

Amount of substance

16 questions · 82 marks

Answer all questions. The marks available are shown against each part. Every question is taken unaltered from a past paper; the source is noted beneath it. In Section A, choose the best answer and write its letter in the box.

Section A · Multiple choice

9 questions · 9 marks

1. Which compound needs the greatest amount of oxygen for the complete combustion of 1 mol of the compound? 1 mark

[1 mark]

A ethanal

☐

B ethanol

☐

C ethane-1,2-diol

☐

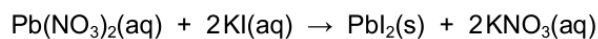
D methanol

☐

Answer

AQA 7405/3 Chemistry · 2021 · Paper 3, Question 25

2. Lead(II) nitrate and potassium iodide react according to the equation 1 mark



In an experiment, 25.0 cm³ of a 0.100 mol dm⁻³ solution of each compound are mixed together.

Which amount, in mol, of lead(II) iodide is formed?

[1 mark]

A 1.25 x 10⁻³

☐

B 2.50 x 10⁻³

☐

C 1.25 x 10⁻²

☐

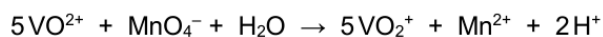
D 2.50 x 10⁻²

☐

Answer

AQA 7405/3 Chemistry · June 2019 · Paper 3, Question 7

3. What is the minimum volume, in cm^3 , of 0.02 mol dm^{-3} KMnO_4 solution needed to oxidise 0.01 mol of VO^{2+} ? 1 mark



[1 mark]

A 10

☐

B 50

☐

C 100

☐

D 200

☐

Answer

— AQA 7405/3 Chemistry · June 2020 · Paper 3, Question 31

4. What is the relative molecular mass (M_r) of benzene-1,4-dicarboxylic acid? 1 mark

[1 mark]

A 164.0

☐

B 166.0

☐

C 168.0

☐

D 170.0

☐

Answer

— AQA 7405/3 Chemistry · June 2023 · Paper 3, Question 8

5. When heated, a sample of potassium chlorate(V) (KClO_3) produced 67.2 cm^3 of oxygen, measured at 298 K and 110 kPa 1 mark



What is the amount, in moles, of potassium chlorate(V) that has decomposed?

The gas constant, $R = 8.31 \text{ J K}^{-1} \text{ mol}^{-1}$

[1 mark]

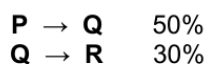
A 9.95×10^{-4} ☐B 1.99×10^{-3} ☐C 2.99×10^{-3} ☐D 4.48×10^{-3} ☐

Answer

— AQA 7405/3 Chemistry · June 2020 · Paper 3, Question 7

6. Compound **P** is converted into compound **R** by a two-stage synthesis via compound **Q**. 1 mark

The yields for the individual steps are:



What is the overall yield of **R** in this synthesis?

[1 mark]

A 15% ☐

B 30% ☐

C 40% ☐

D 80% ☐

Answer

— AQA 7405/3 Chemistry · June 2024 · Paper 3, Question 8

7. Which amount of sodium hydroxide would react exactly with 7.5 g of a diprotic acid, H_2A ($M_r = 150$)? 1 mark

[1 mark]

A 50 cm³ of 0.05 mol dm⁻³ NaOH(aq) ☐

B 100 cm³ of 0.50 mol dm⁻³ NaOH(aq) ☐

C 100 cm³ of 1.0 mol dm⁻³ NaOH(aq) ☐

D 100 cm³ of 2.0 mol dm⁻³ NaOH(aq) ☐

Answer

— AQA 7405/3 Chemistry · June 2019 · Paper 3, Question 6

8. A student rinsed the apparatus before starting an acid-base titration. The results of the titration showed that the volume of acid added from the burette was larger than expected. 1 mark

Which is a possible reason for this?

[1 mark]

A The conical flask was rinsed with water before the titration. ☐

B The walls of the conical flask were rinsed with water during the titration. ☐

C The pipette was rinsed only with water. ☐

D The burette was rinsed only with water. ☐

Answer

— AQA 7405/3 Chemistry · June 2020 · Paper 3, Question 36

1 mark

[1 mark]

- ☐

- B 1.10**

- ☐

- C 1.47**

-

- D 2.26**

- 

Answer

9

Section B • Structured questions

7 questions · 73 marks

10.

4 marks

Deduce the formula of **L**.
Show your working.

[4 marks]

[illegible]

Formula of L _____

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— AQA 7405/2 Chemistry · June 2024 · Paper 2, Question 7

11. Tschermigite is a hydrated, water-soluble mineral, with relative formula mass of 453.2 6 marks

The formula of tschermigite can be represented as $M \cdot xH_2O$, where M represents all the ions present.

Table 4 shows its composition by mass.

Table 4

Element	% by mass
N	3.09
H	6.18
Al	5.96
S	14.16
O	70.61

In an analysis, it is found that the mineral contains the ions NH_4^+ , Al^{3+} and SO_4^{2-}

Calculate the empirical formula of tschermigite and the value of x in $M \cdot xH_2O$

Describe the tests, with their results, including ionic equations, that would confirm the identities of the ions present.

[6 marks]

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— AQA 7405/3 Chemistry · 2022 · Paper 3, Question 2

12. This question is about an experiment to determine the solubility of strontium hydroxide in water at 20 °C 10 marks

Strontium hydroxide is slightly soluble in water. Strontium hydroxide solution reacts in a similar way to calcium hydroxide solution.

- Some solid strontium hydroxide is added to approximately 1 dm³ of distilled water in a stoppered flask.
- The mixture is kept at 20 °C. Every day, the mixture is checked. If no solid is present in the flask, more solid strontium hydroxide is added.
- On the day when no more solid needs to be added, the flask is opened and the mixture is filtered into another flask and stoppered.
- A 25.0 cm³ sample of the filtrate is transferred to a conical flask with a pipette and a few drops of indicator added.
- This sample is titrated with 0.100 mol dm⁻³ hydrochloric acid.
- The titration is repeated several times with further samples of the filtrate. The results are shown in **Table 1** on page 8.

1 Suggest why the solution is kept until no more solid needs to be added.

[1 mark]

2 Suggest why it is important to remove the undissolved strontium hydroxide before the titration.

[1 mark]

3 After the filtration, the solution is stored in a stoppered flask.

Suggest a reason for stoppering the flask.

[1 mark]

4

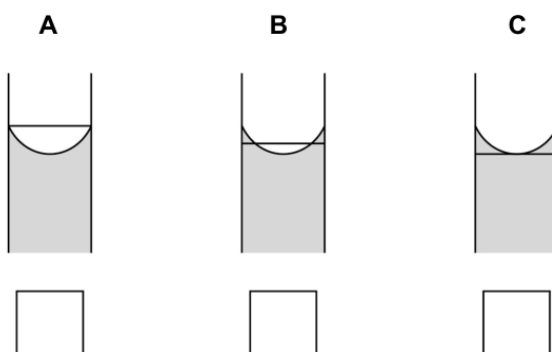
The diagrams in **Figure 2** show the part of a pipette with the graduation line.

Which diagram identifies the pipette that is correctly filled?

[1 mark]

Tick (✓) **one** box.

Figure 2



5

Solubility can be quoted as 'g of solute per 100 cm³ of solution'.

Table 1 shows the results of the titrations between strontium hydroxide and hydrochloric acid. These can be used to determine the solubility of strontium hydroxide.

Table 1

Titration	Rough	1	2	3
Final burette reading / cm ³	34.40	38.00	41.05	37.00
Initial burette reading / cm ³	0.00	5.55	8.05	4.60
Titre / cm ³	34.40	32.45	33.00	32.40

Give the equation for the reaction between strontium hydroxide and hydrochloric acid.

Use the results in **Table 1** to calculate the mean titre.

Use the mean titre to calculate the solubility of strontium hydroxide, in g per 100 cm³ of solution, at 20 °C

[6 marks]

Equation

Mean titre cm³

g per 100 cm³ solution[illegible]

13.

10 marks

1

[1 mark]

.....
Mass g

- 2** The mass of barium hydroxide from Question 06.1 is dissolved in a beaker containing 150 cm³ of distilled water.

Describe how this solution is used to make 250 cm³ of the 0.100 mol dm⁻³ barium hydroxide solution.

[3 marks]

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- 3** Before the first titration, the 25 cm³ pipette is rinsed with a small volume of the 0.100 mol dm⁻³ barium hydroxide solution.

State why it is good practice to rinse the pipette in this way.

[1 mark]

- 4** Hydrochloric acid is added to the burette using a funnel.

State why it is good practice to remove the funnel from the burette before the titration.

[1 mark]

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- 5** In a different experiment, 0.952 g of solid barium hydroxide is used to make 250 cm³ of standard barium hydroxide solution.

25.0 cm³ of this barium hydroxide solution reacts with exactly 24.50 cm³ of hydrochloric acid.

Calculate the concentration of the hydrochloric acid.

[3 marks]

Concentration
 mol dm^{-3}

6

The uncertainty in the 25.0 cm^3 of solution from the pipette is $\pm 0.05 \text{ cm}^3$

The total uncertainty in the 24.50 cm^3 of solution from the burette is $\pm 0.15 \text{ cm}^3$

Calculate the total percentage error in using the pipette and burette.

[1 mark]

Percentage error

— AQA 7405/1 Chemistry · June 2023 · Paper 1, Question 6

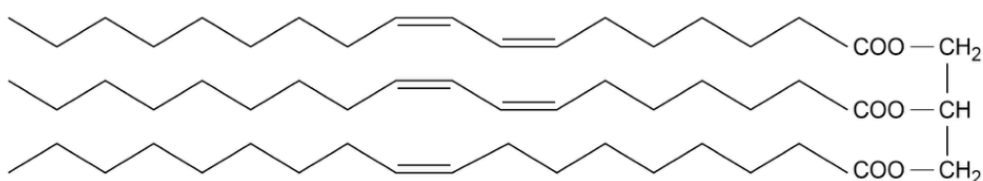
14.

This question is about olive oil.

12 marks

A sample of olive oil is mainly the unsaturated fat **Y** mixed with a small amount of inert impurity.

The structure of **Y** in the olive oil is shown.
Y has the molecular formula $\text{C}_{57}\text{H}_{100}\text{O}_6$ ($M_r = 880$).



Mass of olive oil g

The olive oil solution can be prepared using this method.

- Place a weighing bottle on a balance and record the mass, in g, to 2 decimal places.
- Add olive oil to the weighing bottle until a suitable mass has been added.
- Record the mass of the weighing bottle and olive oil.
- Pour the olive oil into a 250 cm³ volumetric flask.
- Add organic solvent to the volumetric flask until it is made up to the mark.
- Place a stopper in the flask and invert the flask several times.

3

Suggest an extra step to ensure that the mass of olive oil in the solution is recorded accurately.

Justify your suggestion.

[2 marks]

Extra step

Justification

4

State the reason for inverting the flask several times.

[1 mark]

5

A sample of the olive oil was dissolved in methanol and placed in a mass spectrometer. The sample was ionised using electrospray ionisation. Each molecule gained a hydrogen ion (H^+) during ionisation. The spectrum showed a peak for an ion with $\frac{m}{z} = 345$ formed from an impurity in the olive oil.

The ion with $\frac{m}{z} = 345$ was formed from a compound with the empirical formula $\text{C}_5\text{H}_{10}\text{O}$

Deduce the molecular formula of this compound.

[2 marks]

Show your working.

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Molecular formula

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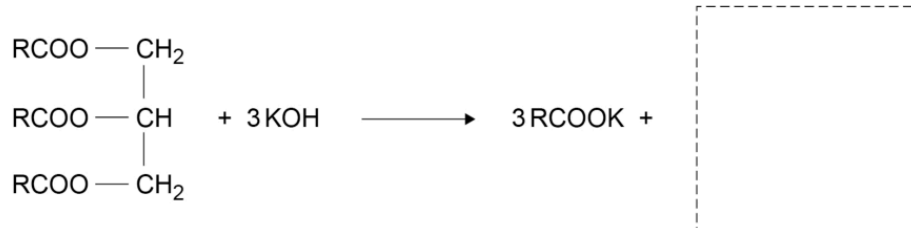
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15. Coconut oil contains a triester with three identical R groups. This triester reacts with potassium hydroxide. 15 marks



- 1 Complete the equation by drawing the structure of the other product of this reaction in the box.

Name the type of compound shown by the formula RCOOK

Give **one** use for this type of compound.

[3 marks]

Type of compound

Use

- 2 The triester in coconut oil has a relative molecular mass, $M_r = 638.0$. In the equation shown at the start of Question 01, R represents an alkyl group that can be written as $\text{CH}_3(\text{CH}_2)_n$

Deduce the value of n in $\text{CH}_3(\text{CH}_2)_n$.
Show your working.

[3 marks]

n

- 3 A 1.450 g sample of coconut oil is heated with 0.421 g of KOH in aqueous ethanol until all of the triester is hydrolysed.
The mixture is cooled.
The remaining KOH is neutralised by exactly 15.65 cm³ of 0.100 mol dm⁻³ HCl

Calculate the percentage by mass of the triester ($M_r = 638.0$) in the coconut oil.

[6 marks]

4

Give a safety precaution used when heating the mixture. Justify your choice.

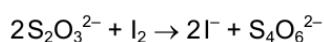
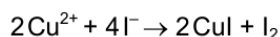
[3 marks]

16. A student does an experiment to determine the percentage of copper in an alloy. 16 marks

The student

- reacts 985 mg of the alloy with concentrated nitric acid to form a solution (all of the copper in the alloy reacts to form aqueous copper(II) ions)
- pours the solution into a volumetric flask and makes the volume up to 250 cm³ with distilled water
- shakes the flask thoroughly
- transfers 25.0 cm³ of the solution into a conical flask and adds an excess of potassium iodide
- uses exactly 9.00 cm³ of 0.0800 mol dm⁻³ sodium thiosulfate (Na₂S₂O₃) solution to react with all the iodine produced.

The equations for the reactions are



1

Calculate the percentage of copper by mass in the alloy.

Give your answer to the appropriate number of significant figures.

[6 marks]

% copper

2

Suggest **two** ways that the student could reduce the percentage uncertainty in the measurement of the volume of sodium thiosulfate solution, using the same apparatus as this experiment.

[2 marks]

1

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2

[1 mark]

[1 mark]

[2 marks]

[4 marks]

[illegible]

Volume

 cm^3

— AQA 7405/1 Chemistry · June 2019 · Paper 1, Question 6