Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Thursday 9 January 2025

Afternoon (Time: 1 hour 30 minutes)

Paper reference **WCH11/01**

Chemistry

International Advanced Subsidiary/Advanced Level
UNIT 1: Structure, Bonding and Introduction to Organic Chemistry

You must have:
Scientific calculator, ruler

Total Marks

Instructions

- Use **black** ink or ball-point pen.
- If pencil is used for diagrams/sketches/graphs it must be dark (HB or B).
- **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 80.
- 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.
- Show all your working in calculations and include units where appropriate.
- Try to answer every question.
- Check your answers if you have time at the end.

Turn over ▶

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P 7 8 4 5 5 A 0 1 2 8

Pearson

SECTION A

Answer ALL the questions in this section.

You should aim to spend no more than 20 minutes on this section.

For each question, select one answer from A to D and put a cross in the box ☒. If you change your mind, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 What is the total number of **atoms** in 8.8 g of carbon dioxide?

[M_r value: $CO_2 = 44$ Avogadro constant, $L = 6.02 \times 10^{23}$ mol^{-1}]

☒ **A** 1.2×10^{23}

☒ **B** 3.6×10^{23}

☒ **C** 1.2×10^{24}

☒ **D** 3.6×10^{24}

(Total for Question 1 = 1 mark)

2 How many moles of **ions** are there in 40 cm^3 of a solution of 0.050 mol dm^{-3} magnesium nitrate, $Mg(NO_3)_2$?

☒ **A** 0.0020 mol

☒ **B** 0.0040 mol

☒ **C** 0.0060 mol

☒ **D** 0.0080 mol

(Total for Question 2 = 1 mark)

3 A water molecule, containing the isotopes of hydrogen and oxygen, hydrogen-1 and oxygen-16, has a mass of 2.9908×10^{-23} g.

What is the mass of an atomic mass unit (amu) measured in grams?

[A_r values: oxygen-16 = 15.995 amu hydrogen-1 = 1.0080 amu]

☒ **A** 6.0185×10^{23}

☒ **B** 6.0221×10^{23}

☒ **C** 1.6605×10^{-24}

☒ **D** 1.6616×10^{-24}

(Total for Question 3 = 1 mark)

4 N_xO_4 is an oxide of nitrogen.
The percentage by mass of oxygen in this oxide is 69.57%.

What is the relative molecular mass of this oxide?

- ☒ **A** 78
- ☒ **B** 92
- ☒ **C** 106
- ☒ **D** 109

(Total for Question 4 = 1 mark)

5 Four different solutions contain chloride ions.
Three of the solutions contain the same number of moles of chloride ions.

Which solution contains a different number?

- ☒ **A** 15.0 cm^3 of 0.80 mol dm^{-3} hydrochloric acid
- ☒ **B** 10.0 cm^3 of 0.40 mol dm^{-3} iron(III) chloride solution
- ☒ **C** 10.0 cm^3 of 0.90 mol dm^{-3} magnesium chloride solution
- ☒ **D** 20.0 cm^3 of 0.60 mol dm^{-3} sodium chloride solution

(Total for Question 5 = 1 mark)

6 A solution contains 95 ppm of a solute.

What mass of the solute is dissolved in 1 kg of this solution?

- ☒ **A** 95 g
- ☒ **B** 0.95 g
- ☒ **C** 0.095 g
- ☒ **D** 0.000095 g

(Total for Question 6 = 1 mark)

7 A sample of hydrated magnesium sulfate contains 43% by mass of water.

What is the formula of this magnesium sulfate?

- ☒ **A** $MgSO_4 \cdot 9H_2O$
- ☒ **B** $MgSO_4 \cdot 5H_2O$
- ☒ **C** $MgSO_4 \cdot 2.5H_2O$
- ☒ **D** $MgSO_4 \cdot 1.25H_2O$

(Total for Question 7 = 1 mark)

8 Ethanoic acid can be produced by the oxidation of butane.

$$2C_4H_{10} + 5O_2 \rightarrow 4CH_3COOH + 2H_2O$$

The atom economy, by mass, for the production of ethanoic acid is

☒ **A** 13%

☒ **B** 67%

☒ **C** 77%

☒ **D** 87%

(Total for Question 8 = 1 mark)

9 The first four ionisation energies of the elements gallium (Ga), indium (In), germanium (Ge) and tin (Sn) are shown.

Which values are the first four ionisation energies of gallium?

☒ **A** 557 1821 2705 5200

☒ **B** 579 1979 2963 6200

☒ **C** 709 1412 2943 3930

☒ **D** 762 1537 3302 4411

(Total for Question 9 = 1 mark)

10 Sulfur has a higher melting temperature than white phosphorus, P_4.

Which is a possible reason for this?

☒ **A** sulfur molecules have a greater permanent dipole than phosphorus molecules

☒ **B** sulfur has stronger covalent bonds than phosphorus

☒ **C** sulfur has a giant covalent structure and phosphorus has a simple molecular structure

☒ **D** sulfur molecules have more electrons than phosphorus molecules

(Total for Question 10 = 1 mark)

Use this space for any rough working. Anything you write in this space will gain no credit.

11 Which species are arranged in order of **increasing** radius?

- ☒ **A** $K^+ < Ar < Cl^- < Br^-$
- ☒ **B** $Cl^- < Ar < K^+ < Br^-$
- ☒ **C** $Br^- < Cl^- < Ar < K^+$
- ☒ **D** $Cl^- < Br^- < Ar < K^+$

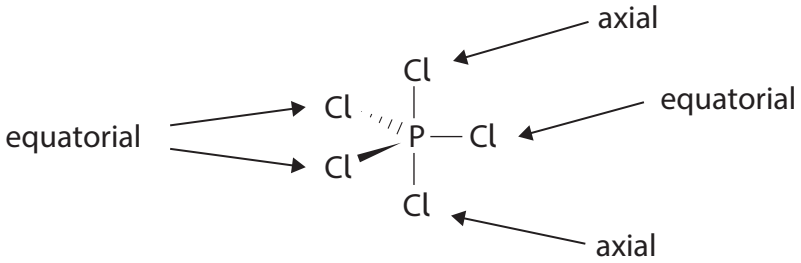
(Total for Question 11 = 1 mark)

12 Which cation would be the most polarising?

		Radius	Charge
☒	**A**	small	large
☒	**B**	small	small
☒	**C**	large	small
☒	**D**	large	large

(Total for Question 12 = 1 mark)

13 In the gas phase, PCl_5 exists as molecules. They are trigonal bipyramidal.



Each chlorine atom can be replaced one at a time by a fluorine atom.
The two axial chlorine atoms are replaced before the three equatorial atoms.

Which of the resulting molecules does **not** have a permanent dipole?

- ☒ **A** PCl_4F
- ☒ **B** PCl_3F_2
- ☒ **C** PCl_2F_3
- ☒ **D** $PClF_4$

(Total for Question 13 = 1 mark)

14 Which hazard warning symbol would be found on a bottle of hexane?

☒ **A** 

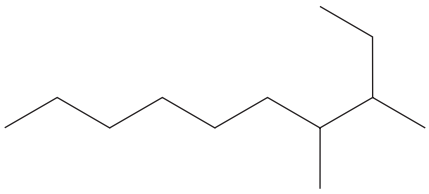
☒ **B** 

☒ **C** 

☒ **D** 

(Total for Question 14 = 1 mark)

15 What is the IUPAC name for the hydrocarbon shown?



☒ **A** 2-ethyl-3-methylnonane

☒ **B** 3,4-dimethyldecane

☒ **C** 8-ethyl-7-methylnonane

☒ **D** 7,8-dimethyldecane

(Total for Question 15 = 1 mark)

16 Which statement about the cracking of crude oil is true?

The cracking of crude oil

☒ **A** separates the mixture into pure compounds

☒ **B** separates the mixture into fractions

☒ **C** separates saturated from unsaturated compounds

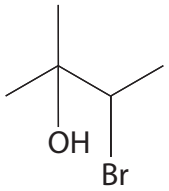
☒ **D** decreases the average number of carbon atoms per molecule

(Total for Question 16 = 1 mark)

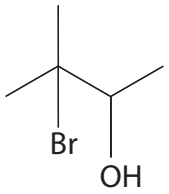
17 Bromine and bromine water can be used to test for a carbon-carbon double bond. When **bromine water** reacts with 2-methylbut-2-ene, there is one major organic product.

Which is the skeletal formula of the **major** product?

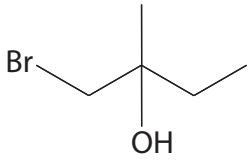
☒ **A**



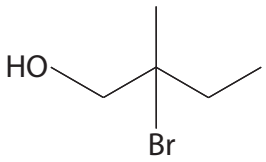
☒ **B**



☒ **C**



☒ **D**



(Total for Question 17 = 1 mark)

18 Which of these formulae are correct for the compound 1,4-diethylcyclohexene?

(i)
skeletal formula

$C_{10}H_{18}$

(ii)
molecular formula

C_5H_9

(iii)
empirical formula

☒ **A** none of the three

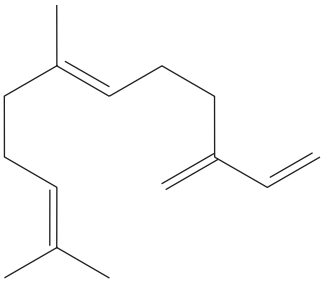
☒ **B** (i) only

☒ **C** (ii) and (iii) only

☒ **D** (i), (ii) and (iii)

(Total for Question 18 = 1 mark)

19 β-Farnesene is an alarm pheromone released by aphids.



How many π bonds and how many σ bonds are present in this molecule?

☒ **A** 4π and 31σ

☒ **B** 4π and 38σ

☒ **C** 8π and 28σ

☒ **D** 8π and 34σ

(Total for Question 19 = 1 mark)

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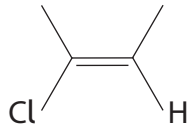
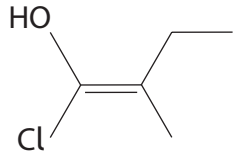
20 Which structure is a *Z*-isomer?

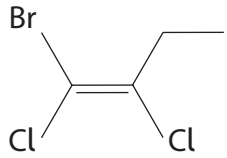
☒ **A**



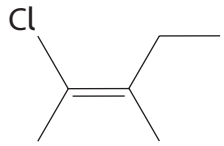
☒ **B**



☒ **C**



☒ **D**



(Total for Question 20 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

SECTION B

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

21 Chloroethene and 1-chloropropene are the first two members of a homologous series. 1-Chloropropene exists as two geometric isomers.

(a) (i) Draw the **displayed** formulae of chloroethene and one geometric isomer of 1-chloropropene.

(2)

chloroethene 1-chloropropene

(ii) Explain why chloroethene and 1-chloropropene are members of a homologous series.

(2)

(iii) Explain why 1-chloropropene exists as two geometric isomers, but chloroethene does not.

(3)

(b) Chloroethene and 1-chloropropene are both monomers.

(i) Draw the structure of poly(1-chloropropene).

(2)

(ii) The polymer of chloroethene, known as PVC, is used to make water pipes and gutters, which were previously made of metal.

Suggest **two** advantages of using PVC instead of metal in water pipes and gutters, other than cost.

(2)

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(Total for Question 21 = 11 marks)

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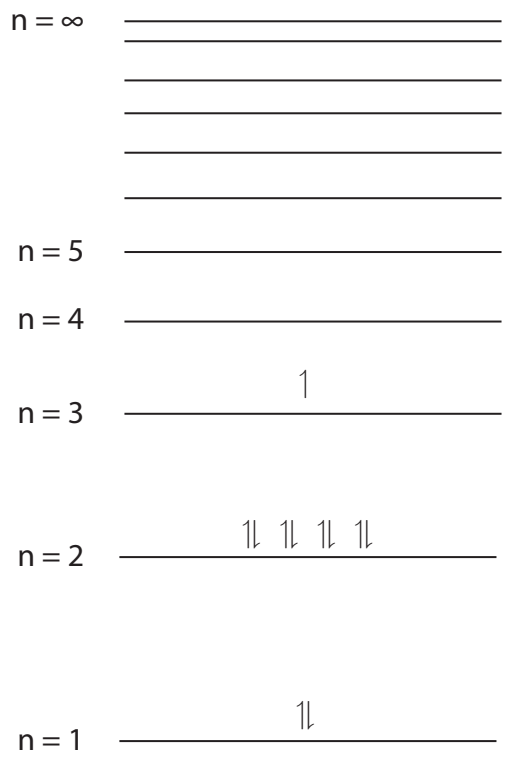
22 The diagram shows the arrangement of electrons in the energy levels of a sodium atom.



(a) Give the reason why the two electrons in the n = 1 energy level are represented by arrows pointing in opposite directions.

(1)

(b) Explain whether or not all of the electrons in the n = 2 energy level have the same energy.

(2)

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(c) Name the shape of the orbital occupied by the electron in the n = 3 energy level.

(1)

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(Total for Question 22 = 4 marks)

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23 Samples of germanium consist of five isotopes, four of which are stable.
The fifth isotope, germanium-76, is radioactive but with a very long half-life.

This means that the isotopic composition is almost constant.
The table shows data for four of the isotopes.

Atom	^{70}Ge	^{73}Ge	^{74}Ge	^{76}Ge
Mass number	70	73	74	76
Abundance / %	20.5	7.8	36.5	7.8

(a) (i) Calculate the mass number of the fifth isotope of germanium.
The relative atomic mass of germanium is 72.6.

You must show your working.

(3)

(ii) Give the main reason why the answer in (a)(i) should not be quoted to more than 2 significant figures.

(1)

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(b) The radioactive decay of germanium-76 forms stable atoms of selenium-76.

Compare and contrast the atomic structure of an atom of germanium-76 with an atom of selenium-76.

(4)

(Total for Question 23 = 8 marks)

24 A sample of a volatile liquid **X** was vaporised.
At 473 K and 110 000 Pa, 3.50 g of **X** occupies 1.79 dm^3.

(a) (i) Calculate the number of moles of **X** in the sample.

[$R = 8.31\ J\ mol^{-1}\ K^{-1}$]

Use $pV = nRT$

(4)

(ii) Deduce the relative molecular mass of **X**.

(1)

(iii) Compound **X** contains 85.7 % carbon and 14.3 % hydrogen by mass.

Calculate the empirical formula of **X**.

(2)

(iv) Deduce the molecular formula of **X**.

(1)

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(b) A few drops of a purple solution of acidified potassium manganate(VII) were added to a sample of liquid **X** and shaken.
The solution remained purple.

State what can be deduced about the structure of **X** from this experiment.

(1)

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(c) Identify, by name or formula, **two** possible structural isomers of **X** using your answers to (a)(iv) and (b).

(2)

(Total for Question 24 = 11 marks)

25 Chlorine reacts with both alkanes and alkenes.

(a) Three steps in the mechanism for the reaction of chlorine with butane to form 1-chlorobutane are shown.

Step **1** $Cl_2 \rightarrow 2Cl\bullet$

Step **2** $Cl\bullet + CH_3CH_2CH_2CH_3 \rightarrow CH_3CH_2CH_2CH_2\bullet + HCl$

Step **3** $CH_3CH_2CH_2CH_2\bullet + Cl_2 \rightarrow CH_3CH_2CH_2CH_2Cl + Cl\bullet$

(i) Name the mechanism and type of this reaction.

(1)

.....

(ii) Give the essential condition for Step **1** to occur.

(1)

.....

(iii) Name the type of step illustrated by Step **3**.

(1)

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(iv) A different type of step, other than the ones shown, also occurs in the reaction.

Describe this type of step, including two possible examples which might occur in this reaction.

(4)

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(b) Chlorine is not a polar molecule but can react with alkenes through an electrophilic addition reaction.

(i) State what is meant by the term polar molecule and why chlorine is not polar.

(2)

(ii) Explain why chlorine reacts with alkenes even though it is not a polar molecule.

(2)

(Total for Question 25 = 11 marks)

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26 Sulfur hexafluoride, SF_6, is used in the electric power industry as an insulating gas. It can be used in this way as it is very unreactive.

Fluorine reacts with sulfur to form SF_6.
Impurities of S_2F_{10} and SF_4 also form and must be removed because they are too reactive.

(a) Give the name of the compound S_2F_{10}.

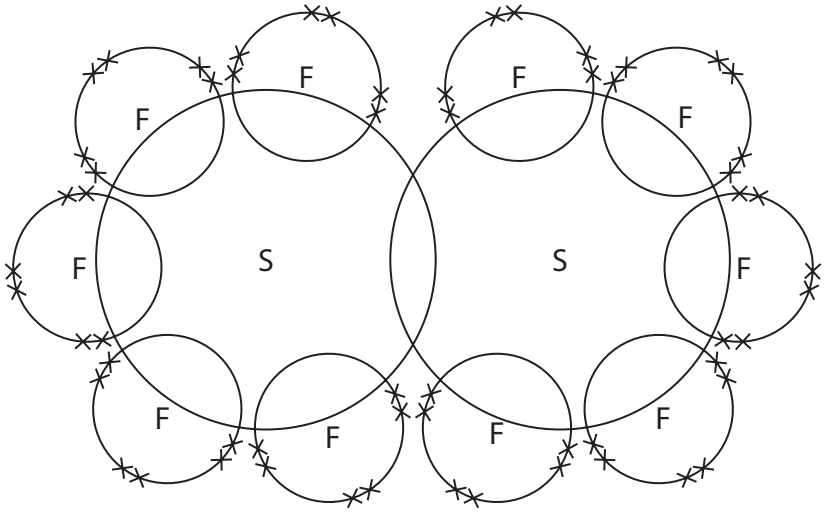
(1)

.....

(b) Molecules of S_2F_{10} consist of two SF_5 units linked by a S—S bond.

Complete the dot-and-cross diagram of S_2F_{10}, showing the outer shell electrons.
Use dots (●) for the sulfur electrons and crosses (×) for the fluorine electrons.

(2)

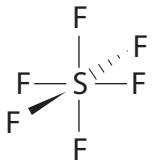


(c) Draw a dot-and-cross diagram of SF_4, showing all the outer shell electrons.
Use dots (●) for the sulfur electrons and crosses (×) for the fluorine electrons.

(2)

(d) Complete the table showing clearly the shapes of the other two molecules and the F—S—F bond angles.

(4)

Molecule	Diagram	F—S—F bond angle
SF_6		90°
S_2F_{10}		
SF_4		

(e) Justify the shape around the sulfur atom in both SF_6 and SF_4.

(3)

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(f) SF_4 and S_2F_{10} are reactive, but SF_6 is unreactive.

Suggest reasons for this by considering the shape and bonding in each molecule.

(3)

(Total for Question 26 = 15 marks)

TOTAL FOR SECTION B = 60 MARKS
TOTAL FOR PAPER = 80 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									(13)	(14)	(15)	(16)	(17)	
6.9 Li lithium 3	9.0 Be beryllium 4		relative atomic mass atomic symbol name atomic (proton) number									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