

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 7 May 2014 – 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 ►

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**PEARSON**

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

- 1** A series of tests was carried out on **A**, a white powder. **A** is known to contain one cation and one anion. Complete the table below. You may use names or formulae in your answers.

	Test	Observation	Inference	
(a)	Carry out a flame test on A	Cation is calcium.	(1)
(b)	Add a few drops of dilute nitric acid to an aqueous solution of A , followed by aqueous silver nitrate. Then add concentrated aqueous ammonia solution.	Anion is probably iodide. This confirms the anion is iodide.	(2)
(c)	Add an aqueous solution of chlorine to an aqueous solution of A .	The colour of the resulting solution is	The colour is due to the formation of	(2)
(d)	Add an aqueous solution of starch to the mixture formed in (c).	The colour of the resulting mixture is	This confirms the inference made in (c).	(1)
(e)	Add a solution of sodium carbonate to an aqueous solution of A . When there is no further change, add dilute hydrochloric acid to the mixture.	A white precipitate forms. The precipitate dissolves in the acid and bubbles of gas are seen.	The precipitate is The gas is	(2)



(f) When **concentrated** sulfuric acid is added to a **solid** sample of **A**, there is a vigorous redox reaction.

(i) Identify, by name or formula, the product formed by the oxidation of the iodide ion in this reaction. Describe the appearance of this product.

(2)

Product

Appearance

(ii) Identify, by name or formula, one product formed when the concentrated sulfuric acid is reduced. Describe an observation you could make that shows this product has formed.

(2)

Product

Observation

.....

(Total for Question 1 = 12 marks)





2 This question concerns the analysis of an organic compound.

- (a) (i) How can the relative molecular mass of a compound be found from its mass spectrum?

(1)



- (ii) The general formula of an alcohol can be written ROH, where R is an alkyl group.

The relative molecular mass of an alcohol **Q** is 88. The formula of the alkyl group may be represented as C_xH_y.

State the values of x and y.

(1)

x y

- (b) When **Q** was warmed with a mixture of sulfuric acid and aqueous potassium dichromate(VI), there was no colour change.

Deduce the displayed formula of alcohol **Q**.

(1)



(c) When a sample of **Q** was reacted with phosphorus(V) chloride, PCl_5 , steamy fumes were seen.

(i) Identify these steamy fumes by name or formula.

(1)

(ii) The steamy fumes were tested by reacting them with ammonia gas. A white smoke was seen.

Write an equation, including state symbols, for the reaction in which the white smoke was formed.

(2)

(d) One of the isomers of the alcohol **Q** is an ether. Ethers contain two alkyl groups linked by an oxygen atom and can be represented as R-O-R.

Explain how the information in an **infrared** spectrum would be used to decide whether the spectrum is produced by an alcohol or an ether. Wavenumber data are not required.

(1)

(Total for Question 2 = 7 marks)





- 3 (a) The concentrations of acids and alkalis can be found by titration using a suitable indicator.

Give the colours which are seen if the indicator phenolphthalein is used.

(2)

Colour in acid

Colour in alkali

- (b) Another type of titration is a **thermometric** titration.

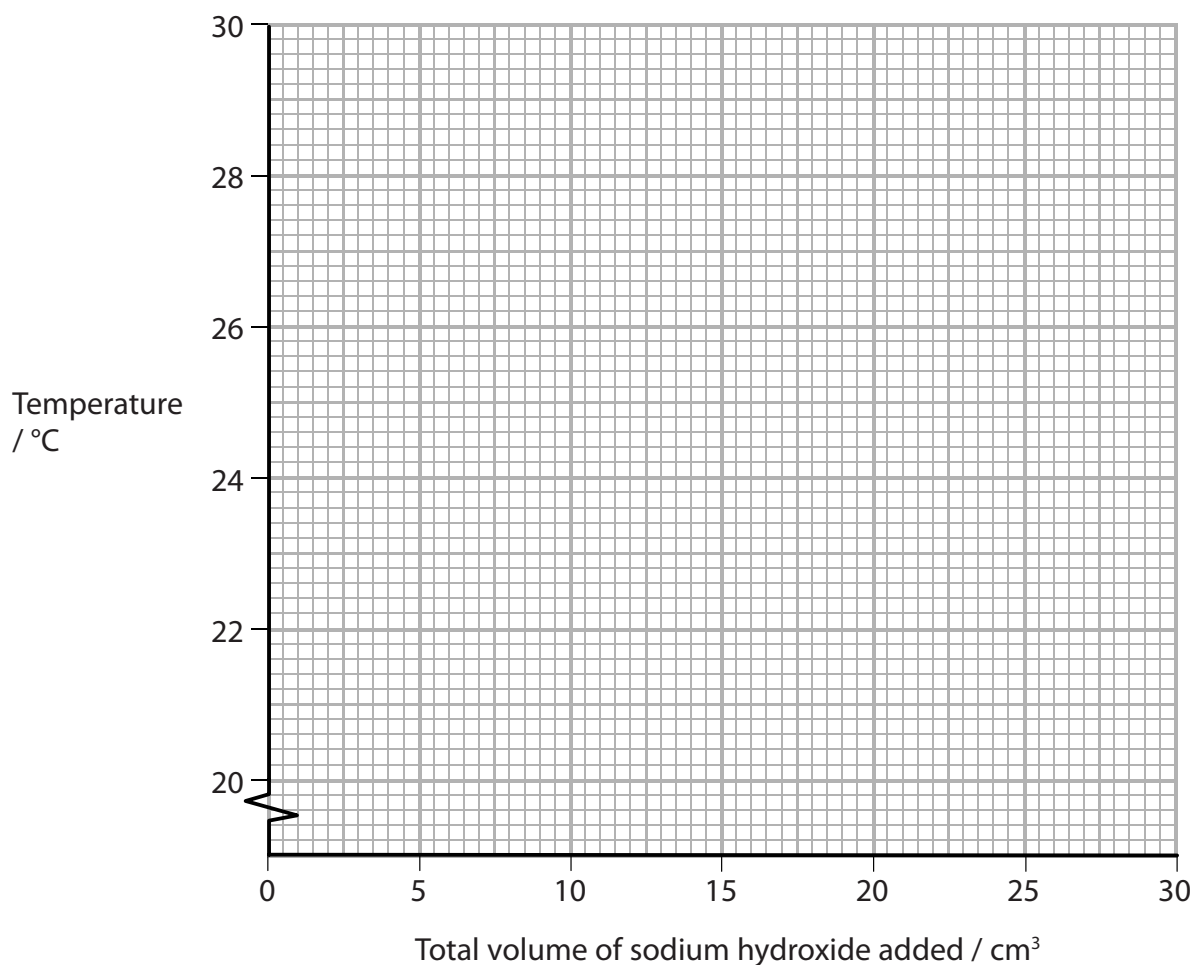
In a thermometric titration, 20.0 cm³ of 1.50 mol dm⁻³ hydrochloric acid was placed in a well-insulated cup, and its temperature was measured. Portions of sodium hydroxide solution were added from a burette. The mixture was stirred continuously and the temperature measured after each addition.

Total volume of sodium hydroxide added /cm ³	0.00	5.00	10.00	15.00	20.00	25.00	30.00
Temperature / °C	20.4	22.8	25.5	28.0	27.2	24.1	20.8

On the axes opposite, plot a graph of temperature against the total volume of sodium hydroxide added. Draw two straight lines on your graph and extrapolate the lines until they intersect. Hence find the maximum temperature of the reaction mixture and the total volume of sodium hydroxide which just neutralized the hydrochloric acid.

(4)





Maximum temperature.....

Total volume of sodium hydroxide that just neutralized the hydrochloric acid.

.....





(c) In an experiment using a **different** sample of sodium hydroxide solution, 20.0 cm^3 of 1.50 mol dm^{-3} hydrochloric acid was neutralized by 15.50 cm^3 of sodium hydroxide solution. The starting temperature was 20.4°C and the temperature at neutralization was 30.6°C .

(i) Calculate the energy, in joules, transferred when the acid is just neutralized.

$$\begin{array}{ccccccc} \text{Energy transferred} & = & \text{total mass of solution} & \times & 4.18 & \times & \text{temperature rise} \\ \text{(J)} & & \text{(g)} & & (\text{J g}^{-1} \text{ }^\circ\text{C}^{-1}) & & \text{(}^\circ\text{C)} \end{array}$$

Assume that the density of the solution is 1 g cm^{-3} .

(1)

(ii) The number of moles of hydrochloric acid used was 3.00×10^{-2} .

Calculate the enthalpy change of the reaction, in kJ mol^{-1} , for the neutralization of one mole of hydrochloric acid.

Give your answer to **three** significant figures and include a sign.

(2)

$\Delta H = \dots\dots\dots \text{kJ mol}^{-1}$



(iii) Why is it important that the temperature readings are taken as quickly as possible?

(1)

.....

.....

(iv) Thermometric titrations can also be carried out using an electronic probe connected to a computer, instead of a thermometer.

The sodium hydroxide is run into the acid from the burette at a steady rate. The acid is in an insulated beaker with a magnetic stirrer. The computer then produces a plot of the results.

Explain why this modified method can give improved results, other than because of any increase in accuracy of the temperature readings by the electronic probe.

(2)

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(d) (i) Calculate the concentration, in mol dm⁻³, of the sodium hydroxide used when 20.0 cm³ of 1.50 mol dm⁻³ hydrochloric acid is neutralized by 15.50 cm³ of sodium hydroxide.

(2)





(ii) Each time a burette is read, the error is $\pm 0.05 \text{ cm}^3$.

Calculate the percentage error in using a burette to measure a volume of 5.00 cm^3 of sodium hydroxide.

(1)

(e) (i) When a titration is carried out using an indicator, the concentrations of acid and alkali are usually between 0.05 and 0.20 mol dm^{-3} .

Explain why more concentrated solutions are used in thermometric titrations.

(1)

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(ii) Sodium hydroxide is described as an irritant at concentrations less than 0.50 mol dm^{-3} .

In what way is more concentrated sodium hydroxide hazardous?

(1)

.....

.....

(Total for Question 3 = 17 marks)



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- 4 Butanone, $\text{CH}_3\text{COCH}_2\text{CH}_3$, can be prepared from butan-2-ol, $\text{CH}_3\text{CH}(\text{OH})\text{CH}_2\text{CH}_3$, using the procedure below.

An organic solvent suitable for this procedure has a low boiling temperature and is extremely flammable, so adequate safety precautions must be taken.

Procedure

1. Place about 10 g of sodium dichromate(VI) and 20 cm^3 of distilled water in a conical flask. Shake the flask to dissolve the solid. Then slowly add about 8 cm^3 of concentrated sulfuric acid.
 2. Dissolve 5.00 g of butan-2-ol in the organic solvent in a round-bottom flask. Stand the flask in a large beaker containing ice and water. Slowly add the acidified sodium dichromate(VI) solution through a funnel to the butan-2-ol solution in the flask.
 3. When the addition is finished, leave the mixture to cool and separate the organic layer, which contains the butanone, from the aqueous layer.
 4. Wash the organic layer with sodium hydrogencarbonate solution, and then with water. Discard the aqueous layer.
 5. Add some sodium sulfate, Na_2SO_4 , to the organic layer and wait until this solution is clear.
 6. Decant the solution into a flask, and add a few anti-bumping granules. Use distillation to remove the solvent, which has a **lower** boiling temperature than butanone. The solvent boils between 32°C and 36°C .
- (a) What colour change will be seen when the acidified sodium dichromate(VI) reacts with the butan-2-ol?

(1)

From to



(b) The reaction is exothermic. Other than the risk of explosion, why is it important to cool the flask in a beaker of ice and water in **step 2**?

(1)

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.....

.....

(c) State the purpose of washing the crude butanone in **step 4** with sodium hydrogencarbonate solution. Describe the method used to carry out this process, naming the piece of apparatus used.

(3)

Purpose

Method

.....

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.....

.....

(d) What is the purpose of adding sodium sulfate in **step 5**?

(1)

.....

.....





- (e) Draw a labelled diagram of the apparatus used in **step 6** to distil off the solvent from the organic layer. The diagram should show at least one precaution which must be taken when distilling an extremely flammable liquid.

(4)

- (f) (i) Calculate the volume, in cm^3 , of 5.00 g of butan-2-ol.

The density of butan-2-ol is 0.805 g cm^{-3} .

(1)



- (ii) Each mole of butan-2-ol can produce a maximum yield of one mole of butanone.

Calculate the mass of butan-2-ol that would be required to make 3.00 g of butanone if the yield is 64%.

Relative molecular masses:

butan-2-ol	74.1
butanone	72.1

(3)

(Total for Question 4 = 14 marks)

TOTAL FOR PAPER = 50 MARKS





The Periodic Table of Elements

1		2		3		4		5		6		7		0 (8)																																																																																																																																																									
6.9 Li lithium 3	9.0 Be beryllium 4	23.0 Na sodium 11	24.3 Mg magnesium 12	39.1 K potassium 19	40.1 Ca calcium 20	45.0 Sc scandium 21	47.9 Ti titanium 22	47.9 Ti titanium 22	50.9 V vanadium 23	50.9 V vanadium 23	52.0 Cr chromium 24	54.9 Mn manganese 25	55.8 Fe iron 26	55.8 Fe iron 26	58.9 Co cobalt 27	58.9 Co cobalt 27	58.7 Ni nickel 28	58.7 Ni nickel 28	63.5 Cu copper 29	63.5 Cu copper 29	65.4 Zn zinc 30	65.4 Zn zinc 30	69.7 Ga gallium 31	72.6 Ge germanium 32	74.9 As arsenic 33	74.9 As arsenic 33	79.0 Br bromine 35	79.0 Br bromine 35	83.8 Kr krypton 36	83.8 Kr krypton 36	85.5 Rb rubidium 37	87.6 Sr strontium 38	88.9 Y yttrium 39	88.9 Y yttrium 39	91.2 Zr zirconium 40	91.2 Zr zirconium 40	92.9 Nb niobium 41	92.9 Nb niobium 41	95.9 Mo molybdenum 42	95.9 Mo molybdenum 42	98 Tc technetium 43	98 Tc technetium 43	101.1 Ru ruthenium 44	101.1 Ru ruthenium 44	102.9 Rh rhodium 45	102.9 Rh rhodium 45	106.4 Pd palladium 46	106.4 Pd palladium 46	107.9 Ag silver 47	107.9 Ag silver 47	112.4 Cd cadmium 48	112.4 Cd cadmium 48	114.8 In indium 49	114.8 In indium 49	118.7 Sn tin 50	118.7 Sn tin 50	121.8 Sb antimony 51	121.8 Sb antimony 51	127.6 Te tellurium 52	127.6 Te tellurium 52	126.9 I iodine 53	126.9 I iodine 53	131.3 Xe xenon 54	131.3 Xe xenon 54	132.9 Cs caesium 55	137.3 Ba barium 56	138.9 La* lanthanum 57	138.9 La* lanthanum 57	178.5 Hf hafnium 72	178.5 Hf hafnium 72	180.9 Ta tantalum 73	180.9 Ta tantalum 73	183.8 W tungsten 74	183.8 W tungsten 74	186.2 Re rhenium 75	186.2 Re rhenium 75	190.2 Os osmium 76	190.2 Os osmium 76	192.2 Ir iridium 77	192.2 Ir iridium 77	195.1 Pt platinum 78	195.1 Pt platinum 78	197.0 Au gold 79	197.0 Au gold 79	200.6 Hg mercury 80	200.6 Hg mercury 80	204.4 Tl thallium 81	204.4 Tl thallium 81	207.2 Pb lead 82	207.2 Pb lead 82	209.0 Bi bismuth 83	209.0 Bi bismuth 83	[209] Po polonium 84	[209] Po polonium 84	[210] At astatine 85	[210] At astatine 85	[222] Rn radon 86	[222] Rn radon 86	[223] Fr francium 87	[226] Ra radium 88	[227] Ac* actinium 89	[227] Ac* actinium 89	[261] Rf rutherfordium 104	[261] Rf rutherfordium 104	[262] Db dubnium 105	[262] Db dubnium 105	[266] Sg seaborgium 106	[266] Sg seaborgium 106	[264] Bh bohrium 107	[264] Bh bohrium 107	[277] Hs hassium 108	[277] Hs hassium 108	[268] Mt meitnerium 109	[268] Mt meitnerium 109	[271] Ds darmstadtium 110	[271] Ds darmstadtium 110	[272] Rg roentgenium 111	[272] Rg roentgenium 111	140 Ce cerium 58	141 Pr praseodymium 59	144 Nd neodymium 60	144 Nd neodymium 60	150 Sm samarium 62	150 Sm samarium 62	152 Eu europium 63	152 Eu europium 63	157 Gd gadolinium 64	157 Gd gadolinium 64	159 Tb terbium 65	159 Tb terbium 65	163 Dy dysprosium 66	163 Dy dysprosium 66	165 Ho holmium 67	165 Ho holmium 67	167 Er erbium 68	167 Er erbium 68	169 Tm thulium 69	169 Tm thulium 69	173 Yb ytterbium 70	173 Yb ytterbium 70	175 Lu lutetium 71	175 Lu lutetium 71	232 Th thorium 90	[231] Pa protactinium 91	[231] Pa protactinium 91	238 U uranium 92	238 U uranium 92	[242] Pu plutonium 94	[242] Pu plutonium 94	[243] Am americium 95	[243] Am americium 95	[247] Cm curium 96	[247] Cm curium 96	[245] Bk berkelium 97	[245] Bk berkelium 97	[251] Cf californium 98	[251] Cf californium 98	[254] Es einsteinium 99	[254] Es einsteinium 99	[253] Fm fermium 100	[253] Fm fermium 100	[256] Md mendelevium 101	[256] Md mendelevium 101	[254] No nobelium 102	[254] No nobelium 102	[257] Lr lawrencium 103	[257] Lr lawrencium 103

* Lanthanide series
* Actinide series

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

