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.

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P 4 2 9 8 0 A 0 1 1 6

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 ....

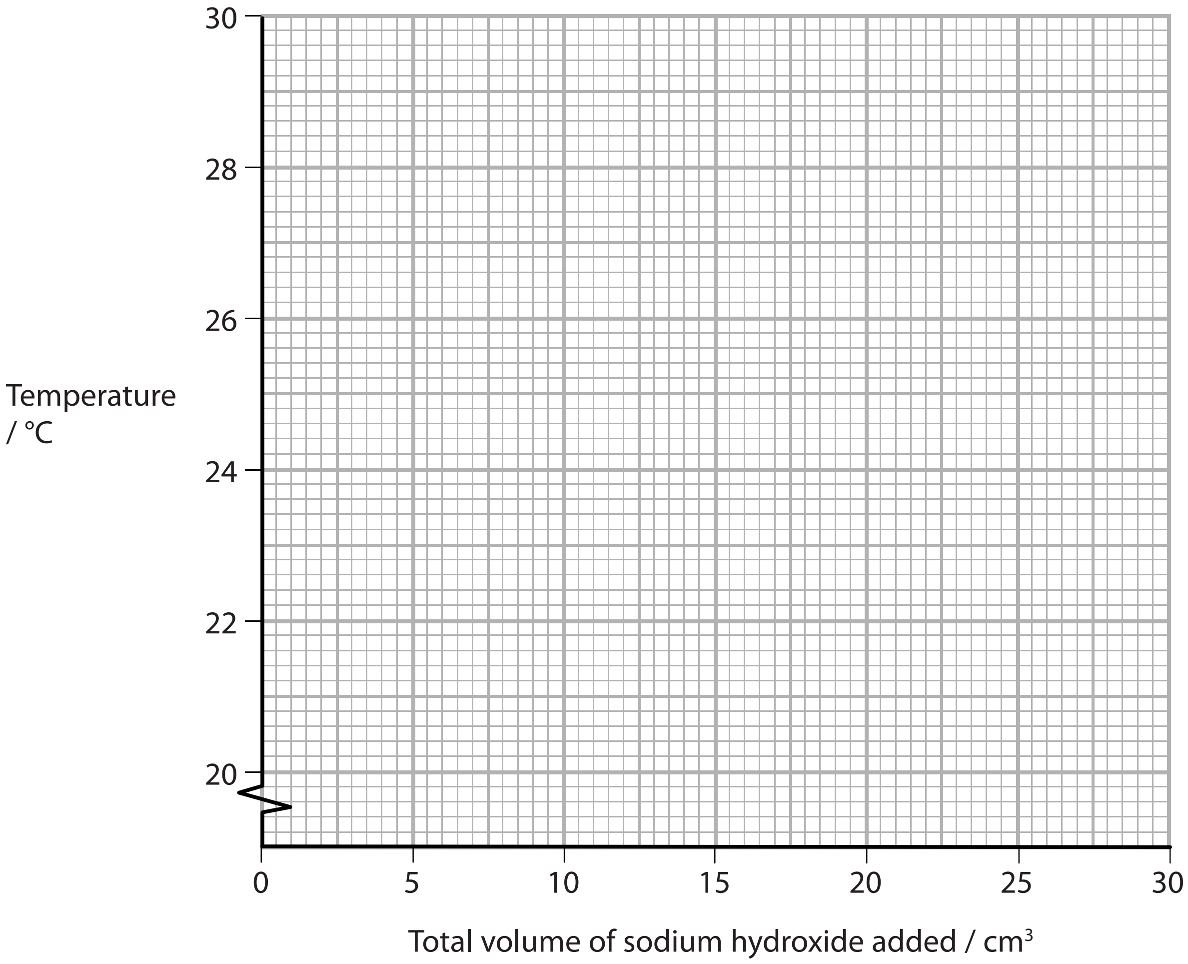
(b) Another type of titration is a **thermometric** titration.

In a thermometric titration, 20.0 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 / °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.

$$\underset{(J)}{\text{Energy transferred}} = \underset{(g)}{\text{total mass of solution}} \times \underset{(J\,g^{-1}\,°C^{-1})}{4.18} \times \underset{(°C)}{\text{temperature rise}}$$

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)

$\Delta H =$ .... 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)

....

....

....

....

....

(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 ±0.05 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)

(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, $CH_3COCH_2CH_3$, can be prepared from butan-2-ol, $CH_3CH(OH)CH_2CH_3$, 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)

(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

(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

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

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

* 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