

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		Paper Reference	
Time: 1 hour 15 minutes		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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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)



P 4 2 9 8 0 A 0 3 1 6

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)

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.....

- (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)



P 4 2 9 8 0 A 0 5 1 6

- 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.

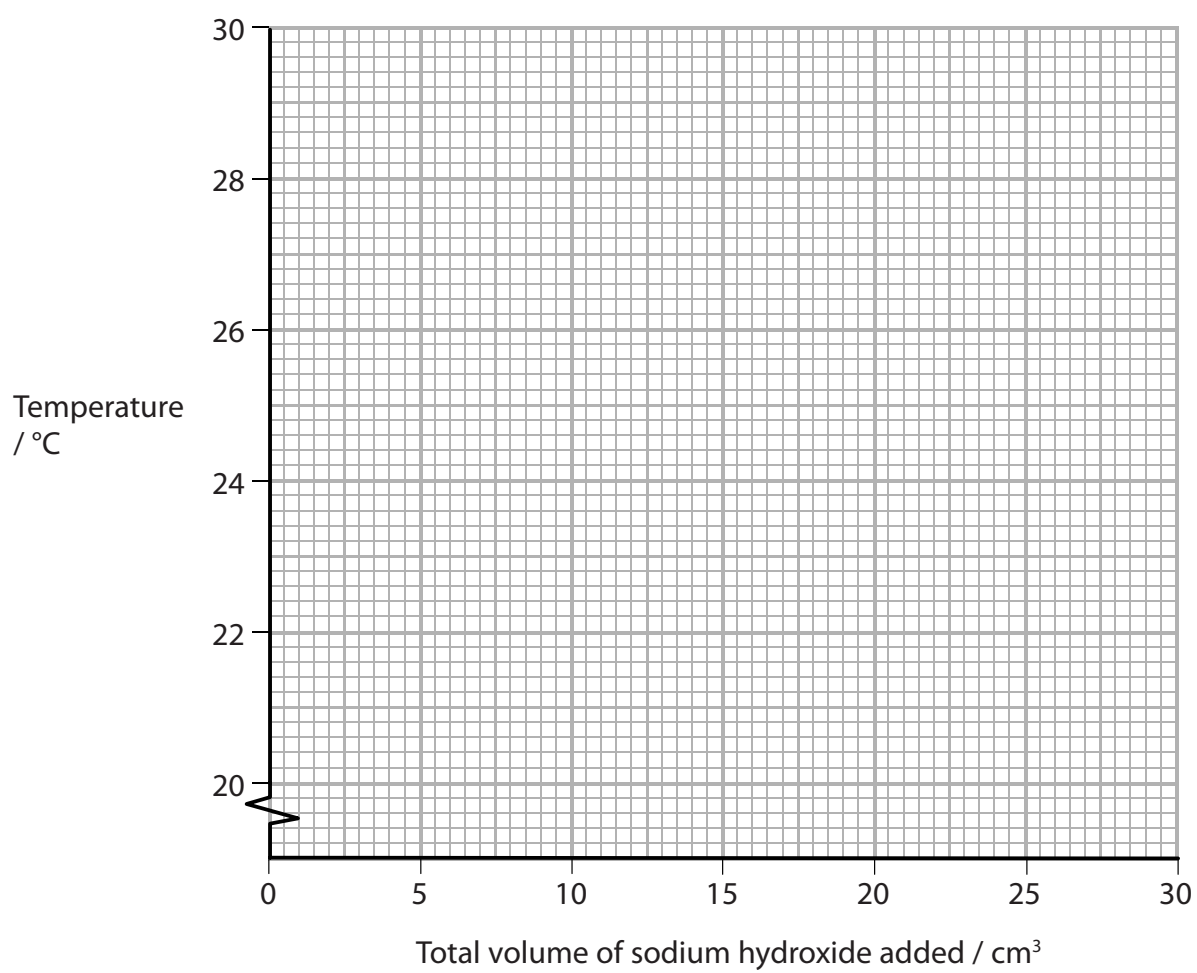
In a thermometric titration, 20.0 cm^3 of 1.50 mol dm^{-3} hydrochloric acid was placed in a well-insulated cup, and its temperature was measured. Portions of sodium hydroxide solution were added from a burette. The mixture was stirred continuously and the temperature measured after each addition.

Total volume of sodium hydroxide added / cm^3	0.00	5.00	10.00	15.00	20.00	25.00	30.00
Temperature / $^{\circ}\text{C}$	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.

.....



P 4 2 9 8 0 A 0 7 1 6

- (c) In an experiment using a **different** sample of sodium hydroxide solution, 20.0 cm³ of 1.50 mol dm⁻³ hydrochloric acid was neutralized by 15.50 cm³ 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)

$\Delta H = \dots\dots\dots$ kJ mol⁻¹



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

(1)

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.....

(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 cm^3 of 1.50 mol dm^{-3} hydrochloric acid is neutralized by 15.50 cm^3 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)

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(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 cm³ of distilled water in a conical flask. Shake the flask to dissolve the solid. Then slowly add about 8 cm³ 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)

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P 4 2 9 8 0 A 0 1 3 1 6

- (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



P 4 2 9 8 0 A 0 1 5 1 6

The Periodic Table of Elements

1.0 H hydrogen 1																	
Key																	
relative atomic mass atomic symbol name atomic (proton) number																	
(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)	(18)
6.9	9.0											10.8	12.0	14.0	16.0	19.0	4.0
Li lithium 3	Be beryllium 4											B boron 5	C carbon 6	N nitrogen 7	O oxygen 8	F fluorine 9	He helium 2
23.0	24.3											27.0	28.1	31.0	32.1	35.5	39.9
Na sodium 11	Mg magnesium 12											Al aluminium 13	Si silicon 14	P phosphorus 15	S sulfur 16	Cl chlorine 17	Ar argon 18
39.1	40.1	45.0	47.9	50.9	52.0	54.9	55.8	58.9	58.7	63.5	65.4	69.7	72.6	74.9	79.0	79.9	83.8
K potassium 19	Ca calcium 20	Sc scandium 21	Ti titanium 22	V vanadium 23	Cr chromium 24	Mn manganese 25	Fe iron 26	Co cobalt 27	Ni nickel 28	Cu copper 29	Zn zinc 30	Ga gallium 31	Ge germanium 32	As arsenic 33	Se selenium 34	Br bromine 35	Kr krypton 36
85.5	87.6	88.9	91.2	92.9	95.9	[98]	101.1	102.9	106.4	107.9	112.4	114.8	118.7	121.8	127.6	126.9	131.3
Rb rubidium 37	Sr strontium 38	Y yttrium 39	Zr zirconium 40	Nb niobium 41	Mo molybdenum 42	Tc technetium 43	Ru ruthenium 44	Rh rhodium 45	Pd palladium 46	Ag silver 47	Cd cadmium 48	In indium 49	Sn tin 50	Sb antimony 51	Te tellurium 52	I iodine 53	Xe xenon 54
132.9	137.3	138.9	178.5	180.9	183.8	186.2	190.2	192.2	195.1	197.0	200.6	204.4	207.2	209.0	[209]	[210]	[222]
Cs caesium 55	Ba barium 56	La* lanthanum 57	Hf hafnium 72	Ta tantalum 73	W tungsten 74	Re rhenium 75	Os osmium 76	Ir iridium 77	Pt platinum 78	Au gold 79	Hg mercury 80	Tl thallium 81	Pb lead 82	Bi bismuth 83	Po polonium 84	At astatine 85	Rn radon 86
[223]	[226]	[227]	[261]	[262]	[266]	[264]	[277]	[268]	[271]	[272]	Elements with atomic numbers 112-116 have been reported but not fully authenticated						
Fr francium 87	Ra radium 88	Ac* actinium 89	Rf rutherfordium 104	Db dubnium 105	Sg seaborgium 106	Bh bohrium 107	Hs hassium 108	Mt meitnerium 109	Ds darmstadtium 110	Rg roentgenium 111							
* Lanthanide series			140	141	144	[147]	150	152	157	159	163	165	167	169	173	175	
* Actinide series			Ce cerium 58	Pr praseodymium 59	Nd neodymium 60	Pm promethium 61	Sm samarium 62	Eu europium 63	Gd gadolinium 64	Tb terbium 65	Dy dysprosium 66	Ho holmium 67	Er erbium 68	Tm thulium 69	Yb ytterbium 70	Lu lutetium 71	
			232	[231]	238	[237]	[242]	[243]	[247]	[245]	[251]	[254]	[253]	[256]	[254]	[257]	
			Th thorium 90	Pa protactinium 91	U uranium 92	Np neptunium 93	Pu plutonium 94	Am americium 95	Cm curium 96	Bk berkelium 97	Cf californium 98	Es einsteinium 99	Fm fermium 100	Md mendelevium 101	No nobelium 102	Lr lawrencium 103	