Write your name here

Surname	Other names

Pearson Edexcel
International Advanced Level

Centre Number | | | | | |

Candidate Number | | | | |

Chemistry

International Advanced Subsidiary/Advanced Level
Unit 3: Practical Skills in Chemistry I

Sample Assessment Materials for first teaching September 2018

Time: 1 hour 20 minutes

Paper Reference **WCH13/01**

You must have:
Scientific calculator, ruler

Total Marks

Instructions

- Use **black** ink or **black** 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.*
- **Show all your working in calculations and include units where appropriate**.

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.*
- There is a Periodic Table on the back page of this paper.

Advice

- Read each question carefully before you start to answer it.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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Answer ALL questions.

Write your answers in the spaces provided.

1 The enthalpy change for the reaction between zinc and copper(II) sulfate solution can be determined using the procedure shown.

The equation for the reaction is:

$$Zn(s) + CuSO_4(aq) \rightarrow ZnSO_4(aq) + Cu(s)$$

Procedure

Step **1** Weigh about 5 g of zinc powder. This is an excess.

Step **2** Measure 50 cm^3 of 1.0 mol dm^{-3} copper(II) sulfate solution into a polystyrene cup.

Step **3** Start a stop clock. Stir the solution continuously with a thermometer and measure the temperature of the solution each minute for 3 minutes.

Step **4** At **exactly** 3.5 minutes, add the zinc powder to the copper(II) sulfate solution.

Step **5** Continue to stir the mixture and read the temperature each minute from 4 to 10 minutes.

(a) (i) Name the **most** suitable piece of apparatus for measuring 50 cm^3 of copper(II) sulfate solution.

(1)

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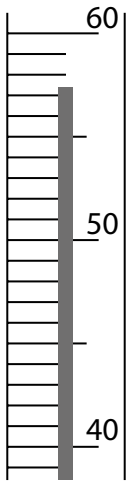
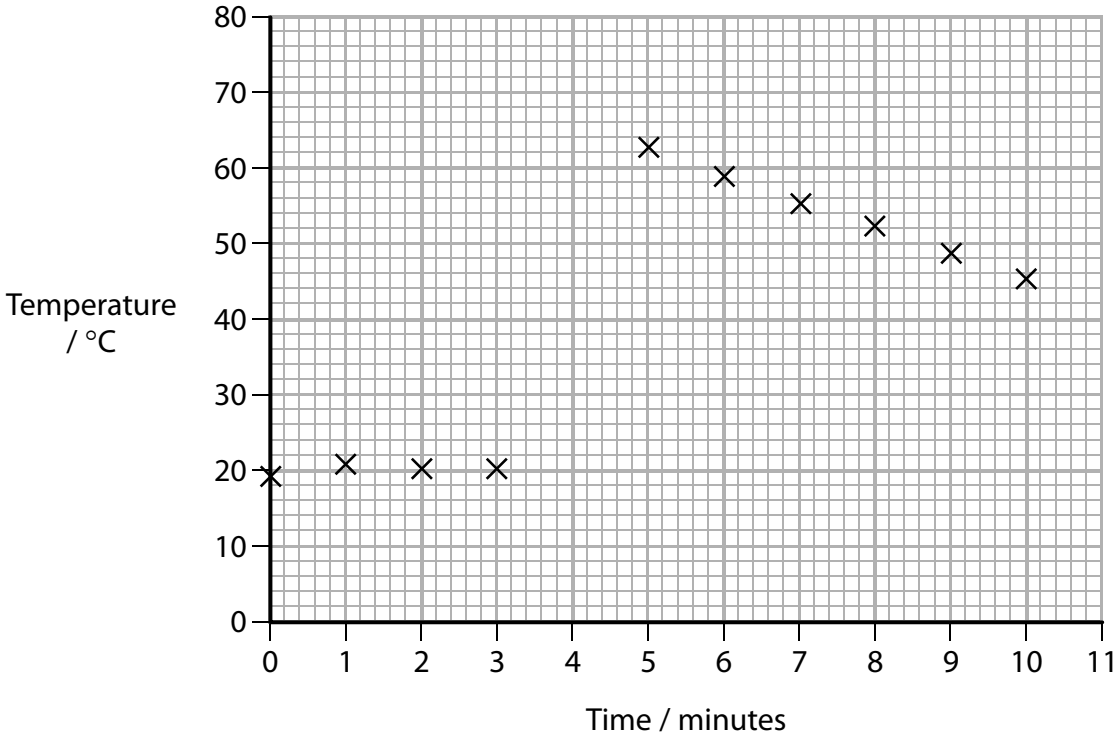
(ii) The diagram shows part of the thermometer at 4 minutes. Record the temperature in the table of results **and** plot the point on the graph.

(1)



Results

Time / minutes	0	1	2	3	4	5	6	7	8	9	10
Temperature / °C	19.0	20.5	20.0	20.0		62.5	58.5	55.0	52.0	48.5	45.0



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(b) The maximum temperature change for the reaction, ΔT, is estimated by drawing two lines of best fit on the graph and extrapolating them.

(i) Give the reason why the point you plotted in (a)(ii) should **not** be included in the lines of best fit.

(1)

.....

.....

(ii) Estimate the maximum temperature change, ΔT.
Show your working on the graph.

(3)

ΔT = ... °C

(iii) Give a reason why the temperature of the solution is measured for 3 minutes **before** adding the zinc.

(1)

.....

.....

(iv) Give the main reason why the temperature of the solution is measured over a period of time **after** adding the zinc.

(1)

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(c) (i) Use the value you have obtained for the temperature rise (ΔT) in (b)(ii) to calculate the heat energy produced in the reaction between zinc and copper(II) sulfate solution. Include units with your answer.

(Assume the specific heat capacity of the solution to be 4.2 $J\,g^{-1}\,°C^{-1}$ and the density of the solution to be 1.0 $g\,cm^{-3}$.)

(1)

(ii) The solution contained 0.050 mol of copper(II) sulfate.
Calculate the enthalpy change, ΔH, for the reaction between zinc and copper(II) sulfate solution.
Give your answer to an appropriate number of significant figures and include a sign and units.

(3)

(d) Suggest one improvement to the **procedure**, other than changing the measuring equipment or repeating the experiment, which would give a more accurate result.

(1)

.....

.....

(Total for Question 1 = 13 marks)

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2 A student was given five boiling tubes, each containing one aqueous solution:

dilute hydrochloric acid, HCl(aq)

potassium carbonate, K_2CO_3(aq)

sodium iodide, NaI(aq)

dilute nitric acid, HNO_3(aq)

sodium chloride, NaCl(aq).

The solutions were labelled **A**, **B**, **C**, **D** and **E**, but not necessarily in this order.

The student carried out three tests on each solution.

Test 1

- The student put about 2 cm^3 of each solution into separate test tubes.
- The student added one spatula measure of solid sodium carbonate, Na_2CO_3, to each test tube.
- Observations were recorded in Table 1, in the column labelled Test 1.

Test 2

- The student put about 1 cm^3 of each solution into separate test tubes.
- The student added an equal volume of aqueous silver nitrate solution, $AgNO_3$, to each test tube.
- Observations were recorded in Table 1, in the column labelled Test 2.

Test 3

- To the final mixture in each test tube from Test 2, the student added about 1 cm^3 of dilute nitric acid, HNO_3.
- Observations were recorded in Table 1, in the column labelled Test 3.

Solution	Test 1	Test 2	Test 3
A	effervescence	no reaction	unchanged
B	no reaction	yellow precipitate	unchanged
C	no reaction	white precipitate	unchanged
D	effervescence	white precipitate	unchanged
E	no reaction	white precipitate	effervescence

Table 1

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(a) (i) Identify each of the solutions from the observations recorded in Table 1. Write the letter that corresponds to each solution in Table 2.

(3)

Solution	Letter
dilute hydrochloric acid, HCl(aq)	
potassium carbonate, K_2CO_3(aq)	
sodium iodide, NaI(aq)	
dilute nitric acid, HNO_3(aq)	
sodium chloride, NaCl(aq)	

Table 2

(ii) State how you use the observations to distinguish between potassium carbonate and sodium chloride solutions.

(1)

.....

.....

.....

(b) The student suggested that a flame test could also be used to help to distinguish between potassium carbonate solution and sodium chloride solution. State how the flame colours would differ.

(1)

.....

.....

(c) A further chemical test was carried out on the precipitates from Test 3 to confirm the identity of the original solution.

Give this test, and its result, which would distinguish between sodium iodide solution and sodium chloride solution.

(2)

.....

.....

.....

.....

(Total for Question 2 = 7 marks)

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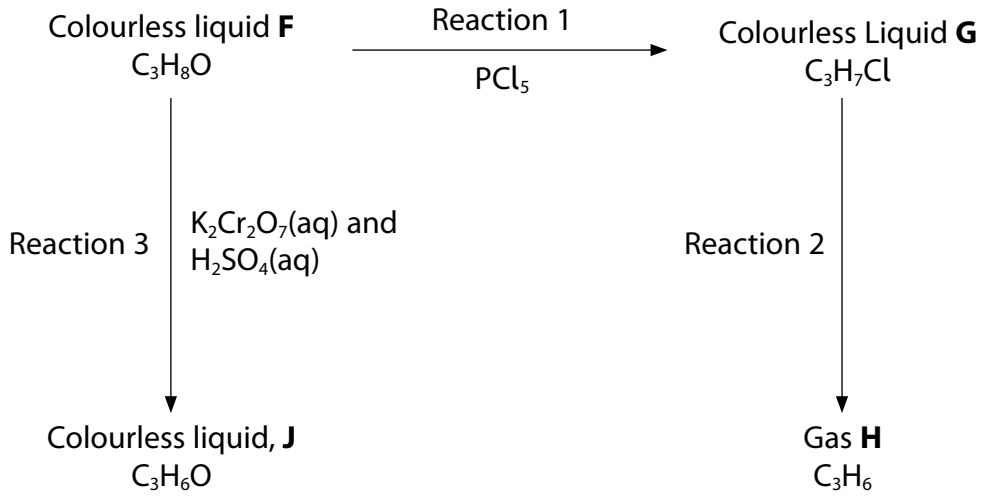
3 This question is about the reaction sequence involving compound **F**, which has the molecular formula C_3H_8O.



(a) In reaction 1, misty fumes were observed.

(i) Identify, by name or formula, the misty fumes.

(1)

.....

(ii) State what can be deduced about compound **F** from this observation.

(1)

.....

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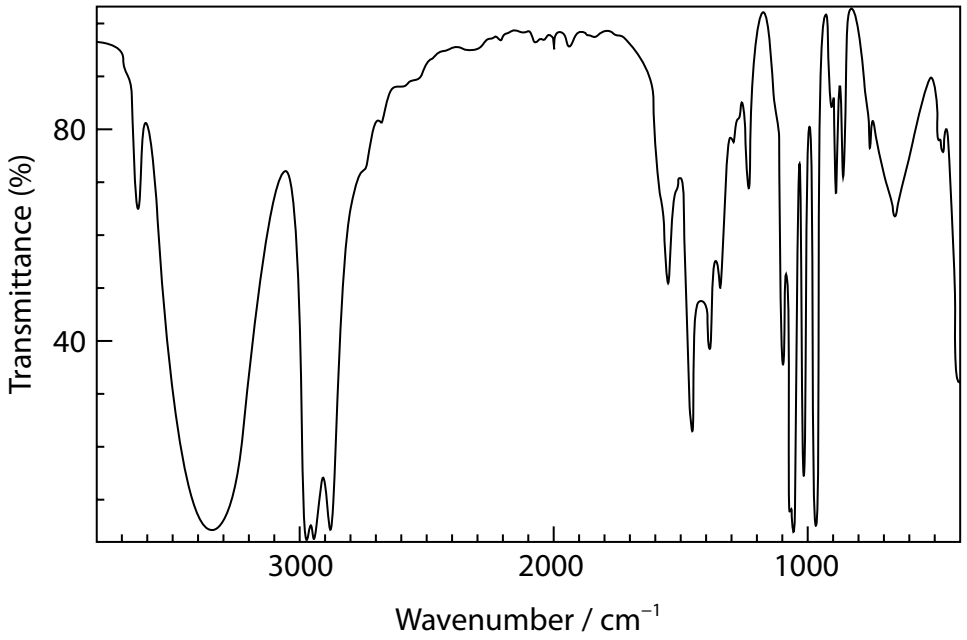
(b) The infrared spectrum of liquid **F** is shown.



Give the wavenumber range of the absorption which confirms your deduction in (a)(ii).

(1)

.....

(c) Gas **H**, C_3H_6, was formed in Reaction 2. The functional group present in **H** was identified by shaking a sample of **H** in a test tube with a few drops of bromine dissolved in a non-polar organic solvent.

(i) Give the colour change observed for this reaction.

(1)

From .....

To .....

(ii) Write an equation for the reaction of C_3H_6 with bromine.

(1)

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(d) Reaction 3 was carried out by slowly adding a solution of acidified potassium dichromate(VI) to liquid **F** in a cooled flask. The flask was set up for distillation and gently heated. The product, **J**, was distilled directly out of the reaction mixture.

(i) Draw a diagram of the apparatus suitable for the distillation of **J** from the reaction mixture.

(3)

(ii) Draw the structures of two possible isomers of **J**, C_3H_6O, in the boxes.

(2)

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(e) The identity of **J** can be confirmed by spectroscopy and by chemical tests.

(i) The infrared spectrum of **J** has absorbances at 2716 and 2893 cm^{-1}.

Identify the bond responsible for these absorbances, and hence the functional group in **J**.

(1)

(ii) Give a chemical test and its expected result to confirm the identity of **J**.

(2)

(f) Name compound **F**.

(1)

(Total for Question 3 = 14 marks)

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4 A class of students carried out experiments to determine the value of **x** in the formula of hydrated sodium carbonate, $Na_2CO_3.xH_2O$.

Hydrated sodium carbonate was heated until no more water of crystallisation remained. Anhydrous sodium carbonate, Na_2CO_3, was formed.

$$Na_2CO_3.xH_2O \rightarrow Na_2CO_3 + xH_2O$$

The students were given the following instructions:

- weigh a sample of the hydrated sodium carbonate in a pre-weighed crucible
- heat the crucible containing the sample to remove the water of crystallisation
- allow the crucible to cool and then reweigh the crucible.

A student's results are shown in Table 3.

(a) Complete Table 3.

(2)

Measurement	Value / g
Mass of crucible empty	19.36
Mass of crucible + hydrated sodium carbonate	26.06
Mass of crucible + anhydrous sodium carbonate	21.98
Mass of hydrated sodium carbonate	
Mass of anhydrous sodium carbonate	
Mass of water removed	

Table 3

(b) (i) Calculate the number of moles of water removed on heating the hydrated sodium carbonate.

(1)

(ii) Calculate the number of moles of anhydrous sodium carbonate, Na_2CO_3, formed after heating.

(2)

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(iii) Use your answers from (b)(i) and (b)(ii) to calculate the value of **x**. Give your answer to **three** significant figures.

(2)

(c) **Each** use of the balance to find a mass reading in the table has a maximum uncertainty of ±0.005 g.

Calculate the percentage error in the measurement of the mass of the crucible and hydrated sodium carbonate (26.06 g) before heating.

(1)

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(d) The Data Book value for **x** is 10.

One student obtained a value for **x** of 8.63 and another student obtained a value for **x** of 10.79.

Explain the practical errors that could have led to each of these values.

(4)

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(e) Devise an experiment involving a titration that could be used to determine the value of **x** in $Na_2CO_3.xH_2O$.

List the essential steps in the practical procedure.

You are not expected to explain how the data is used to calculate **x**.

(4)

(Total for Question 4 = 16 marks)

TOTAL FOR PAPER = 50 MARKS

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The Periodic Table of Elements

1 (1)	2 (2)											3 (13)	4 (14)	5 (15)	6 (16)	7 (17)	0 (8) (18)
							1.0 H hydrogen 1										4.0 He helium 2
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							

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

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

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