

CHEMISTRY

UNIT 1(IAL)
2020 — 2025

Chapter 1	Structure, Bonding And Introduction To Organic Chemistry	Page 1
Chapter 2	Energetics, Group Chemistry, Halogenoalkanes And Alcohols	-----
Chapter 3	Practical Skills In Chemistry I	-----
Chapter 4	Rates, Equilibria And Further Organic Chemistry	-----
Chapter 5	Transition Metals And Organic Nitrogen Chemistry	-----
Chapter 6	Practical Skills In Chemistry II	-----
ANSWERS		Page 208



1 - (WCH11/1(IAL)_Summer_2020_Q1) - Structure, Bonding And Introduction To Organic Chemistry

What is the empirical formula of butane?

- ☐ A C_4H_{10}
- ☐ B C_2H_5
- ☐ C $CH_{2.5}$
- ☐ D C_nH_{2n+2}

2 - (WCH11/1(IAL)_Summer_2020_Q2) - Structure, Bonding And Introduction To Organic Chemistry

When zinc is added to copper(II) sulfate solution, copper is formed.

(a) Which of these is the best name for this type of reaction?

(1)

- ☐ A addition
- ☐ B displacement
- ☐ C neutralisation
- ☐ D substitution

(b) Which is the ionic half-equation for a process that takes place during this reaction?

(1)

- ☐ A $Cu^{2+} + e^- \rightarrow Cu^+$
- ☐ B $Cu^+ + e^- \rightarrow Cu$
- ☐ C $Zn \rightarrow Zn^+ + e^-$
- ☐ D $Zn \rightarrow Zn^{2+} + 2e^-$

3 - (WCH11/1(IAL)_Summer_2020_Q3) - Structure, Bonding And Introduction To Organic Chemistry

How many molecules are there in 44.0g of carbon monoxide?

$$\left[\begin{array}{l} \text{Avogadro constant } L = 6.02 \times 10^{23} \text{ mol}^{-1} \\ A_r \text{ values: } C = 12.0 \quad O = 16.0 \end{array} \right]$$

- ☐ A 3.83×10^{23}
- ☐ B 6.02×10^{23}
- ☐ C 9.46×10^{23}
- ☐ D 1.89×10^{24}

4 - (WCH11/1(IAL)_Summer_2020_Q4) - Structure, Bonding And Introduction To Organic Chemistry

A compound has $M_r = 84$ and its composition by mass is 71.4% carbon, 9.6% hydrogen and 19.0% oxygen.

What is the molecular formula of this compound?

[A_r values: H = 1.0 C = 12.0 O = 16.0]

- ☐ A $C_4H_3O_2$
- ☐ B $C_4H_4O_2$
- ☒ C C_5H_8O
- ☐ D $C_6H_{10}O$

5 - (WCH11/1(IAL)_Summer_2020_Q5) - Structure, Bonding And Introduction To Organic Chemistry

The formula of barium chloride is $BaCl_2$.

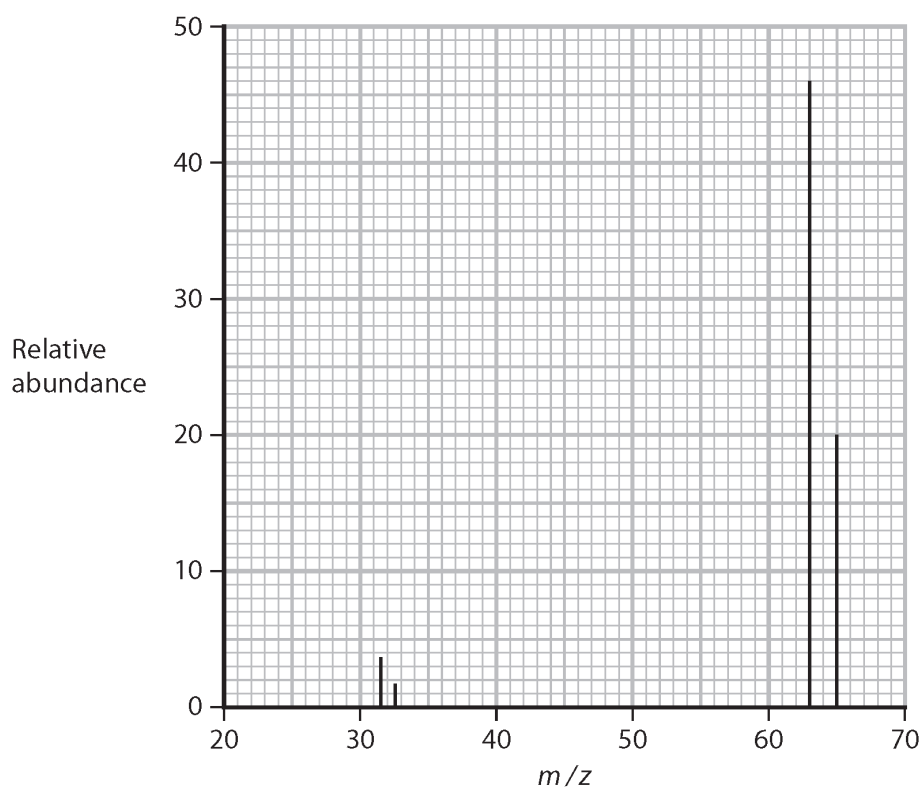
Which is correct for barium chloride?

[A_r values: Ba = 137.3 Cl = 35.5]

- ☐ A barium chloride exists as a molecule
- ☐ B barium chloride is a compound
- ☒ C the empirical formula of barium chloride is BaCl
- ☐ D the M_r of barium chloride is 172.8

6 - (WCH11/1(IAL)_Summer_2020_Q6) - Structure, Bonding And Introduction To Organic Chemistry

The mass spectrum of a sample of an element is shown.



(a) What is the A_r of the element?

(1)

- ☐ **A** 42.0
- ☐ **B** 48.0
- ☐ **C** 63.6
- ☐ **D** 64.0

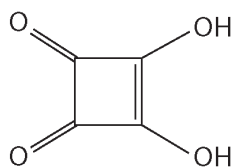
(b) Which species could be responsible for the peak at $m/z = 32.5$?

(1)

- ☐ **A** $^{32}\text{S}^+$
- ☐ **B** $^{63}\text{Cu}^{2+}$
- ☐ **C** $^{65}\text{Cu}^{2+}$
- ☐ **D** $^{98}\text{Tc}^{3+}$

7 - (WCH11/1(IAL)_Summer_2020_Q7) - Structure, Bonding And Introduction To Organic Chemistry

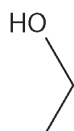
What is the molecular formula of the compound shown?



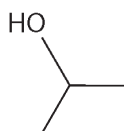
- ☐ A C_2HO_2
- ☐ B $C_4H_2O_4$
- ☐ C $C_4H_4O_4$
- ☐ D $C_4H_6O_4$

8 - (WCH11/1(IAL)_Summer_2020_Q8) - Structure, Bonding And Introduction To Organic Chemistry

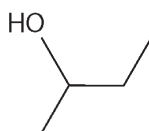
A sequence of four molecules is shown.



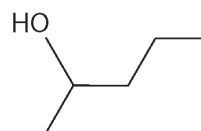
1



2



3



4

(a) What is the molecular formula for the fifth molecule in this sequence?

(1)

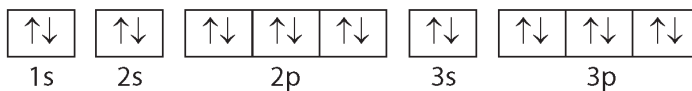
- ☐ A CH_4O
- ☐ B $C_6H_{11}O$
- ☐ C $C_6H_{14}O$
- ☐ D $C_7H_{16}O$

(b) What is the name of this type of sequence?

(1)

- ☐ A functional group
- ☐ B homologous series
- ☐ C homolytic series
- ☐ D skeletal formulae

9 - (WCH11/1(IAL)_Summer_2020_Q9) - Structure, Bonding And Introduction To Organic Chemistry

Which ion does **not** have the electronic configuration shown?

- ☐ A K^+
- ☐ B Ca^{2+}
- ☐ C Ti^{2+}
- ☐ D Sc^{3+}

10 - (WCH11/1(IAL)_Summer_2020_Q10) - Structure, Bonding And Introduction To Organic Chemistry

What is the electronic configuration of the nitride ion, N^{3-} ?

- ☐ A $1s^2 2s^2$
- ☐ B $1s^2 2s^2 2p^3$
- ☐ C $1s^2 2s^2 2p^4$
- ☐ D $1s^2 2s^2 2p^6$

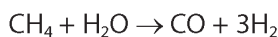
11 - (WCH11/1(IAL)_Summer_2020_Q11) - Structure, Bonding And Introduction To Organic Chemistry

Which of these ions has the smallest ionic radius?

- ☐ A Al^{3+}
- ☐ B Ga^{3+}
- ☐ C Mg^{2+}
- ☐ D F^-

12 - (WCH11/1(IAL)_Summer_2020_Q12) - Structure, Bonding And Introduction To Organic Chemistry

What is the percentage atom economy, by mass, for the production of hydrogen in the reaction shown?

[A_r values: H = 1.00 C = 12.0 O = 16.0]

- ☐ A 8.8%
- ☐ B 17.6%
- ☐ C 21.4%
- ☐ D 82.4%

13 - (WCH11/1(IAL)_Summer_2020_Q13) - Structure, Bonding And Introduction To Organic Chemistry

How many lone pairs of electrons are there in the outer shell of the sulfur atom in a molecule of H_2S ?

- ☐ A zero
- ☐ B one
- ☐ C two
- ☐ D four

14 - (WCH11/1(IAL)_Summer_2020_Q14) - Structure, Bonding And Introduction To Organic Chemistry

In which sequence are the molecules in order of **decreasing** bond angle?

- ☐ A $\text{BeCl}_2 > \text{BCl}_3 > \text{CH}_4$
- ☐ B $\text{BeCl}_2 > \text{NH}_3 > \text{CH}_4$
- ☐ C $\text{CH}_4 > \text{BCl}_3 > \text{BeCl}_2$
- ☐ D $\text{CH}_4 > \text{NH}_3 > \text{BeCl}_2$

15 - (WCH11/1(IAL)_Summer_2020_Q15) - Structure, Bonding And Introduction To Organic Chemistry

In which sequence are the molecules in order of **decreasing** bond angle?

- ☐ A $\text{BeCl}_2 > \text{BCl}_3 > \text{CH}_4$
- ☐ B $\text{BeCl}_2 > \text{NH}_3 > \text{CH}_4$
- ☐ C $\text{CH}_4 > \text{BCl}_3 > \text{BeCl}_2$
- ☐ D $\text{CH}_4 > \text{NH}_3 > \text{BeCl}_2$

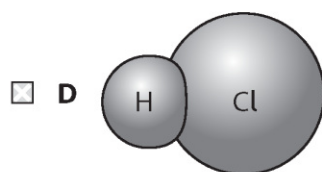
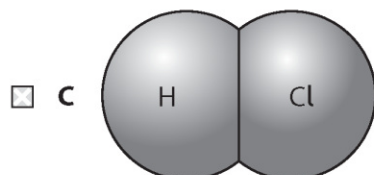
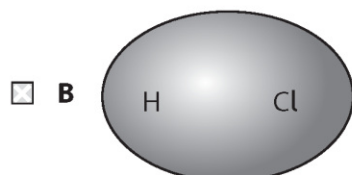
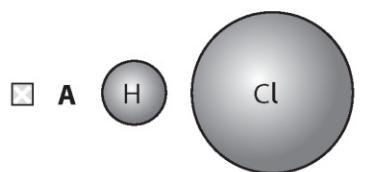
16 - (WCH11/1(IAL)_Summer_2020_Q16) - Structure, Bonding And Introduction To Organic Chemistry

Which pair of ions will form the compound with the most covalent character?

- ☐ A Li^+ and I^-
- ☐ B Na^+ and Br^-
- ☐ C K^+ and Cl^-
- ☐ D Rb^+ and F^-

17 - (WCH11/1(IAL)_Summer_2020_Q17) - Structure, Bonding And Introduction To Organic Chemistry

Which diagram best represents the electron density in a molecule of hydrogen chloride?



18 - (WCH11/1(IAL)_Summer_2020_Q18) - Structure, Bonding And Introduction To Organic Chemistry

This question is about the structure of atoms.

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

(2)

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(b) State the shape of an s orbital and the shape of a p orbital.

(1)

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(c) Describe what can be deduced about the electronic structure of sodium from its successive ionisation energies.

(3)

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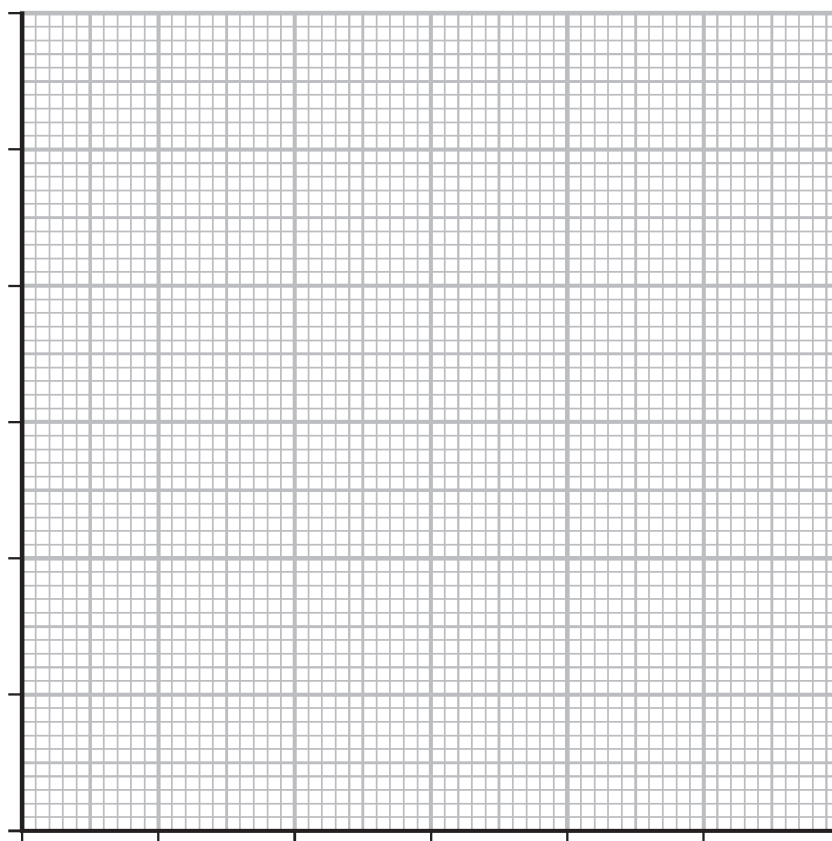
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(d) (i) The log of the **fourth** ionisation energy for six elements is shown in the table.

Element	$\log_{10}$ (fourth ionisation energy / kJ mol^{-1})
O	3.87
F	3.92
Ne	3.97
Na	
Mg	4.02
Al	4.06

Plot a graph of these data.

(3)



(ii) Use your graph to estimate the fourth ionisation energy for sodium, in kJ mol^{-1} .

(1)

(iii) Suggest why the fourth ionisation energies of neon and sodium are similar in magnitude even though the elements are in different periods of the Periodic Table.

(1)

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19 - (WCH11/1(IAL)_Summer_2020_Q19) - *Structure, Bonding And Introduction To Organic Chemistry*

This question is about the compound ammonium dichromate(VI), $(\text{NH}_4)_2\text{Cr}_2\text{O}_7$.

(a) $(\text{NH}_4)_2\text{Cr}_2\text{O}_7$ breaks down at around 180°C , producing an oxide of chromium, nitrogen and water as the only products.

- (i) Write an equation for the reaction.
State symbols are not required.

(2)

- (ii) Give a name for this type of reaction.

(1)

(b) When 0.00100 mol of ammonium dichromate(VI) was heated, 25.2 cm^3 of nitrogen gas, measured at laboratory temperature, was formed.

Calculate the temperature in the laboratory, in degrees Celsius, using the ideal gas equation. Use atmospheric pressure = 101 kPa.

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

(4)

(c) (i) Draw a dot-and-cross diagram of the ammonium ion.

Use dots (●) for the nitrogen electrons and crosses (×) for the hydrogen electrons.

(2)

(ii) Explain the shape of the ammonium ion using electron-pair repulsion theory.

(2)

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(d) Ammonium dichromate(VI) comes with several warnings on its packaging.

- This compound is toxic when inhaled and by passing through the skin.
- Handle with extreme caution.
- Contact can irritate and burn the skin and eyes, with possible eye damage.
- Inhaling can irritate the nose and throat.
- Ammonium dichromate(VI) is a strong oxidiser that enhances the combustion of other substances.

(i) Some of the symbols shown are used for ammonium dichromate(VI).

Identify the symbols for ammonium dichromate(VI) by placing a tick (✓) in the box under each relevant symbol.

(2)

(ii) Suggest why ammonium dichromate(VI) is **not** stored in the same cupboard as alkanes.

(1)

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ANSWERS

1 - (WCH11/1(IAL)_Summer_2020_Q1) - Structure, Bonding And Introduction To Organic Chemistry

B

2 - (WCH11/1(IAL)_Summer_2020_Q2) - Structure, Bonding And Introduction To Organic Chemistry

Question number	Answer	Mark
(a)	The only correct answer is B (displacement) A is incorrect because addition usually refers to organic reactions C is incorrect because no acids or bases are involved D is incorrect because substitution usually refers to organic reactions	(1)

Question number	Answer	Mark
(b)	The only correct answer is D ($\text{Zn} \rightarrow \text{Zn}^{2+} + 2\text{e}^-$) A is incorrect because Cu^+ is not formed B is incorrect because Cu^+ is not a reactant C is incorrect because Zn^+ is not formed	(1)

3 - (WCH11/1(IAL)_Summer_2020_Q3) - Structure, Bonding And Introduction To Organic Chemistry

C

4 - (WCH11/1(IAL)_Summer_2020_Q4) - Structure, Bonding And Introduction To Organic Chemistry

C

5 - (WCH11/1(IAL)_Summer_2020_Q5) - Structure, Bonding And Introduction To Organic Chemistry

B

6 - (WCH11/1(IAL)_Summer_2020_Q6) - Structure, Bonding And Introduction To Organic Chemistry

Question number	Answer	Mark
(a)	The only correct answer is C (63.6) A is incorrect as this is the answer when the abundance of the single charge peaks are used but are divided by 100 B is incorrect because this is the average of the mass of all the ions with the abundancies not considered D is incorrect because this is the A, when the mass of the two single charge peaks are averaged with the abundancies not considered	(1)

Question number	Answer	Mark
(b)	The only correct answer is C ($^{65}\text{Cu}^{2+}$) A is incorrect because sulphur would not produce the rest of the peaks B is incorrect because this is the peak at 31.5 D is incorrect because this would give a peak at 32.7	(1)

7 - (WCH11/1(IAL)_Summer_2020_Q7) - Structure, Bonding And Introduction To Organic Chemistry

B

8 - (WCH11/1(IAL)_Summer_2020_Q8) - Structure, Bonding And Introduction To Organic Chemistry

Question number	Answer	Mark
(a)	The only correct answer is C ($C_6H_{14}O$) A is incorrect because this precedes the first molecule in the sequence B is incorrect because this is not in this sequence D is incorrect because this is the sixth molecule in the sequence	(1)
(b)	The only correct answer is B (homologous series) A is incorrect because this structure is within each of the molecules C is incorrect because homolytic is a type of bond breaking D is incorrect because this is the type of structure shown	(1)

9 - (WCH11/1(IAL)_Summer_2020_Q9) - Structure, Bonding And Introduction To Organic Chemistry

C

10 - (WCH11/1(IAL)_Summer_2020_Q10) - Structure, Bonding And Introduction To Organic Chemistry

D

11 - (WCH11/1(IAL)_Summer_2020_Q11) - Structure, Bonding And Introduction To Organic Chemistry

A

12 - (WCH11/1(IAL)_Summer_2020_Q12) - Structure, Bonding And Introduction To Organic Chemistry

B

13 - (WCH11/1(IAL)_Summer_2020_Q13) - Structure, Bonding And Introduction To Organic Chemistry

C

14 - (WCH11/1(IAL)_Summer_2020_Q14) - Structure, Bonding And Introduction To Organic Chemistry

A

15 - (WCH11/1(IAL)_Summer_2020_Q15) - Structure, Bonding And Introduction To Organic Chemistry

A

16 - (WCH11/1(IAL)_Summer_2020_Q16) - Structure, Bonding And Introduction To Organic Chemistry

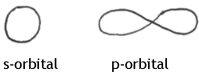
A

17 - (WCH11/1(IAL)_Summer_2020_Q17) - Structure, Bonding And Introduction To Organic Chemistry

D

18 - (WCH11/1(IAL)_Summer_2020_Q18) - Structure, Bonding And Introduction To Organic Chemistry

Question Number	Answer	Additional guidance	Mark
(a)	A statement that makes reference to the following points: - a region within an atom (1) - can hold (up to) two electrons (with opposing spins) or where there is a high probability of finding an electron (1)	Allow A region around the nucleus Allow area/place/space for region Ignore path/track/orbiting Do not award in the nucleus Allow a percentage between 90 and 95 Allow a greater chance of finding / most likely to find Do not award just likely Marks are standalone	(2)

Question Number	Answer	Additional guidance	Mark
(b)	s-orbitals are spherical / ball shaped and p-orbitals are dumbbell shaped	IGNORE the words circular or figure of eight or pear shaped Accept labelled diagrams e.g.  s-orbital p-orbital Accept a p-orbital on any axis Allow correct unlabelled diagrams or descriptions in the correct order Allow 3 p-orbitals overlapping if they are specifically labelled as 3 p-orbitals Ignore references to numbers of electrons Ignore has two lobes for p-orbital	(1)

Question Number	Answer	Additional guidance	Mark
(c)	A description that makes reference to: - three (quantum) shells (1) 2, 8, 1 (1) - Indication of which electrons are in which (quantum) shell (1)	Accept energy levels Accept the numbers in the reverse order Allow descriptions of the large jumps between IE1 & IE2 and IE9 & IE10 e.g. - It has one electron in its outermost shell or - First electron removed is in the third shell / 3s or 8 electrons in 2nd quantum shell or - Two electrons are on the innermost shell Allow one electron in valence shell Ignore one valence electron Ignore spd notation	(3)

Question Number	Answer	Additional guidance	Mark
(d)(i)	- axes correct way round and both suitably labelled (1) - suitable choice of linear scale so that the points cover at least 50% of the grid in both directions (1) - all 5 points plotted correctly (1)	Example of a graph: Do not award log as an axis label Ignore units and brackets on the y-axis Accept atomic numbers on the x-axis Allow element symbols Al to O Allow MP3 for bar charts Allow half square tolerance on plotted points Ignore any lines joining the points	(3)

Question Number	Answer	Additional guidance	Mark
(d)(ii)	$(10^{3.99}) = 9772 \text{ (kJ mol}^{-1}\text{)}$	Accept answers given in standard form Accept answers given in the grid for (d)(i) Allow 9544 – 10000 (kJ mol⁻¹) TE from graph in 18(d)(i) Allow any SF Ignore units even if incorrect	(1)

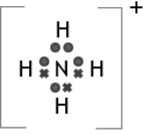
Question Number	Answer	Additional guidance	Mark
(d)(iii)	The fourth electron is removed from the same / second (quantum) shell	Allow both electrons are removed from 2p orbitals / the 2p subshell Allow same energy level Do not award same electronic structure / same orbital in place of same shell Ignore shielding Ignore nuclear charge Ignore references to electron pairs repelling	(1)

19 – (WCH11/1(IAL)_Summer_2020_Q19) – Structure, Bonding And Introduction To Organic Chemistry

Question Number	Answer	Additional guidance	Mark
(a)(i)	$(\text{NH}_4)_2\text{Cr}_2\text{O}_7 \rightarrow \text{N}_2 + 4\text{H}_2\text{O} + \text{Cr}_2\text{O}_3$	1 mark for Cr₂O₃ 1 mark for all the rest being correct Allow multiples Marks are standalone	(2)

Question Number	Answer	Additional guidance	Mark
(a)(ii)	(thermal) decomposition or redox	Ignore oxidation or reduction on their own	(1)

Question Number	Answer	Additional guidance	Mark
(b)	- conversion of units for P and V (1) - substitution in equation and rearrange (1) - answer in K (1) - convert to °C (1)	Example of calculation: $P = 101000 / 1.01 \times 10^5 \text{ Pa}$ $V = 0.0000252 / 2.52 \times 10^{-5} \text{ m}^3$ Allow incorrect use standard form e.g. $10.1 \times 10^4 \text{ Pa}$ $T = \frac{101000 \times 0.0000252}{0.001 \times 8.31}$ $T = 306.28 \text{ (K)}$ $T = 33.3(^{\circ}\text{C})$ (33.1°C if 273.15 is used for conversion of kelvin to Celsius) Ignore SF except 1 SF on final answer TE throughout but only award for MP4 if final answer in °C is between 0 and 50°C Units if given must be correct <i>Comment:</i> Correct answer with no working scores 4 306.28(K) scores 3 30.85°C scores 3 33.7°C scores 3 as they have used R as 8.3 33.55°C scores 3 using 8.3 and 273.15 306.7K scores 2 as they have used R as 8.3	(4)

Question Number	Answer	Additional guidance	Mark
(c)(i)	A drawing that shows: - four pairs of electrons and 4 hydrogen atoms around nitrogen (1) - one dative covalent bond and plus sign (1)	 Allow answers without brackets Allow use of any symbol for the electrons as long as it is clear which is the dative covalent bond (e.g. by use of an arrow) Ignore placement of positive sign	(2)

Question Number	Answer	Additional guidance	Mark
(c)(ii)	An explanation that makes reference to: - tetrahedral / tetrahedron (1) (four) pairs of electrons arranged in position of minimum repulsion / maximum separation (1)	MP1 may be scored with a 3D diagram or an answer given in 19(c)(i) Allow phonetic spelling Allow equal repulsion of electron-pairs Allow reference to bonding pairs Ignore reference to bonds Ignore all bond angles Do not award references to lone pairs Marks are standalone	(2)

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