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

Thursday 7 May 2015 – Afternoon
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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P 4 4 8 8 3 A 0 1 1 6

PEARSON

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

1 (a) A series of tests is carried out on a white solid, **X**, which contains one cation and one anion.

Complete the table below.

	Test	Observation	Inference (Name or formula)	
(i)	Carry out a flame test on **X**	A persistent yellow colour	The cation in **X** is	**(1)**
(ii)	Add dilute hydrochloric acid to the solid **X** Bubble the gas given off into limewater	Effervescence The limewater turns cloudy	The anion in **X** is	**(1)**

(iii) Write a balanced equation, including state symbols, for the reaction between the gas formed in the reaction in (a)(ii) and limewater (calcium hydroxide solution).

(2)

(b) Another white solid, **Y**, also contains one cation and one anion.

Complete the table below.

	Test	Observation	Inference	
(i)	Carry out a flame test on **Y**	.....	Strontium ions are present	**(1)**
(ii)	Add dilute nitric acid and dilute aqueous silver nitrate to a solution of **Y**	....	The anion in **Y** is probably a chloride	**(1)**

(iii) A further test is carried out on the mixture formed in (b)(ii). This confirms that **Y** contains chloride ions, and **not** bromide or iodide ions.

Describe this test and give the result.

(2)

Test.....

.....

Result.....

.....

(iv) What would you observe when the mixture formed in (b)(ii) is left to stand in sunlight?

Name the **product** responsible for this observation.

(2)

Observation.....

Product.....

(c) When aqueous solutions of **X** and **Y** are mixed, a white precipitate forms.

Write an **ionic** equation for the reaction which produces the white precipitate. State symbols are not required.

(1)

(Total for Question 1 = 11 marks)

2 An organic compound, **Z**, has only one –OH group.

(a) State the test which confirms the presence of an –OH group and give the result of a positive test.

(2)

Test .....

Result .....

.....

(b) Name **two** series of organic compounds, with different general formulae, each of which has one –OH group.

(1)

..... and .....

(c) Neither red nor blue litmus paper changed colour when used to test an aqueous solution of **Z**. A different sample of **Z** was warmed with a mixture of aqueous potassium dichromate(VI) and sulfuric acid. No change was observed.

What can be deduced about the identity of the functional group in **Z** from each of these observations? Justify your answer.

(2)

Test with litmus paper

.....

.....

Warming with aqueous potassium dichromate(VI) and sulfuric acid

.....

.....

(d) **Z** was investigated by measuring the volume of carbon dioxide formed on complete combustion.

A sample of 0.10 mol of **Z** produced 9.6 dm^3 of carbon dioxide.

Under the conditions of the experiment, the molar volume of a gas is 24 $dm^3\,mol^{-1}$.

Use this information to calculate the number of carbon atoms in one molecule of **Z**. Use the result of your calculation and your deduction in (c) to draw the displayed formula of **Z**. Show your working.

(3)

(e) **Z** has several isomers, only some of which contain an –OH group.

(i) Give **one** piece of evidence from their mass spectra which would show that two compounds could be isomers.

(1)

.....

.....

(ii) How could infrared spectroscopy be used to show that two isomers of **Z** both have an –OH group? You are not required to give wavenumber values.

(1)

.....

.....

.....

.....

(Total for Question 2 = 10 marks)

3 This question is about enthalpy changes which occur on dissolving different substances.

(a) The enthalpy change which occurs when solid ammonium chloride, NH_4Cl, dissolves in water was found using the method below.

25.0 cm^3 of water was measured using a burette and put into a small beaker. The temperature of the water was measured.

5.00 g of powdered ammonium chloride was added to the water, the mixture was stirred continuously and the lowest temperature of the resulting solution was recorded.

Results:

Initial temperature of water = 22.0 °C

Lowest recorded temperature = 11.5 °C

(i) Calculate the energy transferred when 5.00 g of ammonium chloride dissolves in 25.0 cm^3 of water.

Hence calculate the enthalpy change, $\Delta H_{solution}$, which occurs when 1 mol of ammonium chloride dissolves in water.

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

Use the equation:

Energy transferred (J) = mass of water $\times$ 4.18 $\times$ temperature change.

The density of water is 1.00 g cm^{-3}

(3)

(ii) The thermometer used in this experiment gave a total uncertainty in the temperature measurement of just under ±5%.

The mass of ammonium chloride was measured using a balance which had an uncertainty of ±0.005 g in each reading.

Show by calculation that the uncertainty of the result of the experiment would not be improved significantly if a more precise balance was used.

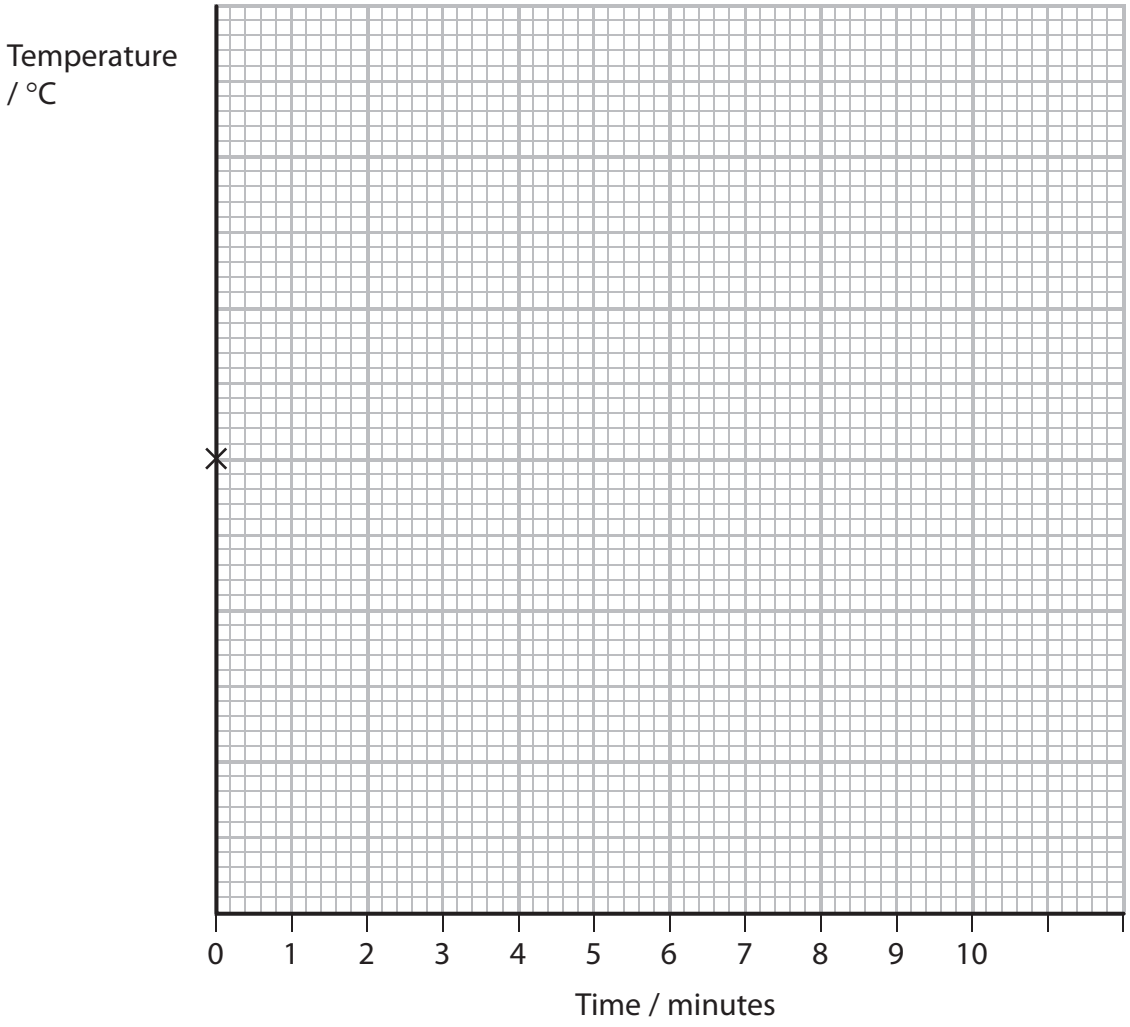
(2)

(b) In order to determine a more accurate value for the temperature change, the experiment in (a) was repeated with some modifications to the procedure.

The temperature of the water was measured as a stop clock was started, and again after one minute and two minutes. Three minutes after starting the clock, the ammonium chloride was added to the water. The temperature was then read each minute from the fourth to the tenth minute, while stirring the mixture continuously.

(i) On the grid below, mark where you would expect to find the points when the temperature measurements are plotted against time. The initial temperature has been plotted for you. You are **not** expected to plot the position of the points accurately; simply indicate their approximate position relative to the starting point.

(2)



(ii) On the grid, draw the lines needed to determine the maximum temperature change. Add a label to show the maximum temperature change on the graph.

(2)

(iii) A student carried out the experiment using water from a tap. What is the purpose of measuring the temperature of the water at 0, 1 and 2 minutes from the time of starting the clock?

(1)

.....

.....

(c) The equation for the thermal decomposition of ammonium chloride is shown below.

$$NH_4Cl(s) \rightarrow NH_3(g) + HCl(g)$$

(i) Suggest why the enthalpy change for this reaction, $\Delta H_{reaction}$, is difficult to determine directly by experiment.

(1)

.....

.....

(ii) Some enthalpy changes which can be determined experimentally are listed below.

$NH_4Cl(s) + water \rightarrow NH_4Cl(aq)$ ΔH_1

$NH_3(g) + water \rightarrow NH_3(aq)$ ΔH_2

$HCl(g) + water \rightarrow HCl(aq)$ ΔH_3

$NH_3(aq) + HCl(aq) \rightarrow NH_4Cl(aq)$ ΔH_4

By adding arrows to the diagram below, construct a Hess cycle which can be used to calculate the enthalpy change, $\Delta H_{reaction}$, for the thermal decomposition of ammonium chloride.

Label each arrow with the appropriate symbol chosen from the list above for the enthalpy change. Assume that water is added where necessary to make a solution.

(1)

(iii) Give the expression for the enthalpy change, $\Delta H_{reaction}$, for the thermal decomposition of ammonium chloride, in terms of the other enthalpy changes in the cycle.

(1)

$\Delta H_{reaction} =$

(Total for Question 3 = 13 marks)

4 Cyclohexene, C_6H_{10}, can be prepared by dehydrating cyclohexanol, $C_6H_{11}OH$, with phosphoric acid.

$$C_6H_{11}OH \xrightarrow{H_3PO_4} C_6H_{10} + H_2O$$

Procedure

Step 1 12.0 cm^3 of cyclohexanol was put into a small flask. 5 cm^3 of concentrated phosphoric acid, an excess, was added slowly to the cyclohexanol using a dropping pipette. Some anti-bumping granules were added to the mixture and the flask was set up for distillation.

Step 2 The portion of the distillate collected between 80 °C and 90 °C contained only cyclohexene and water.

Step 3 The distillate of cyclohexene and water was transferred to a separating funnel and a saturated solution of sodium chloride was added. Most of the water which was in the distillate went into the saturated sodium chloride layer.

Step 4 The crude cyclohexene was run out of the separating funnel and dried with anhydrous calcium chloride.

Step 5 The calcium chloride was removed by filtration through glass wool, and the liquid was redistilled to collect pure cyclohexene.

Cyclohexene has an unpleasant smell and irritates the eyes, so the entire experiment was carried out in a fume cupboard. In **Step 1**, tubing was connected to carry any uncondensed cyclohexene to a drain.

(a) The chemicals involved in this reaction are all hazardous if they make contact with the eyes, or if swallowed or inhaled.

Other than their effect on the eyes or their toxicity, state **two** different hazards of the chemicals involved in this reaction. Name the chemical associated with each hazard.

(2)

Chemical	Hazard

(b) Calculate the number of moles of cyclohexanol used in this experiment. The density of cyclohexanol is 0.962 g cm^{-3}.

(2)

(c) Draw a labelled diagram showing how to distil the reaction mixture in **Step 1** and collect the distillate boiling between 80 °C and 90 °C.

(4)

(d) Explain the difference between a 'dehydrating agent', such as the phosphoric acid used in **Step 1**, and a 'drying agent', such as the anhydrous calcium chloride used in **Step 4**.

(2)

.....

.....

.....

.....

(e) Suggest **one** advantage of using glass wool, rather than filter paper, when removing the calcium chloride in **Step 5**.

(1)

.....

.....

(f) Calculate the mass of cyclohexanol needed to obtain 10.0 g cyclohexene if the yield is 75%.

(3)

(g) The cyclohexene was tested by mixing it with bromine dissolved in an organic solvent.

(i) What colour change would be observed?

(1)

.....

(ii) Give the **displayed** formula for the organic product of this reaction.

(1)

(Total for Question 4 = 16 marks)

TOTAL FOR PAPER = 50 MARKS

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The Periodic Table of Elements

1	2											3	4	5	6	7	0 (8) (18)
							1.0 H hydrogen 1										4.0 He helium 2
(1)	(2)		Key: relative atomic mass / atomic symbol / name / atomic (proton) number									(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