Write your name here

Surname	Other names

Pearson Edexcel
International
Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Chemistry

Advanced Subsidiary

Unit 3: Chemistry Laboratory Skills I

Tuesday 24 October 2017 – Morning
Time: 1 hour 15 minutes

Paper Reference
WCH03/01

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.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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Pearson

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

1 Student A and student B, working separately, each carried out a series of tests on two white solids, **X** and **Y**. Both solids contained one cation and one anion.

The students heated solid **X**, which gave off a colourless gas that turned damp red litmus paper blue. The gas also produced white smoke when tested with a glass rod dipped in concentrated hydrochloric acid.

(a) (i) Identify, by name or formula, the colourless gas.

(1)

.....

(ii) Identify, by name or formula, the white smoke produced.

(1)

.....

(b) The students dissolved a sample of solid **X** in deionised water, added dilute hydrochloric acid and carried out the test for sulfate ions. The test was positive.

(i) Identify, by name or formula, the reagent used to test for sulfate ions.

(1)

.....

(ii) State the observation for a positive result in the test for sulfate ions.

(1)

.....

(c) Give the **formula** of solid **X**.

(1)

.....

(d) The students carried out a flame test on solid **Y** and observed a red colour. Student A was confident of the identity of the cation in solid **Y** but student B was correct to be unsure.

Explain why student A should have been unsure of the identity of the cation in solid **Y**.

What is the correct inference from the flame test about the identity of the cation in solid **Y**?

(3)

(e) The students dissolved a sample of solid **Y** in deionised water and then added dilute nitric acid followed by silver nitrate solution. The students observed the formation of a precipitate.

Student A added concentrated ammonia to the precipitate and observed that the precipitate dissolved to give a colourless solution.

Student B used dilute ammonia and made the same observation.

(i) What should student A infer from the dissolving of the precipitate in concentrated ammonia?

(1)

(ii) What inference about the identity of the anion in solid **Y** should student B make?

(1)

(iii) Give one possible **formula** for solid **Y**.

(1)

(Total for Question 1 = 11 marks)

2 Borax is hydrated sodium tetraborate, $Na_2B_4O_7.10H_2O$ (molar mass = 381.2 g mol^{-1}). It is a primary standard which can be used to determine the concentration of a solution of hydrochloric acid.

(a) Sodium hydroxide is not suitable to be used as a primary standard because the solid absorbs moisture from the air.

The mass of pure sodium hydroxide required to make a solution of known concentration is calculated. This mass is weighed out and dissolved to make the solution. Explain how the absorption of moisture from the air affects the concentration of this solution.

(1)

.....

.....

.....

(b) The mass of an empty weighing bottle was measured and then it was reweighed containing a sample of borax. The mass of the borax sample was 9.53 g. This sample was dissolved in deionised water and transferred, with washings, to a 500 cm^3 volumetric flask. The mixture was made up to the mark with deionised water and mixed thoroughly.

(i) A two-decimal point balance has the measurement uncertainty of ±0.01 g for each measurement.

What would be the possible numerical range for a mass of 9.53 g?

(1)

.....

(ii) Calculate the concentration, in mol dm^{-3}, of the borax solution.

(2)

(iii) 25.0 cm^3 of the borax solution was pipetted into each of three conical flasks.

Calculate the number of moles of borax in each conical flask.

(1)

(c) A few drops of methyl orange indicator were added to each conical flask.
A hydrochloric acid solution of unknown concentration was placed in a burette and titrated against the borax solution.

The following titration results were obtained.

Titration	1	2	3
Burette reading (final) /cm^3	17.00	33.25	16.35
Burette reading (initial) /cm^3	0.00	17.00	0.00
Titre /cm^3	17.00	16.25	16.35

(i) What is the colour change at the **end-point**?

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

(1)

(ii) What is the likely colour of the solution in the conical flask in titration 1 after 17.00 cm^3 of hydrochloric acid has been added?

(1)

.....

(iii) 1 mol of borax reacts with water to produce 2 mol of sodium hydroxide, which then neutralises the hydrochloric acid.

Calculate the concentration of the hydrochloric acid in **g dm^{-3}**, giving your answer to **three** significant figures.

You will need to use

- your answer to part (b)(iii).
- the mean titre calculated from the results table.

(3)

(Total for Question 2 = 10 marks)

3 A series of analytical tests is carried out to identify two colourless liquids labelled **W** and **Z**. The molecules of **W** and **Z** contain only carbon, hydrogen and oxygen and each has only one functional group.

(a) Both **W** and **Z** were inferred to have a hydroxy group, —OH, as a result of their reaction with phosphorus(V) chloride, PCl_5.

Containers of phosphorus(V) chloride have the following hazard labels.

First label

Second label

(i) What precaution would reduce the risk due to the hazard indicated by the first label, other than wearing safety goggles and laboratory coats?

(1)

.....

(ii) Phosphorus(V) chloride is a solid and not a liquid, so why is the second hazard label used?

(1)

.....

.....

(iii) What would be the observation when PCl_5 is added to liquids **W** and **Z**?

(1)

.....

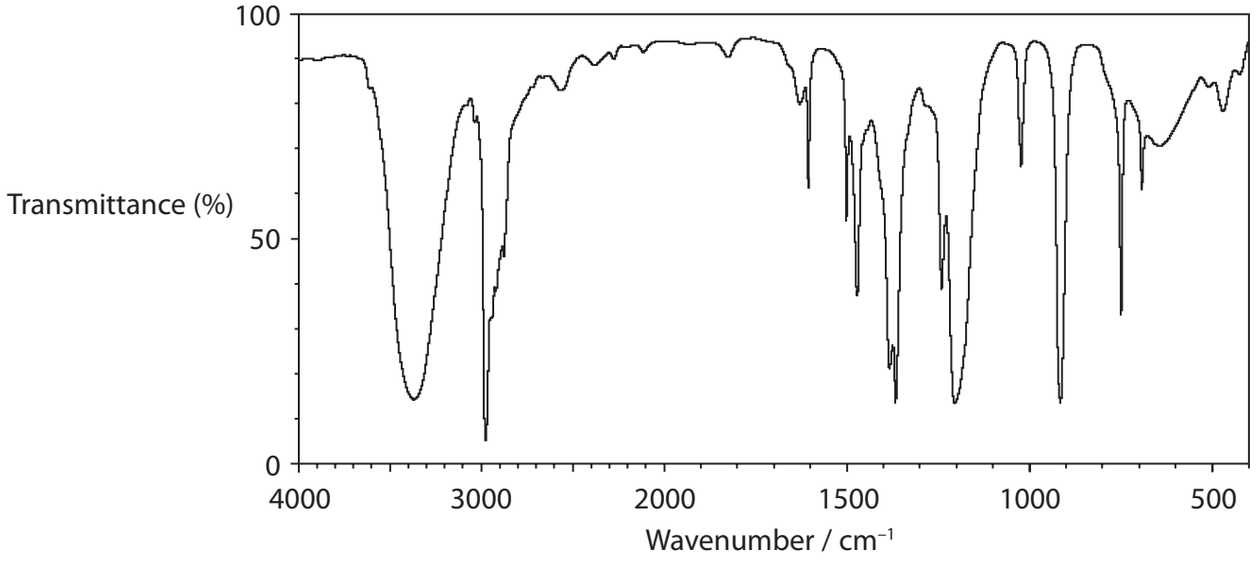
(iv) Suggest a reagent that may be used in an alternative test to confirm the presence of a hydroxy group, —OH. Give the observation for the positive result of this test.

(2)

Reagent .....

Observation .....

(b) The infrared spectrum for liquid **W** is



Group	Bond stretching vibration	Wavenumber / cm^{-1}
Alcohol	O—H	3750 – 3200
Aldehyde	C=O	1740 – 1720
Alkane	C—H	2962 – 2853
Carboxylic acid	O—H	3300 – 2500
Ketone	C=O	1700 – 1680

Using information from the spectrum and the table, name the functional group in **W**.

(1)

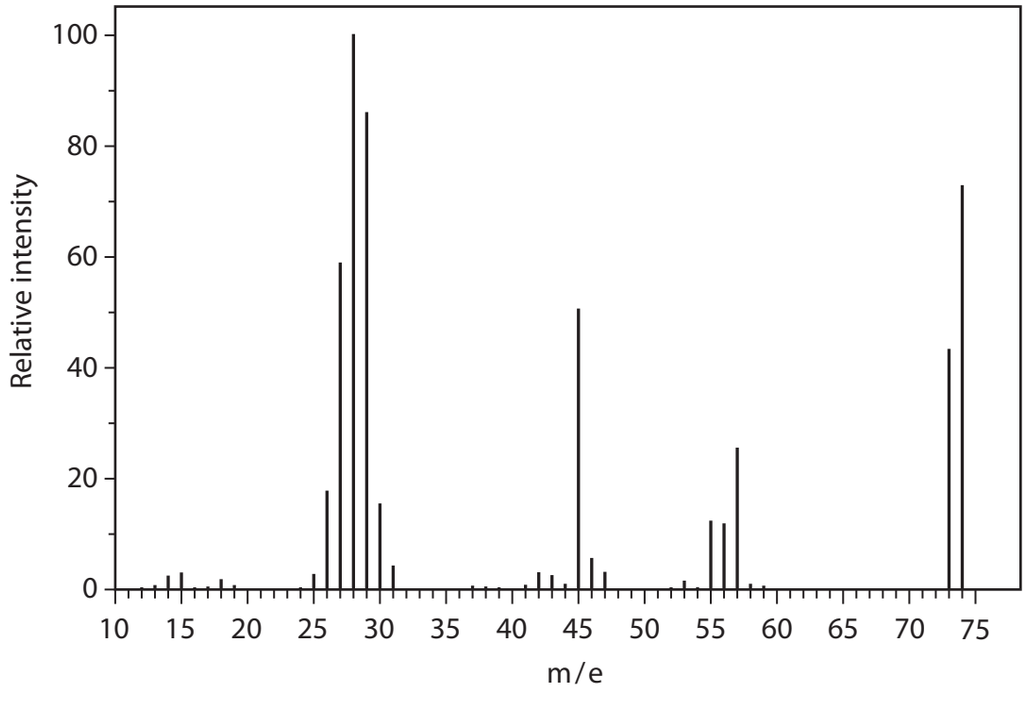
.....

(c) A molecule of **W** has four carbon atoms.
W does **not** react with acidified sodium dichromate(VI).

Identify **W**, by name or formula.

(1)

(d) The mass spectrum of **Z** is



(i) Label with an asterisk (*) the peak which corresponds to the $COOH^+$ fragment.

(1)

(ii) A molecule of **Z** has three carbon atoms. Draw its **skeletal** formula.

(1)

(Total for Question 3 = 9 marks)

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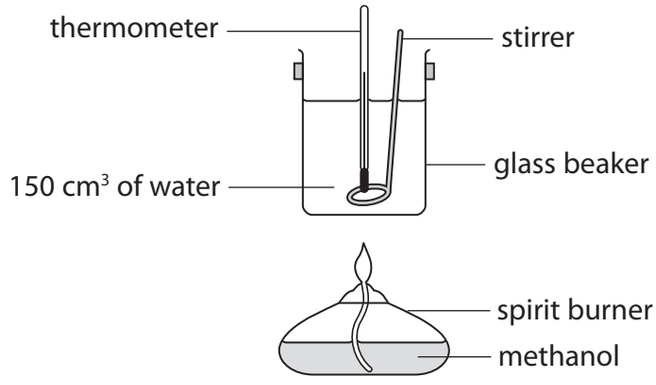
4 The enthalpy change of combustion of methanol was measured using the following procedure:

- A 250 cm^3 measuring cylinder was used to measure 150 cm^3 of water into a glass beaker and the initial temperature of the water recorded.
- A spirit burner was filled with methanol and its mass recorded.
- The spirit burner was placed under the beaker as shown.



- The burner was lit and the water in the beaker was stirred while the methanol was burned.
- After about three minutes, the flame was extinguished and the maximum temperature of the water recorded.
- The spirit burner was reweighed and the mass recorded.

The results are given in the following table.

Measurement	Value
Mass of spirit burner and methanol **before** burning /g	186.87
Mass of spirit burner and methanol **after** burning /g	185.27
Mass of methanol burned /g	
Initial temperature /°C	21.5
Maximum temperature /°C	72.0
Temperature change /°C	

(a) Complete the table to show the mass of methanol burned and the temperature change as a result of this combustion.

(1)

(b) Calculate the energy transferred, in joules, for this combustion experiment.

Energy transferred = mass of water × specific heat capacity × temperature change

Density of water = 1.0 g cm^{-3}

Specific heat capacity of water = 4.18 J g^{-1} $°C^{-1}$

(1)

(c) Calculate the number of moles of methanol, CH_3OH, burned in this experiment.

(1)

(d) Calculate the enthalpy change of combustion, ΔH_c, in kJ mol^{-1}.
Give your answer to the nearest **whole number** and include a sign.

(2)

ΔH_c = ... kJ mol^{-1}

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(e) The experimental value for the enthalpy change of combustion for methanol is less negative than the Data Booklet value.

Identify **two** improvements that could be made, either to the apparatus shown in the diagram or to the procedure which would give an enthalpy change closer to the Data Booklet value. Justify your suggested changes.
Do **not** include repeating the experiment or using more accurate measuring equipment.

(4)

Improvement 1 .....

.....

Justification .....

.....

.....

Improvement 2 .....

.....

Justification .....

.....

.....

(f) State and explain the effect, if any, on the value obtained for the enthalpy change of combustion if the water in the beaker was not stirred.

(1)

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.....

.....

(g) If there is insufficient oxygen for the complete combustion of methanol, what is observed on the underside of the beaker?

(1)

.....

.....

(Total for Question 4 = 11 marks)

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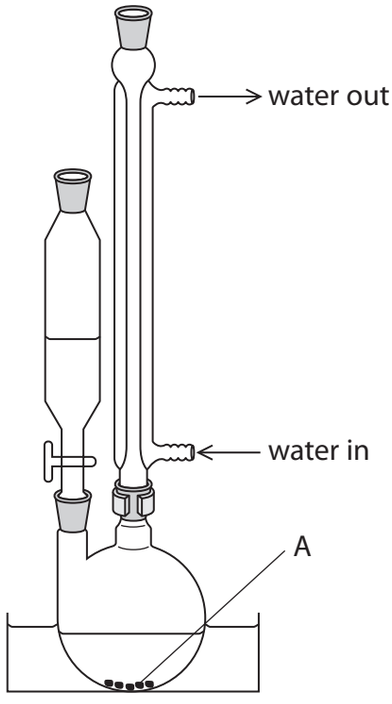
5 A preparation of 1-bromobutane is outlined below.

Procedure

Step **1** Suitable quantities of sodium bromide solution and butan-1-ol were added to a twin-necked flask already containing material **A**. The reflux condenser was then fitted in one neck and a tap funnel in the other neck.



Step **2** After immersing the flask in cold water, a suitable volume of concentrated sulfuric acid was placed in the tap funnel and then added drop-by-drop to the mixture in the flask.

Step **3** After all the acid was added, the mixture was heated under reflux for 45 minutes. The apparatus was then rearranged for distillation.

Step **4** The crude 1-bromobutane was distilled off and washed with sodium hydrogencarbonate solution.

Step **5** The washed 1-bromobutane was separated and anhydrous calcium chloride added.

(a) Identify the material labelled **A** in the flask, and explain its purpose.

(2)

.....

.....

.....

(b) What does the method of adding the sulfuric acid in Step **2** suggest about the nature of the reaction?

(1)

(c) Explain why it is important to close the tap of the tap funnel once all the sulfuric acid has been added.

(1)

(d) What is the purpose of washing with sodium hydrogencarbonate solution in Step **4**?

(1)

(e) What piece of apparatus would be used in Step **5** to obtain 1-bromobutane from the mixture obtained in Step **4**? Justify your answer.

(2)

(f) How is the appearance of the 1-bromobutane changed by the addition of anhydrous calcium chloride in Step **5**?

(1)

(g) After the 1-bromobutane has been decanted from the calcium chloride, what additional step is needed to obtain **pure** 1-bromobutane?

(1)

(Total for Question 5 = 9 marks)

TOTAL FOR PAPER = 50 MARKS

The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8)
							1.0 H hydrogen 1										(18) 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 **atomic symbol** name 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

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
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

* Lanthanide series

* Actinide series