Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

Wednesday 08 May 2024

Morning (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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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 How many **atoms** are there in 10 g of methane?

[A_r values: H = 1.0 C = 12.0 $L = 6.02 \times 10^{23}\,mol^{-1}$]

☒ **A** 3.76×10^{23}

☒ **B** 9.63×10^{23}

☒ **C** 1.88×10^{24}

☒ **D** 4.82×10^{24}

(Total for Question 1 = 1 mark)

2 What is the maximum volume of butane that can be completely burned in 39 cm^3 of oxygen at room temperature and pressure?

$$C_4H_{10}(g) + 6.5O_2(g) \rightarrow 4CO_2(g) + 5H_2O(l)$$

☒ **A** 6.0 cm^3

☒ **B** 12 cm^3

☒ **C** 24 cm^3

☒ **D** 45 cm^3

(Total for Question 2 = 1 mark)

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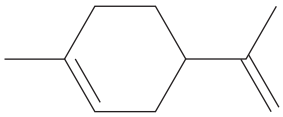
3 This question is about limonene.



(a) What is the molecular formula of limonene?

(1)

- ☒ **A** $C_{10}H_{10}$
- ☒ **B** $C_{10}H_{16}$
- ☒ **C** $C_{10}H_{18}$
- ☒ **D** $C_{10}H_{22}$

(b) Limonene is completely hydrogenated by hydrogen in the presence of a nickel catalyst. What is the **empirical formula** of the product formed?

(1)

- ☒ **A** C_5H_{11}
- ☒ **B** C_5H_9
- ☒ **C** C_5H_8
- ☒ **D** CH_2

(Total for Question 3 = 2 marks)

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

4 What is the best definition of a hydrocarbon?

- ☒ **A** a compound containing carbon, hydrogen and oxygen
- ☒ **B** a compound containing carbon and hydrogen only
- ☒ **C** a compound that contains single carbon to carbon bonds
- ☒ **D** a mixture containing carbon and hydrogen only

(Total for Question 4 = 1 mark)

5 This question is about the production of ethanol by fermentation of glucose or by hydration of ethene.

(a) What is the percentage atom economy by mass for the production by fermentation?

$$C_6H_{12}O_6 \rightarrow 2CH_3CH_2OH + 2CO_2$$

(1)

- ☒ **A** 24.4%
- ☒ **B** 25.6%
- ☒ **C** 48.9%
- ☒ **D** 51.1%

(b) What is the percentage atom economy by mass for the production by hydration?

$$C_2H_4 + H_2O \rightarrow CH_3CH_2OH$$

(1)

- ☒ **A** 39.1%
- ☒ **B** 60.9%
- ☒ **C** 78.2%
- ☒ **D** 100%

(Total for Question 5 = 2 marks)

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6 This question is about electronic configurations.

(a) What is the electronic configuration of an atom of calcium?

(1)

- ☒ **A** [Ne] $3s^1$
- ☒ **B** [Ar] $4s^1$
- ☒ **C** [Ne] $3s^2$
- ☒ **D** [Ar] $4s^2$

(b) What is the electronic configuration of a Cr^{3+} ion?

(1)

- ☒ **A** [Ar] $3d^2 4s^1$
- ☒ **B** [Ar] $3d^3$
- ☒ **C** [Ar] $3d^4$
- ☒ **D** [Ar] $3d^5$

(Total for Question 6 = 2 marks)

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

7 This question is about bond angles.

(a) What is the expected bond angle in a boron trichloride molecule, BCl_3?

(1)

- ☒ **A** 90°
- ☒ **B** 107°
- ☒ **C** 109.5°
- ☒ **D** 120°

(b) What is the expected bond angle in an ammonium ion?

(1)

- ☒ **A** 90°
- ☒ **B** 104.5°
- ☒ **C** 107°
- ☒ **D** 109.5°

(c) What is the expected bond angle in an oxygen difluoride molecule, OF_2?

(1)

- ☒ **A** 90°
- ☒ **B** 104.5°
- ☒ **C** 109.5°
- ☒ **D** 180°

(Total for Question 7 = 3 marks)

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8 Which is the strongest **oxidising** agent in these displacement reactions?

$$Cl_2 + 2Br^- \rightarrow Br_2 + 2Cl^-$$

$$Br_2 + 2I^- \rightarrow 2Br^- + I_2$$

☒ **A** chlorine

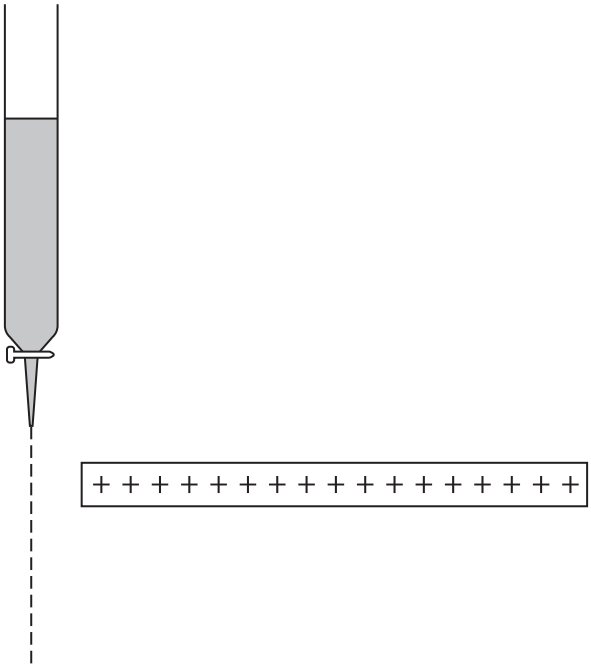
☒ **B** bromide ions

☒ **C** bromine

☒ **D** iodide ions

(Total for Question 8 = 1 mark)

9 To compare polar and non-polar liquids, a stream of liquid from a burette and a positively charged plastic rod can be used. Which row of the table shows the correct direction of deflection?



		Direction of deflection	
		Polar liquid	**Non-polar liquid**
☒	**A**	towards the rod	away from the rod
☒	**B**	away from the rod	no deflection
☒	**C**	towards the rod	no deflection
☒	**D**	no deflection	towards the rod

(Total for Question 9 = 1 mark)

10 Which equation represents the **second** ionisation energy of magnesium?

- ☒ **A** $Mg(g) \rightarrow Mg^{2+}(g) + 2e^-$
- ☒ **B** $Mg^+(g) \rightarrow Mg^{2+}(g) + e^-$
- ☒ **C** $Mg^+(s) \rightarrow Mg^{2+}(s) + e^-$
- ☒ **D** $Mg(g) \rightarrow Mg^+(g) + e^-$

(Total for Question 10 = 1 mark)

11 This question is about the isoelectronic ions N^{3-}, O^{2-}, F^-, Na^+, Mg^{2+} and Al^{3+}.

(a) Which ions are shown in order of **decreasing** ionic radius?

(1)

- ☒ **A** $Na^+ > Mg^{2+} > Al^{3+}$
- ☒ **B** $Mg^{2+} > Na^+ > Al^{3+}$
- ☒ **C** $Al^{3+} > Na^+ > Mg^{2+}$
- ☒ **D** $Al^{3+} > Mg^{2+} > Na^+$

(b) Which ions are shown in order of **increasing** ionic radius?

(1)

- ☒ **A** $F^- < O^{2-} < N^{3-}$
- ☒ **B** $F^- < N^{3-} < O^{2-}$
- ☒ **C** $O^{2-} < N^{3-} < F^-$
- ☒ **D** $N^{3-} < O^{2-} < F^-$

(Total for Question 11 = 2 marks)

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12 Which pair of compounds will **not** react to form a precipitate?

- ☒ **A** $AgNO_3(aq)$ and $CaCl_2(aq)$
- ☒ **B** $Ca(OH)_2(aq)$ and $CO_2(g)$
- ☒ **C** $Ba(OH)_2(aq)$ and $HCl(aq)$
- ☒ **D** $KI(aq)$ and $Pb(NO_3)_2(aq)$

(Total for Question 12 = 1 mark)

13 What is observed when iron(II) carbonate reacts with ethanoic acid?

- ☒ **A** colourless solution
- ☒ **B** colourless solution and effervescence
- ☒ **C** green solution and effervescence
- ☒ **D** green solution

(Total for Question 13 = 1 mark)

14 Which is the simplest ionic equation for an alkali reacting with an acid?

- ☒ **A** $2H^+(aq) + 2OH^-(aq) \rightarrow 2H_2O(l)$
- ☒ **B** $H^+(aq) + OH^-(aq) \rightarrow H_2O(aq)$
- ☒ **C** $H^+(aq) + OH^-(aq) \rightarrow H_2O(l)$
- ☒ **D** $2H^+(aq) + O^{2-}(aq) \rightarrow H_2O(l)$

(Total for Question 14 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

SECTION B

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

15 This question is about silver.

(a) Silver chloride decomposes in light. This reaction was used in the first photographic plates.

Write an equation for this decomposition.
Include state symbols.

(2)

(b) Silver can form in displacement reactions.

(i) State **two** observations that are made when copper metal is added to silver nitrate solution.

(2)

.....

.....

.....

.....

(ii) Write an equation for this displacement reaction.
Include state symbols.

(2)

(c) (i) Describe the bonding in pure silver metal.
Include a 2D diagram to show the arrangement of 12 of the silver particles involved.

(3)

(ii) Pure silver cups are too soft so small amounts of copper are added to make an alloy.

Explain why copper makes the silver less malleable.

(2)

(Total for Question 15 = 11 marks)

16 This question is about silicon.

(a) (i) Define relative atomic mass.

(2)

.....

.....

.....

.....

(ii) Calculate the relative atomic mass of a sample of silicon, using the isotopic abundance data provided.
Give your answer to 3 significant figures.

Isotope	Abundance (%)
^{28}Si	91.07
^{29}Si	4.62
^{30}Si	3.00
^{32}Si	1.31

(2)

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(iii) In the mass spectrum of silicon, there is also a small peak at $m/z = 14$.
Deduce the formula of this particle.

(1)

(b) Consider the elements Al, Si, P and S.

(i) Explain the trend in the first ionisation energies of Al, Si and P.

(3)

(ii) Explain why sulfur does **not** follow this trend.

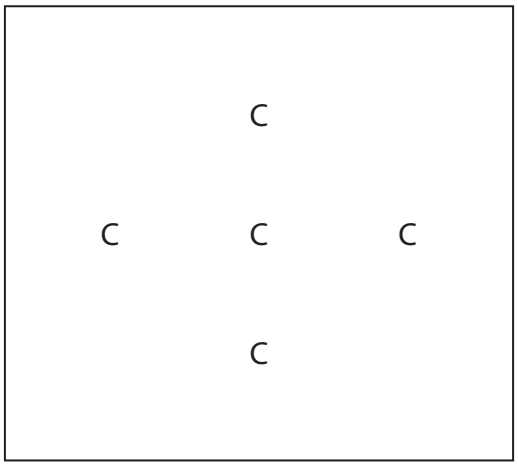
(2)

(Total for Question 16 = 10 marks)

17 Carbon exists as several different structures called allotropes.

(a) Complete the dot-and-cross diagram by adding all the electrons in the outer shells of the five carbon atoms in a diamond tetrahedral unit.

(2)



(b) Draw a labelled 3D structure of graphite, showing two layers of at least 13 carbon atoms each and the forces between the layers.

(2)

(c) Suggest why diamond has a greater density than graphite.

(2)

(Total for Question 17 = 6 marks)

18 Baking powder is added to cake mixtures to make cakes 'rise' by releasing a gas during cooking.

Baking powder contains an acidic derivative of tartaric acid and about 30% by mass of sodium hydrogencarbonate.

Baking powder releases the gas in two types of reaction during cooking, one of which is neutralisation.

(a) (i) Give the name of the second type of reaction.

(1)

.....

(ii) Suggest why neutralisation does not occur in an unopened container of baking powder.

(1)

.....

.....

(b) (i) The acidic derivative of tartaric acid contains 20.8% potassium, 25.5% carbon, 2.66% hydrogen by mass and the rest is oxygen.

Calculate the empirical formula.

(2)

(ii) The acidic derivative of tartaric acid can be represented by the formula $H^+K^+A^{2-}$.

Write the equation for the neutralisation of sodium hydrogencarbonate by $H^+K^+A^{2-}$.

State symbols are not required.

(2)

(iii) Calculate the maximum volume, in **cm^3**, of carbon dioxide gas released by the neutralisation reaction in (b)(ii) from 5.00 g of baking powder, in an oven at 190°C at 101 000 Pa.

Baking powder contains 30% sodium hydrogencarbonate by mass.
[$pV = nRT$]

(5)

(iv) Calculate the decrease in volume when the carbon dioxide gas is cooled to 20°C.

(2)

(Total for Question 18 = 13 marks)

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19 Both butter and margarine are fats used in cooking.

(a) Margarines are sold as unsaturated fats.

State the meaning of the term unsaturated.

(1)

.....

.....

(b) (i) The degree of unsaturation can be determined by the reaction with bromine water.

Name the type of reaction.

(1)

.....

Data using 0.5 g of some unsaturated fat in this bromination is given in the table.

Average number of C═C bonds per molecule	Volume of 0.0625 mol dm^{-3} bromine water / cm^3
1	28.3
2	57.3
3	86.9
4	115

(ii) Plot a graph of the data. Include a line of best fit.

(3)

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(iii) Data for the bromination of 0.5 g samples of a margarine are shown.

Trial	Volume of 0.0625 mol dm^{-3} bromine water / cm^3
1	36.9
2	34.1
3	39.3
4	32.5

Calculate the mean volume of bromine water using all results in the table.

(1)

(iv) Determine the average number of C═C bonds per molecule of the unknown sample to 2 significant figures, using your graph.

(1)

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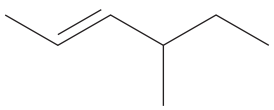
(c) (i) Using the simplest alkene as an example, draw the mechanism to show the reaction with liquid bromine.

(4)

(ii) Name this compound by applying IUPAC rules.

(1)



(d) Explain the meaning of "trans" in "trans" fats, using a **skeletal** formula showing four carbon atoms in your answer.

(2)

(Total for Question 19 = 14 marks)

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20 Many synthetic polymers are used in the home.
Some are used as containers and others as coatings.

PVC and PTFE are two such examples.

(a) Draw the **displayed** formula of each of the monomers for these polymers.

(2)

chloroethene

tetrafluoroethene

(b) Incineration and recycling are two methods of disposing of polymer waste.
Give **one** advantage and **one** disadvantage for each method.

(4)

Incineration

advantage .....

.....

.....

disadvantage .....

.....

.....

Recycling

advantage .....

.....

.....

disadvantage .....

.....

.....

(Total for Question 20 = 6 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