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 24 January 2018 – Morning
Time: 1 hour 15 minutes

Paper Reference
WCH03/01

Candidates 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.*

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.

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.
- Show all your working in calculations and give units where appropriate.

Turn over ►

6/5/6/4/1/1/

Pearson

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

1 Experiments were carried out on a sample of hydrated calcium nitrate crystals, $Ca(NO_3)_2.2H_2O$

(a) Describe how to carry out a flame test to show which cation is present in the sample.

Give the expected result of the test.

(4)

....

....

....

....

....

....

....

Result ....

(b) The calcium nitrate crystals were heated gently in a test tube. Fumes which looked like steam were given off.

Give the **name** of a substance that could be used to test for the presence of steam in the fumes. Describe the expected colour change for this test.

(2)

Substance ....

Colour change ....

(c) On further heating of the sample, a mixture of two gases was evolved. One of the gases was coloured, the other was colourless.

(i) Identify the coloured gas and give its colour.

(1)

Identity of gas ....

Colour of gas ....

(ii) Identify the colourless gas. Give a test for the gas and its result.

(1)

Identity of gas ....

Test and result ....

....

(d) A white solid remained after complete decomposition.

Complete the equation for this decomposition of the hydrated crystals.
State symbols are not required.

(2)

$Ca(NO_3)_2.2H_2O \rightarrow$

(e) The white solid which remained in the test tube was allowed to cool to room temperature. Distilled water was added to it, and a solution formed.

(i) Give the **name** of the solution which forms when distilled water is added to the white solid.

(1)

....

(ii) This solution is used in a common laboratory test for a gas.
Identify this gas.

(1)

....

(Total for Question 1 = 12 marks)

2 (a) A gaseous hydrocarbon **X** reacted with bromine to give a colourless product.

At room temperature and pressure, 6.00 g of **X** occupied a volume of 5.14 dm^3. Under these conditions, 1 mol of gas occupies 24.0 dm^3.

Show how all these pieces of information are used to identify **X**, and give its **displayed** formula.

(3)

....

....

(b) A compound **Y** was prepared by reacting **X** with potassium manganate(VII) under suitable conditions. **Y** is a liquid at room temperature.

(i) Phosphorus(V) chloride, PCl_5, was added to **Y** and fumes of hydrogen chloride were detected.

Describe a **chemical** test for hydrogen chloride, other than by using an indicator, and give the result of the test.

(2)

Test ....

....

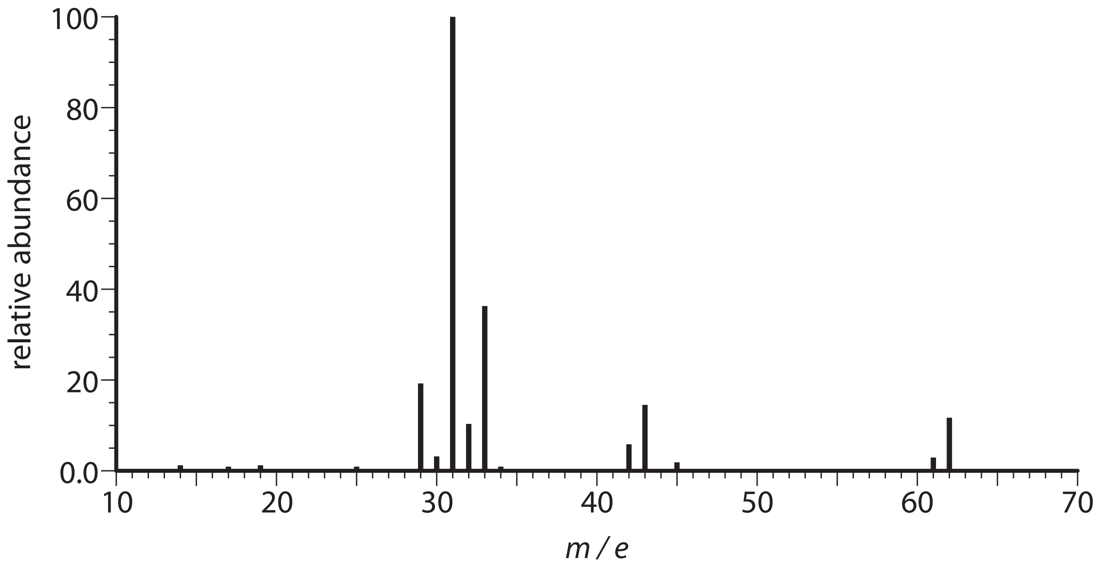
Result ....

(ii) It was found that 0.25 mol of **Y** produced 0.50 mol hydrogen chloride in its reaction with phosphorus(V) chloride.

State what can be deduced about a molecule of **Y** from this information.

(2)

(iii) The mass spectrum of **Y** is shown.



Use the mass spectrum to find the relative molecular mass of **Y**.

Use your value of the relative molecular mass, your answers to (a) and (b)(ii) and information from the Periodic Table to deduce the **structural** formula of **Y**.

(2)

(iv) When compound **Y** was heated with acidified potassium dichromate(VI) under appropriate conditions, it was oxidised to a carboxylic acid.

Draw a labelled diagram of the apparatus which is normally used to make a carboxylic acid by oxidation of compounds such as **Y**.

(3)

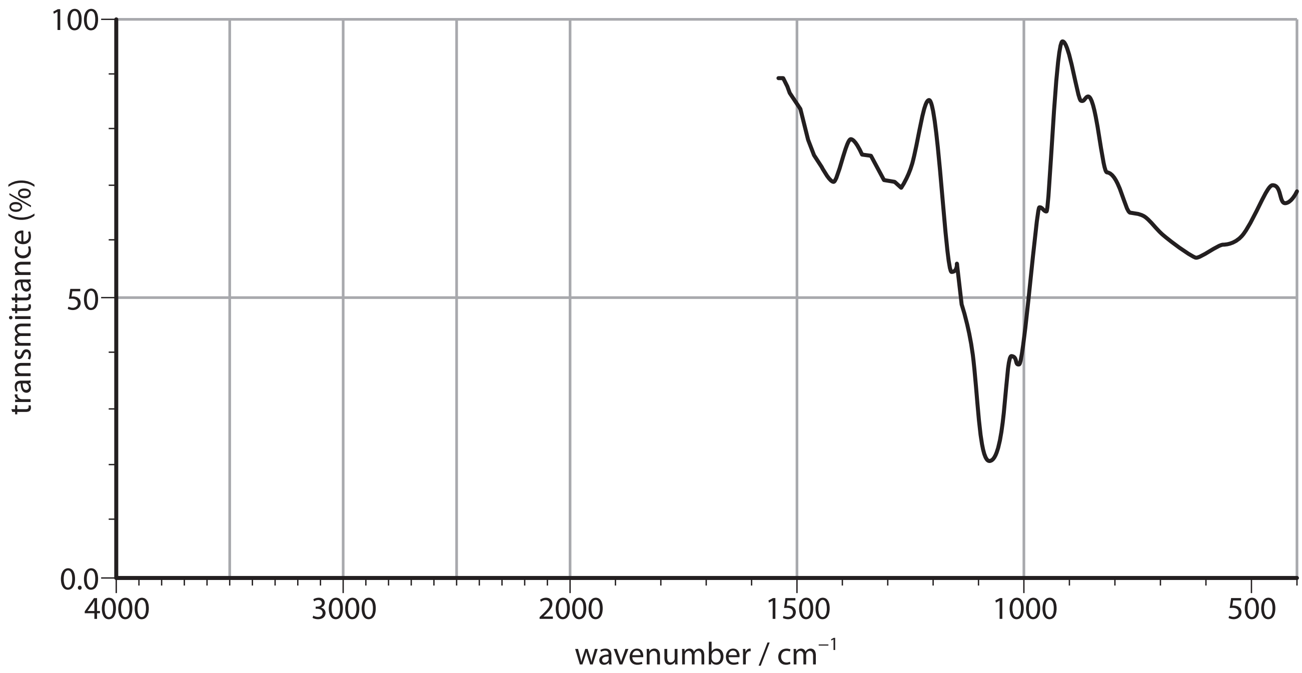
(v) When compound **Y** is oxidised more gently than in (b)(iv), a different product, **Z**, is formed. **Z** contains only one type of functional group.

The table shows the IR absorption ranges of some organic functional groups.

Group	Intensity	Wavenumber range / cm^{-1}
O–H stretching in alcohols	variable, broad	3750 – 3200
O–H stretching in carboxylic acids	weak	3300 – 2500
C=O stretching in aldehydes	strong	1740 – 1720
C=O stretching in ketones	strong	1700 – 1680
C=O stretching in carboxylic acids	strong	1725 – 1700
C–H stretching in aldehydes	weak	2900 – 2820
	weak	2775 – 2700
C–H stretching in alkenes	variable	3095 – 3010
C=C stretching in alkenes	variable	1669 – 1645

The incomplete infrared spectrum of **Z** is shown below. On the spectrum, draw **two** of the peaks you would expect to see between 4000 and 1500 cm^{-1} for different bond stretches for product **Z**.

(2)



(Total for Question 2 = 14 marks)

P 5 1 6 0 2 A 0 7 1 6

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3 An experiment was carried out to measure the enthalpy change, Δ*H*, of the reaction between magnesium and copper(II) sulfate solution.

$$Mg(s) + CuSO_4(aq) \rightarrow Cu(s) + MgSO_4(aq)$$

50.0 cm^3 of 0.150 mol dm^{-3} copper(II) sulfate solution was put into a polystyrene cup. The temperature of the solution was measured as a stop clock was started, and then at one and two minutes.

At exactly three minutes, a piece of magnesium ribbon of mass 0.250 g was added. Further temperature readings were taken every minute for a further seven minutes. A graph of temperature versus time was plotted and the results were used to calculate the enthalpy change of the reaction.

(a) Show by calculation that the magnesium is in excess.

(2)

(b) Describe what you would **see** when the magnesium and copper(II) sulfate solution react.

(1)

....

....

(c) The temperature measurements were recorded.

Time / minutes	0	1	2	3	4	5	6	7	8	9	10
Temperature /°C	21.0	21.1	21.0	X	33.8	33.0	32.3	31.5	30.7	30.0	29.2

On the grid provided, draw a graph of temperature (vertical axis) against time (horizontal axis). Label both axes.

Use your graph to find the maximum temperature rise for the reaction.
Show your working on the graph and enter your value on the answer line provided.

(3)

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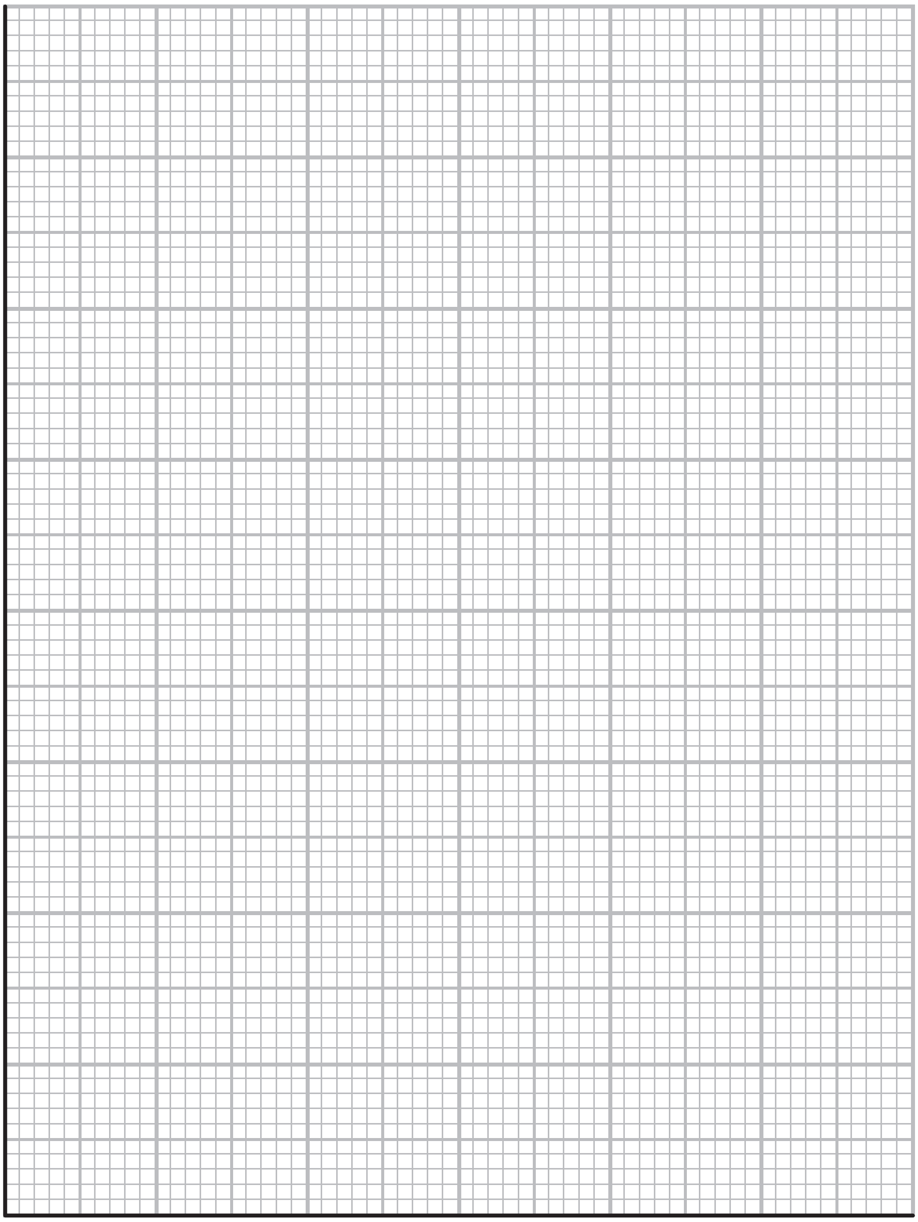

Maximum temperature rise ....

(d) Use your answers to (a) and (c) to calculate the enthalpy change of the reaction in $kJ\,mol^{-1}$.

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

Use the expression:

energy transferred in joules = 50.0 × 4.18 × maximum temperature rise

(3)

(e) A student used a burette to measure the $50.0\,cm^3$ of copper(II) sulfate solution required. The uncertainty in each burette reading is $\pm 0.05\,cm^3$.

Calculate the percentage uncertainty due to the burette in this student's experiment.

(1)

(f) The experiment was repeated using copper(II) chloride solution, $CuCl_2$, in place of copper(II) sulfate solution.

The enthalpy change of the reaction was the same in each case within experimental error. Suggest the reason for this.

(1)

....

....

(Total for Question 3 = 11 marks)

4 The halogenoalkane, 2-chloro-2-methylpropane, can be prepared by reacting 2-methylpropan-2-ol with concentrated hydrochloric acid.

$$(CH_3)_3COH \xrightarrow{\text{concentrated HCl}} (CH_3)_3CCl$$

Step **1** 20 cm^3 of 2-methylpropan-2-ol and 70 cm^3 of concentrated hydrochloric acid are mixed in a large conical flask, which is stoppered and shaken for about 20 minutes. The pressure is released at intervals.

Step **2** 6 g of sodium chloride is added to the flask. When the solid has dissolved, the mixture is transferred to a separating funnel and the aqueous layer discarded.

Step **3** About 20 cm^3 of 0.1 mol dm^{-3} aqueous sodium hydrogencarbonate is added to the organic layer in the separating funnel. This is shaken and the pressure released frequently. The aqueous layer is discarded again and the 2-chloro-2-methylpropane is transferred to a small flask to which anhydrous sodium sulfate is added and the mixture is shaken again.

Step **4** The mixture is filtered into a small flask. On distillation, a fraction containing 2-chloro-2-methylpropane is collected.

Data

	Molar mass / g mol^{-1}	Density / g cm^{-3}
2-methylpropan-2-ol	74.1	0.789
2-chloro-2-methylpropane	92.6	0.842

The density of the aqueous solutions is approximately 1.2 g cm^{-3}.

(a) State the main hazard of each of the reactants, 2-methylpropan-2-ol and concentrated hydrochloric acid, other than any toxic effects they may have.

(2)

	Hazard
2-methylpropan-2-ol	
Concentrated hydrochloric acid	

(b) Describe how the pressure is released in Step **1**.

(1)

....

....

(c) Explain why the pressure must be released in Step **1**, even though no gas is formed in this reaction.

(1)

....

....

....

....

(d) Suggest the purpose of adding sodium chloride in Step **2**.

(1)

....

....

(e) Draw a diagram of the separating funnel and contents in Step **3**. Label each layer.

(2)

(f) Suggest what you would **see** after the anhydrous sodium sulfate has been shaken with the mixture in Step **3**.

(1)

....

(g) The boiling temperature of 2-chloro-2-methylpropane is 51°C.

Give a suitable temperature **range** to collect the product in Step **4**.

(1)

....

(h) Calculate the mass of 2-chloro-2-methylpropane which would be produced in this experiment if the yield is 85%.

(4)

(Total for Question 4 = 13 marks)

TOTAL FOR PAPER = 50 MARKS

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The Periodic Table of Elements

Key

relative atomic mass **atomic symbol** name atomic (proton) number

1.0 **H** hydrogen 1

1 (1)	2 (2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	3 (13)	4 (14)	5 (15)	6 (16)	7 (17)	0 (8) (18)
																	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											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