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

Wednesday 14 January 2015 – Morning
Time: 1 hour 15 minutes

Paper Reference
WCH03/01

Candidates may use a calculator.

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.*

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

Turn over ▶

6/6/6/6/4/

P 4 5 0 4 3 A 0 1 1 6

PEARSON

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

1 Tests were carried out on compounds **P** and **Q**. Complete the tables below.

(a) Compound **P** is a white inorganic solid which contains one cation and one anion.

	Test	Observation	Inference (Name or formula)	
(i)	Warm **P** with dilute aqueous sodium hydroxide	A gas is given off which turns damp red litmus paper blue	The gas is	**(1)**
(ii)	Add dilute nitric acid followed by aqueous silver nitrate to an aqueous solution of **P**	A cream coloured precipitate forms	**P** contains the .... ion	**(1)**
(iii)	Add dilute aqueous ammonia to the cream coloured precipitate	....	This confirms the inference in (a)(ii)	**(1)**

(iv) The **formula** of **P** is ....

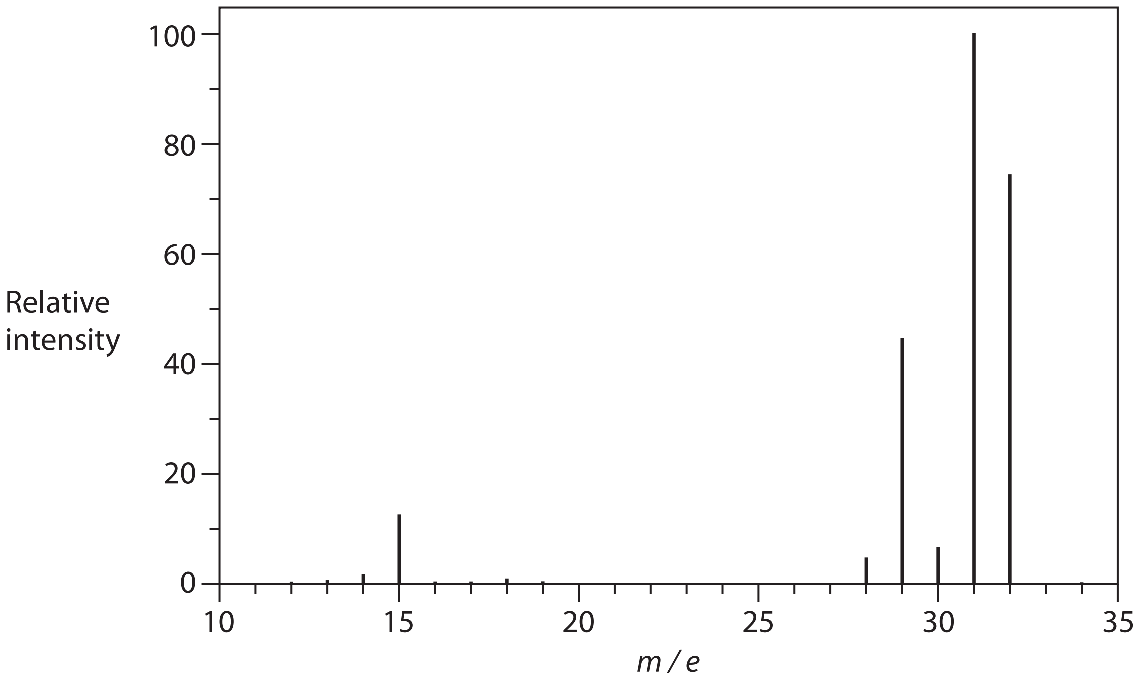
(1)

P 4 5 0 4 3 A 0 2 1 6

(b) **Q** is an organic liquid which has only one functional group. **Q** dissolves in water forming a **neutral** solution.

	Test	Observation	Inference	
(i)	Add bromine water to **Q**	The bromine is not decolorised	....	**(1)**
(ii)	Add phosphorus(V) chloride to **Q**	Misty fumes which react with ammonia to form a white smoke	The misty fumes are .... The **formula** of the functional group in **Q** is	**(2)**
(iii)	Add a small piece of sodium to **Q**	....	This confirms the inference made in (b)(ii)	**(1)**

(iv) The mass spectrum of **Q** is shown below.



Identify **Q** by name or formula. Use information from the spectrum to justify your answer.

(2)

Identity of **Q** ....

Justification ....

....

....

(Total for Question 1 = 10 marks)

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2 A white powder is the carbonate of an element in Group 2. Its formula can be written XCO_3.

0.150 g of the pure carbonate was mixed with excess dilute hydrochloric acid.

The following reaction occurred.

$$XCO_3(s) + 2HCl(aq) \rightarrow XCl_2(aq) + CO_2(g) + H_2O(l)$$

(a) Describe the test for carbon dioxide.

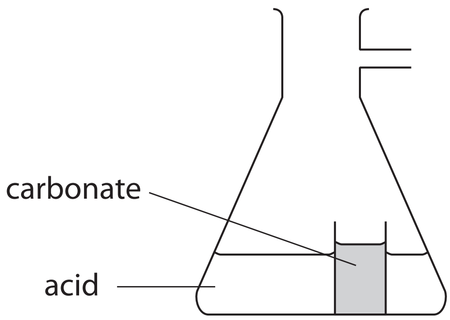
(1)

Test ....

Observation ....

(b) The carbonate and dilute hydrochloric acid were mixed in a conical flask with a side arm. Complete the diagram below to show how to collect the carbon dioxide and measure its volume.

(2)



(c) The volume of carbon dioxide, measured at room temperature and pressure, was 41 cm^3. Calculate the number of moles of gas formed.

[The molar volume of a gas under these conditions is 24 $dm^3\ mol^{-1}$.]

(1)

(d) Use your answer to (c), and the mass of the carbonate used, to calculate the molar mass of XCO_3.

(2)

(e) Deduce the value which this experiment gives for the relative atomic mass of **X**. Suggest which Group 2 metal is most likely to be **X**.

(1)

(f) Suggest why less gas is collected than expected. You should assume that the reaction is complete and no gas escapes.

(1)

....

....

(g) What would be observed when a flame test is carried out on XCO_3?

(1)

....

(h) A student attempted to determine the molar mass of other carbonates of Group 2 by the method used in this question.

The student measured the volume of gas produced by each carbonate, but replaced hydrochloric acid with sulfuric acid.

Explain why the results of the student's experiments would give very inaccurate values for the molar mass of some carbonates of Group 2.

(2)

....

....

....

....

(Total for Question 2 = 11 marks)

3 A titration was carried out to find the relative molecular mass of a solid acid. The formula of the acid can be written H_2A.

(a) 1.05 g of the acid was dissolved in water and the solution made up to 250 cm^3.

Name the piece of apparatus used for making a solution with volume exactly 250 cm^3.

(1)

....

(b) 25.0 cm^3 of the acid solution was pipetted into a conical flask and titrated with 0.100 mol dm^{-3} sodium hydroxide solution. This titration was repeated three times.

The equation for the reaction is shown below.

$$H_2A(aq) + 2NaOH(aq) \rightarrow Na_2A(aq) + 2H_2O(l)$$

(i) The indicator used in the titration was phenolphthalein. What colour change took place at the end point of the titration?

H_2A and its ions are colourless.

(2)

From .... to ....

(ii) The following results were recorded.

Titration number	1	2	3	4
Burette reading (final) /cm^3	23.60	46.90	24.35	47.65
Burette reading (initial) /cm^3	0.00	23.60	1.00	24.40
Volume of NaOH used /cm^3	23.60	23.30	23.35	23.25

Titration number 1 was a rangefinder, or rough titration.
Describe how you would use the rough titration value when carrying out the accurate titrations.

(1)

....

....

....

....

(iii) The uncertainty in each burette reading was ± 0.05 cm^3.

Calculate the percentage uncertainty in titration number 2.

(1)

(iv) Calculate the mean titre for titration numbers 2, 3 and 4.

(1)

Mean titre = ... cm^3

(v) Calculate the number of moles of sodium hydroxide in the mean titre and hence calculate the number of moles of H_2A in the 25.0 cm^3 pipette samples.

(2)

(vi) Calculate the relative molecular mass of H_2A. You **must** show your working.

(2)

(c) The acid, H_2A, can be prepared by the oxidation of ethane-1,2-diol, $HOCH_2CH_2OH$.

(i) State the reagents and conditions needed for this oxidation reaction.

(2)

Reagents .... and ....

Conditions ....

(ii) What colour change would occur when the oxidation took place?

(1)

From .... to ....

(iii) Use the formula of ethane-1,2-diol to deduce the **displayed** formula of H_2A.

(1)

(Total for Question 3 = 14 marks)

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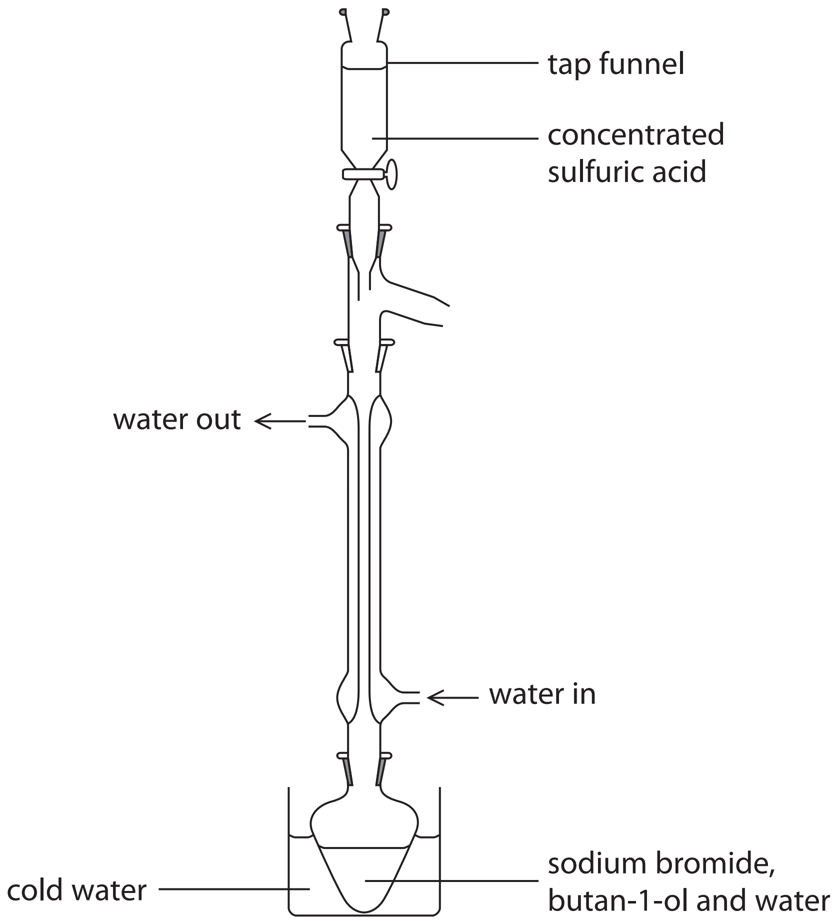
4 One method of preparing 1-bromobutane from butan-1-ol is given below.

Procedure

Step 1 10 g of sodium bromide, 10 cm^3 of water and 7.5 cm^3 of butan-1-ol are placed in a flask. The flask is partially immersed in a large beaker of cold water. A condenser is fitted vertically in the neck of the flask as shown in the diagram.



Step 2 10 cm^3 of concentrated sulfuric acid is dripped slowly from the tap funnel into the reaction mixture. The flask is shaken gently.

Step 3 The tap funnel is removed from the top of the condenser and the flask is taken out of the cold water bath. The flask is then heated gently for about 45 minutes.

Step 4 The apparatus is then rearranged for distillation. The 1-bromobutane and water are distilled into a small beaker where they form two layers.

Step 5 The 1-bromobutane layer is separated from the water.

Step 6 The 1-bromobutane layer is washed with concentrated hydrochloric acid to remove unreacted butan-1-ol.

Step 7 The 1-bromobutane is then washed with dilute sodium carbonate solution.

You will need the following data to answer the questions.

Butan-1-ol, $CH_3CH_2CH_2CH_2OH$ $M_r = 74$

1-bromobutane, $CH_3CH_2CH_2CH_2Br$ $M_r = 137$

Liquid	Density / g cm^{-3}
butan-1-ol	0.81
water	1.0
concentrated hydrochloric acid	1.2
1-bromobutane	1.3

(a) The use of the beaker of cold water in **Step 1**, and the slow addition of concentrated sulfuric acid in **Step 2**, both prevent a reaction which gives unwanted **inorganic** products.

Identify **one** of these unwanted products. State the type of reaction occurring when these products form.

(2)

Product ....

Type of reaction ....

....

(b) (i) Explain why the condenser is set up so that the water flows from bottom to top, as shown in the diagram.

(1)

....

....

....

(ii) Without the reflux condenser, the procedure in **Step 2** would become more hazardous. Explain why.

(1)

....

....

(c) To achieve the best possible yield of 1-bromobutane, the purification stages should involve the minimum number of transfers of the organic product from one piece of apparatus to another.

(i) How could the water layer be removed from the small beaker in **Step 5** without transferring the organic product?

(1)

....

(ii) Name the apparatus you would use to carry out the washing of the crude 1-bromobutane in **Step 6**.

Describe how you would obtain the organic layer from this mixture.

(2)

....

....

....

....

(d) What is the purpose of **Step 7**?

(1)

....

....

(e) After **Step 7**, the crude 1-bromobutane is washed with pure water and separated again. Two further steps are needed to obtain a pure sample of 1-bromobutane.

State what these steps are. Detailed experimental procedures are not required, but you should name any reagents which are needed.

(3)

Step 8 ....

....

....

....

Step 9 ....

....

(f) (i) Calculate the mass of butan-1-ol used in **Step 1**.

(1)

(ii) In this experiment, a student obtained 7.5 g of 1-bromobutane.

Calculate the percentage yield of 1-bromobutane. Assume that each mole of butan-1-ol can produce a maximum of one mole of 1-bromobutane.

Give your answer to **two** significant figures.

(3)

(Total for Question 4 = 15 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)											(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							

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

Key

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

* 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