Please check the examination details below before entering your candidate information

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

**Pearson Edexcel**
**International Advanced Level**

| Centre Number | Candidate Number |
|---|---|
| | |

**Time** 1 hour 20 minutes

**Paper reference** **WCH13/01**

# 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.
- **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.*
- Show all your working in calculations and include units where appropriate.

## 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.
- There is a Periodic Table on the back cover of this paper.

## Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.
- Good luck with your examination.

*Turn over* ▶

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P 6 4 6 2 5 A 0 1 1 6

Pearson

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

**1** The white solids sodium sulfate and potassium carbonate may be distinguished using a flame test.

(a) (i) Identify a material from which the flame test wire could be made.
Justify your answer.

**(2)**

(ii) Describe how to carry out a flame test on a solid, giving the expected flame colour for each of these compounds.

**(4)**

(b) Sodium sulfate and potassium carbonate may also be distinguished using **chemical** tests.

Give a **chemical** test for each compound which would confirm the identity of the **anion**. Include the expected results.

**(4)**

Test 1 .....

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Test 2 .....

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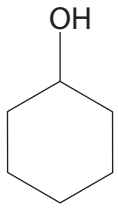
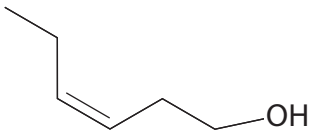
**(Total for Question 1 = 10 marks)**

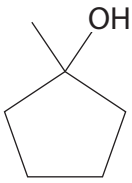
**2** This question is about the reactions of three compounds with the formula $C_6H_{12}O$.
The compounds are cyclohexanol, *Z*-hex-3-en-1-ol and 1-methylcyclopentanol.




cyclohexanol




*Z*-hex-3-en-1-ol




1-methylcyclopentanol

(a) Give a chemical test to show the presence of the –OH group in all three compounds, including the expected result.

**(2)**

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(b) (i) Give a chemical test to show the presence of the carbon-carbon double bond in *Z*-hex-3-en-1-ol, including the expected result.

**(2)**

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.....

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(ii) The test you have given in (b)(i) is repeated with 1-methylcyclopentanol.

Give the observation for this test with 1-methylcyclopentanol.

**(1)**

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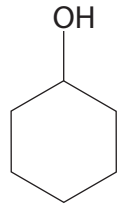
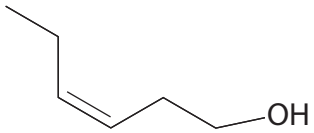
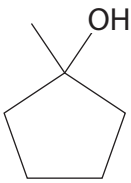
.....

.....

(c) Separate samples of each of these compounds are warmed with acidified potassium dichromate(VI).

Complete the table to give the colour changes observed, if any.

**(2)**

| Compound | Colour change |
|---|---|
|   | |
|   | |
|   | |

(d) Spectroscopy provides information about the structure of these three compounds.

Some infrared data is given in the table.

| Group | Wavenumber range / $cm^{-1}$ |
|---|---|
| O—H stretching in alcohols | 3750 – 3200 |
| O—H stretching in carboxylic acids | 3300 – 2500 |
| C═O stretching in aldehydes | 1740 – 1720 |
| C═O stretching in ketones | 1720 – 1700 |
| C═O stretching in carboxylic acids | 1725 – 1700 |
| C—H stretching in aldehydes | 2900 – 2820<br>2775 – 2700 |
| C═C stretching in alkenes | 1669 – 1645 |

(i) Identify the wavenumber range and the bond responsible for **one** peak which you would expect to see in the infrared spectra of all three compounds.

**(1)**

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(ii) Identify the wavenumber range and the bond responsible for **one** peak which you would expect to see in the infrared spectra of only one of the compounds.

**(1)**

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(iii) Give a reason why there is a peak at $m/z = 100$ in the mass spectra of all three compounds.

**(1)**

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(iv) Fragmentation of 1-methylcyclopentanol results in a significant peak at $m/z = 85$.

Suggest the structures of the **two** species formed when one bond in 1-methylcyclopentanol breaks resulting in the peak at $m/z = 85$.

**(2)**

**(Total for Question 2 = 12 marks)**

**3** A saturated solution of barium hydroxide was formed by adding barium oxide to water until no more would dissolve. The equation for the reaction is

$$BaO(s) + H_2O(l) \rightarrow Ba(OH)_2(aq)$$

The resulting mixture was filtered to remove excess solid.

The concentration of the barium hydroxide solution was found by titrating portions of the saturated solution with hydrochloric acid of known concentration.

10.0 $cm^3$ portions of the saturated barium hydroxide solution were placed in conical flasks and titrated with 0.200 mol $dm^{-3}$ hydrochloric acid added from a burette.

Three drops of methyl orange indicator were added to the solution in each conical flask.

(a) State the colour **change** observed at the end-point of the titration.

**(2)**

From ..... to .....

(b) Some of the results are shown.

| Titration | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Final burette reading / $cm^3$ | 22.60 | 44.45 | 23.05 | |
| Initial burette reading / $cm^3$ | 0.10 | 22.60 | 1.25 | 23.20 |
| Titre / $cm^3$ | 22.50 | 21.85 | | 21.90 |

(i) Complete the table.

**(1)**

(ii) Give a reason why the first titre should **not** be used to calculate the mean titre.

**(1)**

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(iii) Calculate the number of moles of hydrochloric acid in the mean titre.

**(2)**

(iv) The equation for the reaction in the titration is

$$Ba(OH)_2(aq) + 2HCl(aq) \rightarrow BaCl_2(aq) + 2H_2O(l)$$

Calculate the concentration of barium hydroxide, in g $dm^{-3}$, giving your answer to an appropriate number of significant figures.

**(3)**

(c) Solid samples of soluble barium compounds such as barium oxide are toxic by inhalation due to the presence of barium ions.

Give a safety precaution that should be used to minimise this risk when adding barium oxide to water.

**(1)**

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(d) Barium also forms a peroxide. A bottle of barium peroxide has the hazard symbol

Give the meaning of this symbol.

**(1)**

.....

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

**4** A sample of 1-bromobutane may be prepared by reacting butan-1-ol with sodium bromide and 50 % concentrated sulfuric acid.

$$C_4H_9OH + NaBr + H_2SO_4 \rightarrow C_4H_9Br + NaHSO_4 + H_2O$$

**Procedure**

Step **1** Add suitable quantities of butan-1-ol and sodium bromide solution to a round-bottom flask. Place the flask in a cold water bath.
Add concentrated sulfuric acid drop by drop to the flask.

Step **2** Heat the mixture in the flask under reflux for about 45 minutes.

Step **3** Rearrange the apparatus for distillation and distil the reaction mixture.
The distillate collected contains 1-bromobutane and water in separate layers.
Remove as much of the water layer as possible.

Step **4** Transfer the impure 1-bromobutane to a separating funnel, add sodium hydrogencarbonate solution and shake the mixture.
Run off the organic layer into a clean conical flask.

Step **5** Add anhydrous calcium chloride, stopper the flask and allow it to stand.
Decant the liquid.

Step **6** Distil the product over a suitable temperature range to give pure 1-bromobutane.

**Data**

| Property | Butan-1-ol | 1-Bromobutane |
|---|---|---|
| Density / g $cm^{-3}$ | 0.810 | 1.27 |
| Molar mass / g $mol^{-1}$ | 74 | 137 |
| Boiling temperature / °C | 118 | 102 |

(a) Suggest why the percentage yield of 1-bromobutane might be lower if the cold water bath was **not** used in Step **1**.

**(2)**

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(b) (i) State what must be added to the mixture in the flask before heating in Step **2**.

**(1)**

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(ii) Draw a labelled diagram of the apparatus that you would use to heat the mixture under reflux in Step **2**.

**(3)**

(c) Purification of the product occurs in Steps **3**–**6**.

(i) State why sodium hydrogencarbonate solution is added in Step **4**.

**(1)**

(ii) Addition of sodium hydrogencarbonate solution in Step **4** causes vigorous effervescence.

Explain how the problem associated with Step **4** should be dealt with.

**(2)**

(iii) Give the purpose of the anhydrous calcium chloride used in Step **5**.

**(1)**

(iv) State how the appearance of the organic liquid would change in Step **5**.

**(1)**

(d) For the final distillation in Step **6**, a thermometer with a scale giving readings to the nearest 1°C was provided.

Give a suitable temperature **range** for the collection of the pure 1-bromobutane.

**(1)**

.....

(e) A student was asked to prepare 20 $cm^3$ of 1-bromobutane using the procedure described. The student knew that the percentage yield would be less than 100 %.

(i) Give **one** possible reason for the yield being less than 100 %.

**(1)**

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(ii) After some research the student decided to use 21.0 g of butan-1-ol to prepare 20 $cm^3$ of 1-bromobutane.

Calculate the percentage yield that the student expected to obtain.

**(4)**

**(Total for Question 4 = 17 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) | | | | | | | | | | | (13) | (14) | (15) | (16) | (17) | |
| 6.9 Li lithium 3 | 9.0 Be beryllium 4 | | | | | | | | | | | 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 | | | | | | | |

Key

relative atomic mass
**atomic symbol**
name
atomic (proton) number

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 |