

Bonding

Q1. (2018)

- 4 Ethanol is a liquid at room temperature. It has a low melting point and boiling point.

Why?

- A Ethanol is an ionic compound.
- B The forces of attraction between ethanol molecules are strong.
- C The forces of attraction between ethanol molecules are weak.
- D There are no forces of attraction between ethanol molecules.

Your answer

☐

[1]

Q2. (2018)

- 6 Which statement about **covalent** bonding is true?

- A Electrons are transferred from one atom to another.
- B Electrons are delocalised.
- C Electrons are shared between atoms.
- D Ions are formed.

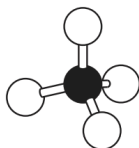
Your answer

☐

[1]

Q3. (2018)

- 15 Look at the diagram of a methane molecule.



Which statement about methane is correct?

- A Electrons are transferred from hydrogen atoms to carbon atoms.
- B The covalent bonds in methane are weak.
- C The force of attraction between methane molecules is weak.
- D The ionic bonds between carbon and hydrogen are very strong.

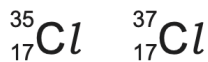
Your answer

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[1]

Q4. (2018) – 19d

- 19 Look at the information about two atoms of chlorine.



The **atomic number** of chlorine is 17.

A)

- (d) (i) The electronic structure of sodium is 2.8.1. The electronic structure of oxygen is 2.6. Sodium and oxygen react together to make sodium oxide.

Sodium oxide is an **ionic** compound.

Draw 'dot and cross' diagrams to show the ions made when sodium reacts with oxygen.

Show the charges on the ions.

[3]

B)

(ii) What is the **formula** of sodium oxide?

[1]

Q5. (2018)

25* Look at the data about some substances.

Substance	Melting point (°C)	Boiling point (°C)	Does it conduct electricity?	Density (g/cm ³)
A	0	100	no	1.0
B	>3000	>4000	no	3.5
C	801	1413	Solid does not conduct but conducts when melted or when dissolved in water	2.2

Explain the type of **bonding** present in each substance **A**, **B** and **C**.

Relate the type of bonding to the **properties** of each substance.

[6]

Q6. (2019)

2 Carbon dioxide exists as a simple molecule.

Why do simple molecules have low boiling points?

- A** Simple molecules have weak covalent bonds between atoms.
- B** Simple molecules have weak intermolecular forces between atoms.
- C** Simple molecules have weak ionic bonds between the molecules.
- D** Simple molecules have weak intermolecular forces between the molecules.

Your answer

[1]

Q7. (2019)

- 5 Carbon can form different **allotropes**.

Which of these are allotropes of carbon?

- A Diamond, graphite, graphene.
- B Diamond, granite, graphite.
- C Fullerene, graphene, ethene.
- D Granite, graphite, graphene.

Your answer

☐

[1]

Q8. (2019)

- 15 Which of these substances has a **giant covalent structure**?

- A Carbon dioxide
- B Magnesium oxide
- C Sulfur dioxide
- D Silicon dioxide

Your answer

☐

[1]

Q9. (2019)

A)

- 16 Lithium is a metal found in Group 1 of the Periodic Table.

- (a) (i) Describe the structure and bonding in a metal.

You may include a diagram in your answer.

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

B)

- (ii) Lithium is **malleable** even though metallic bonds are strong.

Explain why metals are malleable.

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

C)

- (iii) Lithium can conduct electricity in the solid and liquid state.

Explain why metals can conduct electricity.

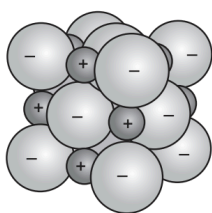
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Q10. (2019)

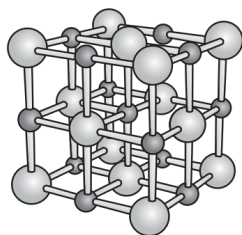
21 Sodium chloride, NaCl , is an ionic compound.

Sodium chloride forms a giant ionic lattice that can be represented using different models.

Look at the diagrams. They show two models of sodium chloride.



Space-filling model



Ball-and-stick model

A)

(a) (i) A scientist thinks the ball-and-stick model should be used to model ionic compounds.

Describe **two limitations** of using the ball-and-stick model for ionic compounds.

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

B)

(ii) Ionic compounds can also be modelled using a dot-and-cross diagram.

Draw a dot and cross diagram to show the ions in sodium chloride.

[2]

Q11. (2020)

8 Ammonia has a simple molecular structure.

Which statement explains why ammonia has a low melting point and a low boiling point?

- A The covalent bonds between the atoms are strong.
- B The covalent bonds between the atoms are weak.
- C The intermolecular forces between the molecules are strong.
- D The intermolecular forces between the molecules are weak.

Your answer

☐

[1]

Q12. (2020)

9 Graphite is a form of carbon. Graphite can conduct electricity.

Why can graphite conduct electricity?

- A Delocalised electrons are between layers.
- B The ions can move.
- C Layers have weak intermolecular forces.
- D Strong covalent bonds are between the carbon atoms.

Your answer

☐

[1]

Q13. (2020)

13 Which equation shows the formation of a Group 2 metal ion?

M represents a Group 2 metal and e^- represents an electron.

- A $M + e^- \rightarrow M^+$
B $M + 2e^- \rightarrow M^{2+}$
C $M \rightarrow M^+ + e^-$
D $M \rightarrow M^{2+} + 2e^-$

Your answer

[1]

Q14. (2020)

15 Phosphoric acid contains phosphate ions, PO_4^{3-} .

Phosphoric acid is completely neutralised by sodium hydroxide.

What is the formula of the salt that is made?

- A Na_2PO_4
B Na_3PO_4
C $Na(PO_4)_3$
D $Na_2(PO_4)_3$

Your answer

[1]

Q15. (2020)

16 This question is about structure and bonding.

(a) Look at the two structures, A and B, in Fig. 16.1.

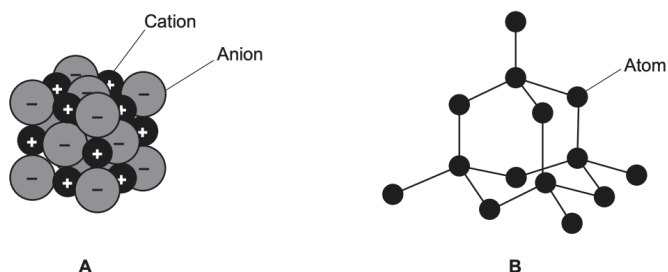


Fig. 16.1

A)

(i) Identify the bonding in structure A.

Explain your answer.

Bonding

Explanation

[2]

B)

(ii) Explain why structure B has a high melting point.

.....

.....

..... [2]

C)

- (iii) Explain why structure **B** does **not** conduct electricity.

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

D)

- (b) Look at the structure of a metal in **Fig. 16.2**. Metals are malleable, which means they can be hammered or pressed into shape without breaking or cracking.

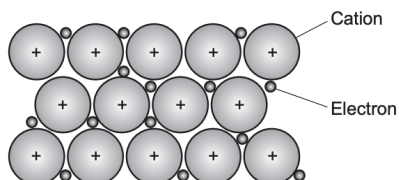


Fig. 16.2

Explain why metals are **malleable**.

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

Q16. (2020)

- 21 Sodium oxide, Na_2O , is a white solid.

- (a) Draw a dot and cross diagram to show the ions in sodium oxide.

[2]

Q17. (2021)

- 2 The formula of a sodium ion is Na^+ . The formula of a phosphate ion is PO_4^{3-} .

What is the formula of sodium phosphate?

- A $\text{Na}(\text{PO}_4)_3$
B Na_2PO_4
C Na_3PO_4
D Na_4PO_4

Your answer

☐

[1]

Q18. (2021)

- 3 Which statement describes **ionic** bonding?

- A Electrons are delocalised.
B Electrons are shared between atoms.
C Electrons are transferred from a metal to a non-metal.
D Electrons are transferred from a non-metal to a metal.

Your answer

☐

[1]

Q19. (2021)

14 Which statement about covalent bonding is **not** correct?

- A Covalent bonds are broken when a compound changes state from a liquid to a gas.
- B Covalent bonds are strong.
- C Covalent bonds can be found in both simple compounds and giant structures.
- D Covalent bonds share electrons between atoms.

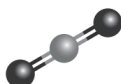
Your answer

☐

[1]

Q20. (2021)

15 A carbon dioxide molecule is shown in the ball and stick model.



Which estimate of the distance between the oxygen atoms in a carbon dioxide molecule is correct?

- A $2.0 \times 10^{-7} \text{ m}$
- B $2.0 \times 10^{-10} \text{ m}$
- C $2.0 \times 10^{-15} \text{ m}$
- D $2.0 \times 10^{-20} \text{ m}$

Your answer

☐

[1]

Q21. (2021)

16 The table shows carbon can exist as several different structures called allotropes.

Allotrope	Covalent bonds
Diamond	
Graphite	
Graphene	3

A)

(a) Complete the table to show how many covalent bonds carbon forms in these allotropes. [2]

B)

(b) (i) Diamond can be used as a cutting tool because it is so hard.

Explain why diamond is so hard.

Use ideas about structure and bonding in diamond in your answer.

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

C)

- (ii) Graphite can be used as a lubricant because it is slippery.

Explain why graphite is slippery.

Use ideas about structure and bonding in graphite in your answer.

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

D)

- (c) Explain why carbon forms many other compounds. Use ideas about the bonding in carbon compounds in your answer.

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

Q22. (2021) – 17c

- (c) Draw lines to connect each substance with its correct type of structure and bonding.

Substance M	Giant Covalent
Substance O	Ionic
Substance P	Metallic
	Polymer
	Simple Covalent

[3]

Q23. (2022)

- 3 A Group 1 element reacts with a Group 7 element, so that both elements have a full outer shell of electrons. The table shows what happens to both elements during the reaction.

	Group 1 element	Group 7 element
A	gains 1 electron	loses 1 electron
B	gains 2 electrons	loses 2 electrons
C	loses 1 electron	gains 1 electron
D	loses 2 electrons	gains 2 electrons

Which row is correct?

Your answer ☐

[1]

Q24. (2022)

- 6 Which statement about carbon allotropes is correct?

- A Buckminsterfullerene is a type of carbon nanotube.
B Carbon atoms in diamond and graphite form 4 covalent bonds.
C Graphene and graphite both have carbon atoms arranged in layers.
D Strong covalent bonds cause diamond to have a high melting point.

Your answer ☐

[1]

Q25. (2022)

14 Which statement about the bonding in magnesium oxide is correct?

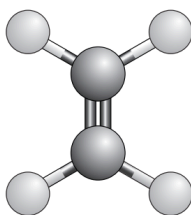
- A There are strong covalent bonds between atoms.
- B There are strong covalent bonds between ions.
- C There are strong electrostatic forces between atoms.
- D There are strong electrostatic forces between ions.

Your answer ☐

[1]

Q26. (2022)

16 The diagram shows a ball and stick model for ethene, C_2H_4 .



A)

(a) Which statements about this ball and stick model of ethene are correct?

Tick (✓) **two** boxes.

The model shows how many electrons the carbon atoms have.

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The model shows how many electrons the hydrogen atoms have.

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The model shows how much space each atom fills.

☐

The model shows that the carbon atoms are bigger than the hydrogen atoms.

☐

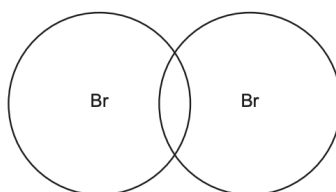
The model shows the difference between double bonds and single bonds.

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[2]

B)

(b) Molecules can be drawn using dot and cross diagrams.



Complete the dot and cross diagram for bromine, Br_2 .

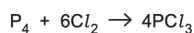
Show the electrons in the outer shells only.

[2]

Q27. (2022) – 21b (iii)

21 Phosphorus can exist as P_4 molecules.

Phosphorus trichloride, PCl_3 , is made in the reaction of phosphorus, P_4 , and chlorine as shown in the equation.



(b) Some information about phosphorus compounds is shown in the table.

Name	Formula	Melting point (°C)	Boiling point (°C)	State at room temperature
Phosphorus trichloride	PCl_3	–94	76	
Phosphorus pentachloride	PCl_5	161	167	
Phosphorus trifluoride	PF_3	–152	–102	

(iii) The scientist thinks phosphorus trichloride is a **giant covalent** compound.

Explain why the scientist is incorrect.

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

Q28. (2022) – 22b

A)

(b) Zinc bromide is an ionic compound made from zinc ions, Zn^{2+} , and bromide ions, Br^- .

(i) Construct a **balanced ionic** equation for the formation of zinc bromide.

..... [2]

B)

(ii) Zinc bromide can conduct electricity when aqueous or molten, but not when solid.

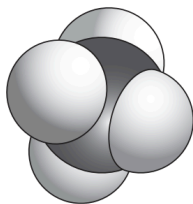
Zinc metal can conduct electricity when solid.

Explain why.

Zinc bromide
.....
Zinc metal
..... [3]

Q29. (2023)

- 5 The diagram shows a 3D space filling model of methane.



What are the limitations of showing methane as a 3D space filling model?

- A It does not show how close together the atoms are.
- B It does not show how many electrons are in a bond.
- C It does not show the relative size of the atoms.
- D It does not show the relative volume that the atoms take up.

Your answer ☐

[1]

Q30. (2023)

- 8 Calcium phosphate contains the ions Ca^{2+} and PO_4^{3-} .

What is the formula for calcium phosphate?

- A CaPO_4
- B Ca_2PO_4
- C $\text{Ca}_2(\text{PO}_4)_3$
- D $\text{Ca}_3(\text{PO}_4)_2$

Your answer ☐

[1]

Q31. (2023)

- 11 Which row explains how the structure of graphene is different from the structure of graphite?

	Graphene	Graphite
A	3 covalent bonds to each carbon atom	4 covalent bonds to each carbon atom
B	covalent bonds in 3D	covalent bonds in one 2D plane
C	intermolecular forces	no intermolecular forces
D	one layer	many layers

Your answer ☐

[1]

Q32. (2023) – 20b, 20c (iv)

Context:

- 20 (a) A scientist has a sample of seawater. The sample contains sand, water and salt.

The scientist wants to collect **pure** samples of:

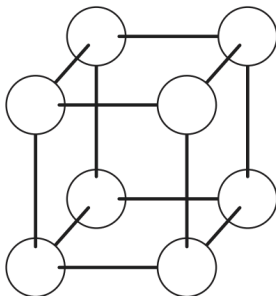
- sand
- water
- salt.

Question:

A)

- (b) The salt collected is sodium chloride.

Complete the ball and stick model by labelling the sodium ions and the chloride ions.



[2]

B)

- (c) Seawater can contain isotopes of sulfur.

- (iv) Explain why magnesium sulfate has a high melting point.

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

Q33. (2024)

- 2 Graphite and graphene are allotropes of carbon.

Which statement is correct about graphite and graphene?

- A Graphite has delocalised electrons, graphene uses all electrons in bonding.
- B Graphite has four bonds from each carbon atom, graphene only has three.
- C Graphite is a giant covalent structure, graphene is not.
- D Graphite is made up of layers, graphene is a single layer.

Your answer

☐

[1]

Q34. (2024)

- 3 A lithium ion is Li^+ and a phosphate ion is PO_4^{3-} .

What is the formula of lithium phosphate?

- A $\text{Li}(\text{PO}_4)_3$
- B Li_2PO_4
- C $\text{Li}_2(\text{PO}_4)_3$
- D Li_3PO_4

Your answer

☐

[1]

Q35. (2024) – 17c

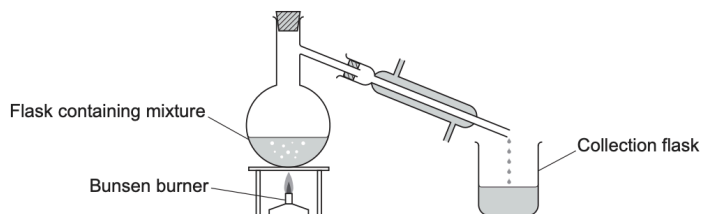
Context:

17 A student wants to separate a mixture of compounds.

Different separation methods are used depending on the mixture.

(b) The student decides to use simple distillation to separate a mixture.

They set up the apparatus shown in the diagram.



(ii) The student wants to record the boiling point of the pure liquid that is collected in the collection flask.

Question:

(c) The pure liquid collected has the molecular formula $(C_2H_5)_2O$ and a boiling point of $35^\circ C$.

Which statements about the pure liquid are **correct**?

Tick (✓) **two** boxes.

The empirical formula is CH_2 .

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The melting point is lower than $35^\circ C$.

☐

The pure liquid contains two compounds.

☐

The pure liquid is an element.

☐

The pure liquid will be a gas at above $35^\circ C$.

☐

[2]

A)

21



[6]

.. [6]

B)

(b)

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3

.. [3]

C)

- (ii) Construct the dot and cross diagram for the ions in magnesium chloride, MgCl_2 .

Show the outer electron shells only.

Dot and cross diagram:

[2]