Please check the examination details below before entering your candidate information

Candidate surname	Other names

Centre Number | Candidate Number

Pearson Edexcel International Advanced Level

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.
- **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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Q:1/1/1/1/

P 7 0 9 6 4 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 Elements in their most stable state exist as

☒ **A** atoms in giant structures only

☒ **B** atoms in molecules and atoms in giant structures only

☒ **C** isolated atoms and atoms in giant structures only

☒ **D** isolated atoms, atoms in molecules and atoms in giant structures

(Total for Question 1 = 1 mark)

2 A sample of nitrogen gas contains 1.204×10^{22} molecules.

What is the mass of this sample?

[A_r N = 14.0 Avogadro constant (L) = 6.02×10^{23} mol^{-1}]

☒ **A** 0.14 g

☒ **B** 0.28 g

☒ **C** 0.56 g

☒ **D** 1.12 g

(Total for Question 2 = 1 mark)

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

3 When magnesium oxide reacts with dilute sulfuric acid the equation is

$$MgO(s) + H_2SO_4(aq) \rightarrow MgSO_4(aq) + H_2O(l)$$

What is the ionic equation for the reaction?

- ☒ **A** $MgO(s) + 2H^+(aq) + SO_4^{2-}(aq) \rightarrow Mg^{2+}(aq) + SO_4^{2-}(aq) + H_2O(l)$
- ☒ **B** $MgO(s) + 2H^+(aq) \rightarrow Mg^{2+}(aq) + H_2O(l)$
- ☒ **C** $Mg^{2+}(s) + SO_4^{2-}(aq) \rightarrow Mg^{2+}(aq) + SO_4^{2-}(aq)$
- ☒ **D** $O^{2-}(s) + 2H^+(aq) \rightarrow H_2O(l)$

(Total for Question 3 = 1 mark)

4 A solution of sodium chloride, NaCl, is prepared by dissolving 10.0 g of the solid in distilled water and making the solution up to 250.0 cm^3.

What is the concentration of the solution, in mol dm^{-3}?

[M_r NaCl = 58.5]

- ☒ **A** 0.171
- ☒ **B** 0.684
- ☒ **C** 10.0
- ☒ **D** 40.0

(Total for Question 4 = 1 mark)

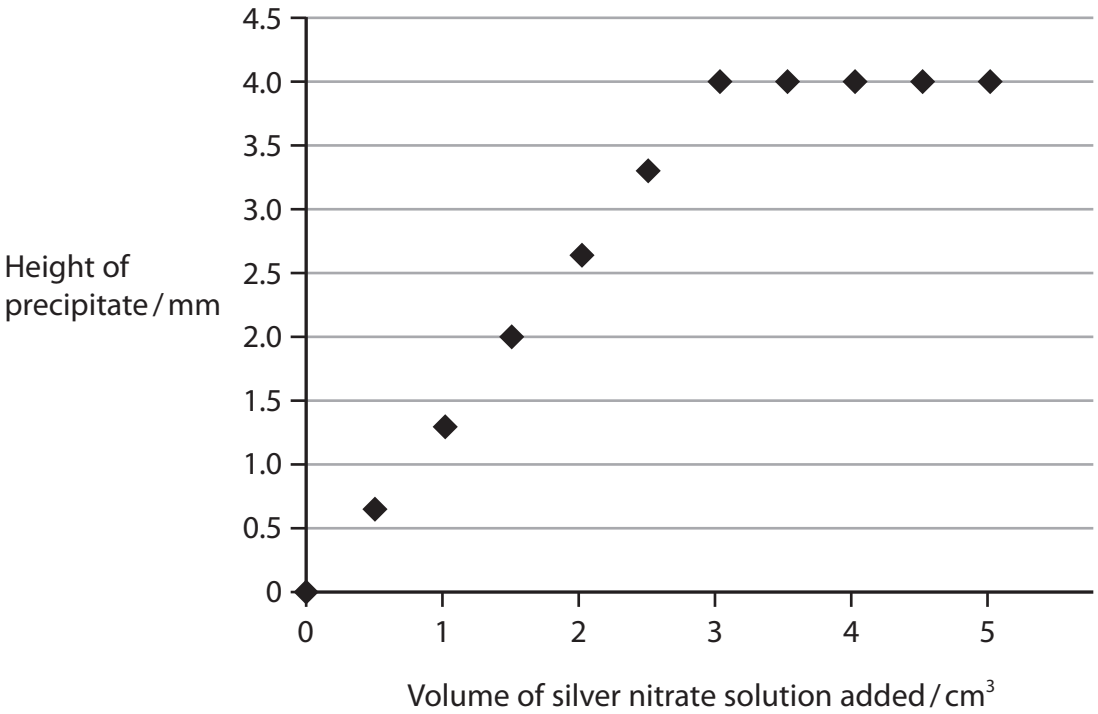
Use this space for any rough working. Anything you write in this space will gain no credit.

5 Ten test tubes, each containing 1.0 cm^3 of a chromium chloride solution of concentration 0.1 mol dm^{-3}, were placed in a test tube rack.

Different volumes of silver nitrate solution of concentration 0.1 mol dm^{-3} were added to each test tube, giving a precipitate of silver chloride.

$$Ag^+(aq) + Cl^-(aq) \rightarrow AgCl(s)$$

The precipitates formed were allowed to settle and their heights measured. The results were plotted on a graph.



What is the formula of the chromium chloride?

- ☒ **A** $CrCl$
- ☒ **B** Cr_3Cl_4
- ☒ **C** Cr_4Cl_3
- ☒ **D** $CrCl_3$

(Total for Question 5 = 1 mark)

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

6 The atomic number of the element scandium is 21 and the mass number of its only isotope is 45.

(a) What is the number of electrons in a scandium ion, Sc^+?

(1)

- ☒ **A** 20
- ☒ **B** 21
- ☒ **C** 22
- ☒ **D** 23

(b) In a mass spectrometer, scandium forms Sc^+ and Sc^{2+} ions.

What is the m/z value for the mass spectrum peak due to the Sc^{2+} ions?

(1)

- ☒ **A** 22.5
- ☒ **B** 33.0
- ☒ **C** 45.0
- ☒ **D** 90.0

(Total for Question 6 = 2 marks)

7 Which equation represents the first ionisation energy of iodine?

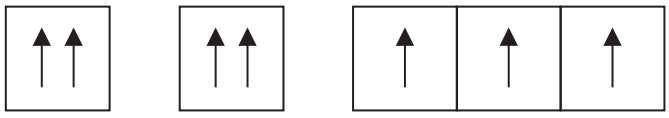
- ☒ **A** $I_2(s) \rightarrow 2I^+(g) + 2e^-$
- ☒ **B** $I_2(g) \rightarrow 2I^+(g) + 2e^-$
- ☒ **C** $\frac{1}{2}I_2(s) \rightarrow I^+(g) + e^-$
- ☒ **D** $I(g) \rightarrow I^+(g) + e^-$

(Total for Question 7 = 1 mark)

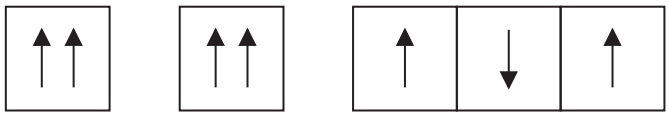
Use this space for any rough working. Anything you write in this space will gain no credit.

8 What is the electronic configuration of a nitrogen atom?

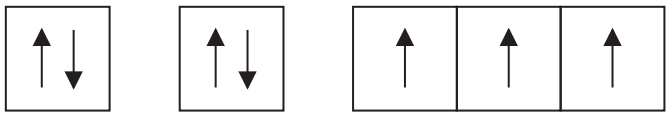
☒ **A**



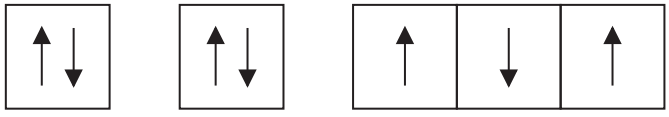
☒ **B**



☒ **C**



☒ **D**



(Total for Question 8 = 1 mark)

9 The element manganese has the atomic number $Z = 25$.

What are the numbers of s, p and d electrons in an atom of manganese?

	s electrons	p electrons	d electrons
☒ **A**	6	12	7
☒ **B**	8	12	5
☒ **C**	6	18	1
☒ **D**	8	17	0

(Total for Question 9 = 1 mark)

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

10 Which row in the table shows the correct forces in a crystal of lithium iodide?

	Attractive forces between ions with opposite charges	Repulsive forces between ions with like charges	Some covalent bonding forces
☒ **A**	✓	×	×
☒ **B**	✓	✓	×
☒ **C**	✓	×	✓
☒ **D**	✓	✓	✓

(Total for Question 10 = 1 mark)

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

11 Some physical properties of five substances are shown.
The letters are **not** element symbols.

Substance	Electrical conductivity			Melting temperature /°C
	Solid	Liquid	Solution in water	
L	poor	good	good	770
M	good	good	reacts	98
N	good	good	insoluble	1083
P	poor	poor	insoluble	113
Q	poor	poor	good	10

(a) Which of these substances could be metals?

(1)

- ☒ **A** N only
- ☒ **B** L and M only
- ☒ **C** M and N only
- ☒ **D** L, M and N only

(b) Which substance has properties showing that it changes from a molecular structure to ions when it dissolves in water?

(1)

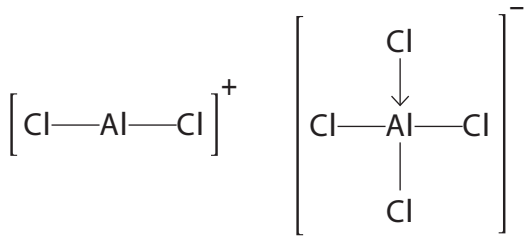
- ☒ **A** L
- ☒ **B** M
- ☒ **C** P
- ☒ **D** Q

(Total for Question 11 = 2 marks)

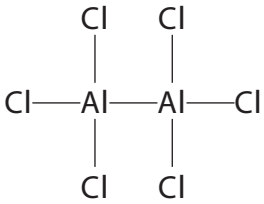
12 At 180 °C, aluminium chloride exists as Al_2Cl_6.

What is the structure of Al_2Cl_6?

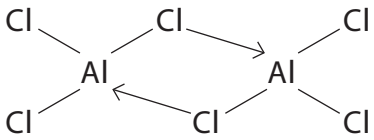
☒ **A**



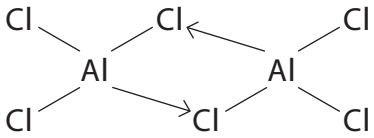
☒ **B**



☒ **C**



☒ **D**



(Total for Question 12 = 1 mark)

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

13 When carrying out chemical experiments, the hazards and risks must be considered.

For a given chemical

- ☒ **A** the hazard is fixed but the risk varies
- ☒ **B** the hazard varies but the risk is fixed
- ☒ **C** both hazard and risk are fixed
- ☒ **D** both hazard and risk vary

(Total for Question 13 = 1 mark)

14 Heterolytic fission produces

- ☒ **A** free radicals only
- ☒ **B** ions only
- ☒ **C** free radicals and positive ions only
- ☒ **D** free radicals and negative ions only

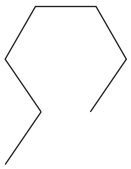
(Total for Question 14 = 1 mark)

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

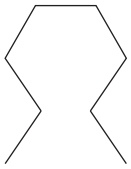
15 A hydrocarbon **X** has a molar mass of 98 g mol^{-1}. When a sample of **X** is shaken with bromine water, the colour of the bromine water does **not** change.

Which of these could be the structure of **X**?

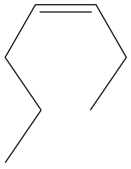
☒ **A**



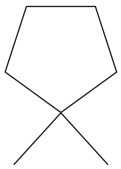
☒ **B**



☒ **C**



☒ **D**



(Total for Question 15 = 1 mark)

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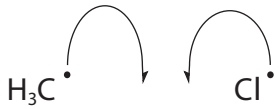
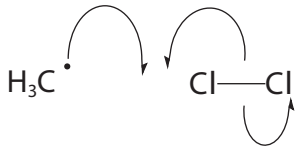
16 Which of these atmospheric pollutants is **not** emitted during the combustion of alkane car fuels?

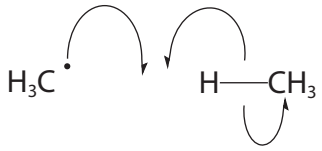
- ☒ **A** ammonia
- ☒ **B** nitrogen dioxide
- ☒ **C** sulfur dioxide
- ☒ **D** octane

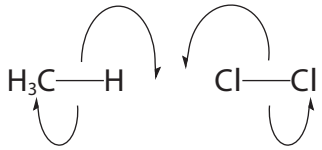
(Total for Question 16 = 1 mark)

17 Which of these occurs in a **propagation** step in the reaction of methane with chlorine?

- ☒ **A** 

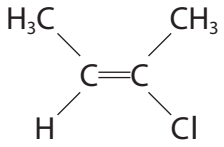
- ☒ **B** 

- ☒ **C** 

- ☒ **D** 

(Total for Question 17 = 1 mark)

18 What is the IUPAC name for the compound with the structure shown?



- ☒ **A** *cis*-2-chlorobut-2-ene
- ☒ **B** *trans*-2-chlorobut-2-ene
- ☒ **C** *E*-2-chlorobut-2-ene
- ☒ **D** *Z*-2-chlorobut-2-ene

(Total for Question 18 = 1 mark)

TOTAL FOR SECTION A = 20 MARKS

SECTION B

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

19 The element iron forms two chlorides: iron(II) chloride, $FeCl_2$, and iron(III) chloride, $FeCl_3$.

(a) A known mass of iron powder is added to 200 cm^3 of a hot solution of iron(III) chloride with a concentration of 0.500 mol dm^{-3}. When the reaction is complete, the solution only contains iron(II) chloride.
The unreacted iron is filtered, dried and weighed.

Initial mass of iron powder = 6.17 g
Final mass of iron powder = 3.38 g

(i) Calculate the number of moles of iron that react.

(2)

(ii) Calculate the number of moles of iron(III) chloride that react.

(2)

(iii) Use your answers to (a)(i) and (a)(ii) to write the **ionic** equation for the reaction of iron with iron(III) chloride. Include state symbols.
You **must** show your working.

(3)

(b) The concentration of the solution obtained in (a) is increased by heating it gently to remove some of the water. The solution is allowed to cool and pale green crystals of a hydrated iron(II) chloride, $FeCl_2 \cdot xH_2O$, form.
Analysis shows that these crystals contain 28.1% by mass of iron.

Calculate the number of moles of water of crystallisation, x, per mole of hydrated iron(II) chloride.

(4)

(Total for Question 19 = 11 marks)

20 Naturally occurring bromine has two isotopes: bromine-79 and bromine-81.

(a) State what is meant by the term isotopes.

(1)

.....

.....

.....

(b) Complete the table to show the numbers of subatomic particles in the two isotopes of bromine.

(2)

Isotope	Protons	Neutrons	Electrons
bromine-79			
bromine-81			

(c) The mass spectrum of a sample of bromine is obtained.

(i) Draw a dot-and-cross diagram to show the bonding in a molecule of bromine. Only the outer electrons should be shown.

(2)

(ii) Describe the formation of the molecular ion of bromine in the mass spectrometer. Include an equation.
State symbols are not required.

(2)

.....

.....

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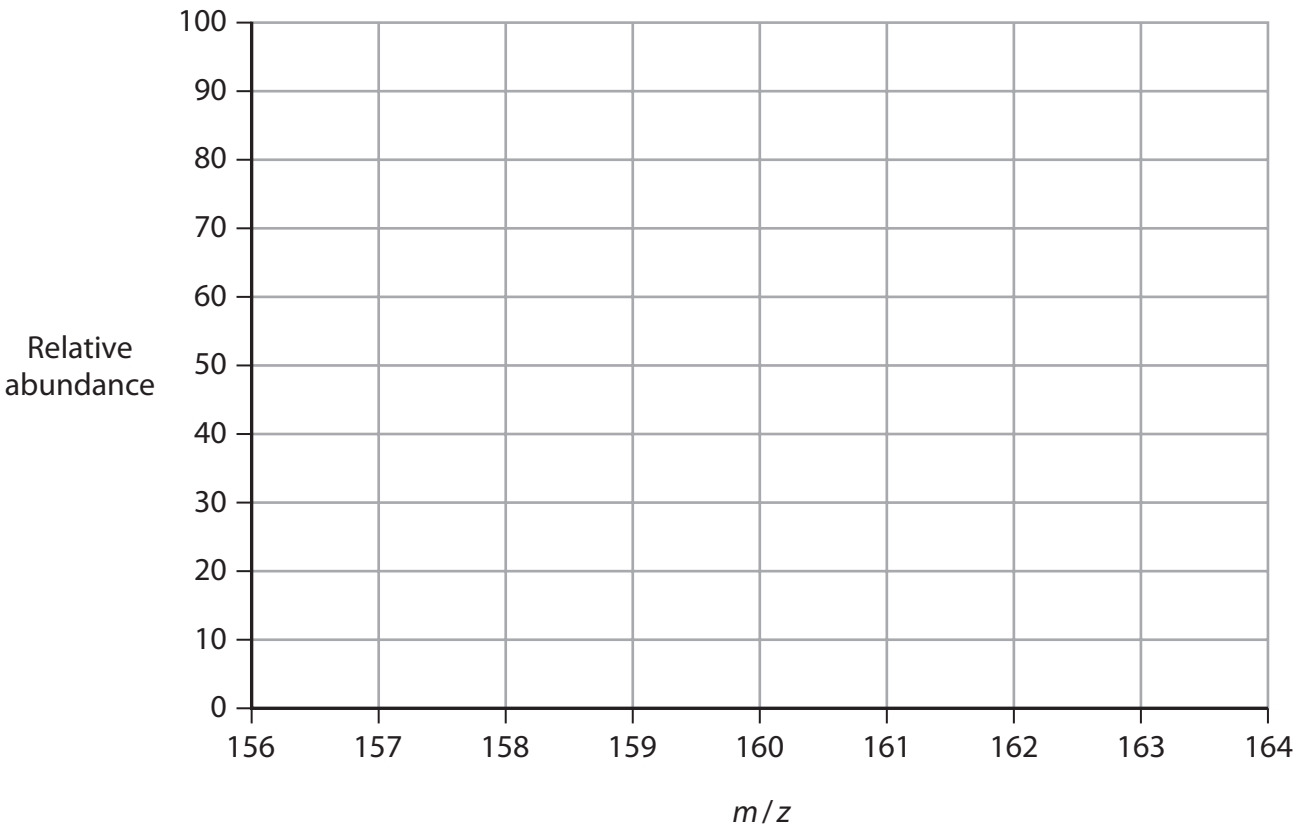
(iii) On the mass spectrum grid, draw the peaks for the bromine molecular ions, showing the relative peak heights.

The bromine isotopes in this sample have the **same** relative abundance.

(2)



(d) The percentage abundances of the isotopes in a different sample of bromine are shown.

Isotope	Percentage abundance
bromine-79	56.38 %
bromine-81	43.62 %

Calculate the relative **molecular** mass of this sample of bromine, giving your answer to **two** decimal places.

(3)

(Total for Question 20 = 12 marks)

21 The elements carbon and silicon both form dioxides.

(a) Carbon dioxide is a simple covalent molecule but silicon dioxide has a giant covalent structure.

(i) Describe the covalent bond between a silicon atom and an oxygen atom in silicon dioxide, in terms of the particles involved.

(2)

(ii) Compare and contrast the covalent bonding in carbon dioxide and silicon dioxide in terms of orbital overlap.

(3)

(b) The shape of the carbon dioxide molecule affects its physical properties.

(i) Explain the shape of the carbon dioxide molecule.

(3)

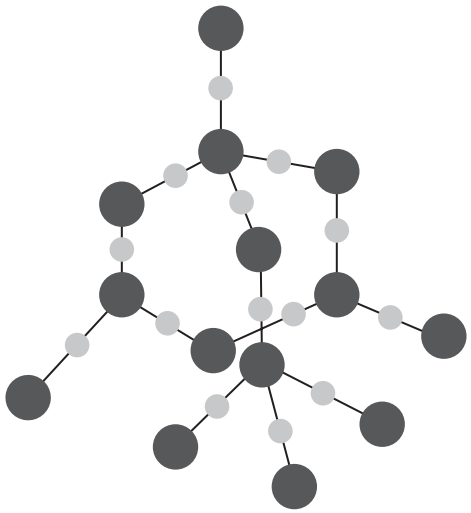
(ii) Explain the polarity of the carbon–oxygen bond.

(2)

(iii) State whether or not the carbon dioxide molecule is polar.
Justify your answer.

(1)

(c) The structure of silicon dioxide may be referred to as a diamond structure.



silicon

oxygen

(i) Using your knowledge of the structure of diamond, suggest how the structure of silicon dioxide is similar to that of diamond.

(1)

(ii) Give a possible reason why silicon dioxide has a lower melting temperature than diamond, even though the Si—O bond is stronger than the C—C bond.

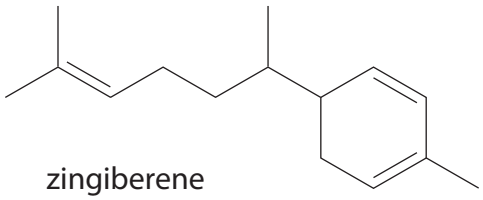
(1)

(Total for Question 21 = 13 marks)

22 Zingiberene is the compound that gives ginger its characteristic flavour.
Its IUPAC name is 2-methyl-5-(6-methylhept-5-en-2-yl)cyclohexa-1,3-diene.

(a) On the structure of zingiberene, draw a circle around the '2-methyl' group referred to in the IUPAC name.

(1)



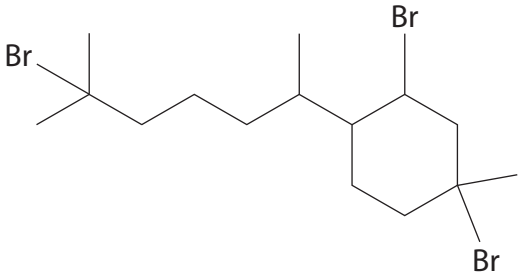
zingiberene

(b) Deduce the molecular formula of zingiberene.

(2)

.....

(c) When zingiberene reacts with excess hydrogen bromide, there are a number of possible products. The structure of the major product is shown.



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

(1)

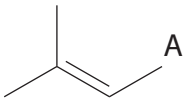
.....

(ii) The diagram shows a simplified structure of zingiberene, in which part of the molecule is represented by A.

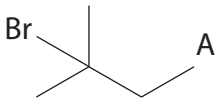
Complete the mechanism for the reaction of zingiberene with **one** molecule of hydrogen bromide.

Include curly arrows, and any relevant dipoles and lone pairs.

(4)



(iii) For the reaction in (c)(ii) there are two possible products:



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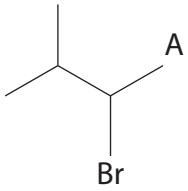
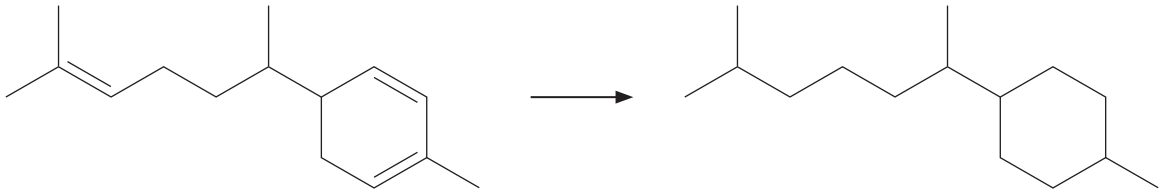


II

Explain why I is the major product, by referring to your mechanism.

(2)

(d) Zingiberene reacts with hydrogen gas in the presence of a catalyst.



(i) Identify the catalyst, by name or formula.

(1)

.....

(ii) 2.0 mol of zingiberene react completely with hydrogen at 150 °C and a pressure of 120 kPa.

Calculate the minimum volume of hydrogen needed under these conditions, stating your units.

[Ideal gas equation is $pV = nRT$ Gas constant (R) = 8.31 J mol^{-1} K^{-1}]

(4)

(Total for Question 22 = 15 marks)

23 Organic waste may be disposed of by landfill or incineration.
Both processes produce gases.

(a) The main gases produced from a typical landfill are shown in the table.

Gas	Percentage by volume / %
methane	50
carbon dioxide	45
nitrogen	4
sulfur compounds	1

(i) Name the process that forms these gases in landfill.

(1)

.....

(ii) State the **main** environmental problem caused by landfill gases, identifying the gas or gases responsible.

(2)

.....

.....

(iii) One tonne of landfill waste produces approximately 12.5 dm^3 of landfill gases per day.

Calculate the mass of carbon dioxide produced in a year by a typical landfill site which contains 90 000 tonnes of waste.
Assume that the gas volume is measured at room temperature and pressure (r.t.p.). [Molar volume of gas at r.t.p. = 24.0 $dm^3\,mol^{-1}$]

(3)

(b) Suggest **two** advantages of incineration over landfill.

(2)

.....

.....

.....

.....

.....

.....

(c) Environmental groups prefer recycling to both landfill and incineration.

Suggest **one** advantage of recycling.

(1)

.....

.....

.....

.....

(Total for Question 23 = 9 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)											(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

* 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