Please check the examination details below before entering your candidate information

Candidate surname	Other names

Pearson Edexcel
International Advanced Level

Centre Number	Candidate Number

Time 1 hour 20 minutes

Paper reference **WCH16/01**

Chemistry

International Advanced Level
UNIT 6: Practical Skills in Chemistry II

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.*
- 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.
- Try to answer every question.
- Check your answers if you have time at the end.
- Good luck with your examination.

Turn over ▶

P64628A

1/1/1/1/1/1

P 6 4 6 2 8 A 0 1 1 6

Pearson

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

1 This question is about compounds containing the ammonium ion, NH_4^+.

(a) Ammonium vanadate(V), NH_4VO_3, is a white solid.

(i) When excess dilute sulfuric acid is added to an aqueous solution of NH_4VO_3, the VO_3^- ion is converted into the VO_2^+ ion.

Write the **ionic** equation for the conversion of VO_3^- to VO_2^+ on the addition of dilute sulfuric acid. State symbols are not required.

(1)

(ii) State the colour of an **acidified** solution of ammonium vanadate(V).

(1)

(iii) A student added zinc metal to an acidified solution of ammonium vanadate(V). The zinc reduced the vanadium in a series of reactions.

The student suggested that the sequence of colours observed could be explained by the presence of the vanadium species shown in the table.

Sequence of colours observed	starting colour → green → blue → green → violet
Suggested vanadium species	VO_2^+ → V^{3+} → VO^{2+} → V^{3+} → V^{2+}

Explain whether or not the student is correct.
Refer to oxidation states of vanadium and account for each colour in the sequence.

(2)

(iv) When the mixture obtained at the end of the sequence in (a)(iii) is filtered, the filtrate changes colour from violet to green on standing. No further changes occur.

Suggest an explanation for these observations.

(2)

(b) Ammonium tetrachlorocuprate(II) dihydrate, $(NH_4)_2CuCl_4 \cdot 2H_2O$, is a blue-green solid. When ammonium tetrachlorocuprate(II) dihydrate is dissolved in water, a blue-green solution **T** is formed.

(i) Suggest the formulae of **two** complex ions present in solution **T**.

(2)

(ii) State how the colour of solution **T** would change on the addition of excess concentrated hydrochloric acid.

(1)

(iii) Describe what would be observed on the addition of aqueous sodium hydroxide to solution **T**.

(1)

(iv) When the mixture from (b)(iii) is warmed, a gas is evolved. Give a test to identify the gas stating the positive result of the test.

(2)

(c) A white solid with a slight vinegar-like smell contains ammonium ions, NH_4^+, and an anion represented by $\mathbf{Y}^-$.

The smell of vinegar intensifies on the addition of a few drops of concentrated sulfuric acid to an aqueous solution of $NH_4\mathbf{Y}$.

On subsequent addition of a few drops of ethanol and heating the mixture, the smell of vinegar is replaced by a sweet and fruity smell.

Explain how **all** this information can be used to identify the anion $\mathbf{Y}^-$.

(3)

(Total for Question 1 = 15 marks)

2 This question concerns the laboratory preparation of tetraamminecopper(II) sulfate-1-water, $Cu(NH_3)_4SO_4 \cdot H_2O$.

Procedure

Step **1** Weigh between 2.1 g and 2.3 g of hydrated copper(II) sulfate, $CuSO_4 \cdot 5H_2O$, in a boiling tube. Add 8 cm^3 of distilled water and place the boiling tube in a hot water bath. Stir the mixture until the crystals have dissolved.

Step **2** Working in a fume cupboard, slowly pour 5 cm^3 of concentrated aqueous ammonia into the boiling tube. Stir until a clear solution is obtained.

Step **3** Measure 12 cm^3 of ethanol into a 100 cm^3 conical flask and add the contents of the boiling tube from Step **2**. Stopper the flask and swirl the contents before placing the flask in an ice bath. Allow the mixture to stand until crystals of $Cu(NH_3)_4SO_4 \cdot H_2O$ have formed.

Step **4** Filter the crystals obtained in Step **3** under reduced pressure, using a Buchner funnel and flask.

Step **5** Pour 5 cm^3 of cold ethanol over the crystals in the funnel.

Step **6** Using a spatula, transfer the crystals to a filter paper on a watch glass. Press a second piece of filter paper on the crystals, to dry them as much as possible.

Step **7** Transfer the crystals to a dry, pre-weighed sample bottle and reweigh.

(a) Give a reason why a measuring cylinder is more suitable than a graduated pipette for measuring the distilled water in Step **1**.

(1)

.....

(b) Give the colour of the solution at the end of Step **2**.

(1)

.....

(c) Give the reason why Step **2** should be carried out in a fume cupboard.

(1)

.....

.....

(d) Give the reason why the addition of ethanol in Step **3** results in the precipitation of crystals of $Cu(NH_3)_4SO_4 \cdot H_2O$.

(1)

(e) Draw a **labelled** diagram of the apparatus used to filter the crystals under reduced pressure in Step **4**.

(3)

(f) (i) State the purpose of the ethanol in Step **5**.

(1)

(ii) Give a reason why the ethanol is cold.

(1)

(g) Starting with 2.17 g of $CuSO_4 \cdot 5H_2O$ and using excess ammonia, a student obtained 2.54 g of product.

(i) Calculate the **apparent** percentage yield of $Cu(NH_3)_4SO_4 \cdot H_2O$.

Give your answer to an appropriate number of significant figures.

(3)

(ii) Suggest a reason why the apparent percentage yield in this preparation is often greater than 100 %.

(1)

.....

.....

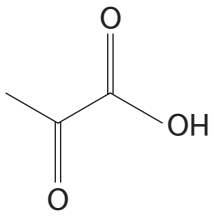
.....

.....

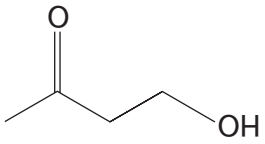
.....

(Total for Question 2 = 13 marks)

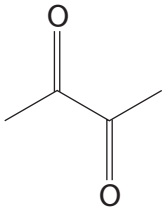
3 This question is about the identification of six organic compounds.



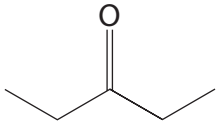
A



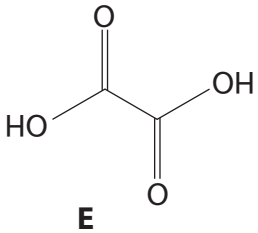
B



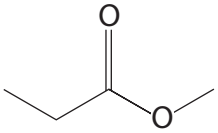
C



D



E



F

(a) From **A**, **B**, **C**, **D**, **E** and **F**, identify the compound with

(i) the fewest peaks in its **carbon-13** NMR spectrum.

(1)

.....

(ii) the most peaks in its **low** resolution **proton** NMR spectrum.

(1)

.....

(iii) three peaks with relative peak area 3:2:3 in its **low** resolution proton NMR spectrum.

(1)

.....

(iv) one triplet and one quartet as the only peaks in its **high** resolution proton NMR spectrum.

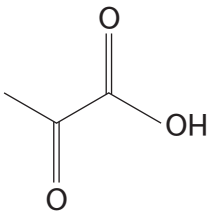
(1)

.....

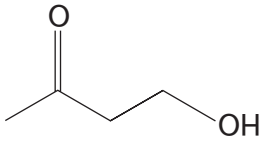
(b) For each of the following pairs, give **one chemical** test, not including indicators, that could be used to distinguish the compounds.

Identify the reagents and give the results of each test.

(i) **A** and **B**



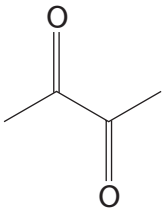
A



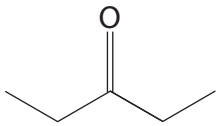
B

(2)

(ii) **C** and **D**



C

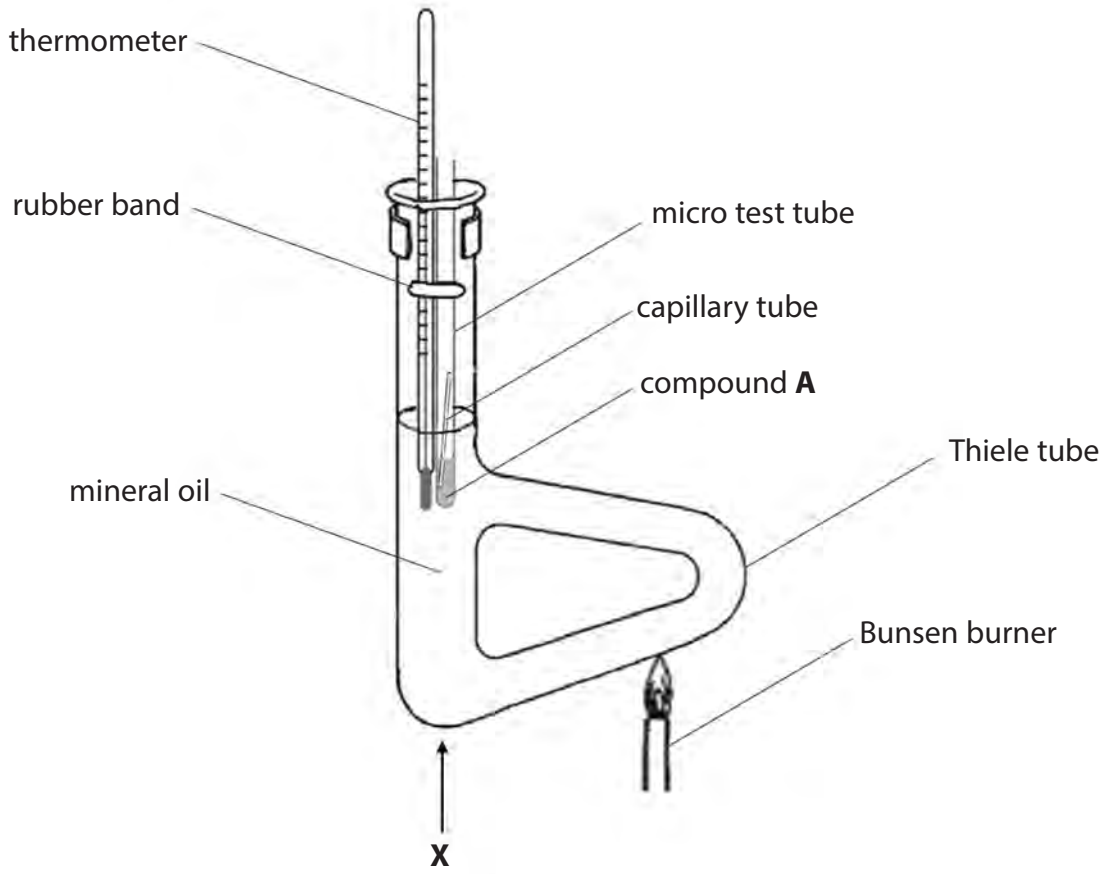


D

(2)

(c) Liquids boil at the temperature at which their vapour pressure is equal to atmospheric pressure.

The apparatus shown below was used to determine the boiling temperature of compound **A**, which is a liquid at room temperature and pressure and has a boiling temperature in the range 120 °C to 180 °C.



Procedure

Step **1** Place a capillary tube, sealed at one end and with the open end facing down, into 0.5 cm^3 of compound **A** in a micro test tube. Attach the micro test tube to a thermometer with a rubber band.

Step **2** Clamp the micro test tube and thermometer in the mineral oil, making sure neither test tube nor thermometer bulb is in contact with the glass walls of the Thiele tube.

Step **3** Move a small Bunsen flame back and forth along the lower part of the side-arm of the Thiele tube. An initial stream of bubbles will come from the open end of the capillary tube.

Step **4** Continue heating until a rapid and continuous stream of bubbles comes from the capillary tube. Stop heating and record the temperature as soon as compound **A** is drawn up into the capillary tube.

(i) State what causes the initial stream of bubbles from the capillary tube in Step **3**.

(1)

.....

.....

(ii) Suggest why the side-arm of the Thiele tube is heated, rather than point **X** on the diagram.

(1)

.....

.....

(iii) Suggest why mineral oil, and not water, is used in the Thiele tube when determining the boiling temperature of compound **A**.

(1)

.....

.....

.....

(iv) Suggest why the results obtained when using this apparatus on different days may **not** be the same, even when no mistakes are made in carrying out the experiment.

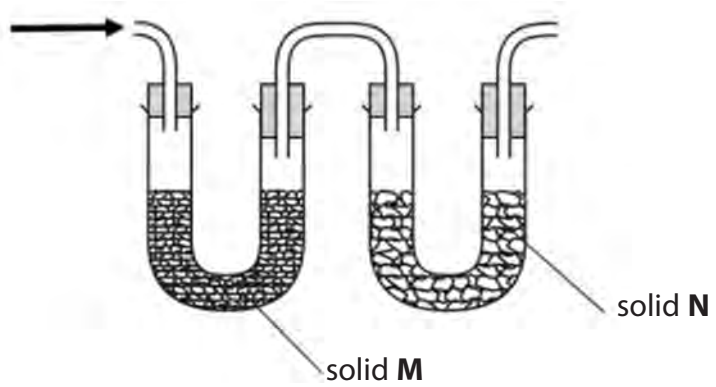
(1)

.....

.....

(d) **One** of the compounds **A**, **B**, **C**, **D**, **E** or **F** was analysed.

To determine its empirical formula, 1.57 g of the compound was burned completely and the combustion products passed through the apparatus shown.



Solid **M** absorbed water and increased in mass by 1.28 g.

Solid **N** absorbed carbon dioxide and increased in mass by 3.14 g.

(i) Identify, by name or formula, suitable substances for solids **M** and **N**.

(2)

Solid **M** .....

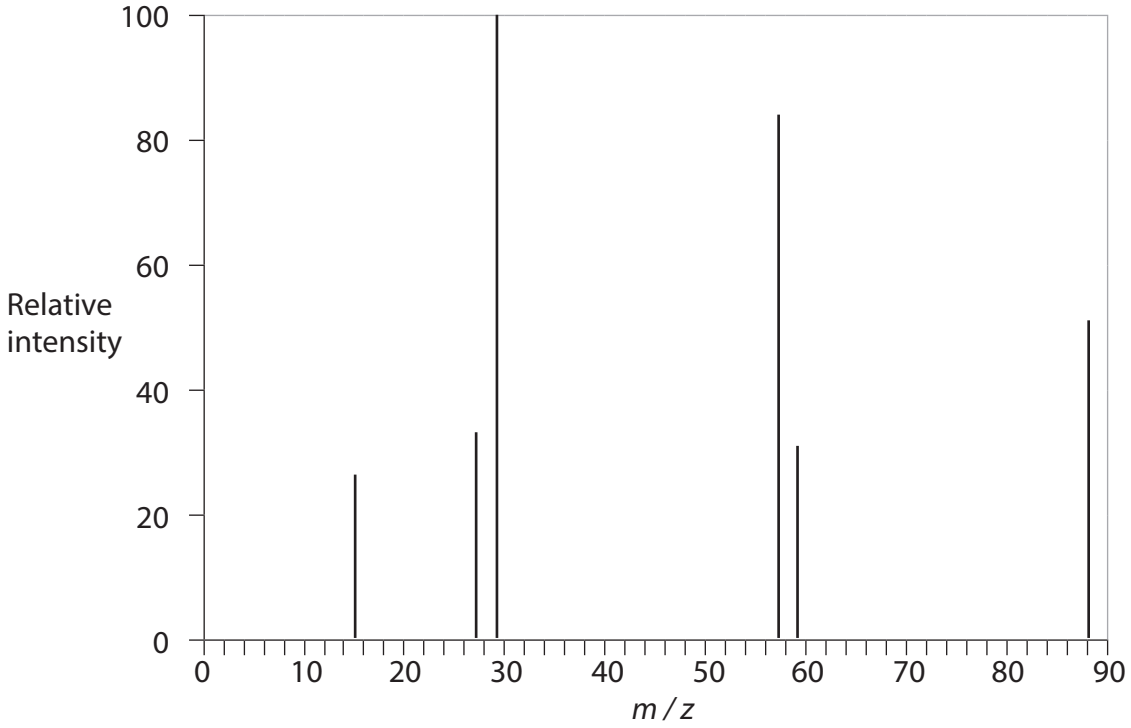
Solid **N** .....

(ii) Calculate the **empirical** formula of the compound, using the data given.

You **must** show your working.

(4)

(iii) The mass spectrum of the compound is shown.



Deduce the relative molecular mass of the compound, using the mass spectrum.

(1)

.....

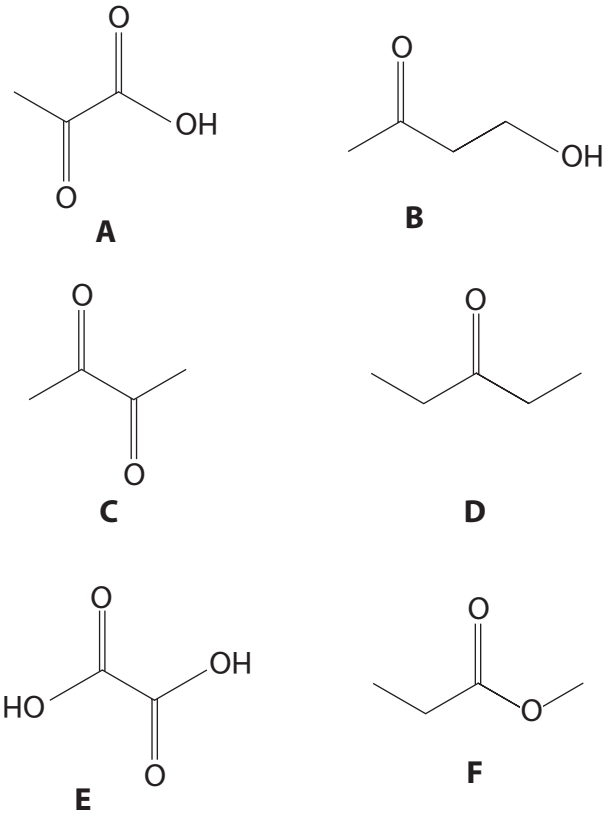
(iv) Deduce the molecular formula of the compound, using your answers to (d)(ii) and (d)(iii).

(1)

.....

(v) Determine the identity of the compound, using your answer to (d)(iv) and the fragmentation pattern of the mass spectrum.
Justify your answer.

(2)



(Total for Question 3 = 22 marks)

TOTAL FOR PAPER = 50 MARKS

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)											(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							

Key

relative atomic mass
atomic symbol
name
atomic (proton) number

Elements with atomic numbers 112-116 have been reported but not fully authenticated

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
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

* Lanthanide series

* Actinide series