GCSE · AQA · Chemistry

2 hours 18 questions

Exam Questions

Concentration of Solutions

Using Concentrations in mol/dm3

Easy (5 questions)	/31
Medium (6 questions)	/28
Hard (7 questions)	/56
Total Marks	**/115**

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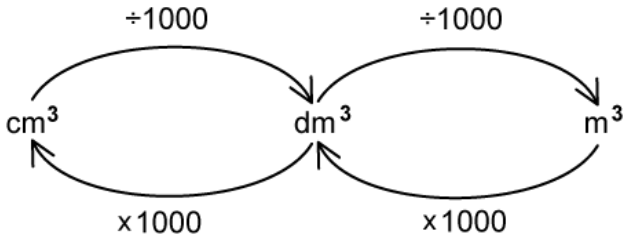
Easy Questions

1 (a) Use the conversion factors in **Figure 1** to convert the volumes in parts (a) - (e):

Figure 1



1000 cm^3 = ____ dm^3

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(1 mark)

(b) 2500 cm^3 = ____ dm^3

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(1 mark)

(c) 50 cm^3 = ____ dm^3

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(1 mark)

(d) ____ cm^3 = 3.2 dm^3

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(1 mark)

(e) ____ cm^3 = 0.75 dm^3

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(1 mark)

2 (a) Write the equation to calculate concentration in terms of moles and volume.

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(1 mark)

(b) How many moles of sodium hydroxide are present in 1.5 dm^3 of a 0.25 mol dm^{-3} sodium hydroxide solution?

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.....

(2 marks)

(c) What is the concentration in g dm^{-3} of the 0.25 mol dm^{-3} solution of sodium hydroxide?

Relative formula mass (M_r): NaOH = 40

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(1 mark)

3 (a) In a titration experiment, 25.0 cm^3 of dilute hydrochloric acid, HCl (aq), was neutralised by 23.5 cm^3 of 0.100 mol dm^{-3} sodium hydroxide solution, NaOH (aq) to produce sodium chloride (NaCl) and water.

hydrochloric acid + sodium hydroxide → sodium chloride + water

Write the balanced symbol equation, including state symbols, for this reaction.

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..... **(2 marks)**

(b) Convert 23.5 cm^3 into dm^3.

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

(c) Calculate the number of moles of sodium hydroxide used in the titration.

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..... **(2 marks)**

(d) State the number of moles of hydrochloric acid neutralised by the sodium hydroxide.

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

(e) Calculate the concentration of the dilute hydrochloric acid.

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..... **(2 marks)**

4 (a) A student neutralised dilute sulfuric acid with potassium hydroxide solution.

Balance the chemical equation for this reaction.

$$\_\_\_ KOH + \_\_\_ H_2SO_4 \rightarrow \_\_\_ K_2SO_4 + \_\_\_ H_2O$$

(2 marks)

(b) The student found that 31.0 cm^3 of 0.250 mol / dm^3 dilute sulfuric acid completely reacted with 25.0 cm^3 of potassium hydroxide solution.

How many moles of sulfuric acid are used in the reaction?

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..... **(3 marks)**

(c) Calculate the concentration of the potassium hydroxide solution in mol / dm^3.

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..... **(3 marks)**

(d) Calculate the concentration of the potassium hydroxide solution in g / dm^3.

Relative atomic masses (A_r): H = 1; K = 39; O = 16

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..... **(2 marks)**

5 (a) A technician needs to make a 0.150 mol / dm^3 solution of barium chloride, $BaCl_2$.

What mass of barium chloride does the technician need to weigh out?

Relative atomic masses (A_r): Ba = 137; Cl = 35.5

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(2 marks)

(b) The technician only has 250 cm^3 volumetric flasks available to make the barium chloride solution.

What mass of barium chloride should the technician use to make the same concentration solution in a 250 cm^3 flask?

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(2 marks)

Medium Questions

1 A solution of sulfuric acid, H_2SO_4, contains 9.8 g of the acid in 250 cm^3 of solution.

What is the concentration in mol/dm^3?

Relative atomic masses (A_r): H = 1 S = 32 O= 16

A. 0.10 mol/dm^3

B. 0.20 mol/dm^3

C. 0.40 mol/dm^3

D. 0.80 mol/dm^3

(1 mark)

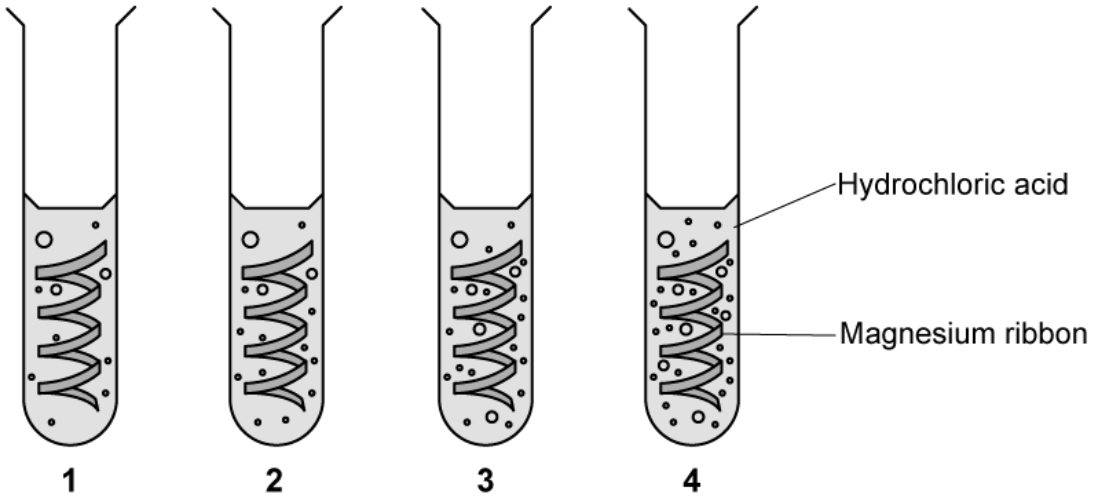
2 (a) A student investigated the rate of reaction between magnesium ribbon and hydrochloric acid.

$$Mg\ (s) + 2HCl\ (aq) \rightarrow MgCl_2\ (aq) + H_2\ (g)$$

The experiment involved changing the concentration of the acid and observing its effect on the rate of reaction.

The student did this by measuring the time taken for the magnesium to stop reacting. She set up the experiment as shown in **Figure 1**.

Figure 1



The concentration and results of the experiment were recorded in **Table 1**.

Table 1

	Concentration / mol dm^{-3}	**Time for reaction to finish / s**
Test tube 1	0.5	78
Test tube 2	1.0	62
Test tube 3	1.5	50
Test tube 4	2.0	36

State **three** variables that the student should control.

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..... **(3 marks)**

(b) The rate of reaction increased as the concentration of hydrochloric acid increased.

Explain why increasing concentration has this effect.

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..... **(3 marks)**

(c) Suggest how the student prepared solutions with differing concentrations.

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..... **(2 marks)**

(d) The student had a stock solution of sodium hydroxide with an exact concentration of 0.200 moles per dm^3.

She wanted to use this solution to find the concentration of a solution of hydrochloric acid.

She used a pipette to transfer 10.00 cm^3 of the hydrochloric acid into a conical flask and filled a burette with the 0.200 moles per dm^3 sodium hydroxide solution.

Describe how a titration could be used to obtain accurate results.

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..... **(6 marks)**

3 (a) Convert the volumes in parts (a) - (e).

1050 cm^3 = _____ dm^3

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(1 mark)

(b) 865 cm^3 = _____ dm^3

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(1 mark)

(c) 37250 cm^3 = _____ dm^3

.....

(1 mark)

(d) _ cm^3 = 1.63 dm^3

.....

(1 mark)

(e) _____ cm^3 = 0.805 dm^3

.....

(1 mark)

4 (a) Calculate the concentration of the following solutions of NaOH in g dm^{-3}. You must show your working.

Relative formula mass (M_r): NaOH = 40

1 mol NaOH in 500 cm^3.

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..... **(3 marks)**

(b) 2.5 mol NaOH in 2000 cm^3

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..... **(3 marks)**

5 How much solute is present in 2 dm^3 of a 0.5 mol/dm^3 solution of potassium iodide?

A. 0.5 mol

B. 1.0 mol

C. 2.0 mol

D. 10 mol

(1 mark)

6 In a titration 25.00 cm^3 of 0.20 mol/dm^3 sodium hydroxide reacted with 26.50 cm^3 of hydrochloric acid.

$$HCl + NaOH \rightarrow NaCl + H_2O$$

What is the concentration of the acid?

A. 0.19 mol/dm^3

B. 0.23 mol/dm^3

C. 0.55 mol/dm^3

D. 0.82 mol/dm^3

(1 mark)

Hard Questions

1 (a) This question is about citric acid ($C_6H_8O_7$).

Citric acid is a solid.

A student used a solution of sodium hydroxide to determine the concentration of a solution of citric acid by titration.

The student made a 250 cm^3 standard solution of sodium hydroxide of concentration 0.150 mol / dm^3

Calculate the mass of sodium hydroxide required.

Relative atomic masses (A_r): Na = 23, O = 16, H = 1

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..... **(3 marks)**

(b) The student used this method to titrate citric acid with sodium hydroxide solution.

1. Pipette 25.0 cm^3 of citric acid solution into a conical flask.
2. Add a few drops of thymol blue indicator to the citric acid solution. Thymol blue is blue in alkali and yellow in acid.
3. Add sodium hydroxide solution from a burette until the end-point is reached.

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

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..... **(3 marks)**

(c) Give **two** reasons why the sodium hydroxide solution is measured using a burette.

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..... **(2 marks)**

(d) The student's titration results are shown in **Table 1**.

Table 1

Titration	**1**	**2**	**3**	**4**	**5**
Volume of sodium hydroxide solution in cm^3	24.60	23.05	23.15	23.30	23.10

The equation for the reaction is:

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

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

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

Use only the concordant results from the table in your calculation.

You must show your working.

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..... **(5 marks)**

2 (a) A student attempted to make pure zinc chloride crystals using the following method.

- Add 5.00 g of zinc carbonate to 25.0 cm^3 hydrochloric acid of 1.25 mol / dm^3 concentration
- Filter the mixture
- Leave until crystals form

Explain why the student must add the zinc carbonate in excess.

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(1 mark)

(b) The student then completed three separate experiments to produce zinc chloride by reacting 15.0 g of zinc carbonate with hydrochloric acid.

$$ZnCO_3\ (s) + 2HCl\ (aq) \rightarrow ZnCl_2\ (aq) + CO_2\ (g) + H_2O\ (l)$$

The highest percentage yield of zinc chloride that the student achieved in a single experiment was 82.4%.

Calculate the mass of zinc chloride the student actually produced in this experiment.

Relative atomic masses (A_r): C = 12, Zn = 65, O = 16, Cl = 35.5, H = 1

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(3 marks)

(c) The lowest yield of zinc chloride crystals that the student achieved was 10.86 g.

The student used these zinc chloride crystals to make a 250 cm^3 solution.

Calculate the concentration of this solution in g / dm^3.

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(1 mark)

(d) The student's third experiment produced 12.24 g of zinc chloride.

The student used these zinc chloride crystals to make a 50.0 cm^3 solution.

Calculate the concentration of this solution in mol / dm^3.

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(2 marks)

3 A student titrated 25.00 cm^3 of 0.40 mol/dm^3 potassium hydroxide solution against sulfuric acid and found that 23.55 cm^3 of the acid was required to reach the end point.

$$H_2SO_4 + 2KOH \rightarrow K_2SO_4 + 2H_2O$$

What is the concentration of the sulfuric acid?

A. 0.42 mol/dm^3

B. 0.105 mol/dm^3

C. 0.35 mol/dm^3

D. 0.21 mol/dm^3

(1 mark)

4 (a) This question is about the reactions of copper compounds.

A student was asked to make copper(II) oxide, CuO, from copper(II) sulfate, $CuSO_4$ using the following method.

- Measure out 25.0 cm^3 of 0.500 mol / dm^3 copper(II) sulfate solution
- Add an excess of sodium hydroxide solution
- Do not filter out the copper(II) hydroxide, $Cu(OH)_2$, precipitate that forms
- Carefully heat the reaction mixture to decompose the copper(II) hydroxide

Write **two** balanced symbol equations, including state symbols, for the two reactions that occur.

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(4 marks)

(b) Calculate the number of grams of copper(II) sulfate present in the student's solution.

Give your answer to three significant figures.

Relative atomic masses (A_r): Cu = 63.5, S = 32, O = 16

(3 marks)

(c) What mass of copper(II) oxide will the student produce?

Give your answer to three significant figures.

(3 marks)

(d) Another student produces 1.27 g of pure, dry copper(II) oxide.

The student's copper(II) oxide is placed into a 100 cm^3 conical flask. After adding 50.0 cm^3 of distilled water, the conical flask is stirred.

The student completed a calculation and concluded that they had made a 25.4 g / dm^3 solution.

Explain how the student achieved this concentration and why it is incorrect.

(2 marks)

5 (a) This question is about acids and alkalis.

A student titrated 25.0 cm^3 portions of sodium hydroxide solution with a 0.121 mol / dm^3 dilute sulfuric acid.

Table 1 shows the student's results.

Table 1

	Titration 1	**Titration 2**	**Titration 3**	**Titration 4**	**Titration 5**
Volume of dilute sulfuric acid in cm^3	11.75	11.10	11.05	10.55	11.10

The equation for the reaction is:

$$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$$

Calculate the concentration of the sodium hydroxide in mol / dm^3

Use only the student's concordant results.

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

(5 marks)

(b) A second student plans to perform the same titration described in part (a).

$$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$$

The second student will replace the sodium hydroxide solution of unknown concentration with a potassium hydroxide solution that has the exact same unknown concentration.

The equation for the new reaction is:

$$2KOH + H_2SO_4 \longrightarrow K_2SO_4 + 2H_2O$$

Before the student starts, they state that the concentration of the potassium hydroxide solution will be the same as the concentration of the sodium hydroxide solution.

State the assumption that the student makes in their statement and explain whether the student is correct.

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..... **(3 marks)**

(c) A third student plans to perform the same titration described in part (a).

$$2NaOH + H_2SO_4 \longrightarrow Na_2SO_4 + 2H_2O$$

They intend to replace the sulfuric acid with hydrochloric acid of the same 0.121 mol / dm^3 concentration.

The equation for the new reaction is:

$$NaOH + HCl \longrightarrow NaCl + H_2O$$

The final concentration of the sodium hydroxide should be the same as part (a).

Explain the difference that the student can expect to see in their experimental results.

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..... **(2 marks)**

6 Sodium hydroxide solution is neutralised by citric acid.

The equation for the reaction is:

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

Calculate the mass of the citric acid needed to neutralise 12.0 cm^3 of 1.02 mol/dm^3 sodium hydroxide solution.

Relative formula mass (M_r): $C_6H_8O_7$ = 192

A. 0.783 g

B. 0. 852 g

C. 1.22 g

D. 2.35g

(1 mark)

7 (a) Sodium hydroxide neutralises sulfuric acid.

The equation for the reaction is:

$$2NaOH + H_2SO_4 \rightarrow Na_2SO_4 + 2H_2O$$

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

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(2 marks)

(b) Explain why the reaction of sodium hydroxide with sulfuric acid is not a redox reaction.

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(2 marks)

(c) Sodium hydroxide solution is considered corrosive at concentrations above 0.5 mol / dm^3 and a low hazard at concentrations below 0.125 mol / dm^3.

Concentrations between these values should be labelled as a health hazard as they can be irritating to the skin and eyes. These concentrations are acceptable for use in the school laboratory, although the lowest possible concentration of sodium hydroxide solution should always be used.

Calculate the maximum and minimum mass of sodium hydroxide required to make a 500 cm^3 sodium hydroxide solution that can be used in the school laboratory.

Relative atomic masses (A_r): Na = 23, O = 16, H = 1

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..... **(2 marks)**

(d) A student was given a bottle of sodium hydroxide solution of unknown concentration.

The student used a pipette to transfer 25.0 cm^3 of this sodium hydroxide solution into a conical flask for titration with 0.150 mol / dm^3 sulfuric acid.

The results of the student's titrations are shown in **Table 1**.

Table 1

	Rough	**Titration 1**	**Titration 2**	**Titration 3**	**Titration 4**
Volume of 0.150 mol / dm^3 sulfuric acid in cm^3	25.25	24.75	25.20	25.00	25.15

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

Use the student's concordant results to determine if the bottle of sodium hydroxide solution of unknown concentration should be labelled as:

- Corrosive
- Health hazard

- Low hazard

Show your working.

(6 marks)