are summarised in Table 11.1

Table 11.1

solution	action on magnesium ribbon
citric acid in water	slow but steady formation of gas bubbles
citric acid in propanol	no reaction

(i) What type of energy change takes place when citric acid was dissolved in water?

Exothermic [1]

(ii) Explain the **observations** for the reaction between a solution of citric acid in water and magnesium.

Formation of bubbles is due to the hydrogen gas evolved when acid react with magnesium metal to form salt and H_2.
The reaction is slow as citric acid is a weak acid - less H^+ ions dissociated. [2]

(iii) Write a balanced chemical equation to show the reaction between magnesium and citric acid in water.

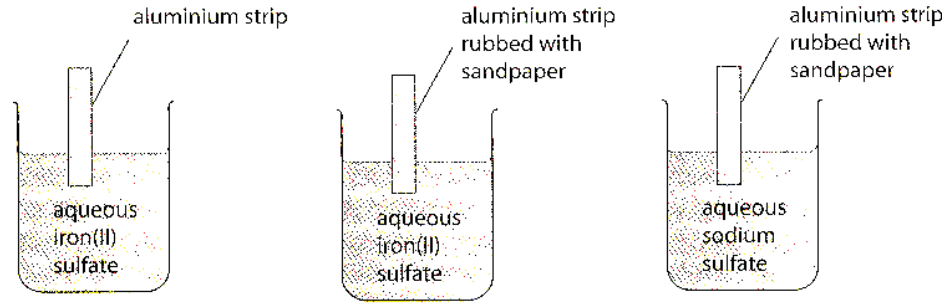
$Mg(s) + 2C_5H_7O_5COOH \rightarrow (C_5H_7O_5COO)_2Mg + H_2$ [1]

(iv) Explain why there was no reaction between magnesium and a solution of citric acid in propanol.

[1]

Propanol is an organic solvent which will not result in hydrogen ions; being produced.

(b) **Fig** 11.2 shows three experiments involving aluminium that were set up in the laboratory.



Experiment 1 **Experiment 2** **Experiment 3**

Fig 11.2

(i) Explain why a reaction occurred in Experiment **2** but not in **1**.

A reaction occurred in Experiment 2 because the aluminum strip is rubbed with sandpaper to remove the oxide layer and aluminium is more reactive than iron . o displacement of iron-from its salt solution can occur. A reaction' does not occur in Experiment 1 as the aluminium strip is still covered by an inert(unreactive) oxide layer.

[3]

(ii) State and explain the observation(s) if any, that will be seen in Experiment **3**.

[There will be no reaction seen in Experiment 3 as aluminium is less reactive than sodium. Hence no displacement reaction will Take place despite the aluminium strip 'being rubbed with Sandpaper

[2]

[Total: 10 marks]

3 Read the information below about the oxides of elements in Period 3 of the Periodic Table.

Elements and their oxides

The table below show the properties of the oxides formed by elements in Period 3.

element	formula of oxide	melting point of oxide/°C	boiling point of oxide/°C
Na	Na_2O	1132	1950
Mg	MgO	2852	3600
Al	Al_2O_3	2072	2977
Si	SiO_2	1600	2230
P	P_4O_6	24	173
	P_4O_{10}	340	360
S	SO_2	-72	-10
	SO_3	17	45
Cl	Cl_2O	-121	2
	Cl_2O_7	-92	82

(a) Describe the pattern for the ratio of each metallic element to oxygen across period 3. Include ratios in your answer.

The ratio of each metallic element to oxygen across period 3 decreases from 2:1 to 2:3 from sodium to aluminium.

[1]

(b) Account for the melting and boiling points of the oxides formed by elements in Period 3 in terms of structure and bonding.

Na_2O, MgO and Al_2O_3 has a giant ionic lattic structure. Large amount of energy is needed to overcome the strong electrostatic forces of attraction between the oppositely charged ions. Thus they have high melting and boiling point.

SiO_2 has a giant molecular structure. Large amount of energy is needed to overcome the strong covalent bond between the silicon and oxygen atoms. [1] Thus it has a high melting and boiling point.

Oxides of P, S and Cl have a simple molecular structure. Small amount of energy is needed to overcome the weak intermolecular forces of attraction/weak van de waals forces between molecules. [1] Thus they have a low melting and boiling point.

If ans does not relates to m.p and b.p minus 1m.

[2]

(c) Suggest a reason for the difference in the melting and boiling points between the two oxides of sulfur.

SO_3 has a high melting and boiling point compared to SO_2 because it has a higher relative molecular mass [1]
Thus the intermolecular forces of attraction is stronger. More energy is needed to overcome it. [1]

(d) The table below shows the variation of atomic and ionic radius across Period 3.

element	atomic radius/nm	simple ion	ionic radius/nm	number of electron shells in simple ion
Na	0.191	Na^+	0.102	
Mg	0.160	Mg^{2+}	0.072	
Al	0.130	Al^{3+}	0.054	
Si	0.118	*	-	-
P	0.110	P^{3-}	0.212	
S	0.102	S^{2-}	0.184	
Cl	0.099	Cl^-	0.181	
Ar	0.095	-	-	-

*Si does not form simple ions and thus the data is omitted from the table

(i) Complete the table above to show the number of shells of electrons in the ions of period 3 elements.[1]

(ii) Use the information from the table to explain the difference between the radii of anions and cations in the same period. [2]

The radii of anions are generally larger than that of cations
+ quoted evidence from table eg average radii of cation vs anions [1] as anions consist of 1 more electron shells [1] compared to cations.

Thus radii of anions are generally larger.

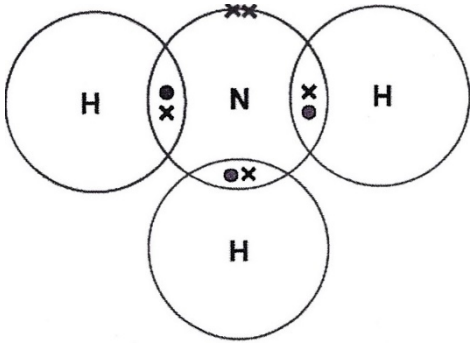
(iii) Suggest why there is no value stated for the ionic radius of argon. [1]

Argon has a stable electronic configuration/stable octet configuration and thus do not gain or lose electrons to form ions/ chemically unreactive/inert [1] and will not affect the radius

4 Aqueous ammonia, NH_3, is used to make many different water-soluble fertilisers.

(a) Draw a 'dot and cross' diagram to show the bonding in ammonia.

Show only the outermost electrons.



NOTE:P 1st [B1] for N atom with correct number of shared electrons reflected from N and H and lone pair on N; 2nd [B1] for all 3 H atoms with correct number of shared electrons reflected

[2]

(b) Ammonium nitrate is an example of a water-soluble fertiliser that can be made.

(i) Name a suitable acid that can be used to make ammonium nitrate from aqueous ammonia.

Nitric acid [1]

(ii) Hence, write a balanced chemical equation with state symbols for the formation of ammonium nitrate.

NH_3 (aq) + HNO_3 (aq) → NH_4NO_3 (aq)

OR: NH_4OH (aq) + HNO_3 (aq) → NH_4NO_3 (aq) + H_2O (*l*)

NOTE: 1st [B1] for all correct formulae and for correct stoichiometric ratio; 2nd [B1] for all correct state symbols [2]

(c) Farmers sometimes need to add calcium hydroxide to the soil for their crops to grow well.

(i) Explain why calcium hydroxide is added to soil by farmers.

To reduce acidity in soil OR increase pH of soil OR control pH of soil
ACCEPT: OWTTE; REJECT: "... neutralise the soil ..." if no reference to "acid/acidity of the soil"

[1]

(ii) With the aid of a suitable ionic equation, explain why adding both calcium hydroxide and ammonium nitrate to the soil at the same time is not recommended.

ionic equation NH_{4+} (aq) + OH^- (aq) → NH_3 (g) + H_2O (l) (CAO)

explanation .

- Calcium hydroxide, an alkali, reacts with reacts with ammonium salt to form ammonia gas
- Loss of nitrogen from soil (ACCEPT: OWTTE)

MR: Question was poorly attempted as mos candidates were unable to write down the correct ionic equation for the reaction. In addition, they were unable to expand on their answer on the consequence of the reaction between the alkali calcium hydroxide and the ammonium based fertiliser.

[3]

[Total: 9 marks]

5 **(a)** Antacid tablets are ingested to provide relief for gastric pains. Antacid tablets containing magnesium carbonate are seldom used nowadays. Instead, magnesium hydroxide is usually used as the active ingredient. Based on the reactions involved, suggest one reason why magnesium hydroxide is preferred to magnesium carbonate. [1]

Carbon dioxide gas will be produced if a carbonate is used. Hence, magnesium hydroxide is preferred.

(b) Irene took some tablets containing magnesium hydroxide to relieve stomach pains caused by excess hydrochloric acid present in the gastric juice.

Write a chemical equation for the above reaction. [1]

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