

GCSE Chemistry (9 – 1)

Acids and Alkalis

Name:

Group:

Instructions

- Read each question carefully before you begin to answer it.
- Use black ink or black ball-point pen for your answers.
- Fill in the boxes at the top of this page with your name and group.
- Attempt to answer every question in the booklet.
- Answer the questions in the spaces provided – there may be more space than you need in some answer spaces.
- Calculators may be used for this booklet.
- For any calculations, you **must** show all your working.
- Any and all drawings or graphs should be completed in pencil.



For markers use	
Question	Mark
1	/5
2	/17
3	/15
4	/8
5	/10
6	/8
Total	/63
%	
Grade	

Information

- The maximum mark for this paper is 63 marks.
- The marks for each question are shown in brackets.
- Please be aware that good English and clear presentation are required in your answers.



1. Acids and alkalis, two groups of chemicals with opposing properties that are measured using the pH scale. Circle the letter of the correct answer for each of the following questions.

- a) When hydrochloric acid and sodium hydroxide react, water is formed.
Which two ions combine to produce the water?

A	B	C	D
Na^+ and Cl^-	Na^+ and H	OH^- and Cl	H^+ and OH^-

(1 mark)

- b) Four different solutions, P, Q, R and S, are tested with universal indicator.

Solution	P	Q	R	S
Colour with universal indicator	red	purple	orange	blue

Which solutions are alkali?

A	B	C	D
P and Q	Q and R	Q and S	R and S

(1 mark)

- c) A student tests an unknown substance, compound Z.
They observe that when it is dissolved in water and tested with methyl orange, the solution turns red.
What could compound Z be?

A	B	C	D
Potassium oxide	Sodium carbonate	Sulfur dioxide	Copper(II) oxide

(1 mark)

- d) Acidic soil contains an excess of hydrogen ions (H^+).
Which ion from calcium hydroxide reacts with the hydrogen ions to neutralise the soil?

A	B	C	D
CO_3^{2-}	NO_3^-	OH^-	SO_4^{2-}

(1 mark)

- e) Acids undergo several key types of reactions. Which of the reactions shown below would not occur?

- A It produces carbon dioxide from a carbonate.
- B It dissolves magnesium oxide.
- C It produces ammonia from ammonium compounds.
- D It produces hydrogen from zinc metal.

(1 mark)

(Total for Question 1 is 5 marks)

2. A student is planning to make three different salts in the lab.
They must choose the best method for each one.

For each salt listed in the table, help the student by:

- Choosing the most suitable method (titration, neutralisation of an insoluble solid, or precipitation).
- Naming the two chemicals they should react together.

a) Complete the table.

Suitable method	Reagent 1	Reagent 2	Salt
Neutralisation		magnesium oxide	magnesium chloride
Titration			potassium sulfate
Precipitation	barium chloride		barium sulfate
Neutralisation			Calcium nitrate

(3 marks)

b) The salt must be separated from the reaction mixture and purified.

- i. Describe the steps used to obtain a pure, dry sample of barium sulfate after the precipitation reaction is complete.

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(3 marks)

- ii. Describe the steps used to obtain pure, dry crystals of magnesium chloride from the solution after the unreacted magnesium oxide has been removed by filtration.

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(3 marks)

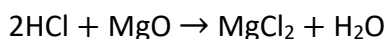
- c) Precipitation reactions can be represented by an ionic equation.

Write the balanced ionic equation, including state symbols, for the formation of barium sulfate.

.....
.....

(2 marks)

- d) In an experiment to make magnesium chloride, a student reacted excess hydrochloric acid with 4.0 g of magnesium oxide. The equation for the reaction is:



After purification, the student obtained an actual yield of 8.5 g of magnesium chloride.

Calculate the percentage yield for this experiment.

(Relative atomic masses (A_r): O = 16, Mg = 24, Cl = 35.5)

Give your answer to three significant figures.

Percentage yield = ... %

(4 marks)

- e) The student's calculated percentage yield was less than 100%.

State **two** reasons why the actual yield in this experiment might be less than the theoretical yield.

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(2 marks)

(Total for Question 2 is 17 marks)

3. This question is about the properties of ammonia.

A student produces a gas they believe to be ammonia.

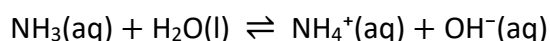
a) Describe the chemical test they would perform to confirm this, and the expected positive result.

Test:
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.....

Positive result:
.....

(2 marks)

b) Ammonia dissolves in water in a reversible reaction to form a basic solution. The equation is:



i. Explain how the presence of the hydroxide ion (OH^-) in the equation confirms that ammonia forms a basic solution.

.....
.....
(1 mark)

ii. The term '**weak base**' is used to describe aqueous ammonia.
Suggest a likely pH value for this solution.

pH = ...
(1 mark)

iii. A student adds aqueous ammonia dropwise to a test tube containing a solution of copper(II) sulfate, and then continues to add it in excess.

Describe the **two** main observations they would make during this process.

First observation (on adding a small amount):
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.....

Final observation (on adding excess ammonia):
.....
.....

(2 marks)

c) A student investigates the reaction between dilute sulfuric acid (H_2SO_4) and aqueous sodium hydroxide (NaOH), which is a strong alkali.

i. Write the **balanced** chemical equation for this reaction.

.....
(2 marks)

ii. What is the general name for the reaction between an acid and an alkali?

.....
(1 mark)

iii. The reaction is exothermic. What would be observed to confirm this?

.....
(1 mark)

d) A titration was performed to determine the exact concentration of the sulfuric acid.

It was found that 15.00 cm^3 of the sulfuric acid was neutralised by 25.0 cm^3 of sodium hydroxide solution with a concentration of 0.0500 mol/dm^3 .

i. Name a suitable indicator for this titration and state the colour change that would occur at the end-point.

Indicator:

Colour change: (2 marks)

ii. Calculate the concentration of the sulfuric acid in mol/dm^3 .
First, calculate the moles of sodium hydroxide used.

Moles of NaOH = ... mol
(1 mark)

iii. Using the mole ratio from your equation in part (c)(i), determine the moles of sulfuric acid that reacted.

Moles of H_2SO_4 = ... mol
(1 mark)

iv. Finally, calculate the concentration of the sulfuric acid. Give your answer to 3 significant figures.

Concentration of H_2SO_4 = ... mol/dm^3
(1 mark)

(Total for Question 3 is 15 marks)

4. Hydrogen chloride can be made by the reaction between hydrogen gas (H₂) and chlorine gas (Cl₂).

a) Complete the balanced equation for this reaction.

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(1 mark)

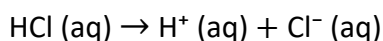
b) Hydrogen chloride (HCl) is a gas that dissolves in water to form hydrochloric acid, a common laboratory chemical.

i. What is meant by the term strong acid?

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(2 marks)

ii. When hydrogen chloride dissolves in water, it fully ionises.

The equation for this process is:



Explain how this equation shows that hydrochloric acid is a strong acid.

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(2 marks)

c) Draw a dot and cross diagram for a molecule of hydrogen chloride.

Show **all** electrons in your diagram.

(2 marks)

d) Hydrogen chloride also reacts to magnesium metal.

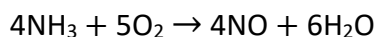
Complete the equation for the reaction of hydrochloric acid with magnesium.

magnesium + hydrochloric acid → + hydrogen
(1 mark)

(Total for Question 4 is 8 marks)

5. There are several stages to the production of nitric acid in industry.

Nitrogen monoxide is required for the production of nitric acid. Nitrogen monoxide can be obtained by passing ammonia and air over a hot catalyst. The equation for the reaction is:



- a) Calculate the atom economy for the production of nitrogen monoxide, NO, in this reaction.

Relative atomic masses: H = 1 N = 14 O = 16

Give your answer to **three** significant figures.

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atom economy = ...

(4 marks)

- b) Ammonia (NH₃), a reactant in this process, dissolves in water to form a weak alkaline solution.

Explain what is meant by the term **weak alkali**.

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(2 marks)

- c) Write the balanced ionic equation for the reversible reaction that occurs when ammonia dissolves in water.

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(2 marks)

- d) The reaction between nitric acid (HNO₃) and an alkali like potassium hydroxide (KOH) is a neutralisation reaction.

Write the ionic equation, including state symbols, for this neutralisation.

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(2 marks)

(Total for Question 5 is 10 marks)

6. Ammonia is a compound which only contains the elements nitrogen and hydrogen. It is a weak alkali.

a) What is an alkali?

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(2 marks)

b) A student has aqueous solutions of ammonia and sodium hydroxide.

Both solutions have a concentration of 0.2 mol/dm^3 how could the student show that ammonia is the weaker alkali?

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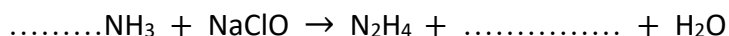
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(2 marks)

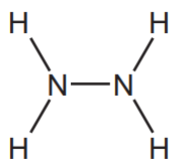
c) Another compound which contains only nitrogen and hydrogen is hydrazine, N_2H_4 .

Complete the equation for the preparation of hydrazine from ammonia.



(2 marks)

d) The structural formula of hydrazine is shown in the figure below.



Draw a diagram showing the arrangement of the electrons in one molecule of the covalent compound hydrazine.

(2 marks)

(Total for Question 6 is 8 marks)