Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International Advanced Level

Centre Number	Candidate Number

HA031169870

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)

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

(4)

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(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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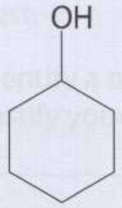
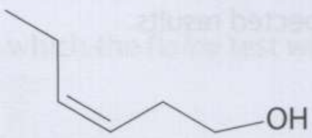
....

(Total for Question 1 = 10 marks)

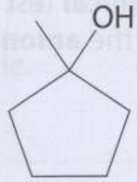
2 This question is about the reactions of three compounds with the formula $C_6H_{12}O$.
The compounds are cyclohexanol, *Z*-hex-3-en-1-ol and 1-methylcyclopentanol.



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)

....

....

....

(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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....

....

(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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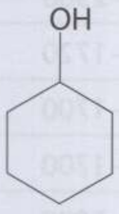
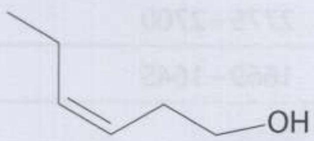
....

....

(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 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)**

....

(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)**

....

(iii) Give a reason why there is a peak at $m/z = 100$ in the mass spectra of all three compounds. **(1)**

....

....

....

(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)**

....

....

(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)**

(ii) Draw a labelled diagram of the apparatus that you would use to heat the mixture under reflux in Step **2**. **(3)**

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(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)

(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

The Periodic Table of Elements

Key

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

1.0 **H** hydrogen 1

1 (1)	2 (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	3 (13)	4 (14)	5 (15)	6 (16)	7 (17)	0 (8) (18)
																	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											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