03 Chemical Bonding and Structure

Set B Competition Practice

Name	Time 50 minutes	Total 25 marks	Score ____ / 25

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
4 Metallic Bonding	2, 3	2	2	
5 Covalent Bonding	4, 24	2	2	
6 Shapes of Molecules	5, 6, 7, 8, 9, 10, 25	7	5	
7 Electronegativity and Polarity	11	1	1	
8 What Makes a Bond Strong	1, 23	2	2	
9 Intermolecular Forces	12, 13, 14, 15, 16, 17, 18	7	5	
10 Giant Covalent Structures and Properties	19, 20, 21, 22	4	3	

A Competition questions

25 MARKS

1 The melting point of CaS is higher than that of KCl. Which of the following are explanations for the observation?

I Ca^{2+} is more positively charged than K^+.
II S^{2-} is more negatively charged than Cl^-.
III The K^+ ion is smaller than the Ca^{2+} ion.

A II only **B** II and III only **C** I and II only **D** I and III only

/1

Answer ____ [1]

2023 SJChO P1 Q36

2 Which statement about metals is **not** correct?

A They conduct electricity because delocalised electrons can move throughout the metal.
B They consist of layers of atoms that can slide over each other.
C They have a giant lattice of oppositely charged ions in a ‘sea’ of delocalised electrons.
D They have a giant lattice of positive ions in a ‘sea’ of delocalised electrons.

/1

Answer ____ [1]

2024 USS O Prelim P2 Q8

3 Two statements about the structure and properties of metals are given.

statement 1: Metals are malleable and have high melting points.

statement 2: Metals have mobile electrons in their structure.

Which statement is correct?

A Both statements are correct and statement 2 explains statement 1.

B Both statements are correct but statement 2 does not explain statement 1.

C Statement 1 is correct but statement 2 is incorrect.

D Statement 2 is correct but statement 1 is incorrect.

Answer [1]

/1

2024 Woodlands O Prelim P1 Q9

4 The table shows the sixth ionisation energies of four consecutive elements in the Periodic Table.

element	W	X	Y	Z
sixth ionisation energy / kJ mol^{-1}	19 800	21 300	8500	9360

What is the formula of the fluoride of W?

A WF_3 **B** WF_4 **C** WF_5 **D** WF_6

Answer [1]

/1

Source: 2024 VJC J2 Prelim P1 Q2

5 Diazene has the molecular formula N_2H_2. Given that nitrogen and hydrogen show their usual numbers of bonds, which describes the shape and bond angle around each central atom? Each option gives the shape, then the bond angle.

A bent, 110° **B** linear, 180°

C tetrahedral, 109° **D** trigonal planar, 120°

Answer [1]

/1

2019 CJC J2 Prelim P1 Q4

6 Iodine and phosphorus each form a trifluoride. What are the shapes of these two molecules? Each option gives IF_3, then PF_3.

A trigonal planar, trigonal pyramidal **B** T-shaped, trigonal pyramidal

C trigonal pyramidal, trigonal planar **D** T-shaped, trigonal planar

Answer [1]

/1

2020 ACJC J1 Promo Q6

7 The valence shell electron pair repulsion (VSEPR) theory is used to predict the bond angles of molecules. Which bond angle is correctly predicted by VSEPR?

	bond pairs around the central atom	lone pairs around the central atom	bond angle
A	2	1	105°
B	2	2	118°
C	3	1	107°
D	3	2	90°

A row A **B** row B **C** row C **D** row D

Answer

/1

[1]

2024 HCI J2 Prelim P1 Q3

8 Which one of the following pairs of compounds shows the same shape and similar bond angles?

A $POCl_3$ and CCl_4

B $AlCl_3$ and NCl_3

C SO_2 and CO_2

D ClF_3 and SF_4

/1

Answer [1]

2022 VJC J1 Promo P1 Q4

9 In which pair of molecules or ions do **both** species contain a bond angle of 107°?

A CH_3^+ and NH_3

B H_2O and NH_2^-

C NH_3 and NH_2^-

D NH_3 and H_3O^+

/1

Answer [1]

SJChO Mock 3 P1 Q29

10 When an iodine atom is covalently bonded to an electron-withdrawing group X, the electron density on the large iodine atom becomes uneven. The tip of the iodine atom directly opposite the X–I bond becomes very electron-deficient, while the region round the middle of the iodine atom is electron-rich. The electron-deficient region can attract an anion A^- without forming a covalent bond. What is the most likely X–I···A^- bond angle for this attraction? (··· shows the non-covalent attraction.)

A 90°

B 180°

C 109.5°

D 120°

/1

Answer [1]

2023 SJChO P1 Q6

11 The table identifies the shape and polarity of four molecules. Which row is correct?

	molecule	molecular shape	polarity
A	xenon tetrafluoride	tetrahedral	non-polar
B	selenium hexafluoride	T-shaped	non-polar
C	trichloromethane	tetrahedral	polar
D	boron trichloride	trigonal planar	polar

A row A

B row B

C row C

D row D

/1

Answer [1]

2024 ASRJC J2 Prelim P1 Q4

12 The table shows the boiling points of some halogenoalkanes.

compound	boiling point / °C
CH_3CH_2Cl	12.3
CH_3CH_2Br	34.8
CH_3CH_2I	70.0

Which of the following correctly explains the difference in the boiling points?

1 The electronegativity difference between the halogen and carbon increases from C–Cl to C–I.

2 The strength of permanent dipole–permanent dipole attraction increases from C–Cl to C–I.

3 The strength of instantaneous dipole–induced dipole attraction increases from CH_3CH_2Cl to CH_3CH_2I.
4 The bond energy of the carbon–halogen bond decreases from C–Cl to C–I.

A 1 and 2 only **B** 2 and 4 only **C** 3 only **D** 3 and 4 only

Answer [1]

/1

2019 YIJC J1 MYE P1 Q13

13 Which of the following substances consists of atoms or molecules held together only by instantaneous dipole–induced dipole forces of attraction?

A CO_2 **B** Cu **C** H_2O **D** SiO_2

Answer [1]

/1

2019 YIJC J1 MYE P1 Q14

14 Information about some hydrocarbons is given below.

hydrocarbon	boiling point / °C
ethane, CH_3CH_3	–89.0
propane, $CH_3CH_2CH_3$	–42.0
butane, $CH_3CH_2CH_2CH_3$	–1.7
2-methylpropane, $(CH_3)_3CH$	–11.7

Which statements help to explain the variation in boiling points of the hydrocarbons?

1 Presence of more hydrogen atoms results in stronger hydrogen bonding.
2 Presence of more covalent bonds results in more energy required to break them.
3 Greater surface area of contact results in stronger instantaneous dipole–induced dipole interactions.
4 Presence of more electrons results in stronger instantaneous dipole–induced dipole interactions.

A 1, 2 and 3 only **B** 2 and 3 only **C** 3 and 4 only **D** 4 only

Answer [1]

/1

2020 VJC J1 Promo P1-P2 Q5

15 Information about the properties of some compounds is given below.

compound	boiling point / °C
HF	19.5
NH_3	–33.3
H_2O	100

Which statement about the hydrogen bonding in these compounds is correct?

A HF has a higher boiling point than NH_3 because each HF molecule can form more hydrogen bonds on average than each NH_3 molecule.

B H_2O has a higher boiling point than HF because the H–O bond dipole is greater than the H–F bond dipole.

C H_2O has a higher boiling point than HF because hydrogen bonding between two molecules of H_2O causes it to dimerise.

D NH_3 has the lowest boiling point because it forms few hydrogen bonds on average and has the smallest bond dipole.

/1

Answer [1]

2022 MI J2 Prelim P1 Q7

16 The boiling point of water (100 °C) is greater than that of HF (20 °C). Which statement is a correct explanation of this?

A Each hydrogen bond formed between water molecules is stronger than that formed between HF molecules.

B There are more atoms in a water molecule than in an HF molecule, resulting in stronger intermolecular forces in water.

C There are, on average, more hydrogen bonds between water molecules than between HF molecules.

D The water molecule has stronger permanent dipole–permanent dipole interactions than the HF molecule.

/1

Answer [1]

2023 NJC J2 Prelim P1 Q3

17 The boiling points of H_2O, H_2S and H_2Se are different. Which statements are correct?

I H_2S has a lower boiling point than H_2Se because H_2S molecules have weaker permanent dipole–permanent dipole forces of attraction.
II H_2O molecules experience weaker temporary dipole–induced dipole forces of attraction than H_2Se molecules.
III H_2O molecules experience stronger permanent dipole–permanent dipole forces of attraction than H_2S molecules.

A I, II and III **B** I and II only **C** II and III only **D** III only

/1

Answer [1]

SJChO Mock 3 P1 Q17

18 Use the table of densities and boiling points of five solvents.

	solvent	molecular formula	density / g cm^{-3}	boiling point / °C
I	chloroform	$CHCl_3$	1.49	61
II	ethanol	C_2H_5OH	0.79	78
III	acetone	$(CH_3)_2CO$	0.78	56
IV	hexane	C_6H_{14}	0.66	69
V	water	H_2O	1.00	100

Which pair of liquids can be separated by liquid–liquid extraction?

A II and IV **B** IV and V **C** III and IV **D** I and II

/1

Answer [1]

Source: 2023 SJChO P1 Q28

19 Which lattice structure is correctly described?

	lattice structure	description

A	giant molecular	lattice of molecules held together by strong covalent bonds
B	giant ionic	each cation is only bonded to the anion to which electrons are transferred
C	giant metallic	all electrons are delocalised within the metal cation lattice
D	simple molecular	molecules held together by weak intermolecular forces

A row A **B** row B **C** row C **D** row D

/1

Answer [1]

2021 DHS J2 Prelim P1 Q4

20 Silicon carbide is a shiny, hard and chemically inert material with a very high melting point. It can be used to sharpen knives and make crucibles. Which type of structure explains these properties?

A a giant crystal lattice structure containing ionic bonds between silicon and carbide ions

B a giant structure with covalent bonds between silicon and carbon atoms forming a tetrahedral network

C a giant layer structure with covalent bonds between atoms and instantaneous dipole–induced dipole interactions between the layers

D a simple molecular structure with covalent bonds between silicon and carbon atoms

/1

Answer [1]

2021 RVHS J1 Common Test P1 Q9

21 Substances X, Y and Z are all solids. Some of their physical properties are given in the table.

substance	X	Y	Z
melting point / °C	772	114	1610
boiling point / °C	1407	183	2205
electrical conductivity when molten	good	poor	poor

What type of structure could each substance have? Each option gives X, Y and Z in that order.

A giant molecular, simple molecular, ionic

B ionic, giant molecular, simple molecular

C ionic, simple molecular, giant molecular

D simple molecular, ionic, giant molecular

/1

Answer [1]

2021 YIJC J1 MYE P1 Q10

22 Which row correctly describes the structure and bonding present in the solid lattice of the given substance?

	substance	structure	bonding
A	ice	giant molecular	covalent and hydrogen bonding
B	iodine	simple molecular	covalent bonding and permanent dipoles
C	sodium sulfate	giant ionic	ionic and covalent bonding
D	copper	giant metallic	ionic bonding

A row A **B** row B **C** row C **D** row D

/1

Answer [1]

2023 DHS J2 Prelim P1 Q4

23 Which property of X_2 increases down the group for X = Cl, Br or I?

A volatility **B** bond length **C** bond energy **D** oxidising power

/1

Answer [1]

2024 RI J2 Prelim P1 Q11

24 Which statement about covalent bonds is true?

A π bonds are stronger than σ bonds.

B The more shared pairs a bond has, the longer the bond.

C Polar bonds are always stronger than non-polar bonds.

D A dative bond can be formed from the head-on overlap of orbitals.

/1

Answer [1]

2022 EJC J1 MYE P1 Q3, adapted

25 Consider these chlorine-containing species: ICl_2^-, ClF_3, ClO_3^-. Which statements about them are correct?

1 The bond angles increase in the order ClF_3, ClO_3^-, ICl_2^-.
2 Two of the three species have an overall dipole moment.
3 Only ClO_3^- is not planar.

A 1, 2 and 3 **B** 1 and 2 only **C** 2 and 3 only **D** 1 only

/1

Answer [1]

2020 VJC J1 Promo P1-P2 Q4

10 The Periodic Table of Elements

Group																	
1	2											13	14	15	16	17	18
							1 H hydrogen 1.0										2 He helium 4.0
3 Li lithium 6.9	4 Be beryllium 9.0											5 B boron 10.8	6 C carbon 12.0	7 N nitrogen 14.0	8 O oxygen 16.0	9 F fluorine 19.0	10 Ne neon 20.2
11 Na sodium 23.0	12 Mg magnesium 24.3	3	4	5	6	7	8	9	10	11	12	13 Al aluminium 27.0	14 Si silicon 28.1	15 P phosphorus 31.0	16 S sulfur 32.1	17 Cl chlorine 35.5	18 Ar argon 39.9
19 K potassium 39.1	20 Ca calcium 40.1	21 Sc scandium 45.0	22 Ti titanium 47.9	23 V vanadium 50.9	24 Cr chromium 52.0	25 Mn manganese 54.9	26 Fe iron 55.8	27 Co cobalt 58.9	28 Ni nickel 58.7	29 Cu copper 63.5	30 Zn zinc 65.4	31 Ga gallium 69.7	32 Ge germanium 72.6	33 As arsenic 74.9	34 Se selenium 79.0	35 Br bromine 79.9	36 Kr krypton 83.8
37 Rb rubidium 85.5	38 Sr strontium 87.6	39 Y yttrium 88.9	40 Zr zirconium 91.2	41 Nb niobium 92.9	42 Mo molybdenum 95.9	43 Tc technetium –	44 Ru ruthenium 101.1	45 Rh rhodium 102.9	46 Pd palladium 106.4	47 Ag silver 107.9	48 Cd cadmium 112.4	49 In indium 114.8	50 Sn tin 118.7	51 Sb antimony 121.8	52 Te tellurium 127.6	53 I iodine 126.9	54 Xe xenon 131.3
55 Cs caesium 132.9	56 Ba barium 137.3	57–71 lanthanoids	72 Hf hafnium 178.5	73 Ta tantalum 180.9	74 W tungsten 183.8	75 Re rhenium 186.2	76 Os osmium 190.2	77 Ir iridium 192.2	78 Pt platinum 195.1	79 Au gold 197.0	80 Hg mercury 200.6	81 Tl thallium 204.4	82 Pb lead 207.2	83 Bi bismuth 209.0	84 Po polonium –	85 At astatine –	86 Rn radon –
87 Fr francium –	88 Ra radium –	89–103 actinoids	104 Rf rutherfordium –	105 Db dubnium –	106 Sg seaborgium –	107 Bh bohrium –	108 Hs hassium –	109 Mt meitnerium –	110 Ds darmstadtium –	111 Rg roentgenium –	112 Cn copernicium –	113 Nh nihonium –	114 Fl flerovium –	115 Mc moscovium –	116 Lv livermorium –	117 Ts tennessine –	118 Og oganesson –

Key

atomic number
atomic symbol
name
relative atomic mass

lanthanoids	57 La lanthanum 138.9	58 Ce cerium 140.1	59 Pr praseodymium 140.9	60 Nd neodymium 144.2	61 Pm promethium –	62 Sm samarium 150.4	63 Eu europium 152.0	64 Gd gadolinium 157.3	65 Tb terbium 158.9	66 Dy dysprosium 162.5	67 Ho holmium 164.9	68 Er erbium 167.3	69 Tm thulium 168.9	70 Yb ytterbium 173.1	71 Lu lutetium 175.0
actinoids	89 Ac actinium –	90 Th thorium 232.0	91 Pa protactinium 231.0	92 U uranium 238.0	93 Np neptunium –	94 Pu plutonium –	95 Am americium –	96 Cm curium –	97 Bk berkelium –	98 Cf californium –	99 Es einsteinium –	100 Fm fermium –	101 Md mendelevium –	102 No nobelium –	103 Lr lawrencium –