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| Candidate surname | Other names |
|---|---|
| | |

**Pearson Edexcel**
**International Advanced Level**

Centre Number | | | | | |

Candidate Number | | | | |

# Monday 20 May 2019

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

**Candidates 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.*

## 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.
- There is a Periodic Table on the back page 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.
- Check your answers if you have time at the end.

*Turn over* ▶

P61476A

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2/1/1/1/1/

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## 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** Which statement is **not** true for sodium chloride?

☒ **A** sodium chloride conducts electricity in aqueous solution

☒ **B** sodium chloride conducts electricity when molten

☒ **C** sodium chloride has a molecular structure

☒ **D** sodium chloride has a giant structure

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

**2** Which of these molecules is the **most** polar?

☒ **A** H—H

☒ **B** H—F

☒ **C** H—Cl

☒ **D** H—Br

**(Total for Question 2 = 1 mark)**

**3** Covalent bonding is best described as the electrostatic attraction between

☒ **A** oppositely charged ions

☒ **B** positive ions and delocalised electrons

☒ **C** a shared pair of electrons

☒ **D** two nuclei and a shared pair of electrons

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

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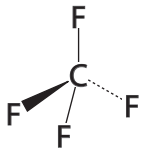
**4** Which is correct for tetrafluoromethane ($CF_4$)?




| | Bonds | Molecule |
|---|---|---|
| ☒ **A** | polar | polar |
| ☒ **B** | non-polar | polar |
| ☒ **C** | polar | non-polar |
| ☒ **D** | non-polar | non-polar |

**(Total for Question 4 = 1 mark)**

**5** Which pair of ions gives the strongest ionic bonding?

☒ **A** $Na^+$ and $F^-$

☒ **B** $K^+$ and $Br^-$

☒ **C** $Mg^{2+}$ and $O^{2-}$

☒ **D** $Ca^{2+}$ and $S^{2-}$

**(Total for Question 5 = 1 mark)**

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**6** In 1.31 g of a chloride of titanium, there is 0.528 g of titanium.

What is the empirical formula of this titanium chloride?

[ $A_r$ values: Ti = 47.9 Cl = 35.5 ]

☒ **A** TiCl

☒ **B** $TiCl_2$

☒ **C** $TiCl_3$

☒ **D** $Ti_2Cl_4$

**(Total for Question 6 = 1 mark)**

**7** Which isotope is used as the standard in the definition of relative atomic mass?

☒ **A** $^{1}H$

☒ **B** $^{12}C$

☒ **C** $^{13}C$

☒ **D** $^{16}O$

**(Total for Question 7 = 1 mark)**

**8** Which statement about subatomic particles is correct?

☒ **A** neutral atoms always contain the same number of protons and electrons

☒ **B** neutral atoms always contain the same number of protons and neutrons

☒ **C** electrons have a relative mass of 1 and a charge of −1

☒ **D** protons have a relative mass of 1 and no charge

**(Total for Question 8 = 1 mark)**

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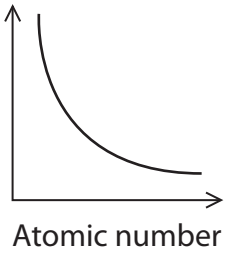
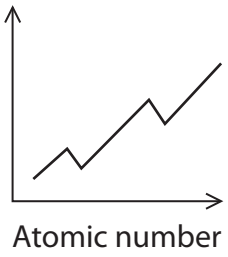
**9** Which sketch graph shows the trend in first ionisation energy values going down Group 1 in the Periodic Table?

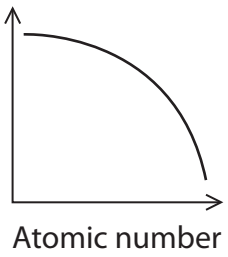
☒ **A**



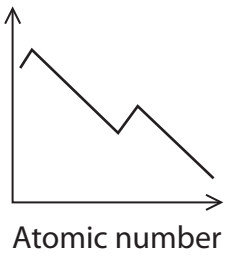

☒ **B**




☒ **C**




☒ **D**




**(Total for Question 9 = 1 mark)**

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**10** Isotopes are atoms of an element that have different

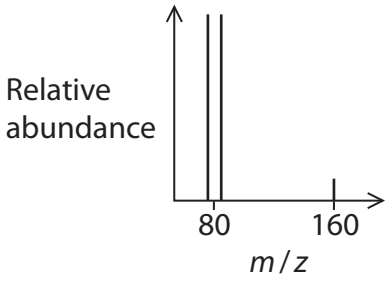
- ☒ **A** electronic structures
- ☒ **B** numbers of electrons
- ☒ **C** numbers of protons
- ☒ **D** numbers of neutrons

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

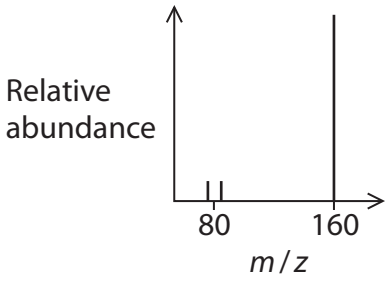
**11** The two stable isotopes of bromine have relative masses of 79 and 81.

Which is the correct pattern of peaks in the mass spectrum of molecular bromine?

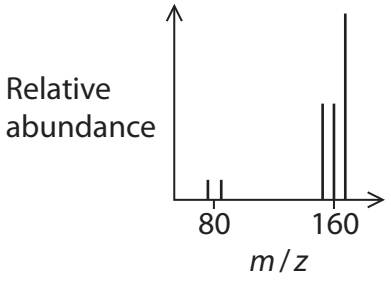
☒ **A**



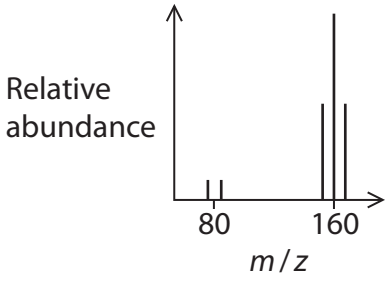

☒ **B**




☒ **C**




☒ **D**




**(Total for Question 11 = 1 mark)**

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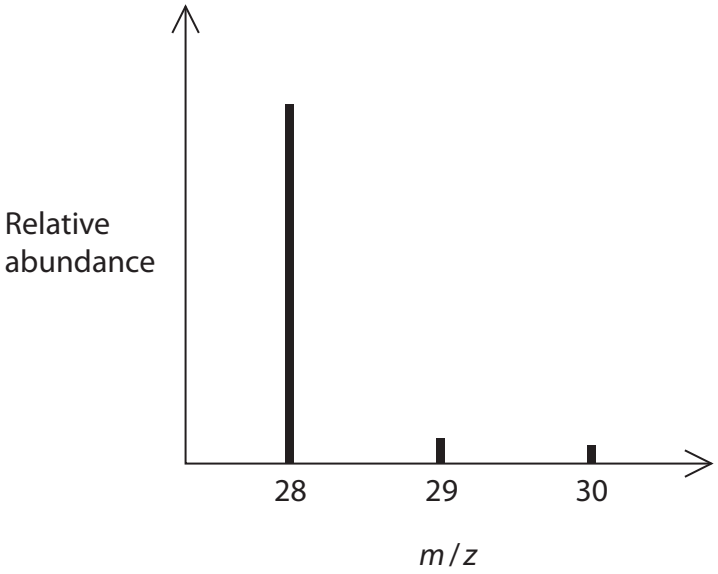
**12** The mass spectrum of a sample of silicon is shown.




What is the **best** estimate for the relative atomic mass of silicon in this sample?

☒ **A** 28.0

☒ **B** 28.2

☒ **C** 28.8

☒ **D** 29.0

**(Total for Question 12 = 1 mark)**

**13** Which is the equation for the **second** ionisation energy of an element, A?

☒ **A** $A(g) \rightarrow A^{2+}(g) + 2e^-$

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

☒ **C** $A^{2+}(g) \rightarrow A^{3+}(g) + e^-$

☒ **D** $A^{2+}(g) \rightarrow A^{4+}(g) + 2e^-$

**(Total for Question 13 = 1 mark)**

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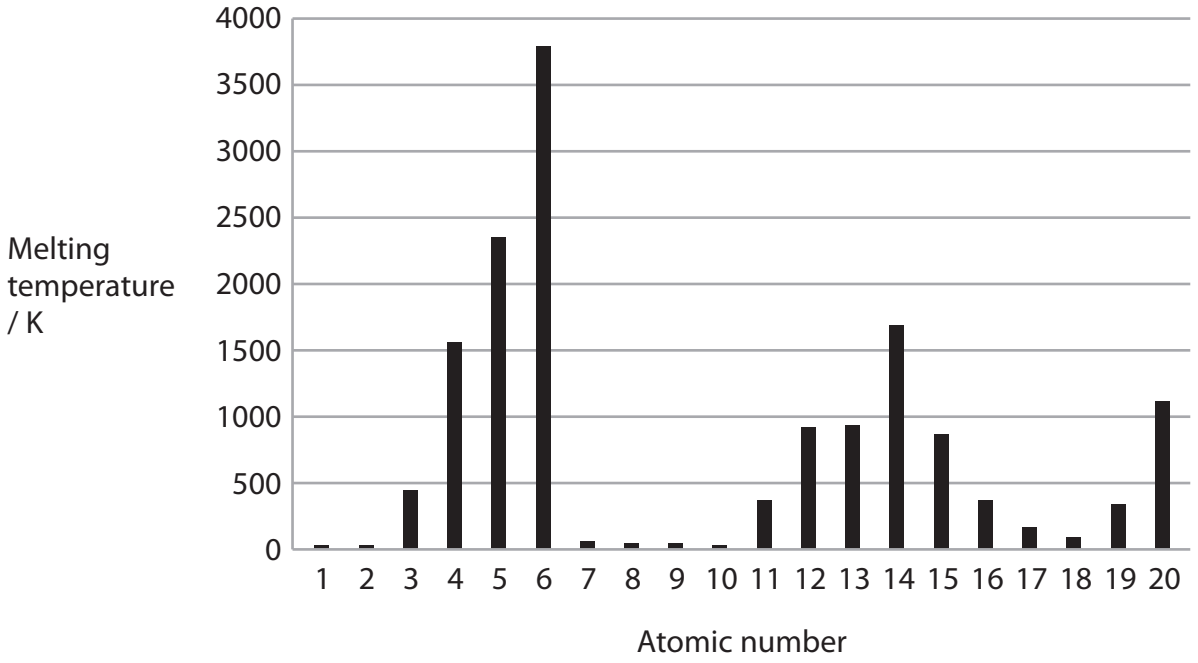
**14** The bar chart shows the melting temperatures of the first twenty elements.




The bar chart shows that melting temperatures

☒ **A** of giant covalent structures are the highest in Period 2 and in Period 3

☒ **B** of metals are always higher than non-metals

☒ **C** increase going down each group

☒ **D** increase across Period 2 and Period 3

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

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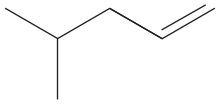
**15** Which is the electronic configuration of the $Sc^{3+}$ ion?

- ☒ **A** $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$
- ☒ **B** $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^5\ 3d^1$
- ☒ **C** $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^1\ 4s^2$
- ☒ **D** $1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6\ 3d^4\ 4s^2$

**(Total for Question 15 = 1 mark)**

**16** What is the name of the product when this molecule reacts with chlorine gas?



- ☒ **A** 5,5-dichloro-2-methylpentane
- ☒ **B** 4,5-dichloro-2-methylpentane
- ☒ **C** 2,3-dichloro-4-methylpentane
- ☒ **D** 1,2-dichloro-4-methylpentane

**(Total for Question 16 = 1 mark)**

**17** What type of bond breaking occurs in this process?

$$H_2O \rightarrow H^+ + OH^-$$

- ☒ **A** electrophilic
- ☒ **B** heterolytic
- ☒ **C** homolytic
- ☒ **D** ionic

**(Total for Question 17 = 1 mark)**

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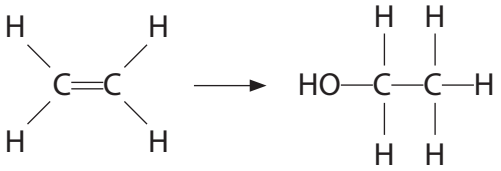
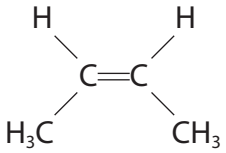
**18** What reagent and conditions are used for this conversion?



- ☒ **A** potassium manganate(VII) in aqueous acid
- ☒ **B** sodium hydroxide in dilute aqueous solution
- ☒ **C** steam and acid catalyst
- ☒ **D** steam and nickel catalyst

**(Total for Question 18 = 1 mark)**

**19** But-2-ene shows geometric isomerism.



What are the prefixes that could be used in naming this isomer?

| | *cis / trans* | *E / Z* |
|---|---|---|
| ☒ **A** | *cis* | *E* |
| ☒ **B** | *cis* | *Z* |
| ☒ **C** | *trans* | *E* |
| ☒ **D** | *trans* | *Z* |

**(Total for Question 19 = 1 mark)**

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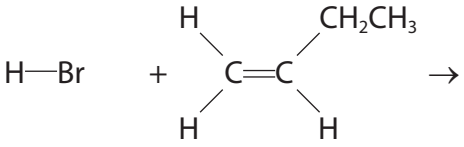
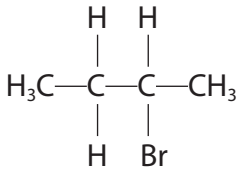
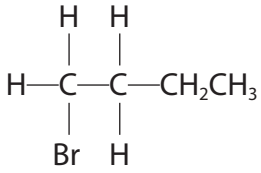
**20** Which is the major product of this reaction?



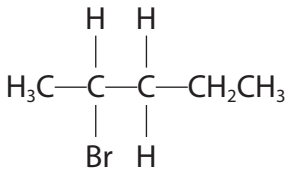
☒ **A**



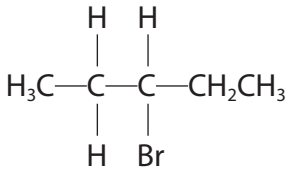
☒ **B**



☒ **C**



☒ **D**



**(Total for Question 20 = 1 mark)**

**TOTAL FOR SECTION A = 20 MARKS**

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## SECTION B

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

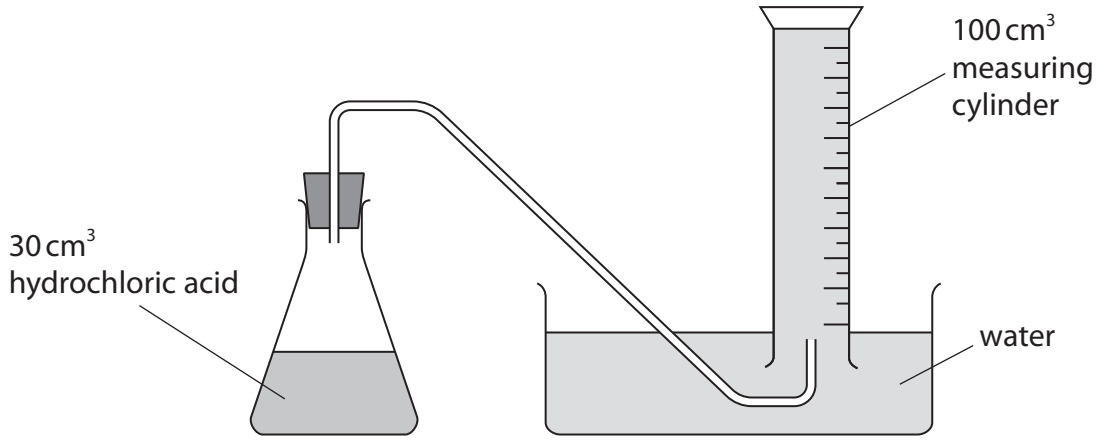
**21** Magnesium carbonate powder reacts with hydrochloric acid.

(a) Complete the equation for this reaction by adding state symbols.

**(1)**

$MgCO_3$(.....) + 2HCl(.....) → $MgCl_2$(.....) + $H_2O$(.....) + $CO_2$(.....)

(b) A student carried out an investigation to determine the molar volume of carbon dioxide using this apparatus.




The student carried out five experiments, adding a different mass of magnesium carbonate each time.

The results are shown in the table.

| Mass of magnesium carbonate / g | Volume of gas collected / $cm^3$ |
|---|---|
| 0.05 | 11 |
| 0.10 | 27 |
| 0.15 | 38 |
| 0.20 | 54 |
| 0.25 | 63 |

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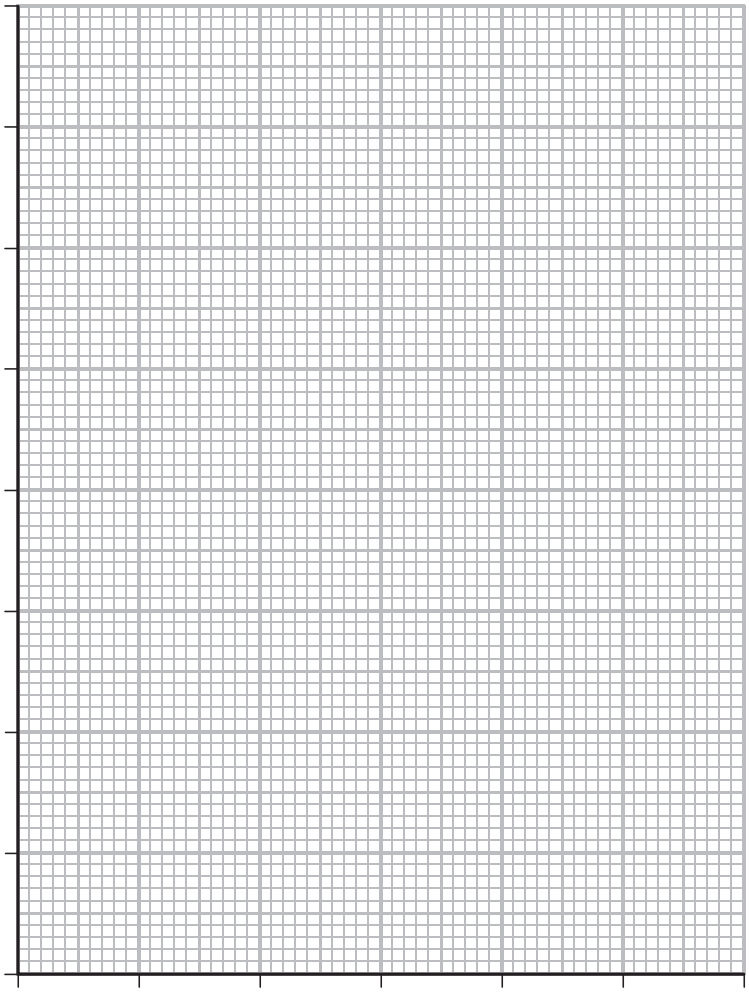
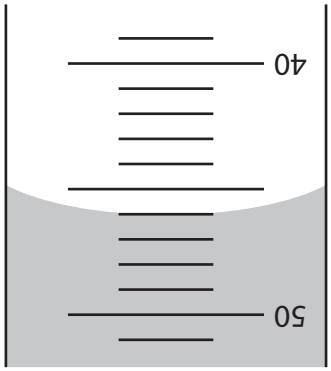
(i) Plot a graph of these results.

**(3)**



(ii) A student carried out a further experiment using a different mass of magnesium carbonate.




Give the volume of gas collected using the **inverted** measuring cylinder.

**(1)**

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(iii) Determine the mass of magnesium carbonate added in the experiment in (b)(ii), using your graph.

**(1)**

.....

(iv) Calculate the molar volume of carbon dioxide using your answers to parts (b)(ii) and (b)(iii). Give your value to an appropriate number of significant figures and include units.

[ $A_r$ values: Mg = 24.3 C = 12.0 O = 16.0 ]

**(4)**

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(v) The acid must be in excess for each experiment.

Calculate the **minimum** concentration of hydrochloric acid needed for 30 $cm^3$ of acid to completely react with 0.25 g of magnesium carbonate.

$$MgCO_3 + 2HCl + MgCl_2 + H_2O + CO_2$$

**(2)**

(c) The value of molar volume calculated in (b)(iv) was lower than the student expected.

Give **two** reasons for the value being lower than expected.

Assume that the correct amounts of hydrochloric acid and magnesium carbonate were used.

**(2)**

**(Total for Question 21 = 14 marks)**

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**22** This question is about fuels and polymers.

Used coffee grounds have been suggested as a carbon-neutral fuel to replace some fossil fuels.

(a) (i) Explain why coffee grounds might be considered a carbon-neutral fuel.

**(2)**

(ii) Explain how the use of fossil fuels causes climate change.

**(2)**

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(b) Long chain alkanes are not normally used as fuels as they produce soot.

(i) Name another pollutant formed by **incomplete** combustion of alkanes.

**(1)**

.....

(ii) Write the equation for the **complete** combustion of octane.
State symbols are not required.

**(2)**

(c) Long chain alkanes are converted into smaller, more useful molecules including alkenes.

(i) Name this process.

**(1)**

.....

(ii) Give a test for alkenes, including the positive result.

**(2)**

.....

.....

.....

.....

(d) Alkenes, such as ethene, can be used to make polymers.

(i) Write a balanced equation for the polymerisation of ethene using displayed formulae.

**(1)**

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(ii) Bananas produce ethene as they ripen.

Suggest one advantage and one disadvantage of using ripening bananas as a source of ethene for polymer production.

**(2)**

(e) Burning poly(chloroethene) in an incinerator results in the formation of hydrogen chloride.

(i) State a **hazard** associated with hydrogen chloride.

**(1)**

(ii) Suggest how the hydrogen chloride could be removed from the waste gases produced in an incinerator.

**(1)**

**(Total for Question 22 = 15 marks)**

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**23** This question is about bonding.

(a) Draw an electron density map for a molecule of oxygen.

**(1)**

(b) Draw a diagram to show the shape of a water molecule.
Give the bond angle.

**(2)**

Bond angle .....

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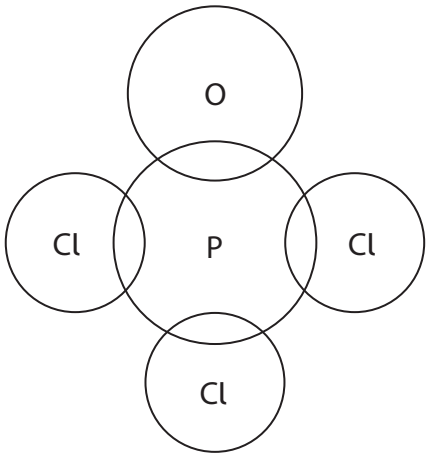
(c) The compound $POCl_3$ has a simple molecular structure.

(i) Complete the dot-and-cross diagram for the $POCl_3$ molecule.

Use crosses (×) for the phosphorus electrons, dots (●) for the chlorine electrons and circles (○) for the oxygen electrons.

**(2)**




(ii) Explain the shape of this molecule using the electron-pair repulsion theory.

**(3)**

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(d) The properties of metals depend on their structure and bonding.

(i) Draw a labelled diagram to show the metallic bonding in calcium.

**(2)**

(ii) Explain how the electrical conductivity, high melting temperature and malleability of metals depend on their structure and bonding.

**(3)**

Electrical conductivity .....

.....

.....

High melting temperature .....

.....

.....

Malleability .....

.....

.....

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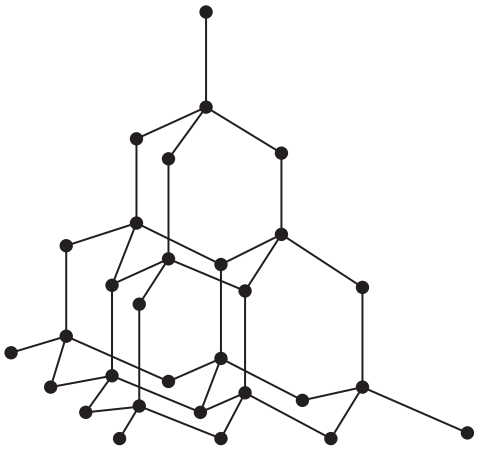
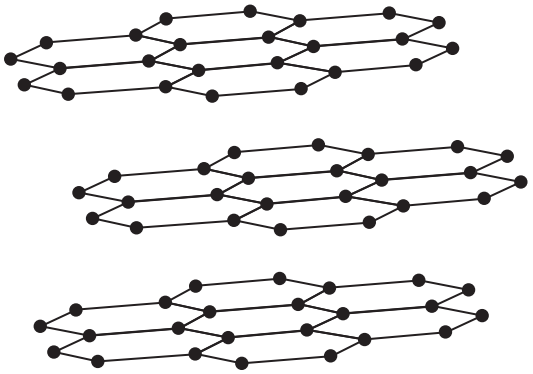
(e) Diamond, graphite and graphene are all forms of carbon.

(i) Explain **two** ways in which the physical properties of diamond and graphite differ. Refer to their structure and bonding in your answer.

**(4)**



diamond



graphite

(ii) State how the structure of graphene is related to the structure of graphite.

**(1)**

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(iii) State a use for graphene, identifying the property that makes it suitable for that use.

**(2)**

.....

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.....

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**(Total for Question 23 = 20 marks)**

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**24** Airbags protect occupants by inflating when a car crashes.

Airbags rely on chemical reactions to produce large volumes of gases quickly. In some airbags, solid sodium azide ($NaN_3$) decomposes forming nitrogen gas and sodium as the only products.

(a) Write an equation for the decomposition of sodium azide.
State symbols are not required.

**(1)**

(b) A passenger airbag requires 120 $dm^3$ of gas to fill it.

Calculate, using the ideal gas equation, the mass of sodium azide required to fill a passenger airbag in this reaction under standard conditions (101 000 Pa, 25°C).

Give your answer to an appropriate number of significant figures.

$[pV = nRT \qquad R = 8.31\ J\,K^{-1}\,mol^{-1}]$

**(6)**

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(c) Two further reactions take place in the airbag.

Reaction **A** $10Na + 2KNO_3 \rightarrow K_2O + 5Na_2O + N_2$

Reaction **B** $K_2O + Na_2O + SiO_2 \rightarrow Na_2K_2SiO_4$

(i) Reaction **A** produces more nitrogen to inflate the airbag.

Calculate the atom economy, by mass, for the production of nitrogen in reaction **A**.

Give your answer to an appropriate number of significant figures.

**(3)**

(ii) State the type of reaction taking place in reaction **B**.

**(1)**

.....

**(Total for Question 24 = 11 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) |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | | | | | | | 1.0 H hydrogen 1 | | | | | | | | | | (18) 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<br>**atomic symbol**<br>name<br>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

| | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| 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

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