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| Candidate surname | Other names |
|---|---|
| | |

Centre Number | Candidate Number

# Pearson Edexcel International Advanced Level

Friday 24 May 2024

Morning (Time: 1 hour 20 minutes)

Paper reference **WCH13/01R**

# Chemistry

## International Advanced Subsidiary/Advanced Level
## UNIT 3: Practical Skills in Chemistry I

You must have:
Scientific calculator, ruler

Total Marks

## Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **Fill in the boxes** at the top of this page with your name, centre number and candidate number.
- Answer **all** questions.
- Answer the questions in the spaces provided
  – *there may be more space than you need.*

## Information

- The total mark for this paper is 50.
- The marks for **each** question are shown in brackets
  – *use this as a guide as to how much time to spend on each question.*
- You will be assessed on your ability to organise and present information, ideas, descriptions and arguments clearly and logically, including your use of grammar, punctuation and spelling.
- A Periodic Table is printed on the back cover of this paper.

## Advice

- Read each question carefully before you start to answer it.
- Show all your working in calculations and include units where appropriate.
- Try to answer every question.
- Check your answers if you have time at the end.

*Turn over* ▶

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**Answer ALL the questions. Write your answers in the spaces provided.**

**1** Sodium sulfite reacts with dilute sulfuric acid, as shown.

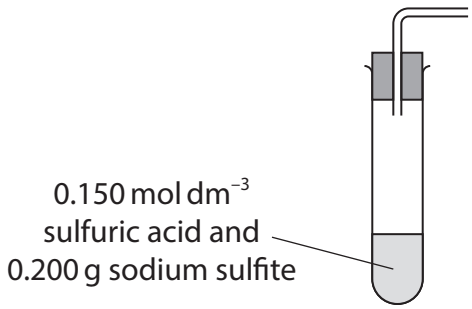
$$Na_2SO_3 + H_2SO_4 \rightarrow Na_2SO_4 + H_2O + SO_2$$

A student carried out an experiment to measure the molar volume of sulfur dioxide. 0.200 g of sodium sulfite was added to 0.150 mol $dm^{-3}$ sulfuric acid in a boiling tube and the volume of gas given off was measured.

Sulfur dioxide is soluble in water, so collecting the gas over water **cannot** be used.

(a) Complete the diagram to show the apparatus that could be used to measure the volume of gas.

**(1)**




(b) Calculate the number of moles of sodium sulfite in 0.200 g.

**(2)**

(c) The reaction produced 29.5 $cm^3$ of sulfur dioxide.

Calculate the molar volume of sulfur dioxide, in $dm^3$, from this result.

**(2)**

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(d) The molar volume calculated was less than expected so after checking for leaks, the student repeated the experiment. The volume produced was still less than expected, so the student decided the acid might not be in excess.

(i) Calculate the minimum volume of 0.150 mol $dm^{-3}$ acid that should be present in the boiling tube to fully react with 0.200 g of sodium sulfite.
Use your answer to (b).

You should include units in your answer.

**(1)**

(ii) Suggest another reason for the molar volume being lower than expected.

**(1)**

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(e) State why the experiment should be carried out in a fume cupboard.

**(1)**

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**(Total for Question 1 = 8 marks)**

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**2** This question is about reactive metals and their compounds.

(a) Lithium, sodium and potassium all react with water.

(i) Describe the differences you would see when this experiment is carried out with the three metals.

**(3)**

(ii) State **two** precautions, other than wearing safety goggles, that should be taken during the experiment.

**(2)**

(b) Group 2 metals all have soluble chloride salts.

(i) Write an **ionic** equation for the reaction of magnesium chloride solution with aqueous sodium hydroxide.

Include state symbols in your answer.

**(1)**

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(ii) State what would be observed during this reaction.

**(1)**

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(iii) It is suspected that a bottle of magnesium chloride solution has been contaminated with barium chloride.

Describe a test and its result, other than a flame test, which could be used to confirm that the bottle contains traces of barium chloride.

**(2)**

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(iv) State the colours produced by the magnesium ions and barium ions in a flame test.

**(2)**

Magnesium

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Barium

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**(Total for Question 2 = 11 marks)**

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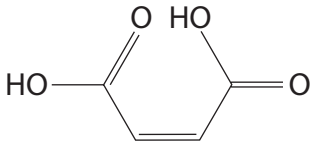
**3** Maleic acid is a solid acid that can be used as a standard for titration.




maleic acid

A 5.00 g sample of maleic acid was dissolved in deionised water and made up to 250 $cm^3$ of solution. A 20.0 $cm^3$ portion of this solution was titrated against sodium hydroxide solution, producing the results shown.

| Titration | Rough | 1 | 2 | 3 |
|---|---|---|---|---|
| Final reading / $cm^3$ | 22.45 | 43.55 | 21.45 | 42.60 |
| Initial reading / $cm^3$ | 0.00 | 22.45 | 0.05 | 21.45 |
| Titre / $cm^3$ | 22.45 | 21.10 | 21.40 | 21.15 |

(a) Phenolphthalein indicator was used in the experiment.

State the colour change seen at the end-point.

**(2)**

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.....

(b) Calculate the mean titre of sodium hydroxide solution using the concordant results.

**(1)**

(c) Calculate the concentration of the maleic acid solution in mol $dm^{-3}$.

[$M_r$ maleic acid = 116]

**(2)**

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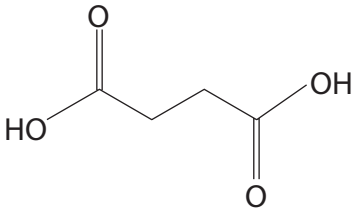
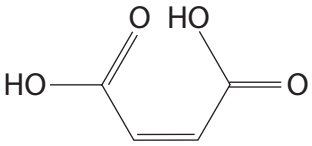
(d) Use your answers to (b) and (c) to calculate the concentration of the sodium hydroxide solution in mol $dm^{-3}$.

**(3)**

(e) Succinic acid is another solid acid.




succinic acid




maleic acid

(i) Describe a laboratory test that could be used to distinguish between solutions of these acids.

**(2)**

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(ii) State the IUPAC name for maleic acid.

**(1)**

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**(Total for Question 3 = 11 marks)**

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**4** An experiment was carried out to compare the rates of hydrolysis of different halogenoalkanes. The method and results are shown.

Step **1** Set up a water bath using a 250 $cm^3$ beaker.

Step **2** Add 5 $cm^3$ of ethanol to a test tube.

Step **3** Add four drops of 1-iodobutane to the test tube.

Step **4** Loosely place a bung in the test tube and place it in the water bath.

Step **5** Pour 5 $cm^3$ of silver nitrate solution into a clean test tube and place it in the water bath.

Step **6** When the solutions have reached the temperature of the water bath, add the silver nitrate solution to the 1-iodobutane in ethanol solution. Replace the bung and shake. Start the timer as you do so.

Step **7** As soon as the solution becomes cloudy, stop the timer.

Step **8** Repeat steps 2 to 7 using a bromoalkane and a chloroalkane instead of 1-iodobutane.

| Halogen element in halogenoalkane | Time taken for precipitate to form / s |
|---|---|
| Iodine | 51 |
| Bromine | 85 |
| Chlorine | 594 |

(a) Justify an appropriate temperature for the water bath.

**(2)**

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(b) Suggest, by name or formula, a bromoalkane and a chloroalkane suitable for this experiment, justifying your answers.

**(2)**

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(c) State how the results of this experiment could be converted into a value that can be used as a measure of rate.

**(1)**

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(d) State why it is not necessary to repeat these experiments for each halogenoalkane.

**(1)**

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(e) Under these conditions, all the silver halide precipitates can appear to be white.

Identify, by name or formula, a compound, the solutions of which can be used to distinguish between the silver halide precipitates.

**(1)**

.....

**(Total for Question 4 = 7 marks)**

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**5** The alcohol, 2-methylpropan-2-ol can be converted into 2-chloro-2-methylpropane using concentrated hydrochloric acid.

The individual steps of the method are listed.

| | |
|---|---|
| **A** | The alcohol and concentrated hydrochloric acid are mixed. The flask is sealed and swirled for 20 minutes, with the bung removed occasionally. |
| **B** | Sodium hydrogencarbonate solution is added. The mixture is swirled and any pressure released. |
| **C** | The organic liquid is distilled and a fraction between 50 °C and 52 °C is collected. |
| **D** | The aqueous layer is run off and discarded. The organic layer is run into a small conical flask and shaken with anhydrous sodium sulfate. |
| **E** | When the solution is clear, the organic liquid is decanted into a round-bottomed flask. |
| **F** | Anhydrous calcium chloride is added to the flask and swirled until dissolved. The mixture is poured into a separating funnel and the lower layer is discarded. |

(a) Complete the list to show the correct order of the steps.

**(2)**

A ____ ____ ____ ____ ____

(b) (i) Write an equation to show the reaction taking place in Step **B**.

Include state symbols in your answer.

**(2)**

(ii) State the purpose of adding anhydrous sodium sulfate in Step **D**.

**(1)**

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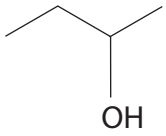
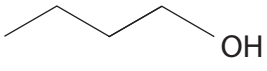
(c) The experiment was repeated using three different alcohols, **X**, **Y** and **Z**.




**X**




**Y**




**Z**

(i) The C–O bond is broken in the mechanism.

Using your knowledge of carbocations, explain which alcohol may react fastest in the experiment.

**(3)**

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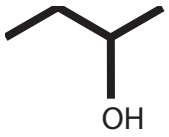
(ii) Describe how a solution of acidified potassium dichromate(VI) and subsequent chemical tests could be used to distinguish between alcohols **X**, **Y** and **Z**.

You may assume that the usual laboratory glassware and chemicals are available.

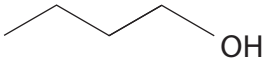
Include the colour change(s) seen.




**X**




**Y**




**Z**

**(5)**

**(Total for Question 5 = 13 marks)**

**TOTAL FOR PAPER = 50 MARKS**

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# The Periodic Table of Elements

| 1 | 2 | | | | | | | | | | | 3 | 4 | 5 | 6 | 7 | 0 (8) (18) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 1.0 H hydrogen 1 | | | | | | | | | | 4.0 He helium 2 |
| (1) | (2) | | Key | | | | | | | | | (13) | (14) | (15) | (16) | (17) | |
| 6.9 Li lithium 3 | 9.0 Be beryllium 4 | | relative atomic mass<br>atomic symbol<br>name<br>atomic (proton) number | | | | | | | | | 10.8 B boron 5 | 12.0 C carbon 6 | 14.0 N nitrogen 7 | 16.0 O oxygen 8 | 19.0 F fluorine 9 | 20.2 Ne neon 10 |
| 23.0 Na sodium 11 | 24.3 Mg magnesium 12 | (3) | (4) | (5) | (6) | (7) | (8) | (9) | (10) | (11) | (12) | 27.0 Al aluminium 13 | 28.1 Si silicon 14 | 31.0 P phosphorus 15 | 32.1 S sulfur 16 | 35.5 Cl chlorine 17 | 39.9 Ar argon 18 |
| 39.1 K potassium 19 | 40.1 Ca calcium 20 | 45.0 Sc scandium 21 | 47.9 Ti titanium 22 | 50.9 V vanadium 23 | 52.0 Cr chromium 24 | 54.9 Mn manganese 25 | 55.8 Fe iron 26 | 58.9 Co cobalt 27 | 58.7 Ni nickel 28 | 63.5 Cu copper 29 | 65.4 Zn zinc 30 | 69.7 Ga gallium 31 | 72.6 Ge germanium 32 | 74.9 As arsenic 33 | 79.0 Se selenium 34 | 79.9 Br bromine 35 | 83.8 Kr krypton 36 |
| 85.5 Rb rubidium 37 | 87.6 Sr strontium 38 | 88.9 Y yttrium 39 | 91.2 Zr zirconium 40 | 92.9 Nb niobium 41 | 95.9 Mo molybdenum 42 | [98] Tc technetium 43 | 101.1 Ru ruthenium 44 | 102.9 Rh rhodium 45 | 106.4 Pd palladium 46 | 107.9 Ag silver 47 | 112.4 Cd cadmium 48 | 114.8 In indium 49 | 118.7 Sn tin 50 | 121.8 Sb antimony 51 | 127.6 Te tellurium 52 | 126.9 I iodine 53 | 131.3 Xe xenon 54 |
| 132.9 Cs caesium 55 | 137.3 Ba barium 56 | 138.9 La* lanthanum 57 | 178.5 Hf hafnium 72 | 180.9 Ta tantalum 73 | 183.8 W tungsten 74 | 186.2 Re rhenium 75 | 190.2 Os osmium 76 | 192.2 Ir iridium 77 | 195.1 Pt platinum 78 | 197.0 Au gold 79 | 200.6 Hg mercury 80 | 204.4 Tl thallium 81 | 207.2 Pb lead 82 | 209.0 Bi bismuth 83 | [209] Po polonium 84 | [210] At astatine 85 | [222] Rn radon 86 |
| [223] Fr francium 87 | [226] Ra radium 88 | [227] Ac* actinium 89 | [261] Rf rutherfordium 104 | [262] Db dubnium 105 | [266] Sg seaborgium 106 | [264] Bh bohrium 107 | [277] Hs hassium 108 | [268] Mt meitnerium 109 | [271] Ds darmstadtium 110 | [272] Rg roentgenium 111 | | | | | | | |

Elements with atomic numbers 112-116 have been reported but not fully authenticated

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| * Lanthanide series | 140 Ce cerium 58 | 141 Pr praseodymium 59 | 144 Nd neodymium 60 | [147] Pm promethium 61 | 150 Sm samarium 62 | 152 Eu europium 63 | 157 Gd gadolinium 64 | 159 Tb terbium 65 | 163 Dy dysprosium 66 | 165 Ho holmium 67 | 167 Er erbium 68 | 169 Tm thulium 69 | 173 Yb ytterbium 70 | 175 Lu lutetium 71 |
| * Actinide series | 232 Th thorium 90 | [231] Pa protactinium 91 | 238 U uranium 92 | [237] Np neptunium 93 | [242] Pu plutonium 94 | [243] Am americium 95 | [247] Cm curium 96 | [245] Bk berkelium 97 | [251] Cf californium 98 | [254] Es einsteinium 99 | [253] Fm fermium 100 | [256] Md mendelevium 101 | [254] No nobelium 102 | [257] Lr lawrencium 103 |

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