# Acids, bases and salts – 2021 IGCSE 0620

**1.** June/2021/Paper_11/No.17

Three separate experiments are carried out on an aqueous solution of S.

The results are shown.

1 Magnesium does not react with the solution.

2 A gas is given off when ammonium sulfate is heated with the solution.

3 Methyl orange turns yellow when added to the solution.

What is S?

**A** hydrochloric acid

**B** sodium hydroxide

**C** sodium chloride

**D** sulfur dioxide

**2.** June/2021/Paper_11,12,13,21,22&23/No.18

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 |

**3.** June/2021/Paper_11&21/No.19

Copper(II) sulfate is prepared by adding excess copper(II) oxide to warm dilute sulfuric acid.

Which purification methods are used to obtain pure solid copper(II) sulfate from the reaction mixture?

1 crystallisation

2 filtration

3 chromatography

4 distillation

**A** 1 and 4 **B** 1 and 2 **C** 2 and 3 **D** 3 and 4

**4.** June/2021/Paper_12/No.17

Which statements about acids are correct?

1 They react with carbonates to form carbon dioxide.

2 They react with metals to form hydrogen.

3 They react with ammonium salts to form ammonia.

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

**5.** June/2021/Paper_12/No.19

Which test for the named gas is correct?

**A** Oxygen extinguishes a lighted splint.

**B** Hydrogen relights a glowing splint.

**C** Ammonia turns blue litmus red.

**D** Carbon dioxide turns limewater milky.

**6.** June/2021/Paper_12/No.20

Three tests are done to identify the ions present in aqueous solution X.

| test | test result |
|---|---|
| dilute nitric acid, followed by aqueous silver nitrate | cream precipitate |
| aqueous sodium hydroxide | white precipitate, soluble in excess |
| aqueous ammonia | white precipitate, soluble in excess |

Which ions are present in X?

**A** $Al^{3+}$ and $Br^-$ **B** $Al^{3+}$ and $I^-$ **C** $Zn^{2+}$ and $Br^-$ **D** $Zn^{2+}$ and $I^-$

**7.** June/2021/Paper_13/No.19

Which methods of salt preparation are suitable for copper(II) chloride?

1 Add copper(II) carbonate to dilute hydrochloric acid.

2 Add copper to dilute hydrochloric acid.

3 Warm copper(II) oxide with dilute hydrochloric acid.

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

**8.** June/2021/Paper_13/No.20

A white solid, J, is tested and the observations are shown.

| test | observations |
|---|---|
| flame test | red flame |
| acidify with nitric acid then add aqueous silver nitrate | white precipitate |

What is J?

**A** lithium bromide

**B** lithium chloride

**C** sodium bromide

**D** sodium chloride

**9.** June/2021/Paper_21/No.21

In which equation is the underlined reactant acting as a base?

**A** $CH_3COO^- + \underline{H_3O^+} \rightarrow CH_3COOH + H_2O$

**B** $\underline{NH_4^+} + OH^- \rightarrow NH_3 + H_2O$

**C** $CO_2 + 2\underline{H_2O} \rightarrow H_3O^+ + HCO_3^-$

**D** $\underline{H^+} + OH^- \rightarrow H_2O$

**10.** June/2021/Paper_21/No.24

Element R forms a covalent compound $R_2Si$ with silicon.

Which row describes R?

| | metallic or non-metallic character | group number in the Periodic Table |
|---|---|---|
| **A** | metallic | II |
| **B** | metallic | VI |
| **C** | non-metallic | II |
| **D** | non-metallic | VI |

**11.** June/2021/Paper_22/No.17

When bismuth(III) chloride, $BiCl_3$, reacts with water, a white precipitate of bismuth(III) oxychloride, $BiOCl$, is formed. The equation for the reaction is shown.

$$BiCl_3(aq) + H_2O(l) \rightleftharpoons BiOCl(s) + 2H^+(aq) + 2Cl^-(aq)$$

The reaction is in equilibrium.

Which changes cause the white precipitate to dissolve?

1 adding acid

2 adding water

3 adding sodium chloride solution

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

**12.** June/2021/Paper_22/No.19

Information about the solubility of salts is shown.

| salt | solubility |
|---|---|
| chlorides | soluble (except for lead(II) chloride and silver chloride) |
| nitrates | soluble |
| sulfates | soluble (except for barium sulfate and lead(II) sulfate) |

Aqueous solutions of which two compounds would produce a precipitate when added together?

**A** $Ba(NO_3)_2$ and $CaCl_2$

**B** $CuSO_4$ and $Zn(NO_3)_2$

**C** $KCl$ and $Na_2SO_4$

**D** $Pb(NO_3)_2$ and $MgSO_4$

**13.** June/2021/Paper_22/No.21

Burning fossil fuels releases sulfur dioxide which leads to acid rain.

Which ion in the rain water causes it to be acidic?

**A** $H^+$ **B** $OH^-$ **C** $O^{2-}$ **D** $SO_4^{2-}$

**14.** June/2021/Paper_23/No.19

Aqueous solutions of sodium sulfate and barium chloride are mixed.

$$Na_2SO_4(aq) + BaCl_2(aq) \rightarrow BaSO_4(s) + 2NaCl(aq)$$

Which process is used to separate a sample of barium sulfate from the reaction mixture?

**A** precipitation

**B** filtration

**C** evaporation

**D** distillation

**15.** March/2021/Paper_12/No.18

Which property is shown by the alkali sodium hydroxide?

**A** It has a pH less than pH 7.

**B** It produces a gas when it is warmed with ammonium chloride.

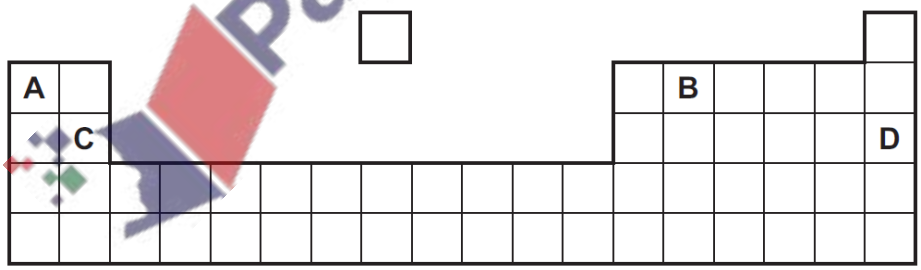
**C** It turns blue litmus red.

**D** It turns universal indicator green.

**16.** March/2021/Paper_12&22/No.19

Part of the Periodic Table is shown.

Which element forms an acidic oxide?



**17.** March/2021/Paper_12&22/No.20

When aqueous sodium hydroxide is added to a solution of a metal ion, a grey-green precipitate forms, which dissolves in excess to form a dark green solution.

What is the identity of the metal ion?

**A** chromium(III)

**B** iron(II)

**C** iron(III)

**D** copper(II)

**18.** March/2021/Paper_22/No.21

Which statements about strong acids are correct?

1 They have a high concentration of $OH^-$ ions.

2 They have a pH value of 1.

3 They completely ionise in water.

4 They turn red litmus blue.

**A** 1 and 3 **B** 1 and 4 **C** 2 and 3 **D** 2 and 4

**19.** June/2021/Paper_41/No.5

This question is about salts.

**(a)** Salts that are insoluble in water are made by precipitation.

- Lead(II) iodide, $PbI_2$, is insoluble in water.
- All nitrates are soluble in water.
- All sodium salts are soluble in water.

You are provided with solid lead(II) nitrate, $Pb(NO_3)_2$, and solid sodium iodide, NaI.

Describe how you would make a pure sample of lead(II) iodide by precipitation.

Your answer should include:

- practical details
- a chemical equation for the precipitation reaction.

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..... [5]



**(b)** Nitrates decompose when heated.

**(i)** When hydrated zinc nitrate is heated, oxygen gas is given off.

Describe a test for oxygen.

test .....

observations .....

[2]

**(ii)** Complete the equation for the decomposition of hydrated zinc nitrate.

$$2Zn(NO_3)_2 \cdot 6H_2O \rightarrow \text{.....}ZnO + \text{.....}NO_2 + O_2 + \text{.....}H_2O$$ [2]

**(c)** Some sulfates are hydrated.

When hydrated sodium sulfate crystals, $Na_2SO_4 \cdot \boldsymbol{x}H_2O$, are heated, they give off water.

$$Na_2SO_4 \cdot \boldsymbol{x}H_2O(s) \rightarrow Na_2SO_4(s) + \boldsymbol{x}H_2O(g)$$

A student carries out an experiment to determine the value of $\boldsymbol{x}$ in $Na_2SO_4 \cdot \boldsymbol{x}H_2O$.

**step 1** Hydrated sodium sulfate crystals are weighed.

**step 2** The hydrated sodium sulfate crystals are then heated.

**step 3** The remaining solid is weighed.

**(i)** Describe how the student can check that all the water has been given off.

.....

.....

..... [2]

**(ii)** In an experiment, 1.61 g of $Na_2SO_4 \cdot \boldsymbol{x}H_2O$ is heated until all the water is given off. The mass of $Na_2SO_4$ remaining is 0.71 g.

[$M_r$: $Na_2SO_4$,142; $H_2O$,18]

Determine the value of ***x*** using the following steps.

- Calculate the number of moles of $Na_2SO_4$ remaining.

..... mol

- Calculate the mass of $H_2O$ given off.

..... g

- Calculate the number of moles of $H_2O$ given off.

..... mol

- Determine the value of ***x***.

***x*** = .....

[4]

[Total: 15]

**20.** June/2021/Paper_42/No.2

Silver has an atomic number of 47.

**(a)** Naturally occurring atoms of silver are $^{107}Ag$ and $^{109}Ag$.

**(i)** State the name given to atoms of the same element with different nucleon numbers.

..... [1]

**(ii)** Complete the table to show the number of protons, neutrons and electrons in each atom and ion of silver shown.

| | $^{107}_{47}Ag$ | $^{109}_{47}Ag^{+}$ |
|---|---|---|
| protons | | |
| neutrons | | |
| electrons | | |

[3]

**(iii)** Complete this definition of relative atomic mass.

Relative atomic mass is the ..... mass of naturally occurring atoms of an element on a scale where the ..... atom has a mass of exactly ..... units.

[3]

**(iv)** A sample of silver has a relative atomic mass of 108.0.

Deduce the percentage of $^{107}Ag$ present in this sample of silver.

..... [1]

**(b)** Silver nitrate is a salt of silver made by reacting silver oxide with an acid.

Write the formula of the acid which reacts with silver oxide to form silver nitrate.

..... [1]

**(c)** Aqueous silver nitrate is a colourless solution containing $Ag^+(aq)$ ions.

**(i)** Describe what is seen when aqueous silver nitrate is added to aqueous sodium iodide, NaI(aq).

..... [1]

**(ii)** Write the ionic equation for the reaction between aqueous silver nitrate and aqueous sodium iodide.
Include state symbols.

..... [3]

**(d)** In the positive test for aqueous nitrate ions, aqueous sodium hydroxide and one other substance are warmed with the nitrate ions.

Name this other substance and the gas formed.

name of substance .....

name of gas .....
[2]

**(e)** When silver nitrate is exposed to sunlight, silver is formed.

Name the type of reaction which needs light to make it happen.

..... [1]

**(f)** Members of one homologous series only react with chlorine in the presence of sunlight.

**(i)** Name a member of this homologous series.

..... [1]

**(ii)** Name **two** products that form when the compound in **(i)** reacts with chlorine.

1 .....

2 .....
[2]

[Total: 19]

**21.** June/2021/Paper_43/No.5

This question is about salts.

**(a)** Salts that are soluble in water can be made by the reaction between insoluble carbonates and dilute acids. Zinc sulfate is soluble in water.

You are provided with solid zinc carbonate, $ZnCO_3$, and dilute sulfuric acid, $H_2SO_4$.

Describe how you would make a pure sample of zinc sulfate crystals.

Your answer should include:

- practical details
- how you would make sure that all the dilute sulfuric acid has reacted
- a chemical equation for the reaction.

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..... [5]



**(b)** Some sulfates decompose when heated.

When hydrated iron(II) sulfate is heated strongly, sulfur dioxide gas is given off.

**(i)** Describe a test for sulfur dioxide.

test .....

observations .....

[2]

**(ii)** Complete the equation for the decomposition of hydrated iron(II) sulfate.

$$.....FeSO_4 \cdot 7H_2O \rightarrow Fe_2O_3 + SO_2 + SO_3 + .....H_2O$$ [2]

**(c)** Some chlorides are hydrated.

When hydrated barium chloride crystals, $BaCl_2 \cdot xH_2O$, are heated they give off water.

$$BaCl_2 \cdot xH_2O(s) \rightarrow BaCl_2(s) + xH_2O(g)$$

A student carries out an experiment to determine the value of ***x*** in $BaCl_2 \cdot xH_2O$.

**step 1** Hydrated barium chloride crystals are weighed.

**step 2** The hydrated barium chloride crystals are then heated.

**step 3** The remaining solid is weighed.

**(i)** Describe how the student can be sure that all the water is given off.

.....

.....

..... [2]

**(ii)** In an experiment, 4.88 g of $BaCl_2 \cdot xH_2O$ is heated until all the water is given off. The mass of $BaCl_2$ remaining is 4.16 g.

[$M_r$: $BaCl_2$, 208; $H_2O$, 18]

Determine the value of ***x*** using the following steps.

- Calculate the number of moles of $BaCl_2$ remaining.

..... mol

- Calculate the mass of $H_2O$ given off.

..... g

- Calculate the number of moles of $H_2O$ given off.

..... mol

- Determine the value of ***x***.

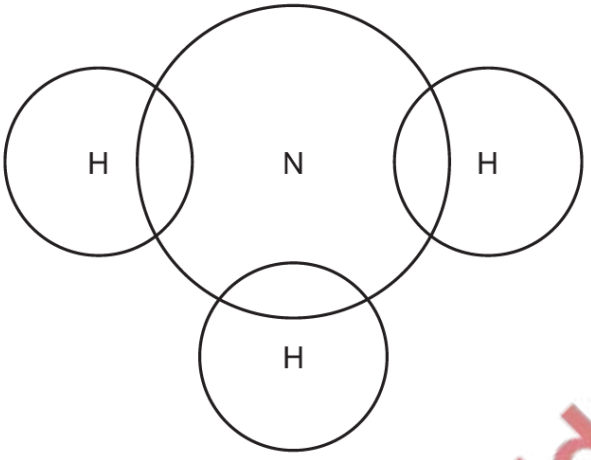
***x*** = .....
[4]

[Total: 15]

**22.** March/2021/Paper_32/No.8

Aqueous ammonia is an alkali.

**(a)** Complete the dot-and-cross diagram to show the electron arrangement in a molecule of ammonia.




[2]

**(b)** Complete the word equation for the reaction of aqueous ammonia with dilute hydrochloric acid.

| ammonia | + | hydrochloric acid | → | ..... ..... |
|---|---|---|---|---|

[1]

**(c)** Describe the colour change when excess aqueous ammonia is added to an acidified solution of methyl orange.

from ..... to ..... [1]

**(d)** Aqueous ammonia reacts with aqueous copper(II) ions to produce compound **B**.

The formula of compound **B** is $CuN_4H_{16}O_2$.

Complete the table to calculate the relative molecular mass of compound **B**.

| type of atom | number of atoms | relative atomic mass | |
|---|---|---|---|
| copper | 1 | 64 | $1 \times 64 = 64$ |
| nitrogen | 4 | 14 | $4 \times 14 = 56$ |
| hydrogen | | 1 | |
| oxygen | | 16 | |

relative molecular mass = .....
[2]

**(e)** Ammonia is used in the production of fertilisers.

State why farmers put fertilisers on the soil where crops are to be grown.

..... [1]

[Total: 7]

**23.** March/2021/Paper_42/No.4

A student wanted to make some zinc chloride crystals.

The student followed the procedure shown.

**step 1** Add excess zinc powder to dilute hydrochloric acid to form aqueous zinc chloride.

**step 2** Remove unreacted zinc powder from the aqueous zinc chloride.

**step 3** Heat the solution until it is saturated.

**step 4** Allow the saturated solution to cool and remove the crystals that form.

**(a)** Write the equation for the reaction in **step 1**. Include state symbols.

..... [3]

**(b)** Explain why **excess** zinc powder is added in **step 1**.

..... [1]

**(c)** Suggest how unreacted zinc powder is removed in **step 2**.

..... [1]

**(d)** A saturated solution is formed in **step 3**.

Suggest what is meant by the term *saturated solution*.

.....

..... [2]

**(e)** Explain why crystals form as the solution cools in **step 4**.

..... [1]

**(f)** Name **two** zinc compounds which react with dilute hydrochloric acid to form zinc chloride.

.....

..... [2]

**(g)** If excess calcium metal is used instead of excess zinc powder in **step 1**, pure calcium chloride crystals do **not** form.

Explain why.

.....

..... [1]

**(h)** Some salts can be made by titration.

In a titration experiment, 20.0 $cm^3$ of aqueous sodium hydroxide reacts exactly with 25.0 $cm^3$ of 0.100 $mol/dm^3$ dilute sulfuric acid to make sodium sulfate.

$$2NaOH(aq) + H_2SO_4(aq) \rightarrow Na_2SO_4(aq) + 2H_2O(l)$$

**(i)** Circle the name of the type of reaction that takes place.

**decomposition** **neutralisation** **precipitation** **reduction**

[1]

**(ii)** Calculate the concentration of the aqueous sodium hydroxide in $g/dm^3$ using the following steps.

- Calculate the number of moles of dilute sulfuric acid used.

..... mol

- Determine the number of moles of sodium hydroxide which react with the dilute sulfuric acid.

..... mol

- Calculate the concentration of the aqueous sodium hydroxide in $mol/dm^3$.

..... $mol/dm^3$

- Calculate the concentration of the aqueous sodium hydroxide in $g/dm^3$.

..... $g/dm^3$

[5]

[Total: 17]