Chemical analysis – 2021/20 GCSE 21st Chemistry Combined Science B

1. Nov/2021/Paper_ J260/02/No.5

A medicine company makes tablets which contain magnesium hydroxide.

Jamal uses dilute hydrochloric acid in a titration to check the mass of magnesium hydroxide in one tablet.

(a) Magnesium hydroxide reacts with dilute hydrochloric acid to form a salt and water.

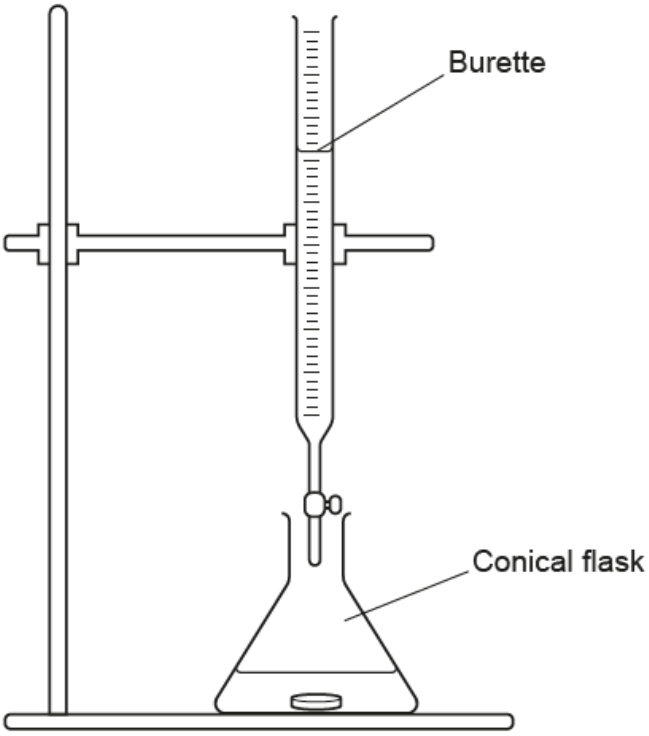
Complete the word equation for the reaction.

magnesium hydroxide + hydrochloric acid → ..... + water

.....

[1]

(b) Jamal adds water and indicator to one tablet in a conical flask. He then adds the acid to the conical flask from a burette until all of the magnesium hydroxide has reacted.



He uses the burette to find the volume of acid that reacts with the magnesium hydroxide in the tablet.

Describe **two** things that he needs to do to get an accurate value for this volume.

1 .....

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2 .....

.....

[2]

(c) Jamal uses his results to work out the mass of magnesium hydroxide in one tablet.

(i) Calculate the **relative formula mass** of magnesium hydroxide, $Mg(OH)_2$.

Use the Data Sheet.

Relative formula mass = ... **[2]**

(ii) Jamal finds that 10.2 cm^3 of acid reacts with one tablet.

He uses this formula to find the mass of magnesium hydroxide in one tablet:

Mass of magnesium hydroxide (mg) = volume of acid (cm^3) × relative formula mass of $Mg(OH)_2$

Calculate the mass of magnesium hydroxide in one tablet.

Use your answer to **(c)(i)**.

Give your answer to **3** significant figures.

Mass of magnesium hydroxide = ... mg **[2]**

(d) The tablets are sold in packs of 100 tablets.

Jamal tests five tablets from three packs of tablets, **Pack A**, **Pack B** and **Pack C**.

Table 8.1 shows his results.

	Mass of magnesium hydroxide (mg)				
Tablet number	**1st**	**2nd**	**3rd**	**4th**	**5th**
Pack A	595	601	591	598	602
Pack B	601	609	603	611	607
Pack C	592	597	591	593	597

Table 8.1

Each tablet should contain a mass of 600 mg of magnesium hydroxide.

The required standard is that each tablet must be within 10 mg of this mass.

Complete **Table 8.2** by deciding if each pack meets the required standard.

Tick (✓) **one** box in each row.

	Meets standard	**Does not meet standard**
Pack A		
Pack B		
Pack C		

Table 8.2

[2]

(e) **(i)** Tablets are an example of a type of substance called a formulation.

Complete the sentences to describe a formulation.

Put a (ring) around the correct answers.

A formulation is a **mixture / single substance**.

Its composition is **fixed / variable**.

[1]

(ii) Which method can be used to show if a substance is pure or impure?

Tick (✓) **one** box.

Chromatography ☐

Combustion ☐

Measurement of pH ☐

Neutralisation ☐

[1]

2. Nov/2021/Paper_ J260/04/No.9(a)

The table shows data about the composition of the Earth's atmosphere 4 billion years ago and today.

	Composition of gases in Earth's atmosphere (%)	
	4 billion years ago	**Today**
Carbon dioxide	20	0.04
Water	50	small
Nitrogen	3	78
Oxygen	0	21
Other gases	.....	small

(a) (i) Complete the table to show the approximate percentage of other gases in the atmosphere 4 billion years ago. **[1]**

(ii) Four billion years ago the Earth was extremely hot.

When the temperature of the Earth cooled to below 100 °C there was a large decrease in the amount of water vapour in the atmosphere.

Describe what happens when hot water vapour cools to below 100 °C.

Use ideas about arrangement and speed of particles in your answer.

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..... **[3]**

3. Nov/2021/Paper_ J260/06/No.9

Kareem does a titration to find the concentration of some dilute sulfuric acid.

He uses 25.0 cm^3 of a sodium hydroxide solution with a concentration of 8.0 g/dm^3 and measures the volume of sulfuric acid which reacts exactly with the sodium hydroxide solution.

(a) The table shows Kareem's results for the volume of acid added.

	Rough trial	**Repeat 1**	**Repeat 2**	**Repeat 3**	**Repeat 4**
Burette reading at end	24.2	47.7	24.6	48.7	24.0
Burette reading at start	0.0	24.2	1	24.6	0.6
Volume added	24.2	23.5	23.6	24.1	23.4

(i) Give **two** errors that Kareem has made when recording his results in the table.

1 .....

2 .....

[2]

(ii) Why is the volume of acid added for the repeat readings **less** than that added in the rough trial?

.....

..... **[1]**

(iii) Kareem decided that the most accurate value for the volume of acid added was 23.5 cm^3.

Explain how he calculated this value.

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..... **[2]**

(b) Kareem's results show that 25.0 cm^3 of 8.0 g/dm^3 sodium hydroxide solution are neutralised by 23.5 cm^3 of sulfuric acid.

The balanced symbol equation for the reaction is:

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

(i) Calculate the mass of sodium hydroxide in 25.0 cm^3 of the 8.0 g/dm^3 solution.

Use the formula: concentration (g/dm^3) = $\frac{\text{mass (g)}}{\text{volume } (dm^3)}$

Mass = ... g **[3]**

(ii) Show that the number of moles of sulfuric acid reacting with the sodium hydroxide is 0.0025.

Use your answer to **(b)(i)**.

Use the formula: number of moles = $\frac{\text{mass of substance (g)}}{\text{relative formula mass (g)}}$

[3]

(iii) Calculate the concentration of the sulfuric acid, in **mol/dm^3**.

Give your answer to **2 significant figures**.

Use the formula: concentration (mol/dm^3) = $\frac{\text{number of moles}}{\text{volume } (dm^3)}$

Concentration = ... mol/dm^3 **[3]**

4. Nov/2021/Paper_ J260/08/No.2(a)

(a) Sea water is a solution of salts in water.

James has three sets of equipment. They are shown in **Fig. 2.1**.

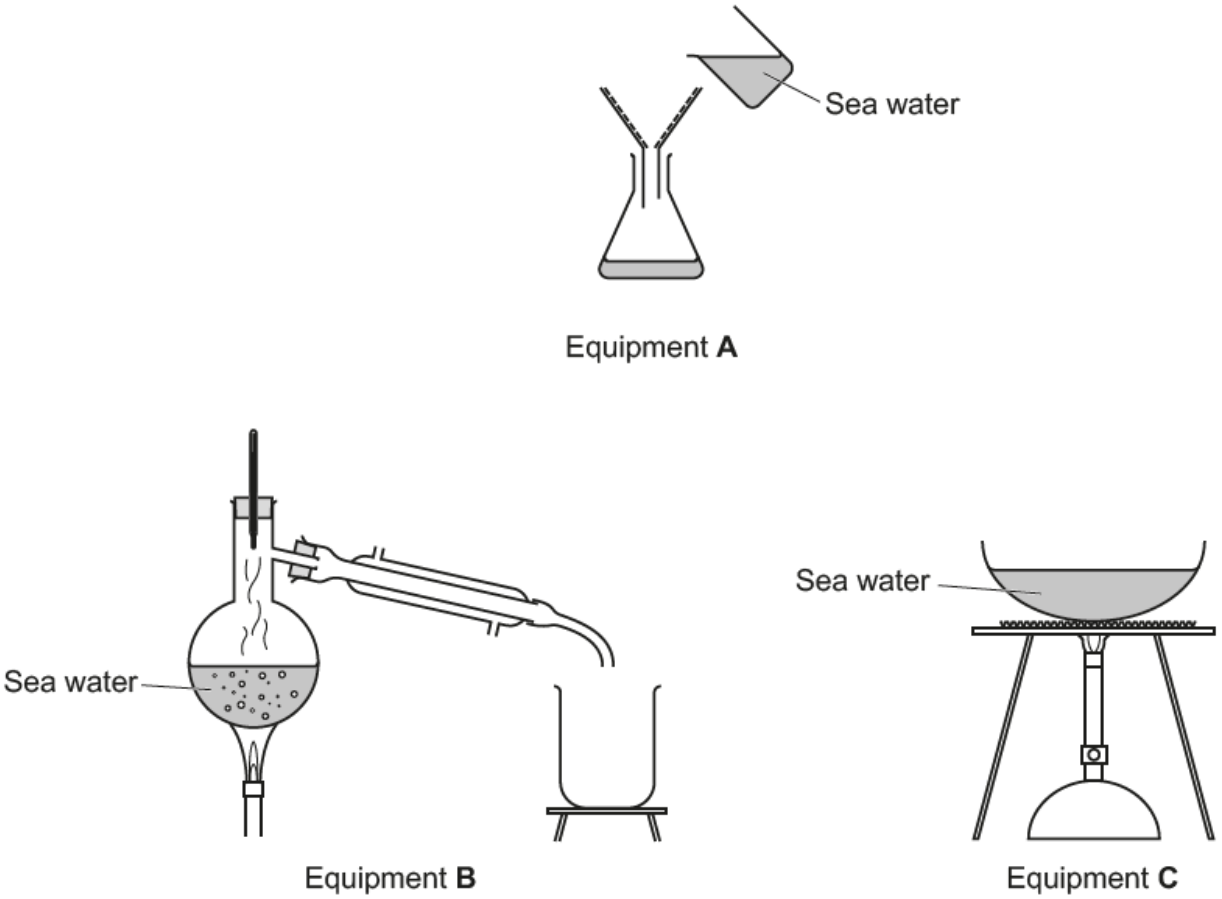

Fig. 2.1

Explain which set of equipment James should use to separate and collect **water** from sea water.

Include in your answer why the other sets of equipment are unsuitable.

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..... **[3]**

5. Nov/2020/Paper_ J260/06/No.3

Fig. 3.1 shows a model for the arrangement of particles in solids, liquids, and gases.

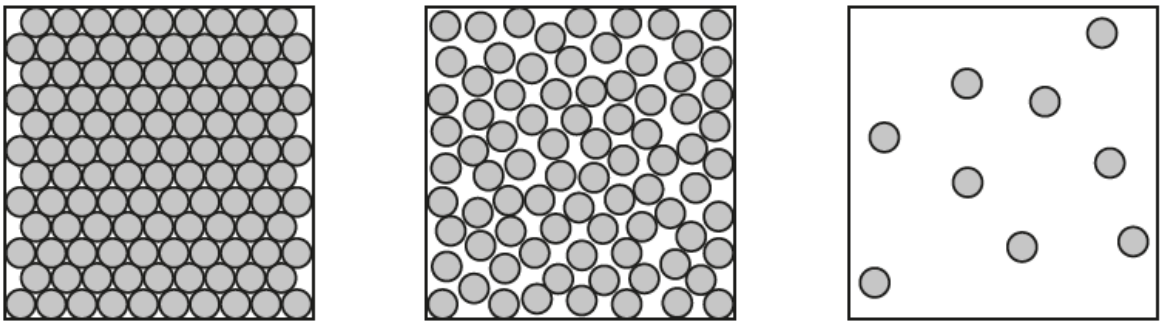

Fig 3.1

Bromine (Br_2) and water (H_2O) are both liquids at room temperature (20 °C).

The table shows their melting and boiling points.

	Melting point (°C)	**Boiling point (°C)**
Bromine	−7	59
Water	0	100

(a) (i) Describe what happens to the arrangement and movement of the **particles** in bromine and water when the temperature changes from −1 °C to 70 °C.

Bromine.....

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.....

.....

Water .....

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.....

.....

[4]

(ii) Give **two** ways in which the gas particles in **bromine gas** are different from the gas particles shown in **Fig. 3.1**.

1 .....

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2 .....

.....

[2]

(b) (i) The melting point of a substance can be used to test its purity.

Ben measures the melting point of an aspirin tablet and compares his results with the melting point given in a data book.

How will his results compare with those in the data book if the aspirin is **impure**?

Explain your answer.

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..... **[2]**

(ii) Which other experiment can Ben use to find out whether his sample of aspirin is **pure**?

Tick (✓) **one** box.

Dissolve the aspirin in water	☐
Use paper chromatography	☐
Do a flame test	☐
React the aspirin with a dilute acid	☐

[1]

6. Nov/2020/Paper_ J260/06/No.8

Jamal is researching the mole, and the Avogadro constant.

(a) (i) Draw lines to connect the Avogadro constant and the mole with their definitions.

	Definition
The mole	The amount of substance containing the same number of particles as there are atoms in 12 g of carbon-12.
	The number of atoms in 1 kg of carbon-12.
Avogadro constant	The number of atoms in 12 g of carbon-12.
	The mass of 1 million atoms.

[2]

(ii) 1 mole of a substance contains 6.0×10^{23} molecules.

Complete the table by calculating the missing values.

Substance	**Relative formula mass**	**Mass of substance (g)**	**Number of moles of substance**	**Number of molecules**
O_2	32	32	1	6.0×10^{23}
H_2	2	.....	2	.....
H_2O	.....	9	0.5	.....

[3]

(iii) Counting atoms and molecules is important when balancing symbol equations.

This is the balanced symbol equation for the reaction between hydrogen and oxygen.

$2H_2 + O_2 \rightarrow 2H_2O$

Which statements about the balanced symbol equation are **true** and which are **false**?

Tick (✓) **one** box in each row.

Statement	true	false
The total number of reactant molecules is the same as the total number of product molecules.		
The total number of reactant atoms is the same as the total number of product atoms.		
The number of each type of atom in the reactants is equal to the number of each type of atom in the products.		

[2]

(b) Jamal reads about an experiment where 6.2g of phosphorus (P) reacts with 21.3g of chlorine (Cl_2) gas to form phosphorus chloride.

$2P(s) + xCl_2(g) \rightarrow 2PCl_x(s)$

(i) Calculate the number of moles of chlorine that react with **2** moles of phosphorus.

Use the relationship: number of moles $= \frac{\text{mass of substance (g)}}{\text{relative formula mass (g)}}$

A_r (Cl) = 35.5 A_r (P) = 31

Moles of chlorine = ... **[3]**

(ii) Explain the effect on the mass of phosphorus chloride formed if **50 g** of chlorine is added to 6.2g of phosphorus.

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..... **[2]**

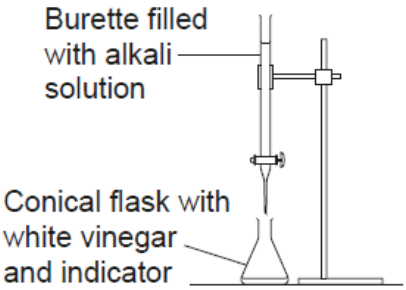
7. Nov/2020/Paper_ J260/08/No.6

Mia has a bottle of white vinegar which states that it contains 6.0% ethanoic acid by volume. White vinegar is a colourless solution of ethanoic acid in water.

Mia checks the percentage of ethanoic acid by volume in white vinegar by titrating the white vinegar with an alkali solution.

Some of Mia's procedure is shown below:

Stage 1. Transfer 25 cm^3 of white vinegar from a measuring cylinder to a conical flask.
Stage 2. Add a few drops of universal indicator to the conical flask.



(a) Mia's teacher says that she can improve the procedure for both **stage 1** and **stage 2** of this experiment.

State **one** improvement for each stage of this experiment, and explain how this improves the procedure.

Stage 1

Improvement .....

.....

Explanation .....

.....

Stage 2

Improvement .....

.....

Explanation .....

.....

[4]

(b) Outline the rest of the procedure to titrate the white vinegar with an alkali solution to obtain **accurate** and **precise** results.

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..... **[3]**

(c) Mia does the titration six times, and her results are shown in the table.

	Titration 1	**Titration 2**	**Titration 3**	**Titration 4**	**Titration 5**	**Titration 6**
Burette reading at end (cm^3)	22.0	43.0	64.2	86.1	21.1	42.3
Burette reading at start (cm^3)	0.0	22.0	43.0	64.2	0.0	21.1
Volume added (cm^3)	22.0	21.0	21.2	21.9	21.1	21.2

Mia uses her results to calculate a mean titration value.

Evaluate Mia's results to suggest which values should be used to calculate the mean.

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..... **[3]**

(d) Mia calculates that 25.0 cm^3 of the white vinegar contains 0.026 moles of ethanoic acid. The relative formula mass of ethanoic acid is 60.0.

The density of ethanoic acid is 1.05 g/cm^3.

Show that the white vinegar contains 6.0% ethanoic acid by volume.

Use the equation: density = mass ÷ volume

Use the equation: number of moles = mass of substance ÷ relative formula mass

[4]