Rewarding Learning

Centre Number

71

Candidate Number

General Certificate of Secondary Education
2014

GCSE Chemistry

Unit 2

Higher Tier

[GCH22]

MV18

THURSDAY 19 JUNE, AFTERNOON

TIME

1 hour 45 minutes, plus your additional time allowance.

INSTRUCTIONS TO CANDIDATES

Write your Centre Number and Candidate Number in the spaces provided at the top of this page.
You must answer the questions in the spaces provided.
Complete in blue or black ink only.
Answer **all seven** questions.

INFORMATION FOR CANDIDATES

The total mark for this paper is 115.
Figures in brackets printed at the end of each question indicate the marks awarded to each question or part question.
Quality of written communication will be assessed in Questions **2** and **4(a)**.
A Data Leaflet, which includes a Periodic Table of the Elements, is included in this question paper.

1 Many multivitamin supplements are produced as tablets which effervesce when added to water. The label of a multivitamin supplement is shown below.

Multivitamin Supplement

Niacin
Calcium carbonate
Vitamin B12
Sweeteners
Salt
Orange flavouring
Citric acid

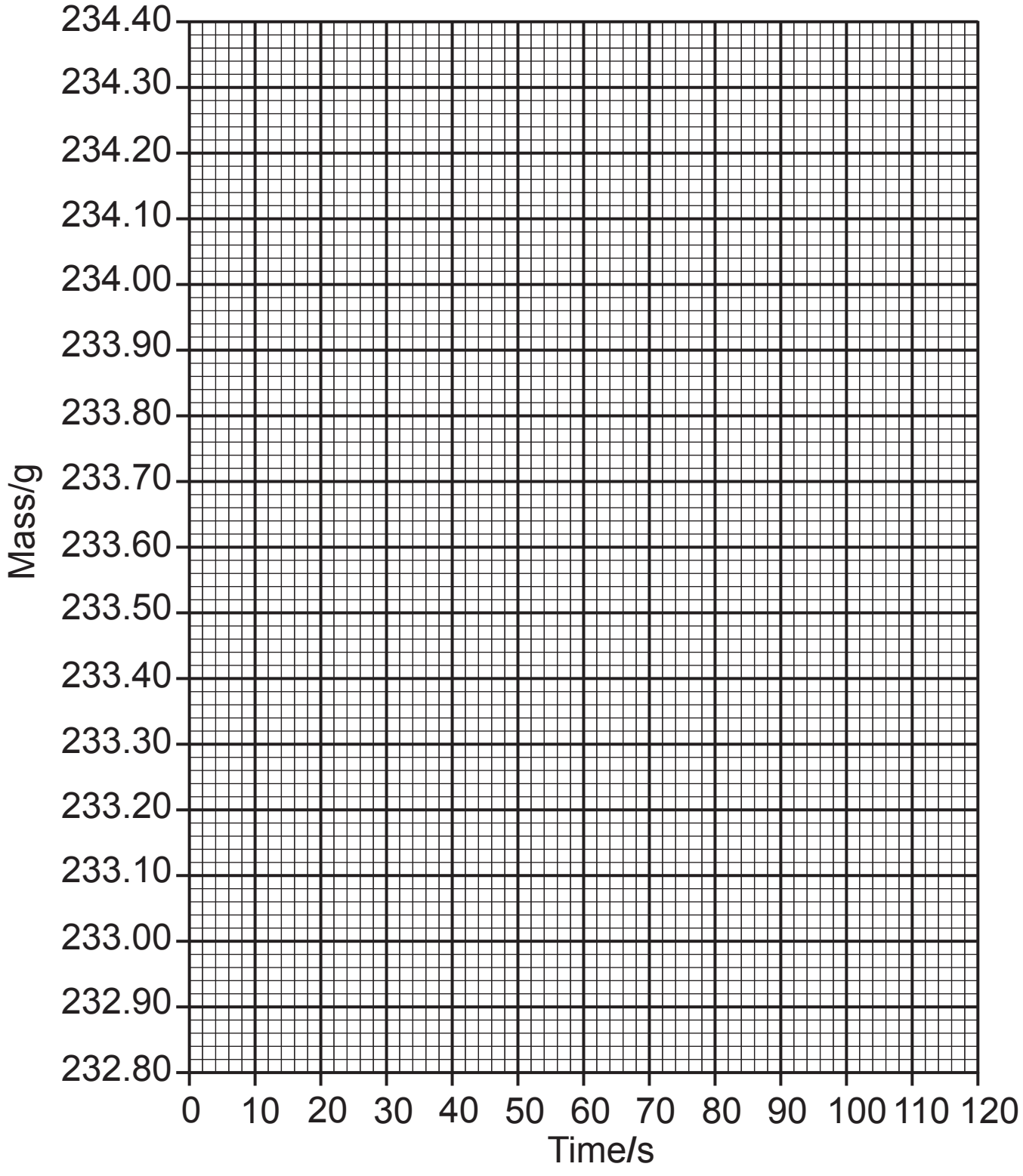
In an experiment one multivitamin tablet was added to 50 cm^3 of water in a conical flask at a temperature of 20 °C. The flask was loosely stoppered with a cotton wool plug and placed on an electronic balance. A stopclock was started as soon as the tablet made contact with the water. The mass was recorded every 20 seconds.

(a) Draw a labelled diagram of the assembled apparatus used to carry out this experiment. **Include all apparatus**. [4 marks]

(b) The results obtained from the experiment are shown below.

Time/s	0	20	40	60	80	100	120
Mass/g	234.10	233.70	233.40	233.20	233.05	233.00	233.00

(i) Plot these results on the graph below. [4 marks]



Using the graph answer the following questions.

(ii) At what time does the reaction stop? [1 mark]

_____

(iii) Calculate the total loss in mass. [1 mark]

_____

(iv) The experiment was repeated using one tablet and 50 cm^3 of water at 40°C. On the same axes, sketch the graph for this experiment and label it B. [3 marks]

(v) State and explain, in terms of particles, the effect of increasing temperature on the rate of a chemical reaction. [3 marks]

_____

_____

_____

_____

_____

_____

(c) Explain what you understand by the term activation energy. [2 marks]

_____

_____

_____

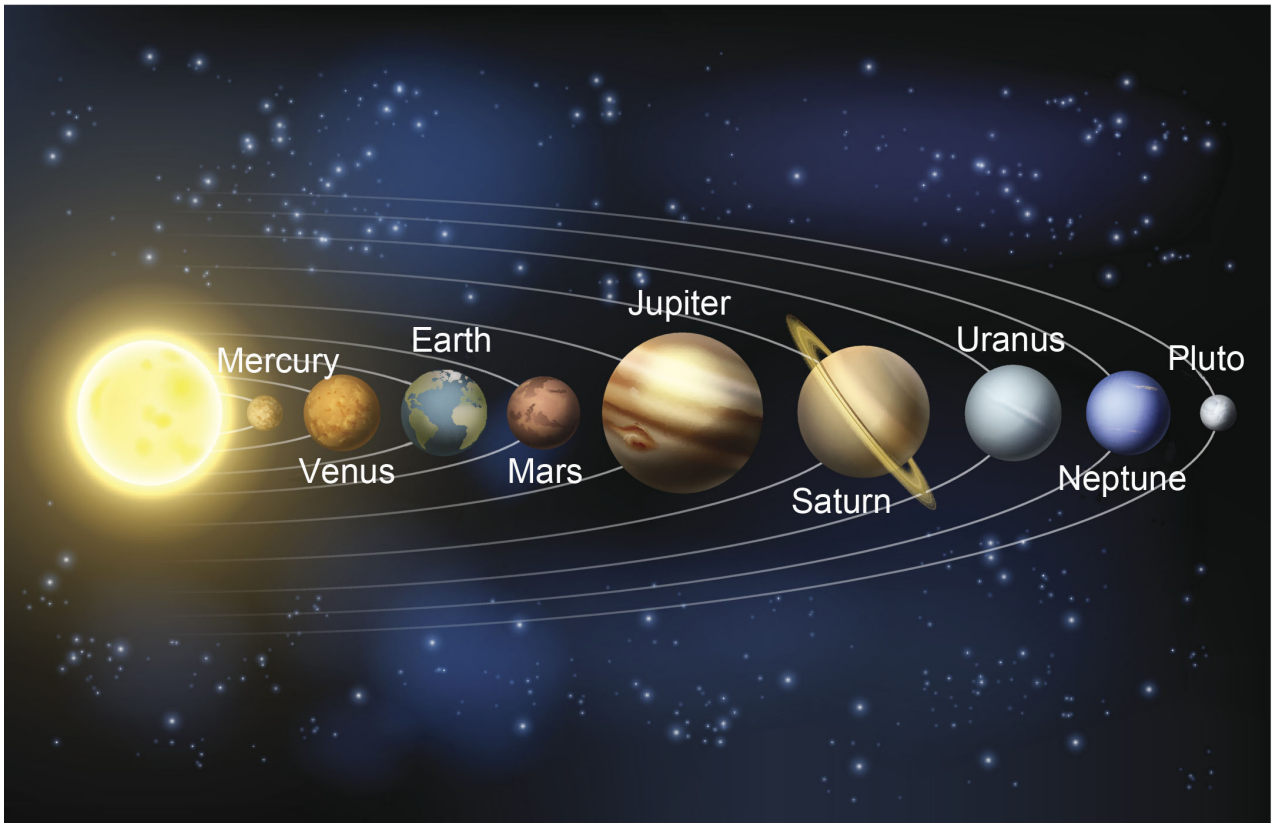
2 Concentrated sulfuric acid is manufactured industrially by the Contact Process. This process occurs in four stages, one of which requires three specific conditions.

Describe the chemistry of the Contact Process. Your answer should include the following:

- balanced symbol equations for each of the four stages
- names of all reactants and products in each reaction
- identification of the stage which requires specific conditions
- details of these conditions [12 marks]

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.

3 The diagram below shows the Earth's solar system.



(a) Mars is often called the red planet due to the presence of haematite on its surface. A recent study of the Huygens Crater on Mars has also shown the presence of iron(III) hydroxide and calcium carbonate.

(i) Calcium carbonate and iron(III) hydroxide undergo thermal decomposition. What is meant by the term thermal decomposition? [2 marks]

_____

_____

(ii) Write a balanced symbol equation for the thermal decomposition of iron(III) hydroxide into iron(III) oxide and water. [3 marks]

_____

(b) Mars does not have tectonic plates but Earth does. What may occur at the boundaries between tectonic plates? [2 marks]

(c) Atmosphere is the term used to describe the collection of gases that surround a planet. The composition of the atmosphere of Mars is shown in the table below.

Gas	**Composition**
Carbon dioxide	95.0%
Nitrogen	3.0%
Noble gases	1.6%
Oxygen	trace
Methane	trace

Compare the composition of the Earth's atmosphere today, with that of the planet Mars. [5 marks]

(d) Changes in the atmosphere of the Earth occurred slowly over millions of years due to photosynthesis and other processes.

(i) An unbalanced symbol equation for the production of glucose ($C_6H_{12}O_6$) in photosynthesis is shown below. Balance this equation. [1 mark]

$$CO_2 \quad + \quad H_2O \quad \rightarrow \quad C_6H_{12}O_6 \quad + \quad O_2$$

(ii) Photosynthesis is an endothermic reaction. In terms of bonds, explain why this reaction is endothermic. [5 marks]

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(Questions continue overleaf)

4 The water supply in some parts of Northern Ireland may be described as being hard water.

(a) Describe in detail how a sample of water may be tested for hardness. [6 marks]

Your answer should include:

- how to determine that hardness is present in the water
- how to determine if the hardness present is temporary or permanent
- all practical details

In this question you will be assessed on your written communication skills including the use of specialist scientific terms.

(b) Temporary hard water is found in areas where limestone rock is common.

(i) Write a balanced symbol equation to show the formation of temporary hard water. [2 marks]

(ii) Describe in detail how temporary hardness arises in water. [3 marks]

(iii) State **two** methods which may be used to remove permanent hardness from water. [2 marks, 1 mark per method]

1. _____

_____

2. _____

_____

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(Questions continue overleaf)

5 **(a)** A homologous series is a family of organic compounds that have the same general formula and show a gradation in physical properties.

(i) State one other feature of a homologous series. [1 mark]

_____

_____

(ii) Alkanes and alkenes are examples of homologous series. Complete the following table. [2 marks]

Name of homologous series	**General formula**	**Molecular formula of compound with three carbon atoms**
Alkanes		C_3H_8
Alkenes	C_nH_{2n}	

(iii) Name the alkane with the molecular formula C_3H_8. [1 mark]

_____

(b) Alkanes and alkenes undergo combustion reactions.

(i) What is meant by the term combustion? [3 marks]

(ii) Write a balanced symbol equation for the complete combustion of methane. [3 marks]

(c) Alkenes contain the C=C functional group.

(i) What do you understand by the term functional group? [1 mark]

(ii) Describe a chemical test which may be used to confirm the presence of the C=C in an alkene. State the result you would expect for a positive test. [3 marks]

(d) Alkenes undergo addition polymerisation to form polymers such as polythene and PVC (polyvinyl chloride).

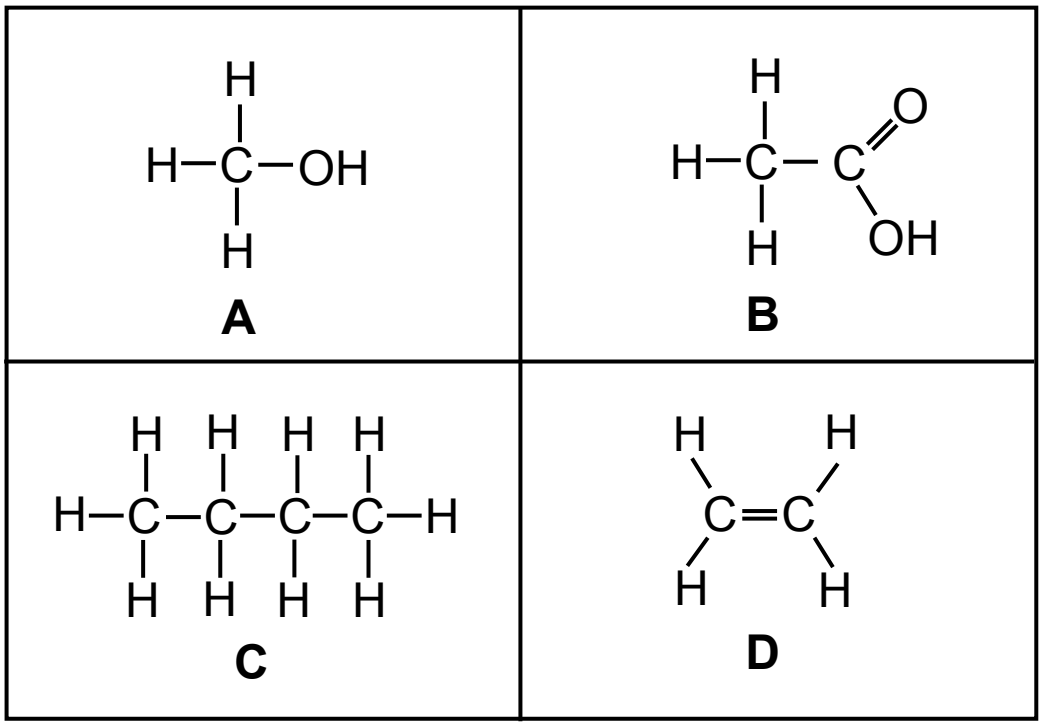
(i) Write a structural equation to show the formation of PVC. [4 marks]

(ii) State one reason why PVC is used to make window frames in preference to wood. [1 mark]

_____

_____

(e) The structures of four organic compounds are shown below.



(i) Name compound **A**. [1 mark]

_____

(ii) What is the functional group in compound **B**? [1 mark]

_____

(iii) Explain why compound **C** is a hydrocarbon. [1 mark]

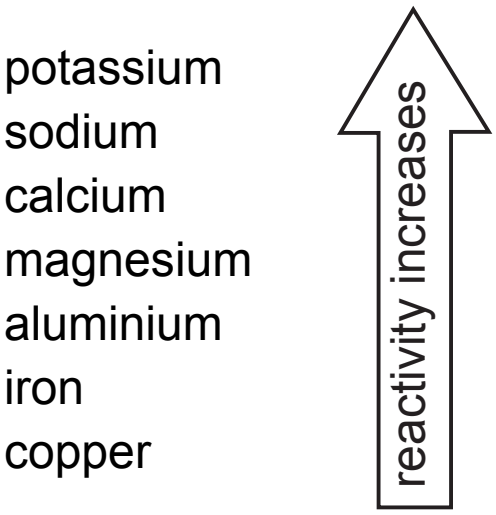
_____

_____

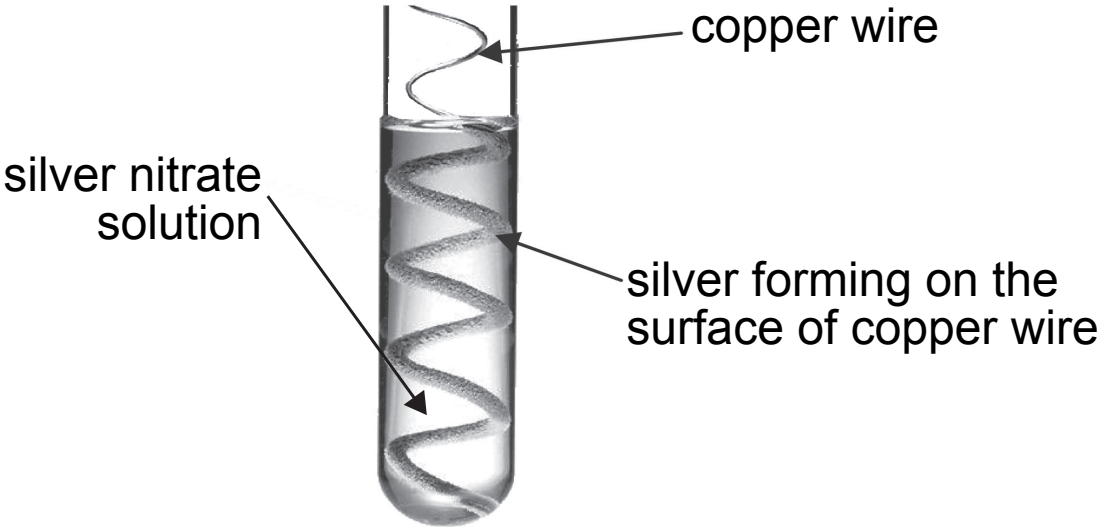
(iv) Which compound (**A**, **B**, **C** or **D**) reacts with sodium carbonate? [1 mark]

_____

6 A reactivity series of some metals is shown below:



(a) Silver metal does not appear on the above reactivity series. Copper metal will react with silver nitrate solution to form silver as shown below.



(i) Write a balanced symbol equation for the reaction of copper with silver nitrate forming silver and copper(II) nitrate. [3 marks]

_____

(ii) Indicate the position of silver on the reactivity series shown above. [1 mark]

(iii) Silver nitrate solution is colourless. What is the colour of the solution at the end of this reaction? [1 mark]

_____

(iv) Explain why copper displaces silver from a solution of silver nitrate. [2 marks]

_____

_____

(b) Silver particles of size 1 to 100 nanometres (nm) are used to kill bacteria in wound dressings.

(i) Explain what you understand by a nanometre. [1 mark]

_____

(ii) Describe one risk which has been associated with the use of silver particles of this size. [1 mark]

_____

_____

(c) Aluminium is a very useful metal due to its high electrical conductivity, relatively low density and lack of reactivity.

(i) Explain why aluminium shows a lack of reactivity even though the reactivity series would suggest it is a moderately reactive metal. [3 marks]

(ii) A balanced symbol equation for a reaction of aluminium is shown below:

$$2Al + 3CuO \rightarrow Al_2O_3 + 3Cu$$

Write a word equation for this reaction. [2 marks]

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(Questions continue overleaf)

7 Homemade wines contain acids such as tartaric acid.

(a) Tartaric acid has the molecular formula $C_4H_6O_6$.
Calculate the percentage of oxygen present in tartaric acid. [3 marks]

Percentage of oxygen _____

(b) To find the concentration of acid in their homemade wine, wine makers can use a wine testing kit. The label of a wine testing kit is shown below.

WINE TESTING KIT

- 25 cm^3 syringe
- 30 cm^3 syringe
- 0.1 mol/dm^3 sodium hydroxide solution
- Phenolphthalein indicator
- Plastic beaker

The instructions on the wine testing kit are:

Measure out 25 cm^3 of wine into the plastic beaker using the 25 cm^3 syringe.
Add 3 drops of phenolphthalein indicator.
Slowly add sodium hydroxide from the other syringe until the indicator changes colour.

State the colour change observed for the phenolphthalein indicator. [2 marks]

From _____ to _____

(c) This method can be carried out more accurately in a laboratory using titration apparatus.

(i) Name the piece of apparatus used to measure out accurately 25.0 cm^3 of wine. [1 mark]

_____

(ii) Name the piece of apparatus used to accurately add the sodium hydroxide solution to the wine in a titration. [1 mark]

_____

(iii) This method is suitable for white wine. Suggest why it is not used to find the concentration of acid in red wine. [1 mark]

_____

(d) In a laboratory experiment 25.0 cm^3 of white wine were placed in a conical flask and a few drops of phenolphthalein indicator added. Sodium hydroxide solution of concentration 0.1 mol/dm^3 was then added slowly to the conical flask. The results of the titration are shown in the table below.

	Initial reading (cm^3)	**Final reading (cm^3)**	**Titre (cm^3)**
Titration 1 (rough)	0.0	20.0	20.0
Titration 2	0.0	18.9	18.9
Titration 3	0.0	19.1	19.1

(i) Calculate the average titre. [2 marks]

Average titre _____ cm^3

(ii) Calculate the number of moles of sodium hydroxide solution used in this titration. [2 marks]

Moles of sodium hydroxide _____

(iii) The equation for the reaction of the tartaric acid in the white wine with sodium hydroxide is shown below. Use this equation to calculate the number of moles of tartaric acid which reacted with the sodium hydroxide solution. [2 marks]

$$C_4H_6O_6 + 2NaOH \rightarrow C_4H_4O_6Na_2 + 2H_2O$$

Moles of tartaric acid _____

(iv) Calculate the concentration of the tartaric acid in mol/dm^3. [2 marks]

Concentration of tartaric acid _____ mol/dm^3

(v) Calculate the concentration of the tartaric acid in g/dm^3. [1 mark]

Concentration of tartaric acid _____ g/dm^3

THIS IS THE END OF THE QUESTION PAPER

SOURCES:

Pg 8, Q3, Diagram showing the Earth's solar system,© iStock / Thinkstock

Pg 20, Q6(a) Diagram showing a silver displacement reaction, © Peticolas/Megna/Fundemental Photos / Science Photo Library

For Examiner's use only	
Question Number	**Marks**
1	
2	
3	
4	
5	
6	
7	
Total Marks	

Examiner Number