02 Chemical Bonding

Set B Exam practice

Name	Time 1 hour 15 minutes	Total 44 marks	Score ____ / 44

A Data Booklet may be used.

Marks by notes section For the marker: total each row. A score below the target means that section of the notes needs revising.

Notes section	Questions	Marks	Target	Score
1 Types of Chemical Bonds	6(b)	2	2	
2 Metallic Bonding	12	2	2	
3 Ionic Bonding	10	4	3	
5 Electronegativity and Bond Strength	6(a), 15	6	4	
6 Dot-and-Cross Diagrams and the Octet Rule	13(a)	2	2	
7 Shapes of Molecules (VSEPR)	1, 4, 5(a), 7, 8	9	6	
8 Polarity of Molecules	13(b), 16	5	3	
9 Intermolecular Forces	3, 9, 11, 17	9	6	
10 Giant Molecular Structures	14	2	2	
11 Structure and Physical Properties	2, 5(b)	3	2	

A Multiple choice

4 MARKS

1 COMMON The Valence Shell Electron Pair Repulsion theory (VSEPR) is used to predict the bond angles of molecules. Which bond angle is correctly predicted by VSEPR?

	number of bonded electron pairs around central atom	number of lone pairs around central atom	bond angle
A	2	1	105°
B	2	2	118°
C	3	1	107°
D	3	2	90°

Answer ☐ [1]

/1

Source: 2024 HCI J2 Prelim P1 Q3

2 Which bonding type does not correspond to its description of physical properties?

	bonding type	physical properties
A	giant covalent	high melting point, conducts electricity when in solution but not when solid
B	simple covalent	low melting point, does not conduct electricity in any state
C	metallic	variety of melting points, conducts electricity when solid and when molten
D	ionic	high melting point, conducts electricity when molten but not when solid

Answer [ ] [1]

/1

Source: A Level 2013 P1 Q5, via EJC 2022 JC1 Chemical Bonding Tutorial, A11

3 Which of the following statements describes a phenomenon which can be explained by intermolecular hydrogen bonding?

A The melting points of the Group 1 hydroxides increase with increasing relative molecular mass (M_r).

B The boiling points of the alkanes increase with increasing relative molecular mass.

C CH_3OCH_3 (M_r = 46) has a higher boiling point than $CH_3CH_2CH_3$ (M_r = 44).

D Ice has a lower density than water at 0 °C.

Answer [ ] [1]

/1

Source: A Level 1990 P1 Q4 (modified), via EJC 2022 JC1 Chemical Bonding Tutorial, A10

4 Predict the most likely bond angle at each nitrogen atom in hydrazine, N_2H_4.

A 107° **B** 109.5° **C** 118° **D** 120°

Answer [ ] [1]

/1

Source: A Level 2009 P1 Q19 (modified), via EJC 2022 JC1 Chemical Bonding Tutorial, A5

B Structured questions

40 MARKS

5 COMMON Sodium amide, $NaNH_2$, is a salt that dissolves in liquid ammonia to form a solution containing NH_2^-.

(a) With reference to the VSEPR theory, name the shapes of and state the bond angles for NH_3 and NH_2^-. Explain your reasoning.

[3]

(b) Explain why the melting point of $NaNH_2$ (210 °C) is much higher than that of NH_3 (–78 °C).

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Source: 2023 HCI J2 Prelim P3 Q1(a)

6 The type of bonding present in a binary compound can be predicted from the electronegativities of the elements involved.

(a) Describe and explain the variation in electronegativity across the third period of the Periodic Table.

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..... **[2]**

(b) State the type of bonding present in sodium fluoride (NaF), silicon tetrafluoride (SiF_4) and the magnesium-aluminium alloy (Mg-Al).

Type of bonding in NaF: .....

Type of bonding in SiF_4: .....

Type of bonding in Mg-Al: ..... **[2]**

/4

Source: 2023 VJC J2 Prelim P2 Q2(a)(i) and (ii)

7 In the manufacture of tinted glass, a variety of carbonates including calcium carbonate were smelted together. State and explain, with reference to the VSEPR theory, the shape of the carbonate ion, CO_3^{2-}.

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..... **[2]**

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Source: 2023 SAJC J2 Prelim P3 Q1(a)(ii)

8 COMMON Dimethyl ether has the formula CH_3OCH_3. Using your knowledge of VSEPR theory, state and explain the bond angle around the oxygen atom in CH_3OCH_3.

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Source: 2025 NJC J2 Prelim P2 Q3(a)(ii)

9 When heated, butane reacts with chlorine to form 1-chlorobutane as one of the products. Explain why $CH_3CH_2CH_2CH_3$ has a lower boiling point than $CH_3CH_2CH_2CH_2Cl$.

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Source: 2018 RI J1 Promo Section C Q1(a)

10 In each pair, which compound has the greater covalent character, and which would you expect to have the higher melting point? Explain.

(a) sodium chloride and sodium iodide

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..... **[2]**

(b) sodium oxide and magnesium oxide

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Source: RJC H2 Chemistry Tutorial 3a (Chemical Bonding I), Q7

11 COMMON Hydrogen fluoride, HF, has a lower boiling point than water even though HF is more polar than water. Explain this observation.

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Source: RJC H2 Chemistry Tutorial 3b (Chemical Bonding II), Q3(a)

12 Describe the structure and bonding in calcium with the aid of a labelled diagram.

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Source: 2023 SAJC J2 Prelim P2 Q2(a)(iii)

13 Silane, SiH_4, is a key raw material in the production of semiconductor-grade silicon.

(a) COMMON Draw the dot-and-cross diagram of silane. State the molecular shape about the central Si atom in silane.

[2]

(b) Is the silane molecule polar or non-polar? Give a reason for your answer.

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..... **[1]**

/3

Source: 2023 YIJC J2 Prelim P2 Q1(b)

14 Silicon has a similar structure to diamond. However, the melting point of silicon, 1414 °C, is lower than that of diamond, 3550 °C. Explain this difference with reference to the structure and bonding of silicon and diamond.

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Source: 2023 RI J2 Prelim P3 Q1(a)(i)

15 **(a)** An oxygen molecule contains both a σ bond and a π bond. Describe how the orbitals overlap to form each bond.

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(b) State the number of σ bonds and π bonds in (i) ethane, C_2H_6, (ii) ethene, C_2H_4, (iii) ethyne, C_2H_2, and (iv) carbon dioxide, CO_2.

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Source: 2020 YIJC JC1 Chemical Bonding Tutorial, Section C2 Q6, adapted

16 The bond energies and the boiling points of three halogens are given.

halogen	bond energy / kJ mol^{-1}	boiling point / °C
Cl_2	244	−34
Br_2	193	59
I_2	151	184

Explain why the bond energy of the halogens decreases down the group while the boiling point increases.

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[4]

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Source: 2020 YIJC JC1 Intermolecular Forces Tutorial, Section E Q6

17 CHALLENGE Explain why the first substance in each pair has a higher boiling point than the second.

(a) PCl_3, $SiCl_4$

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[2]

(b) I_2, H_2O

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[2]

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Source: RJC H2 Chemistry Tutorial 3b (Chemical Bonding II), Q2(a) and (c)