2021 ASSESSMENT MATERIALS

GCSE
CHEMISTRY

Chemistry Test 2: Chemical changes (Higher)

Total number of marks: 36

0 1 Soluble salts are formed by reacting metal oxides with acids.

0 1 . 1 Give **one** other type of substance that can react with an acid to form a soluble salt.

[1 mark]

metal hydroxide

0 1 . 2 Calcium nitrate contains the ions Ca^{2+} and NO_3^-

Give the formula of calcium nitrate.

[1 mark]

$Ca(NO_3)_2$

$$MgO + H_2SO_4 \rightarrow MgSO_4 + H_2O$$

0 1 . 3 Describe a method to make pure, dry crystals of magnesium sulfate from a metal oxide and a dilute acid.

[6 marks]

Magnesium sulfate can be made by reacting magnesium oxide with dilute sulfuric acid. Weigh out approximately 5 g of the magnesium oxide using a scale balance. Measure 50cm^3 of the sulfuric acid using a measuring cylinder and pour it into a beaker. Add the magnesium oxide one spatula at a time until it is in excess, stirring with a glass stirring rod. Filter the mixture using a funnel and filter paper to only be left with the salt and water. Heat the solution in an evaporating dish over a small bunsen burner until small crystals start to form on the edges of the dish. Leave the solution to cool at room temperature for 24hrs to allow large crystals to form. Wash the crystals with distilled water. Dry the crystals by dabbing gently with filter paper.

0 7 This question is about electrolysis.

Aluminium is produced by electrolysing a molten mixture of aluminium oxide and cryolite.

0 7 . 1 Explain why a mixture is used as the electrolyte instead of using only aluminium oxide.

[2 marks]

The mixture has a lower melting point than pure aluminium oxide, reducing the costs needed to extract aluminium. Cryolite acts as a solvent for the aluminium oxide and increases the conductivity of the solution.

0 7 . 2 What happens at the negative electrode during the production of aluminium?

[1 mark]

Tick (✓) **one** box.

- Aluminium atoms gain electrons. ☐
- Aluminium atoms lose electrons. ☐
- Aluminium ions gain electrons. ☑
- Aluminium ions lose electrons. ☐

0 7 . 3 Oxygen is produced at the positive electrode.

Complete the balanced half-equation for the process at the positive electrode.

[2 marks]

$2O^{2-} \rightarrow O_2 + 4e^-$

0 7 . 4 Explain why the positive electrode must be continually replaced.

[3 marks]

The oxygen formed reacts with the carbon at the positive electrode to form CO_2, which burns the electrode away.

0 7 . 5 The overall equation for the electrolysis of aluminium oxide is:

$$2Al_2O_3 \rightarrow 4Al + 3O_2$$

Calculate the mass of oxygen produced when 2000 kg of aluminium oxide is completely electrolysed. $2000000g = 2 \times 10^6$

Relative atomic masses (A_r): O = 16 Al = 27

[4 marks]

	$2Al_2O_3 \rightarrow 4Al + 3O_2$	
mass	2×10^6 g	? $32 \times 29411.76471 = 941176.4706g$
Mr	102	32
moles	19607.84314 $\xrightarrow{\div 2, \times 3}$	29411.76471

Mass of oxygen = 941 kg

Sodium metal and chlorine gas are produced by the electrolysis of molten sodium chloride.

0 7 . 6 Explain why sodium chloride solution **cannot** be used as the electrolyte to produce sodium metal.

[2 marks]

Sodium chloride solution as the electrolyte results in hydrogen gas forming at the negative electrode and chlorine gas forming at the positive electrode. Sodium ions react with OH^- ions from the water to form sodium hydroxyde solution.

0 7 . 7 Calculate the volume of 150 kg of chlorine gas at room temperature and pressure.

The volume of one mole of any gas at room temperature and pressure is 24.0 dm^3

Relative formula mass (M_r): $Cl_2 = 71$

[2 marks]

Volume of 1 mole = 24.0 dm^3

moles of Cl_2 = $\frac{150\,000}{71}$

= 2112.676056

24 x 2112.676

= 50704 dm^3

Volume = 50704 dm^3

0 9 Citric acid is a weak acid.

0 9 . 1 Explain what is meant by a weak acid.

[2 marks]

a weak acid is an acid that only partially dissociates into ions in solution, with a pH between 3 and 7 (not including 7).

A student titrated citric acid with sodium hydroxide solution.

This is the method used.

1. Pipette 25.0 cm^3 of sodium hydroxide solution into a conical flask.
2. Add a few drops of thymol blue indicator to the sodium hydroxide solution.

   Thymol blue is blue in alkali and yellow in acid.
3. Add citric acid solution from a burette until the end-point was reached.

0 9 . 2 Explain what would happen at the end-point of this titration.

Refer to the acid, the alkali and the indicator in your answer.

[3 marks]

The citric acid would react with the sodium hydroxide solution to form a salt and water. The acid neutralises the sodium hydroxide at the end-point of the titration and the thymol blue indicator changes from blue to yellow. Neither acid nor alkali is in excess at the end point.

0 9 . 3 Explain why a pipette is used to measure the sodium hydroxide solution but a burette is used to measure the citric acid solution.

[2 marks]

A pipette can only measure a fixed amount of solution whereas a burette can measure variable amounts which is needed for a titration to determine what volume of acid is needed to neutralise the alkali.

0 9 . 4 **Table 5** shows the student's results.

Table 5

	Titration 1	Titration 2	Titration 3	Titration 4	Titration 5
Volume of citric acid solution in cm^3	13.50	12.10	11.10	12.15	12.15

The equation for the reaction is:

$$C_6H_8O_7 + 3NaOH \rightarrow C_6H_5O_7Na_3 + 3H_2O$$

The concentration of the sodium hydroxide was 0.102 mol/dm^3

Concordant results are those within 0.10 cm^3 of each other.

Calculate the concentration of the citric acid in mol/dm^3

Use only the concordant results from **Table 5** in your calculation.

You must show your working.

[5 marks]

mean titre = $\frac{12.10 + 12.15 + 12.15}{3}$ = 12.13 (volume of acid)

$C_6H_8O_7 + 3NaOH \rightarrow C_6H_5O_7Na_3 + 3H_2O$

n	8.5×10^{-4}	÷3 ←	0.00255
C	?		0.102 ×
V	0.01213		0.025

concentration of acid = $\frac{n}{V} = \frac{8.5 \times 10^{-4}}{0.01213} = 0.070074$

Concentration = 0.070 mol/dm^3