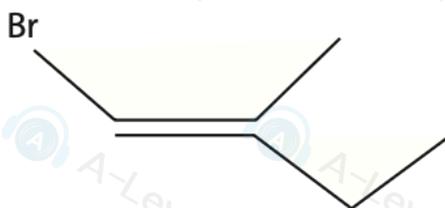


17 What is the IUPAC name for the compound shown?



- A E-1-bromo-2-methylbut-1-ene
- B Z-1-bromo-2-methylbut-1-ene
- C E-1-bromo-2-ethyl-2-methylethene
- D Z-1-bromo-2-ethylpropene

(Total for Question 17 = 1 mark)

5 Diphosphane,  $P_2H_4$ , reacts spontaneously with oxygen.



The equation for this reaction is balanced when

- A  $x = 1$   $y = 6$   $z = 2$
- B  $x = 2$   $y = 6$   $z = 2$
- C  $x = 2$   $y = 7$   $z = 4$
- D  $x = 4$   $y = 9$   $z = 8$

(Total for Question 5 = 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)

3 Which species does **not** contain a total of 16 neutrons?

- A a molecule of ethene,  $^{12}\text{C}_2\text{H}_4$
- B a molecule of oxygen,  $^{16}\text{O}_2$
- C an atom of silicon,  $^{30}\text{Si}$
- D an ion of sulfur,  $^{32}\text{S}^{2-}$

(Total for Question 3 = 1 mark)

5 What types of bonding are present in the compound ammonium chloride,  $\text{NH}_4\text{Cl}$ ?

	Ionic	Covalent	Dative covalent
<input type="checkbox"/> A	✓	x	✓
<input type="checkbox"/> B	x	✓	x
<input type="checkbox"/> C	✓	✓	x
<input type="checkbox"/> D	✓	✓	✓

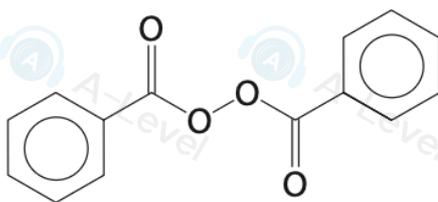
(Total for Question 5 = 1 mark)

12 Which cation would be the most polarising?

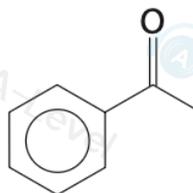
- |                            | Radius | Charge |
|----------------------------|--------|--------|
| <input type="checkbox"/> A | small  | large  |
| <input type="checkbox"/> B | small  | small  |
| <input type="checkbox"/> C | large  | small  |
| <input type="checkbox"/> D | large  | large  |

(Total for Question 12 = 1 mark)

- 14** Polymerisation of alkenes occurs via a free radical mechanism. This reaction is started by the addition of small amounts of another compound. The structure of one of these compounds is shown.



This can be represented as  $R-O-O-R$  where  $R-$  is

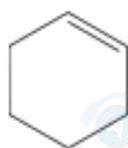


Which step in the mechanism is an initiation step?

- A**  $R-O-O-R \rightarrow 2R-O\cdot$
- B**  $R-O-CH_2-CH_2\cdot + CH_2=CH_2 \rightarrow R-O-CH_2-CH_2-CH_2-CH_2\cdot$
- C**  $2R-O-CH_2-CH_2\cdot \rightarrow R-O-CH_2-CH_2-CH_2-CH_2-O-R$
- D**  $R-O\cdot + CH_2=CH_2 \rightarrow R-O-CH_2-CH_2\cdot$

**(Total for Question 14 = 1 mark)**

15 This question is about cyclohexene, a cyclic alkene.



(a) What is the general formula of cyclic alkenes such as cyclohexene?

(1)



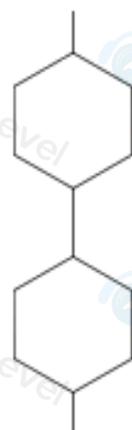
(b) Cyclohexene can form an addition polymer.

Which diagram shows two repeat units of this addition polymer?

(1)



A



B



C



D

- 4 Two identical sealed flasks, containing different gases, are side by side. Each flask contains one gas, with the gases at the same temperature and pressure.

Flask **A** contains  $4.0 \times 10^{-3}$  mol of methane.

Flask **B** contains 160 mg of a different gas.

Which could be the gas in Flask **B**?

- A** argon
- B** carbon dioxide
- C** helium
- D** neon

(Total for Question 4 = 1 mark)

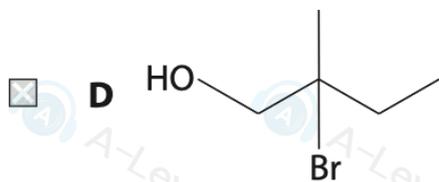
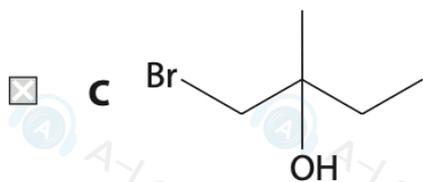
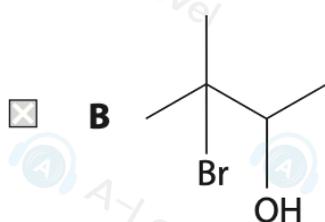
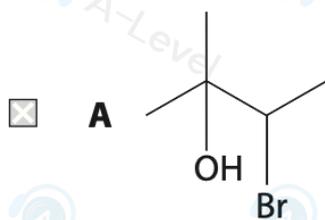
- 9: Which method for the preparation of hydrogen has the highest atom economy by mass?

- A**  $2\text{H}_2\text{O} \rightarrow 2\text{H}_2 + \text{O}_2$
- B**  $\text{CH}_4 + \text{H}_2\text{O} \rightarrow 3\text{H}_2 + \text{CO}$
- C**  $\text{CO} + \text{H}_2\text{O} \rightarrow \text{H}_2 + \text{CO}_2$
- D**  $\text{CH}_3\text{OH} + \text{H}_2\text{O} \rightarrow 3\text{H}_2 + \text{CO}_2$

(Total for Question 9 = 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?



(Total for Question 17 = 1 mark)

**13** Which molecule has the largest bond angle?



(Total for Question 13 = 1 mark)

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



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)**

3 How many oxygen **atoms** are there in 0.0100 mol of  $\text{H}_2\text{SO}_4$ ?

[Avogadro constant,  $L = 6.020 \times 10^{23} \text{ mol}^{-1}$ ]

- A  $6.020 \times 10^{21}$
- B  $1.204 \times 10^{22}$
- C  $2.408 \times 10^{22}$
- D  $4.214 \times 10^{22}$

**(Total for Question 3 = 1 mark)**

10 Which solution contains the **smallest** number of ions?

- A 500 cm<sup>3</sup> of 0.06 mol dm<sup>-3</sup>  $\text{Ca}(\text{NO}_3)_2(\text{aq})$
- B 500 cm<sup>3</sup> of 0.09 mol dm<sup>-3</sup>  $\text{KI}(\text{aq})$
- C 250 cm<sup>3</sup> of 0.12 mol dm<sup>-3</sup>  $\text{BaCl}_2(\text{aq})$
- D 250 cm<sup>3</sup> of 0.09 mol dm<sup>-3</sup>  $(\text{NH}_4)_2\text{SO}_4(\text{aq})$

**(Total for Question 10 = 1 mark)**

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**21** Boron, aluminium and thallium are in Group 3 of the Periodic Table. These elements form molecular compounds with chlorine with the formulae  $\text{BCl}_3$ ,  $\text{AlCl}_3$  and  $\text{TlCl}_3$ . The shape of these molecules depends on the electronic structures of the Group 3 elements.

(a) (i) Give the electronic configuration of aluminium.

**(1)**

(ii) Compare and contrast the electronic structures of boron, aluminium and thallium.

**(2)**

(iii) Deduce, using electron-pair repulsion theory, the expected shape of  $\text{BCl}_3$ ,  $\text{AlCl}_3$  and  $\text{TlCl}_3$ . Justify your answer.

**(3)**

(b) Aluminium chloride is a solid at room temperature.  
At the relatively low temperature of 453 K it sublimes.

- (i) A sample of 5.00 g of aluminium chloride was heated to 455 K at a pressure of  $1.01 \times 10^5$  Pa.  
When all the aluminium chloride had vaporised, the final volume of gas was  $700 \text{ cm}^3$ .

Show that the data is consistent with the formula of aluminium chloride in the gas phase being  $\text{Al}_2\text{Cl}_6$ .

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

(3)

- (ii) Draw the dot-and-cross diagram for  $\text{Al}_2\text{Cl}_6$ . Use dots (•) for the electrons of aluminium and crosses (×) for the electrons of chlorine.

(3)

(c) Thallium also forms ions containing chlorine, for example the  $\text{TlCl}_4^{3-}$  ion. In this ion, the thallium atom has 10 electrons in its outermost shell. Phosphorus in phosphorus pentachloride,  $\text{PCl}_5$ , also has 10 electrons in its outer shell.

Draw the shape of the  $\text{TlCl}_4^{3-}$  ion and predict the bond angles. Include any lone pairs of electrons that influence the shape.

(3)

**19** This question is about mass spectrometry and the shapes of molecules.

(a) In a mass spectrometer vaporised atoms are ionised, and the ions formed are accelerated, deflected and detected.

(i) State how atoms are ionised in the mass spectrometer.

(1)

(ii) State how the ions formed are accelerated.

(1)

(iii) Explain why isotopes of an element have the same chemical reactions but their ions are deflected differently in a mass spectrometer.

(2)

(b) Data from mass spectra may be used to determine the relative atomic masses of elements.

(i) State what is meant by relative atomic mass.

(2)



(ii) Show that the relative peak heights given in the table are consistent with the isotopic ratio of  $^{35}\text{Cl}$  to  $^{37}\text{Cl}$  being 3:1.

(2)

(d) (i) Draw a dot-and-cross diagram of a  $\text{PCl}_3$  molecule.  
Show outer electrons only.

(2)

(ii) Explain the shape of a  $\text{PCl}_3$  molecule.

(3)

**23:** This question is about structure and bonding.

(a) Ionic bonding occurs between metals and non-metals.

(i) Describe ionic bonding.

(1)

(ii) Explain why the ionic bonding in magnesium fluoride might be expected to be stronger than the ionic bonding in sodium fluoride.

(2)

(iii) Sodium and oxygen react to form sodium oxide, which is also ionic.  
Draw the dot-and-cross diagram showing the ions present in sodium oxide.

(2)

(iv) Draw the ionic lattice for sodium chloride.

You should show at least nine ions.

(2)

(b) Non-metal atoms join together using covalent bonds.

(i) Describe covalent bonding.

(1)

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(iii) The three molecules (methane, ammonia and water) each have a different shape. Complete the table below.

(3)

molecule	shape	bond angle
methane		
ammonia		
water		

(iv) Explain the differences between the molecular shapes and bond angles for ammonia and water.

(2)

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(v) Ethene and poly(ethene) have different melting temperatures.

Molecule	Melting temperature (K)
ethene	104.1
poly(ethene)	400

Explain why their melting temperatures are different.

(2)

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(c) Metals are held together by metallic bonding.

(i) Describe metallic bonding.

(1)

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(ii) Metals conduct electricity when solid.

Explain, with the aid of a diagram, why copper conducts electricity.

(2)

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**(Total for Question 23 = 21 marks)**