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

Centre Number | | | | | |

Candidate Number | | | | |

# Friday 18 January 2019

Afternoon (Time: 1 hour 15 minutes) | Paper Reference **WCH03/01**

# Chemistry

## Advanced

## Unit 3: Chemistry Laboratory Skills I

**Candidates must have: Scientific calculator**

Total Marks

## Instructions

- Use **black** ink or **black** 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.*

## 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.
- 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** A white solid **A** contains one cation and one anion.

(a) A small amount of solid **A** was placed in a test tube and aqueous sodium hydroxide added. The mixture was warmed gently.
Complete the inference column in the table.

**(2)**

| Observation | Inference |
|---|---|
| A pungent smelling gas was evolved that turned damp red litmus paper blue | The gas formed is<br>.....<br>The **formula** of the cation in **A** is<br>..... |

(b) (i) An aqueous solution of **A** was placed in a test tube and acidified with dilute nitric acid. A few drops of silver nitrate solution were added.
Complete the inference column in the table.

**(1)**

| Observation | Inference |
|---|---|
| Cream precipitate formed | The precipitate is<br>..... |

(ii) Write the **ionic** equation, including state symbols, for the formation of the cream precipitate in (b)(i).

**(2)**

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(iii) Describe how you would confirm the identity of the **anion** in the cream precipitate formed in (b)(i).

**(2)**

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**(Total for Question 1 = 7 marks)**

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**2** (a) A student was provided with aqueous solutions of four compounds:

barium nitrate

hydrochloric acid

sodium carbonate

sulfuric acid

Four bottles, labelled **B**, **C**, **D** and **E**, each contained one of the solutions. The student mixed pairs of the solutions to determine which solution was in each bottle.

The results are shown.

| Solutions mixed | Observations |
|---|---|
| **B** and **C** | Effervescence with bubbles of a colourless gas given off |
| **B** and **D** | No visible change |
| **B** and **E** | A white precipitate formed which did **not** dissolve on the addition of dilute nitric acid |
| **C** and **D** | Effervescence with bubbles of a colourless gas given off |
| **C** and **E** | A white precipitate formed which dissolved with effervescence on the addition of dilute nitric acid |
| **D** and **E** | No visible change |

Use the observations in the table to deduce the identity of the compound in each bottle. Identify each compound by name or formula.

**B** .....

**C** .....

**D** .....

**E** .....

**(3)**

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(b) (i) The identity of the **cations** present in barium nitrate and sodium carbonate can be confirmed with a flame test on the solid compounds.

Describe how you would carry out a flame test.

**(3)**

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(ii) State the flame colours produced by barium nitrate and sodium carbonate.

Barium nitrate .....

Sodium carbonate .....

**(2)**

**(Total for Question 2 = 8 marks)**

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**3** Chlorine-based bleaches contain sodium chlorate(I), NaClO, as the active ingredient. The concentration of NaClO in bleach was determined by a titration method using sodium thiosulfate.

Sodium chlorate(I) reacted with potassium iodide in acidic solution to produce iodine.

$$ClO^- + 2I^- + 2H^+ \rightarrow I_2 + Cl^- + H_2O$$

The iodine was then titrated with sodium thiosulfate.

$$2S_2O_3^{2-} + I_2 \rightarrow 2I^- + S_4O_6^{2-}$$

**Procedure**

1. A burette was filled with 0.0600 mol $dm^{-3}$ sodium thiosulfate solution.
2. 10.0 $cm^3$ of bleach was pipetted into a 250.0 $cm^3$ volumetric flask and excess potassium iodide and sulfuric acid were added to release iodine. The volume was made up to the mark with distilled water.
3. 25.0 $cm^3$ of this solution was pipetted into a conical flask and titrated with the sodium thiosulfate solution using a suitable indicator.

(a) State the indicator used and give the colour change at the end-point.

**(2)**

| Indicator | Colour change at the end-point |
|---|---|
| ..... | From ..... to ..... |

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(b) (i) Complete the table of results.

**(1)**

| Number of titration | 1 | 2 | 3 | 4 |
|---|---|---|---|---|
| Burette reading (final) / $cm^3$ | 23.65 | 46.45 | 24.40 | 47.10 |
| Burette reading (start) / $cm^3$ | 0.00 | 23.65 | 1.20 | 24.40 |
| Titre / $cm^3$ | | | | |

(ii) State with a reason which results should be used to calculate the mean titre value.

**(2)**

.....

.....

.....

(iii) Calculate the mean titre.

**(1)**

(iv) Calculate the number of moles of sodium thiosulfate in this mean titre.

**(1)**

(v) Calculate the number of moles of iodine in 25.0 $cm^3$ of the diluted solution.

**(1)**

(vi) Calculate the number of moles of sodium chlorate(I) in the 250.0 $cm^3$ volumetric flask.

**(1)**

(vii) Calculate the concentration of sodium chlorate(I) in the **undiluted** bleach in mol $dm^{-3}$.

**(1)**

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(c) The 0.0600 mol $dm^{-3}$ sodium thiosulfate solution used in this titration is known as a standard solution.

Describe the steps you would take to prepare this standard solution as accurately as possible. You are supplied with the appropriate mass of sodium thiosulfate and the usual laboratory glassware, including a volumetric flask.

No calculations are required.

**(3)**

**(Total for Question 3 = 13 marks)**

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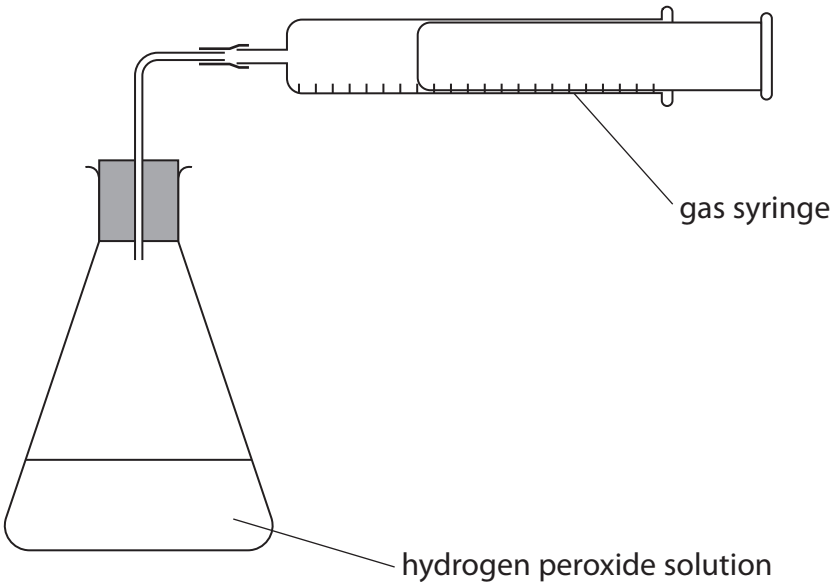
**4** Hydrogen peroxide, $H_2O_2$, decomposes according to the equation

$$2H_2O_2 \rightarrow 2H_2O + O_2$$

The rate of decomposition is increased by a catalyst.

A student tested three metal oxides to determine which was the best catalyst.
The oxides were manganese(IV) oxide, iron(III) oxide and lead(IV) oxide.
They are all solids.

The student used the following apparatus and experimental procedure.




**Procedure**

1. Hydrogen peroxide solution was poured into the conical flask.
2. Solid manganese(IV) oxide was added.
3. The bung was quickly replaced to connect the gas syringe to the conical flask.
4. The procedure was repeated using iron(III) oxide and lead(IV) oxide.

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(a) Suggest **three** things you would do to ensure that the metal oxides are compared fairly, when using this procedure.

**(3)**

1 .....

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2 .....

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3 .....

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.....

(b) State the measurements the student should make to determine which is the best catalyst.

**(2)**

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(c) The student thought that some of the gas escaped from the conical flask before the bung had been replaced.

Suggest how this experiment could be modified to prevent this loss.

**(1)**

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(d) Another student thought that some of the oxygen produced may have come from the decomposition of the metal oxide.

Suggest how this idea could be tested.

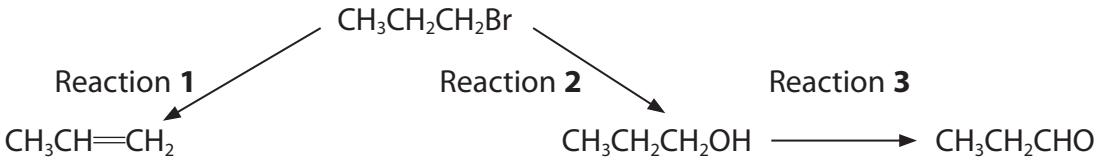
**(2)**

**(Total for Question 4 = 8 marks)**

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**5** Some organic reactions are shown.




(a) Reaction **1** and Reaction **2** use the same reagent but require different conditions.

Identify the reagent and give the conditions needed for Reaction **1**.

**(2)**

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(b) (i) Give a chemical test and its positive result to show the presence of the double bond in $CH_3CH{=}CH_2$.

**(2)**

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(ii) Give the structure of the organic product of the test in (b)(i).

**(1)**

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(c) A student added phosphorus(V) chloride, $PCl_5$, to the product of Reaction **2**, $CH_3CH_2CH_2OH$. Hydrogen chloride was formed.

(i) State the observation the student would be expected to make.

**(1)**

.....

.....

(ii) Complete the table to show the hazard and the appropriate safety precaution for each chemical.

Do not include the wearing of eye protection and a laboratory coat.

**(3)**

| Chemical | Hazard | Safety precaution |
|---|---|---|
| $PCl_5$ | | |
| $CH_3CH_2CH_2OH$ | | |
| HCl | | |

(d) In Reaction **3**, $CH_3CH_2CH_2OH$ is oxidised to $CH_3CH_2CHO$ using aqueous potassium dichromate(VI) acidified with sulfuric acid.

(i) State the colour **change** that occurs during this oxidation reaction.

**(1)**

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(ii) Draw a labelled diagram of the apparatus you would use to carry out Reaction **3** and collect the product.

**(3)**

(iii) Explain how infrared spectroscopy could be used to confirm that **all** the $CH_3CH_2CH_2OH$ has been oxidised to $CH_3CH_2CHO$ in Reaction **3**.
You are not expected to give specific wavenumbers.

**(1)**

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**(Total for Question 5 = 14 marks)**

**TOTAL FOR PAPER = 50 MARKS**

# The Periodic Table of Elements

| 1 (1) | 2 (2) | | | | | | | | | | | 3 (13) | 4 (14) | 5 (15) | 6 (16) | 7 (17) | 0 (8) (18) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 1.0 H hydrogen 1 | | | | | | | | | | 4.0 He helium 2 |
| 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 |

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