ACIDS, BASES & SALTS

O' Levels : MCQs + Theory
(selected questions)

EXERCISE ON WRITING EQUATIONS AND NET IONIC EQUATIONS

For each of the following

a) **Complete the Equation**
b) **Balance the Equation**
c) **Write down the States**
d) **Write the Ionic Equation and state the Spectator ions.**
e) **Method of Preparation**

1. Calcium Carbonate + Nitric acid
2. Potassium Hydroxide + Sulfuric acid
3. Sodium Carbonate + Phosphoric acid
4. ammonium Nitrate + Barium Hydroxide
5. Aluminum Carbonate + Hydrochloric acid
6. Iron (II) oxide + Phosphoric acid
7. Magnesium Hydroxide + Hydrochloric acid
8. Iron (III) Hydroxide + Sulfuric acid
9. Barium Hydroxide + Sulfuric acid
10. Lead (II) Oxide + hydrochloric acid
11. Ammonium Phosphate + Strontium Hydroxide
12. Ammonium Hydroxide + Sulfuric acid
13. Lithium Hydroxide + Hydrochloric acid
14. Nickel (II) Carbonate + Phosphoric Acid
15. Aluminum Oxide + Nitric Acid

MULTIPLE CHOICE QUESTIONS

20 Which statement about oxides is correct?

A A solution of magnesium oxide will have a pH less than 7.

B A solution of sulfur dioxide will have a pH greater than 7.

C Magnesium oxide will react with nitric acid to make a salt.

D Sulfur dioxide will react with hydrochloric acid to make a salt.

32 Which method can be used to obtain ammonia from ammonium sulfate?

A Heat it with an acid.

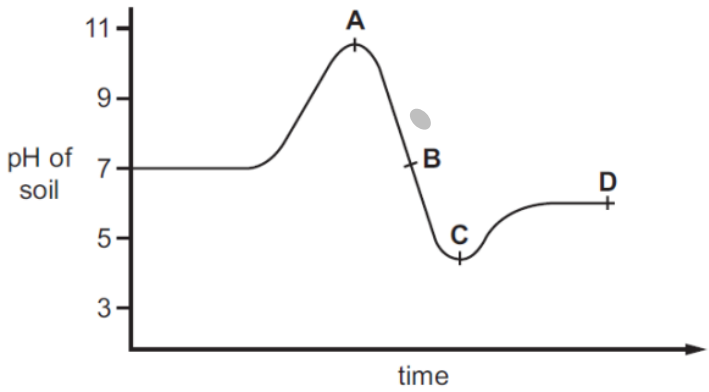
B Heat it with an alkali.

C Heat it with an oxidising agent.

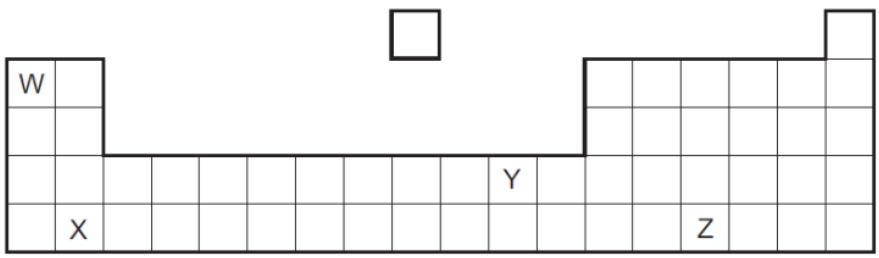
D Heat it with a reducing agent.

22 The graph shows how the pH of soil in a field changes over time.

At which point was the soil neutral?



20 The positions of elements W, X, Y and Z in the Periodic Table are shown.



Which elements form basic oxides?

A W, X and Y **B** W and X only **C** Y only **D** Z only

19 Which substance is the most acidic?

	substance	pH
A	calcium hydroxide	12
B	lemon juice	4
C	milk	6
D	washing up liquid	8

31 Farmers add calcium oxide (lime) and ammonium salts to their fields.

The compounds are not added at the same time because they react with each other.

Which gas is produced in this reaction?

A ammonia

B carbon dioxide

C hydrogen

D nitrogen

18 Which are properties of an acid?

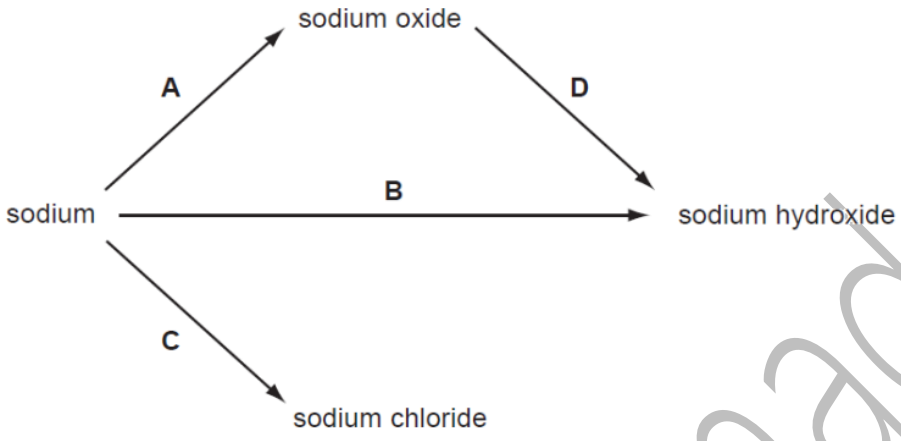
1 reacts with ammonium sulfate to form ammonia

2 turns red litmus blue

	1	2
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

17 Some reactions involving sodium are shown.

Which reaction does **not** involve the formation of a base?



33 Carbon dioxide is produced when dilute hydrochloric acid reacts with

A calcium sulfate.

B carbon.

C copper(II) carbonate.

D limewater.

18 Barium hydroxide is an alkali. It reacts with hydrochloric acid.

How does the pH of the hydrochloric acid change as an excess of aqueous barium hydroxide is added?

A The pH decreases from 14 and becomes constant at 7.

B The pH decreases from 14 to about 1.

C The pH increases from 1 and becomes constant at 7.

D The pH increases from 1 to about 14.

19 A compound is a salt if it

A can neutralise an acid.

B contains more than one element.

C dissolves in water.

D is formed when an acid reacts with a base.

18 Which property is **not** characteristic of a base?

A It reacts with a carbonate to form carbon dioxide.

B It reacts with an acid to form a salt.

C It reacts with an ammonium salt to form ammonia.

D It turns universal indicator paper blue.

20 Which reaction will result in a decrease in pH?

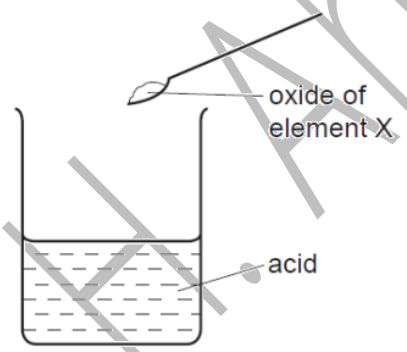
A adding calcium hydroxide to acid soil

B adding citric acid to sodium hydrogen carbonate solution

C adding sodium chloride to silver nitrate solution

D adding sodium hydroxide to hydrochloric acid

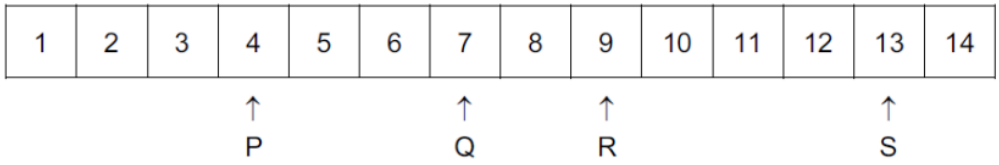
21 The oxide of element X was added to an acid. It reacted to form a salt and water.



What is the pH of the acid before the reaction and what type of element is X?

	pH	type of element X
A	greater than 7	metal
B	greater than 7	non-metal
C	less than 7	metal
D	less than 7	non-metal

21 The diagram shows the pH values of four solutions.



Which of these solutions are alkaline?

A P only

B P and Q only

C Q, R and S only

D R and S only

37 When added in turn to four solutions, aqueous sodium carbonate gives the following results.

Which solution is acidic?

solution	result
A	a blue precipitate forms
B	a white precipitate forms
C	bubbles of gas form
D	no visible reaction occurs

23 Which substances react with dilute sulphuric acid to form a salt?

	magnesium	magnesium oxide	magnesium carbonate	magnesium chloride
A	✓	✓	✓	✗
B	✓	✓	✗	✓
C	✓	✗	✓	✓
D	✗	✓	✓	✓

17 Carbon dioxide is an acidic oxide that reacts with aqueous calcium hydroxide.

Which type of reaction takes place?

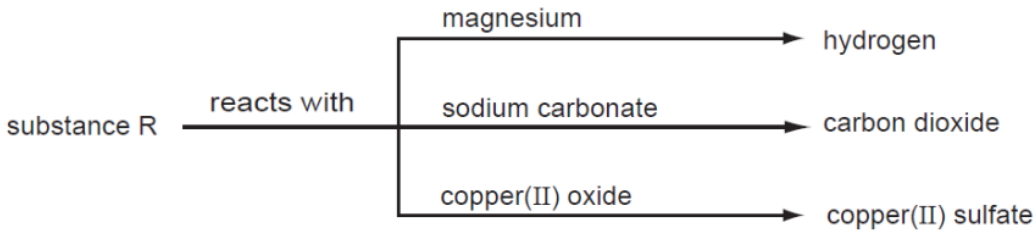
A decomposition

B fermentation

C neutralisation

D oxidation

23 Some reactions of a substance, R, are shown in the diagram.



What type of substance is R?

A an acid

B a base

C an element

D a salt

22 An element E is burned in air. A white solid oxide is formed.

The oxide is tested with damp red litmus paper. The paper turns blue.

What is element E?

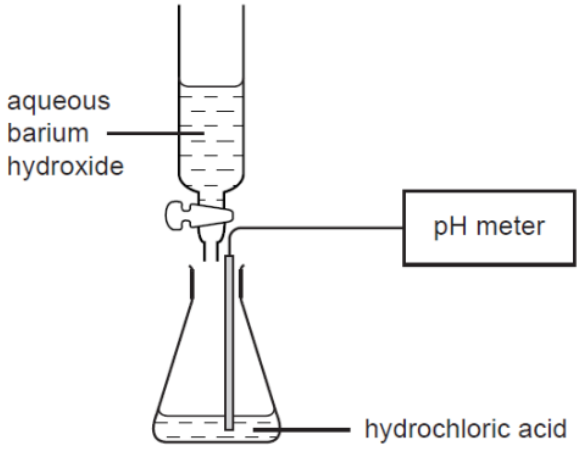
A calcium

B carbon

C iodine

D sulfur

16 Barium hydroxide is an alkali. It reacts with hydrochloric acid.



What happens to the pH of a solution of hydrochloric acid as an excess of aqueous barium hydroxide is added?

A The pH decreases from 14 but becomes constant at 7.

B The pH decreases from 14 to about 1.

C The pH increases from 1 but becomes constant at 7.

D The pH increases from 1 to about 14.

17 Element X is at the left-hand side of the Periodic Table.

Which line in the table shows the correct type and property of the oxide of X?

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

19 Which property does hydrochloric acid have?

A It gives a pale blue precipitate with aqueous copper(II) sulphate.

B It gives a white precipitate with aqueous barium nitrate.

C It releases ammonia from aqueous ammonium sulphate.

D It releases hydrogen with zinc powder.

20 Hydrochloric acid is used to clean a metal surface by removing the oxide layer on the metal.

This is because hydrochloric acid has a .....**X**..... pH and the metal oxide is .....**Y**.....

What are **X** and **Y**?

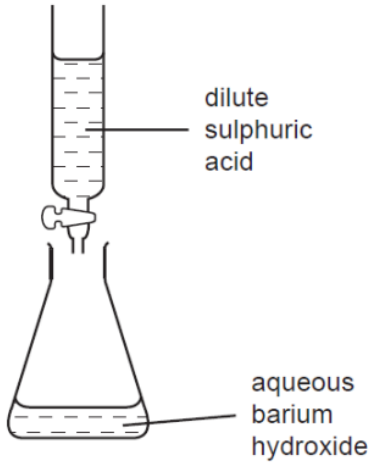
	X	Y
A	high	acidic
B	high	basic
C	low	acidic
D	low	basic

21 The apparatus shown can be used to prepare aqueous copper(II) sulphate.

What are substances **X** and **Y**?

	substance **X**	substance **Y**
A	copper	iron(II) sulphate
B	copper(II) chloride	sulphuric acid
C	copper(II) oxide	sulphuric acid
D	sulphur	copper(II) chloride

22 In the experiment shown, the dilute sulphuric acid is run into the flask of aqueous barium hydroxide until the reaction is complete.



Which processes occur in this reaction?

	neutralisation	precipitation
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

9 The oxide Pb_3O_4 reacts with dilute nitric acid to form lead(II) nitrate, lead(IV) oxide and another product.

What is the equation for this reaction?

A $Pb_3O_4 + 4HNO_3 \rightarrow 2Pb(NO_3)_2 + PbO_2 + 2H_2O$

B $Pb_3O_4 + 2HNO_3 \rightarrow 2PbNO_3 + PbO_4 + H_2$

C $Pb_3O_4 + 4HNO_3 \rightarrow Pb(NO_3)_4 + 2PbO + 2H_2O$

D $2Pb_3O_4 + 2HNO_3 \rightarrow 2Pb_2NO_3 + 2PbO_2 + H_2$

21 Water is added to a test-tube containing dilute sulphuric acid of pH 4.

What could be the pH of the resulting solution?

A 8 **B** 6 **C** 4 **D** 2

22 Aqueous solution **S** is added to aqueous ammonium chloride. The mixture is heated. Ammonia gas is given off.

What could solution **S** contain?

A aluminium

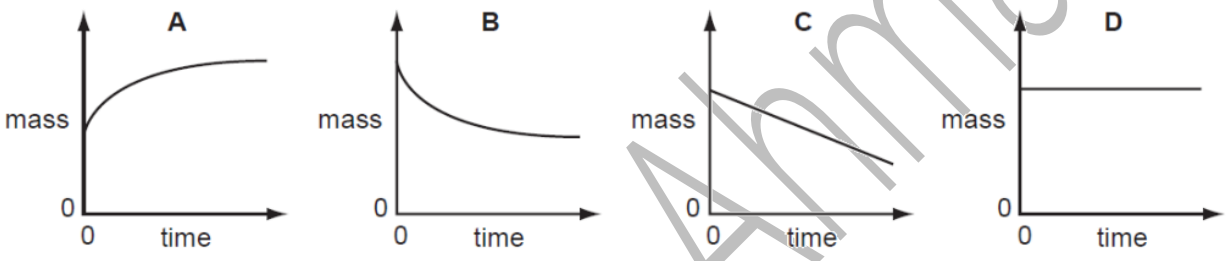
B ammonium sulphate

C sodium chloride

D sodium hydroxide

16 The mass of a beaker and its contents is plotted against time.

Which graph represents what happens when sodium carbonate reacts with an excess of dilute hydrochloric acid in an open beaker?



21 The statements are about metals and their oxides.

Metals …X… electrons to form ions. The oxides of metals are …Y….

Which words correctly complete the statements?

	X	Y
A	gain	acidic
B	gain	basic
C	lose	acidic
D	lose	basic

17 Acids react with bases, carbonates and metals.

Which of these reactions produce a gas?

	reaction of acid with a		
	base	carbonate	metal
A	✓	✓	✓
B	✓	✗	✗
C	✗	✓	✓
D	✗	✓	✗

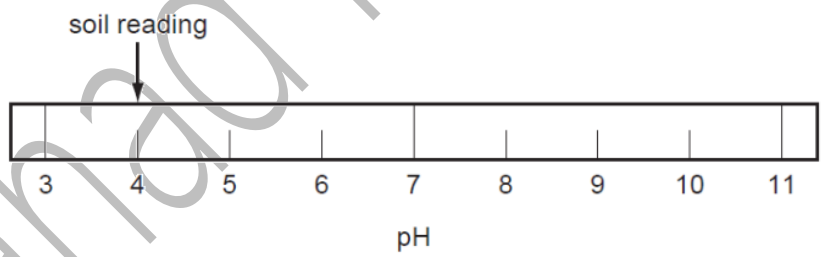
18 Which properties does an acid have?

1 reacts with ammonium sulphate to form ammonia

2 turns red litmus blue

	1	2
A	✓	✓
B	✓	✗
C	✗	✓
D	✗	✗

33 The diagram shows the results of a pH test on a sample of garden soil.



What could be added to the soil to change its pH to 7?

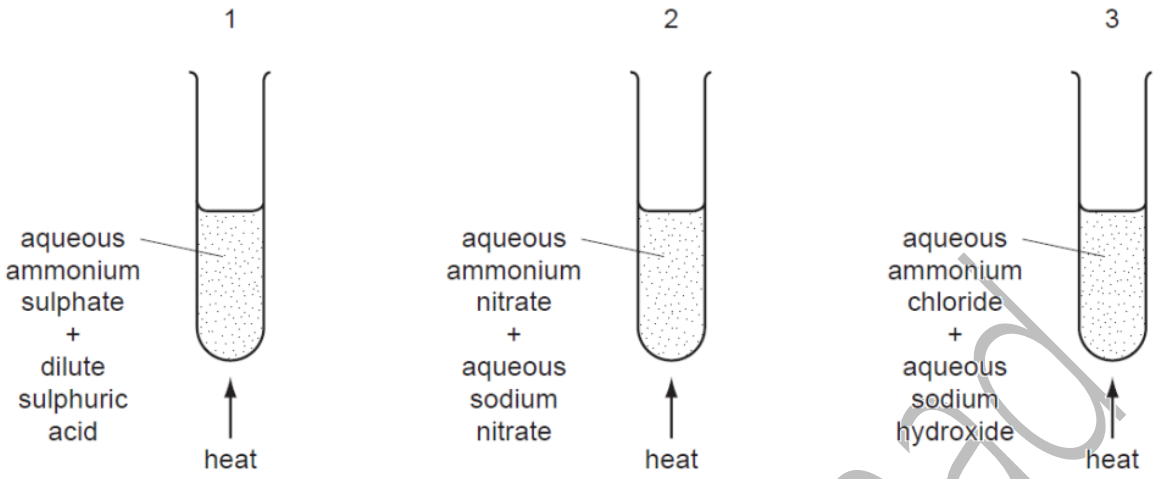
A ammonium nitrate

B lime

C sand

D sodium chloride

31 The diagrams show three experiments.

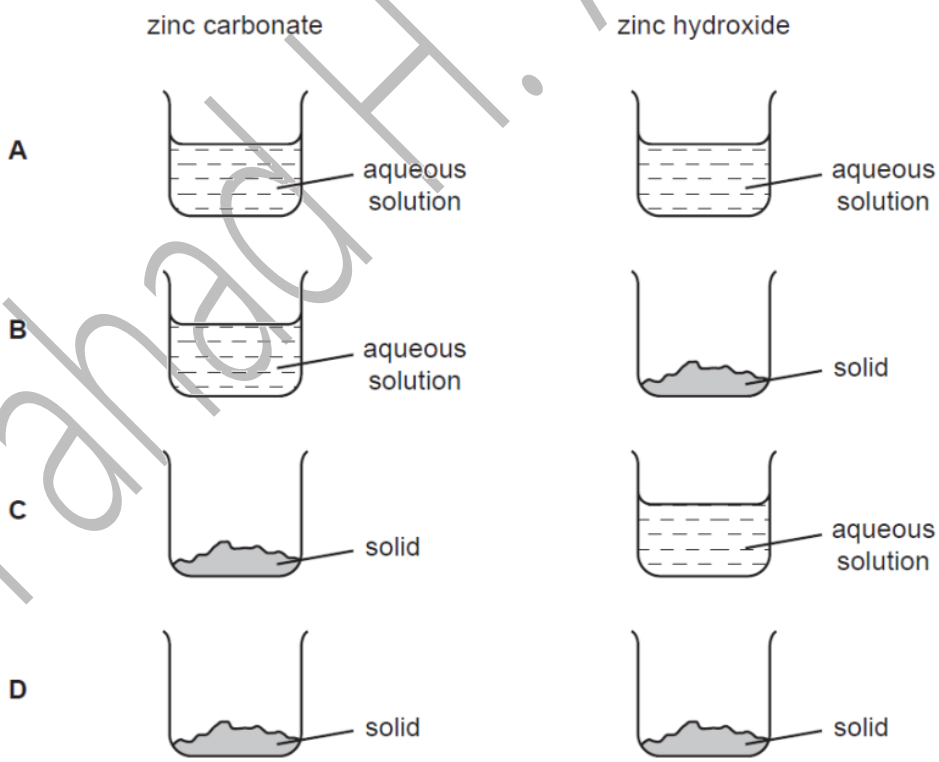


In which experiments is ammonia formed?

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

19 Pure zinc sulphate can be prepared by adding an excess of either zinc carbonate or an excess of zinc hydroxide to dilute sulphuric acid.

In which form are these zinc compounds used?



16 An excess of acid in the stomach causes indigestion that can be cured by an anti-indigestion tablet.

What should the tablet contain to decrease the acidity?

A an acidic substance

B an alkaline substance

C a neutral substance

D Universal Indicator

17 A solution is made by adding sodium oxide to water.

Which pH change can occur?

	pH change		
A	1	→	7
B	7	→	1
C	7	→	12
D	12	→	7

7 Bottles of sodium hydroxide, sodium chloride and sugar have lost their labels.

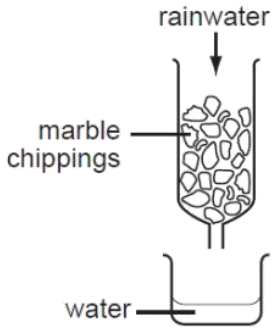
Students test a sample from each bottle. Their results are shown in the table.

bottle	addition of water	conductivity of solution
1	forms an alkaline solution	conducts electricity
2	forms a neutral solution	conducts electricity
3	forms a neutral solution	does not conduct electricity

What are the correct labels for each bottle?

	bottle 1	bottle 2	bottle 3
A	sodium hydroxide	sodium chloride	sugar
B	sodium hydroxide	sugar	sodium chloride
C	sodium chloride	sugar	sodium hydroxide
D	sugar	sodium hydroxide	sodium chloride

34 A sample of acid rainwater (pH = 4) is passed down a glass column packed with marble chippings (calcium carbonate). The water coming from the bottom of the column is collected in a beaker. The pH is now 6.



What causes the change in pH?

A The acid has been filtered.

B The acid has been neutralised.

C The acid is made more concentrated.

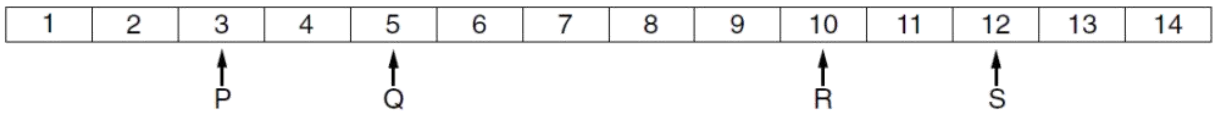
D The acid is precipitated.

20 The chart shows the colour ranges of four different indicators.

Which indicator is blue in an acidic solution?

indicator	pH value: 1 2 3 4 5 6 7 8 9 10 11 12 13 14
A	yellow → ← blue ———
B	— red ——→ blue ← yellow ———
C	——— red ——→ ← blue ———
D	——— colourless ——→ ← blue ———

21 The pH values of four solutions are shown.



Mixing combinations of these solutions can give a solution of pH 6.

Which combination of solutions could **not** do this?

A P and R

B P and S

C Q and R

D R and S

21 For which pH change is there the largest increase in acidity?

	initial pH	final pH
A	1	3
B	2	6
C	3	1
D	6	2

9 One method of producing carbon dioxide is to react calcium carbonate with dilute hydrochloric acid.

What is the balanced chemical equation for the reaction?

A $CaCO_3 + HCl \longrightarrow CaO + CO_2 + HCl$

B $CaCO_3 + 2HCl \longrightarrow CaCl_2 + CO_2 + H_2O$

C $CaCO_3 + 4HCl \longrightarrow CaCl_4 + CO_2 + H_2 + H_2O$

D $Ca(HCO_3)_2 + HCl \longrightarrow CaCl + 2CO_2 + H_2O$

19 Element X forms an oxide, XO, that neutralises sulfuric acid.

Which row describes X and XO?

	element X	nature of oxide, XO
A	metal	acidic
B	metal	basic
C	non-metal	acidic
D	non-metal	basic

17 Different plants grow best under different pH conditions.

Which plant grows best in alkaline soil?

	plant	grows best in soil at pH
A	cabbage	6-8
B	potato	4-7
C	strawberry	5-7
D	wheat	6-7

19 Which statements about alkalis are correct?

1 When reacted with an acid, the pH of the alkali increases.

2 When tested with litmus, the litmus turns blue.

3 When warmed with an ammonium salt, ammonia gas is given off.

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

18 Ant stings hurt because of the methanoic acid produced by the ant.

Which substance could, **most safely**, be used to neutralise the acid?

	substance	pH
A	baking soda	8
B	car battery acid	1
C	lemon juice	3
D	oven cleaner	14

19 Which statement about the reaction of acids is correct?

A They react with ammonium salts to form a salt and ammonia only.

B They react with metal carbonates to give a salt and carbon dioxide only.

C They react with metal hydroxides to give a salt and water only.

D They react with metals to give a salt, hydrogen and water only.

21 Two indicators, bromophenol blue and Congo red, show the following colours in acidic solutions and in alkaline solutions.

indicator	acid	alkali
bromophenol blue	yellow	blue
Congo red	violet	red

A few drops of each indicator are added to separate samples of a solution of pH 2.

What are the colours of the indicators in this solution?

	in a solution of pH 2	
	bromophenol blue is	Congo red is
A	blue	red
B	blue	violet
C	yellow	red
D	yellow	violet

16 Two oxides, X and Y, are added separately to dilute sulfuric acid and dilute sodium hydroxide.

X reacts with dilute sulfuric acid but Y does not react.

Y reacts with aqueous sodium hydroxide but X does not react.

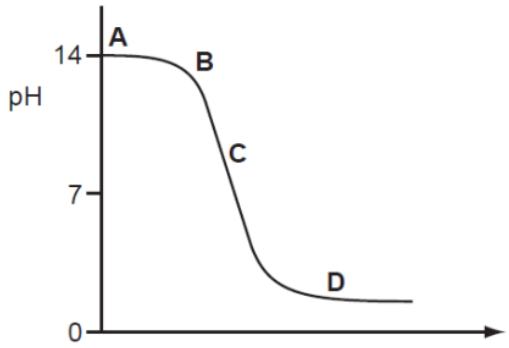
Which type of oxide are X and Y?

	acidic oxide	basic oxide	metallic oxide
A	X	Y	X
B	X	Y	Y
C	Y	X	X
D	Y	X	Y

17 The graph shows how the pH changes as an acid is added to an alkali.

$$\text{acid} + \text{alkali} \rightarrow \text{salt} + \text{water}$$

Which letter represents the area of the graph where both acid and salt are present?



THEORY QUESTIONS

1 **(a)** Match the following pH values to the solutions given below.

1 **3** **7** **10** **13**

The solutions all have the same concentration.

solution	**pH**
aqueous ammonia, a weak base	.....
dilute hydrochloric acid, a strong acid	.....
aqueous sodium hydroxide, a strong base	.....
aqueous sodium chloride, a salt	.....
dilute ethanoic acid, a weak acid	.....

[5]

(b) The formula of the hexanesulfonate ion is $C_6H_{13}SO_3^-$.

The formula of the barium ion is Ba^{2+}. What is the formula of barium hexanesulfonate?

..... [1]

(c) Complete the following equations.

(i) magnesium + hexanesulfonic acid → ..... + ...
..... [1]

(ii) calcium oxide + hexanesulfonic acid → ..... + ...
..... [1]

(iii) .....$C_6H_{13}SO_3H$ + Na_2CO_3 → ..... + ... + ... [2]

(c) It is possible to determine whether zirconium(IV) oxide is acidic, neutral, basic or amphoteric using an acid and an alkali. Complete the table of possible results. If the oxide is predicted to react write 'R', if it is predicted not to react write 'NR'.

if the oxide is	predicted result with hydrochloric acid	predicted result with aqueous sodium hydroxide
acidic		
neutral		
basic		
amphoteric		

[4]

(b) The equation for the reaction in experiment 1 is:

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

Complete the following ionic equation.

$$CaCO_3(s) + 2H^+(aq) \rightarrow \text{.....} + \text{.....} + \text{.....}$$

[1]

---

5 Hydriodic acid, HI(aq), is a strong acid. Its salts are iodides.

(a) It has the reactions of a typical strong acid. Complete the following equations.

(i) .....Li + ...HI → ..... + ... [1]

(ii) zinc carbonate + hydriodic acid → ..... + ... + ... + ... [1]

(iii) MgO + ...HI → ..... + ... [1]

(c) The selenide ion reacts with water.

$$Se^{2-} + H_2O \rightarrow HSe^- + OH^-$$

What type of reagent is the selenide ion in this reaction? Give a reason for your choice.

.....

..... [3]

(d) Thallium(I) hydroxide is an alkali. It has similar properties to sodium hydroxide.

(i) Complete the following word equation.

thallium(I) hydroxide + ammonium sulfate → ..... + ... + ...

[1]

(ii) Complete the equation.

..... TlOH + H_2SO_4 → ..... + ...

[2]

(b) They react with water to form acidic solutions.

$$HCl + H_2O \rightleftharpoons H_3O^+ + Cl^-$$

$$HF + H_2O \rightleftharpoons H_3O^+ + F^-$$

(i) Explain why water behaves as a base in both of these reactions.

.....

..... [2]

(ii) At equilibrium, only 1% of the hydrogen chloride exists as molecules, the rest has formed ions. In the other equilibrium, 97% of the hydrogen fluoride exists as molecules, only 3% has formed ions.

What does this tell you about the strength of each acid?

.....

..... [2]

(iii) How would the pH of these two solutions differ?

..... [1]

[Total: 8]

4 Sulphuric acid is a typical strong acid.

(a) Change the equations given into a different format.

(i) $Mg + H_2SO_4 \longrightarrow MgSO_4 + H_2$
Change into a word equation.

.....

[1]

(ii) lithium oxide + sulphuric acid ⟶ lithium sulphate + water
Change into a symbol equation.

.....

[2]

(iii) $CuO + 2H^+ \longrightarrow Cu^{2+} + H_2O$
Change the ionic equation into a symbol equation.

.....

[2]

(iv) $Na_2CO_3 + H_2SO_4 \longrightarrow Na_2SO_4 + CO_2 + H_2O$
Change into a word equation.

.....

[1]

(b) When sulphuric acid dissolves in water, the following reaction occurs.
$H_2SO_4 + H_2O \longrightarrow HSO_4^- + H_3O^+$
Explain why water is behaving as a base in this reaction.

.....

[2]

(c) Sulphuric acid is a strong acid, ethanoic acid is a weak acid.
Explain the difference between a strong acid and a weak acid.

.....

.....

[2]

[Total: 10]

(c) When nitric acid is added to water the following reaction occurs.

$$HNO_3 + H_2O \longrightarrow NO_3^- + H_3O^+$$

Give the name and the formula of the particle which is transferred from nitric acid to water.

name .....

formula ..... [2]

(iii) Rock phosphate (calcium phosphate) is obtained by mining. It reacts with concentrated sulphuric acid to form the fertiliser, superphosphate. Predict the formula of each of these phosphates.

fertiliser	ions	formula
calcium phosphate	Ca^{2+} and PO_4^{3-}	.....
calcium superphosphate	Ca^{2+} and $H_2PO_4^-$	..... [2]

(iv) The ionic equation for the reaction between the phosphate ion and sulphuric acid is shown below.

$$PO_4^{3-} + 2H_2SO_4 \rightarrow H_2PO_4^- + 2HSO_4^-$$

Explain why the phosphate ion is described as acting as a base in this reaction.

..... [2]
