CrackingCHEM
GCSE | A-LEVEL
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AQA 7405

Bonding I

Original exam questions | TEST IT → EXAM STYLE → HARDER MIXED

SPECIFICATION-LED. PROGRESSIVE. EXAM-FOCUSED.

AQA SPECIFICATION LINKS	3.1.3.1 | 3.1.3.2 | 3.1.3.3 | 3.1.3.4

TEST IT	EXAM STYLE	HARDER MIXED	STRETCH
9	9	3	2

23 ORIGINAL QUESTIONS **191 TOTAL MARKS**

Independent practice material. Every question is original and designed from recurring AQA assessment patterns.

Mapped to AQA Chemistry 7405 | specification checked August 2026

START HERE

How to use this pack

Learn → apply → select → connect

1. Complete TEST IT without notes. Repair any imprecise definition before moving on.
2. For every property explanation, write: structure → particles → attraction → energy or mobility → property.
3. Name the actual particles. Use ions, atoms, molecules or delocalised electrons, never vague words such as ‘things’ or ‘strong bonds’.
4. Count every specified particle twice and check every ion charge, bracket and dative-arrow direction.

Bonding boundary

This pack tests AQA 3.1.3.1-3.1.3.4 only. Shapes, bond angles, electronegativity, polarity and detailed intermolecular-force comparisons belong to Bonding II.

Write or draw

Use the grey dotted lines for written answers and the dashed boxes for diagrams. Longer explanations have enough lines for a complete marking-point chain.

Originality and exam fit

Every question is original. Command words and mark allocations are calibrated against current AQA assessment practice, not copied from a past paper.

SECTION A — TEST IT

Secure definitions, formulae, diagrams and particle language

QUESTION 1 | TEST IT

(a) Predict the ions formed by potassium, magnesium, nitrogen and sulfur atoms. (4 marks)

(b) Explain why 'ionic bonding is the transfer of electrons' is not a correct definition. Give the correct bonding description. (3 marks)

QUESTION 2 | TEST IT

(a) State the formula and charge of sulfate, hydroxide, nitrate, carbonate and ammonium ions. (5 marks)

(b) Write the formulae of barium nitrate, aluminium sulfate, ammonium carbonate, magnesium hydroxide and aluminium oxide. (5 marks)

QUESTION 3 | TEST IT

(a) Describe what is meant by a giant ionic lattice. (2 marks)

(b) Explain why magnesium oxide has a high melting point. (3 marks)

(c) Explain why solid magnesium oxide does not conduct electricity but molten magnesium oxide does. (3 marks)

QUESTION 4 | TEST IT

(a) Define a single covalent bond. (2 marks)

(b) State the number of shared pairs in Cl_2, O_2 and N_2 and give the line representation of each molecule. (3 marks)

(c) State two pieces of information shown by a dot-and-cross diagram. (2 marks)

QUESTION 5 | TEST IT

(a) Draw a dot-and-cross diagram for Cl_2. Show outer-shell electrons only. (3 marks)

(b) Draw a dot-and-cross diagram for O_2. Show outer-shell electrons only. (3 marks)

Cl_2 diagram

O_2 diagram

QUESTION 6 | TEST IT

(a) Define a dative covalent bond. (2 marks)

(b) For $NH_3 + H^+ \rightarrow NH_4^+$, identify the donor and acceptor, state the arrow direction and state how the four N-H bonds compare after formation. (4 marks)

(c) In $F^- + BF_3 \rightarrow BF_4^-$, identify the electron-pair donor and state the direction of the dative arrow. (2 marks)

QUESTION 7 | TEST IT

(a) Define metallic bonding. (3 marks)

(b) Explain why solid magnesium conducts electricity. (2 marks)

(c) Explain why magnesium has a relatively high melting point. (2 marks)

QUESTION 8 | TEST IT

Complete Table 1 for the four crystal structures.

Structure	Particles present	Bond or attraction
giant ionic		
metallic		
giant covalent		
simple molecular		

Give one correct entry in each empty cell. (8 marks)

QUESTION 9 | TEST IT

(a) Draw exactly five I_2 molecules. (2 marks)

(b) Draw a touching, alternating lattice containing exactly four Na^+ ions and four Cl^- ions. Show every charge. (3 marks)

Five I_2 molecules

Four Na^+ and four Cl^- ions

(c) State the particle represented in each diagram. (1 mark)

SECTION B — EXAM STYLE

Apply structure and bonding in original AQA-style contexts

QUESTION 10 | EXAM STYLE

Four solids give the data in Table 2.

Solid	Melting point / °C	Conducts as solid?	Conducts when molten?
W	801	no	yes
X	650	yes	yes
Y	3550	no	no
Z	114	no	no

(a) Identify the most likely structure type of W, X, Y and Z. (4 marks)

(b) For each solid, quote the decisive evidence supporting your choice. (4 marks)

QUESTION 11 | EXAM STYLE

(a) State the particles present in sodium chloride and in magnesium. (2 marks)

(b) Explain why solid magnesium conducts electricity but solid sodium chloride does not. (4 marks)

(c) Both substances conduct when molten. State the mobile charge carrier in each liquid. (2 marks)

QUESTION 12 | EXAM STYLE

(a) State the structure type shared by diamond and graphite. (1 mark)

(b) State how many covalent bonds each carbon atom forms in diamond and in graphite. (2 marks)

(c) Explain why both substances have very high melting points. (3 marks)

(d) Explain why graphite conducts electricity but diamond does not. (3 marks)

(e) Explain why graphite's layers can slide over one another. (1 mark)

QUESTION 13 | EXAM STYLE

A student writes: 'Iodine melts at a low temperature because the weak covalent bonds in I_2 molecules break.'

(a) Identify two errors in the student's statement. (2 marks)

(b) Explain correctly what happens when solid iodine melts. (3 marks)

(c) Explain why diamond melts at a much higher temperature than iodine. (2 marks)

QUESTION 14 | EXAM STYLE

(a) State the particles present in ice. (1 mark)

(b) State which attractions are overcome when ice melts and which bonds are not broken. (2 marks)

(c) State whether energy is absorbed or released during melting. (1 mark)

(d) Describe the attraction and energy changes when water freezes. (2 marks)

(e) Explain why the chemical identity of each water molecule is unchanged during melting. (1 mark)

QUESTION 15 | EXAM STYLE

The ionic compounds $X_2(SO_4)_3$ and $Y(OH)_2$ contain simple ions X and Y.

(a) Deduce the charges on X and Y. (2 marks)

(b) Write the formula of X nitrate. (1 mark)

(c) Write the formula of Y carbonate. (1 mark)

(d) Write the formula of ammonium sulfate. (1 mark)

(e) A student writes X_3SO_4. Explain why this is incorrect and give the correct sulfate formula. (2 marks)

QUESTION 16 | EXAM STYLE

Ammonia forms a dative covalent bond with $AlCl_3$. The electron-deficient aluminium atom accepts a lone pair.

(a) Identify the electron-pair donor and acceptor. (2 marks)

(b) Draw the dative arrow on H_3N and $AlCl_3$. (2 marks)

Dative-arrow diagram

(c) Explain why ammonia can act as the donor. (1 mark)

(d) Explain why an arrow from aluminium towards nitrogen would be incorrect. (2 marks)

QUESTION 17 | EXAM STYLE

Repair each statement using precise particle language.

(a) ‘Electron transfer is the ionic bond.’ (3 marks)

(b) ‘Molten iodine contains iodine atoms because its covalent bonds have broken.’ (2 marks)

(c) 'Solid magnesium conducts because Mg^{2+} ions move through the lattice.' (3 marks)

QUESTION 18 | EXAM STYLE

Three unlabeled samples are known to be sodium chloride, graphite and iodine. Their results are shown in Table 3.

Sample	Thermal observation	Conducts as solid?	Conducts when molten?
P	melts at 114 °C	no	no
Q	melts at 801 °C	no	yes
R	remains solid above 3000 °C	yes	not tested

(a) Identify P, Q and R. (3 marks)

(b) State the structure type of each sample. (3 marks)

(c) For each sample, explain one decisive observation using particles, attractions or mobile charge carriers. (3 marks)

SECTION C — HARDER MIXED

Select the structure, formula and explanation route

QUESTION 19 | HARDER MIXED

A solid oxide has formula M_2O_3. It melts at 2050 °C, does not conduct as a solid and conducts when molten.

(a) Deduce the charge on M ions. (1 mark)

(b) Deduce the structure type. (1 mark)

(c) Explain all three physical-property observations. (5 marks)

(d) Write the formulae of M nitrate and M hydroxide. (2 marks)

QUESTION 20 | HARDER MIXED

Material A contains atoms joined in a continuous three-dimensional covalent network. Material B contains discrete X_8 molecules. Neither material conducts electricity.

(a) Classify the structure of A and B. (2 marks)

(b) Explain why A has a much higher melting point than B. (5 marks)

(c) Explain why neither material conducts electricity. (2 marks)

QUESTION 21 | HARDER MIXED

Material C consists of flat covalent layers. Each atom forms three covalent bonds and contributes one delocalised electron. Weak forces act between the layers.

(a) Classify the structure of C. (1 mark)

(b) Predict and explain its melting point. (3 marks)

(c) Predict and explain its electrical conductivity. (2 marks)

(d) Predict and explain whether its layers can slide. (2 marks)

(e) Explain why C should not be described as simple molecular. (2 marks)

SECTION D — STRETCH / SYNOPTIC

Connect bonding models without crossing into Bonding II

QUESTION 22 | STRETCH / SYNOPTIC

Fluoride ions form BF_4^- ions by donating a lone pair to BF_3. A salt contains Mg^{2+} and BF_4^- ions.

(a) Identify the dative-bond donor and acceptor and describe the arrow fully. (4 marks)

(b) Write the formula of the salt. (1 mark)

(c) State the bonding within BF_4^- and the bonding between Mg^{2+} and BF_4^- ions in the solid. (2 marks)

(d) Explain why the solid does not conduct but the molten salt does. (3 marks)

(e) Explain why the salt is expected to have a high melting point. (3 marks)

QUESTION 23 | STRETCH / SYNOPTIC

Samples A-D are diamond, graphite, magnesium and iodine, in an unknown order.

Sample	Physical evidence
A	conducts as a solid and liquid; melting point 650 °C
B	conducts as a solid; very high melting point; soft layered solid
C	does not conduct; very high melting point; extremely hard
D	does not conduct; melts at 114 °C

(a) Identify A, B, C and D. (4 marks)

(b) Compare B and C. Explain why both have very high melting points but only B conducts electricity. (5 marks)

(c) Explain why D melts at a much lower temperature than C without referring to weak covalent bonds. (3 marks)

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AQA 7405

Bonding I

Fully worked answers | AQA-style marking guidance

FULLY WORKED. PRECISELY MARKED. BUILT FOR IMPROVEMENT.

AQA SPECIFICATION LINKS	3.1.3.1 | 3.1.3.2 | 3.1.3.3 | 3.1.3.4

TEST IT	EXAM STYLE	HARDER MIXED	STRETCH
9	9	3	2

23 QUESTIONS MARKED **191 MARKS EXPLAINED**

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AQA MAP

Specification coverage audit

AQA 3.1.3.1-3.1.3.4 mapped to deliberate practice

Specification area	What the pack tests	Frequent trap	Questions
3.1.3.1 Ionic bonding	Ion formation; simple-ion charges; compound ions; neutral formulae; giant lattices.	Calling electron transfer the bond; missing brackets or failing to simplify.	1-3, 9-11, 15, 17-19, 22
3.1.3.2 Covalent and dative bonds	Shared pairs; single and multiple bonds; dot-and-cross diagrams; donor-to-acceptor arrows in familiar and unfamiliar species.	Reversing the dative arrow; omitting lone pairs; confusing bonds with forces between molecules.	4-6, 13-17, 22
3.1.3.3 Metallic bonding	Positive metal ions; delocalised electrons; conductivity and melting from attraction and mobility.	Saying positive ions move through a solid metal or using 'free electrons' without precision.	7-8, 10-11, 17-18, 23
3.1.3.4 Four crystal structures	Ionic, metallic, giant covalent and molecular particles, attractions, melting and conductivity.	Jumping from structure name to property without particles, attraction, energy or mobility.	3, 7-14, 17-23
Six named AQA crystals	Diamond, graphite, ice, iodine, magnesium and sodium chloride, including comparisons.	Calling diamond molecular; breaking covalent bonds when iodine or ice melts.	3, 7, 9, 11-14, 18, 23
Specified-particle diagrams	Exact molecule and ion counts; charges; alternating ionic lattice; correct dot-and-cross and structure models.	Correct chemistry with the wrong entity count or omitted charges.	5, 9, 12, 16, 22

Boundary check

No shapes, bond angles, electronegativity, polarity, permanent dipoles or detailed intermolecular-force comparisons are assessed. Ice and iodine appear only as the named molecular crystals required by 3.1.3.4.

Research basis

Scope checked against the current official AQA Chemistry 7405 specification and the CrackingChem Year 12 master specification map. Every question is original and uses recurring AQA demand patterns without reproducing a past-paper item.

SECTION A

TEST IT answers

Definitions, formulae, diagrams and precise particles

TEST IT 1

(a) K^+ [1]; Mg^{2+} [1]; N^{3-} [1]; S^{2-}. [1]

(b) Electron transfer forms the ions. [1] Ionic bonding is electrostatic attraction [1] between oppositely charged ions in a lattice. [1]

Common trap

Do not define ionic bonding as electron transfer. Transfer is the ion-formation step.

TEST IT 2

(a) sulfate SO_4^{2-} [1]; hydroxide OH^- [1]; nitrate NO_3^- [1]; carbonate CO_3^{2-} [1]; ammonium NH_4^+. [1]

(b) $Ba(NO_3)_2$ [1]; $Al_2(SO_4)_3$ [1]; $(NH_4)_2CO_3$ [1]; $Mg(OH)_2$ [1]; Al_2O_3. [1]

Examiner insight

A correct ionic formula is neutral and uses the smallest whole-number ratio. Brackets are required when more than one compound ion is present.

TEST IT 3

(a) A regular, repeating three-dimensional arrangement [1] of oppositely charged ions. [1]

(b) Magnesium oxide has a giant ionic lattice. [1] Strong electrostatic attractions act between Mg^{2+} and O^{2-} ions throughout the lattice. [1] Much energy is needed to overcome these attractions. [1]

(c) In the solid, the ions are fixed in lattice positions. [1] When molten, the ions are mobile [1] and carry charge through the liquid. [1]

TEST IT 4

(a) A single covalent bond is a shared pair of electrons [1] attracted to both positive nuclei. [1]

(b) Cl_2: one shared pair, Cl-Cl [1]; O_2: two shared pairs, O=O [1]; N_2: three shared pairs, N≡N. [1]

(c) It shows the outer-shell electrons [1] and which atom each electron originated from. [1]

TEST IT 5

(a) One shared pair containing one dot and one cross. [1] Three lone pairs are shown on each chlorine atom. [1] The two electron origins are distinguished consistently. [1]

(b) Two shared pairs, each containing one dot and one cross. [1] Two lone pairs are shown on each oxygen atom. [1] The two electron origins are distinguished consistently. [1]

Model dot-and-cross diagrams (outer-shell electrons only)

Cl_2: one shared pair

O_2: two shared pairs

Model answer for Question 5: dot-and-cross diagrams.

TEST IT 6

(a) A shared pair of electrons [1] with both electrons supplied by one atom. [1]

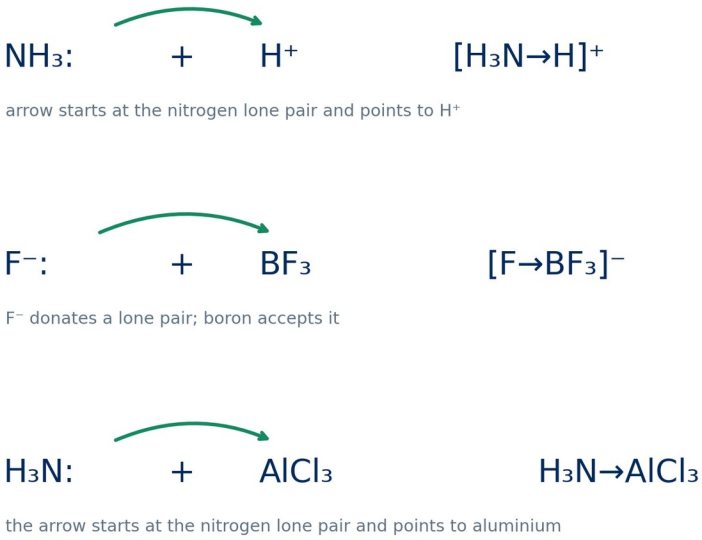
(b) NH_3, through nitrogen, is the donor. [1] H^+ is the acceptor. [1] The arrow starts at nitrogen's lone pair and points to H^+. [1] After NH_4^+ forms, all four N-H bonds are equivalent. [1]

(c) F^- is the donor. [1] The arrow points from a fluoride lone pair towards boron in BF_3. [1]

Common trap

The arrow follows the donated electron pair: donor → acceptor.

Model dative covalent arrows: donor → acceptor



Model dative arrows for Questions 6, 16 and 22.

TEST IT 7

(a) Metallic bonding is strong electrostatic attraction [1] between positive metal ions [1] and delocalised electrons. [1]

(b) Delocalised electrons are mobile [1] and carry charge through the solid lattice. [1]

(c) Strong attractions act between the positive ions and delocalised electrons [1], so substantial energy is needed to overcome them. [1]

TEST IT 8

giant ionic: positive and negative ions [1]; electrostatic attractions between oppositely charged ions. [1]

metallic: positive metal ions and delocalised electrons [1]; electrostatic attraction between the ions and electrons. [1]

giant covalent: atoms [1]; many strong covalent bonds throughout a network. [1]

simple molecular: molecules [1]; forces between molecules. [1]

Examiner insight

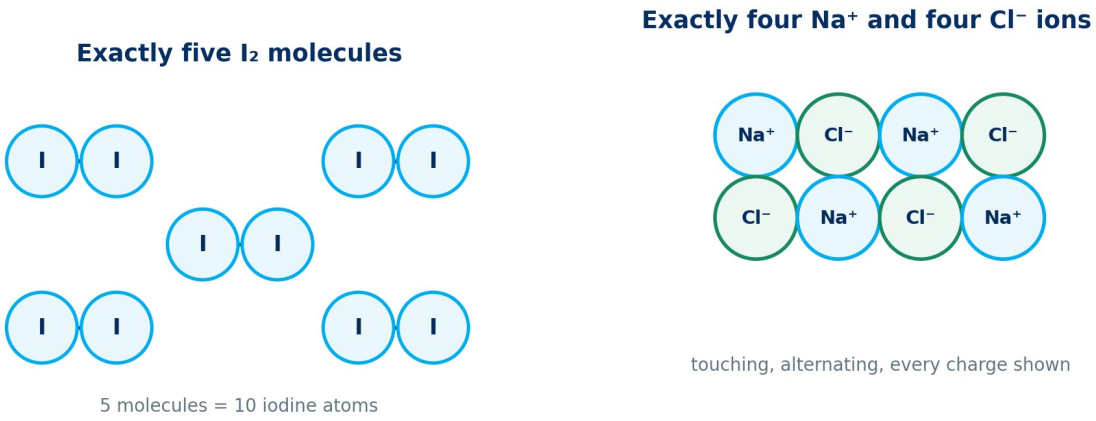
Start with the particles. The rest of a structure-property explanation depends on that first noun.

TEST IT 9

(a) Five distinct I-I pairs are present [1], giving exactly ten iodine atoms arranged as five molecules. [1]

(b) Exactly four Na^+ and four Cl^- ions are shown. [1] Opposite charges alternate in a touching lattice pattern. [1] Every ion has the correct charge. [1]

(c) Iodine is represented by molecules; sodium chloride is represented by ions. [1]



Model answer for Question 9: exact-number particle diagrams.

SECTION B — EXAM STYLE answers

Full marking points and examiner precision

EXAM STYLE 10

(a) W giant ionic [1]; X metallic [1]; Y giant covalent [1]; Z simple molecular. [1]

(b) W conducts only when molten, showing mobile ions in the liquid. [1] X conducts in both states, showing mobile delocalised electrons. [1] Y has a very high melting point and no mobile charge carriers. [1] Z has a low melting point and does not conduct. [1]

EXAM STYLE 11

(a) Sodium chloride contains Na^+ and Cl^- ions. [1] Magnesium contains Mg^{2+} ions and delocalised electrons. [1]

(b) In solid sodium chloride, the ions are charged but fixed. [1] Therefore there are no mobile charge carriers. [1] In magnesium, delocalised electrons are mobile [1] and carry charge through the lattice. [1]

(c) Molten sodium chloride is conducted through mobile Na^+ and Cl^- ions. [1] Molten magnesium is conducted through mobile delocalised electrons. [1]

EXAM STYLE 12

(a) Both are giant covalent structures. [1]

(b) Each carbon forms four covalent bonds in diamond [1] and three in graphite. [1]

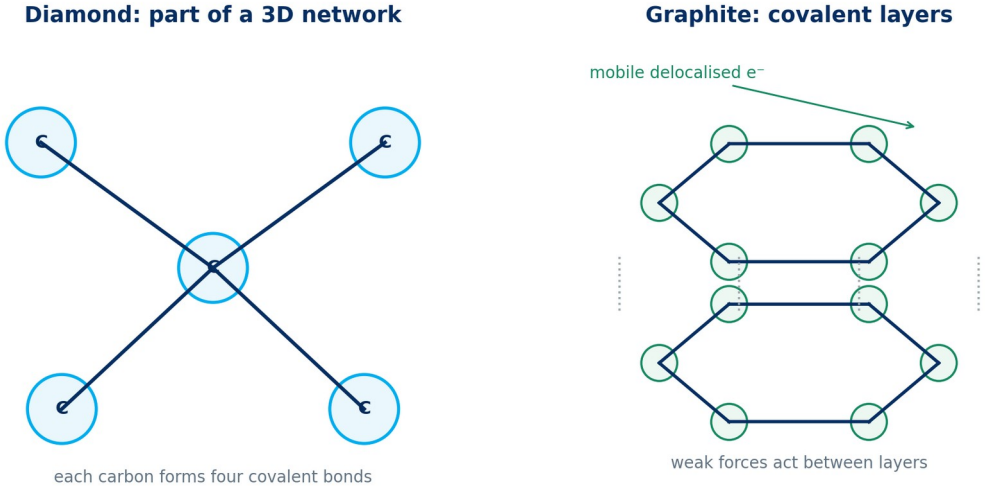
(c) Both contain many strong covalent bonds. [1] These bonds extend throughout a giant structure. [1] Much energy is needed to break enough bonds for melting. [1]

(d) In graphite, one electron per carbon is delocalised and mobile. [1] These electrons carry charge. [1] In diamond, all four outer electrons are used in bonds, so there are no mobile charged particles. [1]

(e) Weak forces act between graphite layers, so the layers can slide. [1]

Common trap

Graphite is not simple molecular. Weak forces act between layers, but strong covalent bonds join atoms within each layer.



Named giant-covalent structure models for Question 12.

EXAM STYLE 13

(a) The I-I covalent bonds are not broken on melting. [1] The melting point is not low because those covalent bonds are weak. [1]

(b) Iodine is a simple molecular crystal of I_2 molecules. [1] Melting overcomes forces between the molecules. [1] The I_2 molecules remain intact. [1]

(c) Diamond is a giant covalent network [1] in which many strong covalent bonds must be broken, requiring much more energy. [1]

EXAM STYLE 14

(a) Ice contains H_2O molecules. [1]

(b) Melting overcomes forces between water molecules [1], not the O-H covalent bonds within them. [1]

(c) Energy is absorbed during melting. [1]

(d) On freezing, attractions form between water molecules [1] and energy is released. [1]

(e) Each H_2O molecule remains intact because its O-H covalent bonds are not broken. [1]

Examiner insight

Detailed intermolecular-force types are not needed here. The assessed distinction is between forces between molecules and covalent bonds within molecules.

EXAM STYLE 15

(a) X^{3+} [1] and Y^{2+}. [1]

(b) $X(NO_3)_3$. [1]

(c) YCO_3. [1]

(d) $(NH_4)_2SO_4$. [1]

(e) X_3SO_4 is not electrically neutral. [1] The correct formula is $X_2(SO_4)_3$. [1]

EXAM STYLE 16

(a) NH_3, through nitrogen, is the donor. [1] $AlCl_3$, through aluminium, is the acceptor. [1]

(b) The arrow starts at the nitrogen lone pair [1] and points towards aluminium. [1]

(c) Nitrogen has a lone pair available to donate. [1]

(d) The shared pair is supplied by nitrogen, not aluminium. [1] An Al → N arrow therefore reverses the donor-to-acceptor direction. [1]

EXAM STYLE 17

(a) Electron transfer forms positive and negative ions. [1] The ionic bond is electrostatic attraction [1] between oppositely charged ions in a lattice. [1]

(b) Molten iodine still contains I_2 molecules. [1] Melting overcomes forces between molecules, not I-I covalent bonds. [1]

(c) Mg^{2+} ions are fixed in the solid lattice. [1] Delocalised electrons are mobile [1] and carry charge through the metal. [1]

Common trap

Every repaired answer names the actual mobile or immobile particle.

EXAM STYLE 18

(a) P iodine [1]; Q sodium chloride [1]; R graphite. [1]

(b) P simple molecular [1]; Q giant ionic [1]; R giant covalent. [1]

(c) P melts at low temperature because only forces between I_2 molecules are overcome. [1] Q conducts when molten because its ions are mobile. [1] R conducts as a solid because delocalised electrons are mobile. [1]

SECTION C — HARDER MIXED answers

Select and connect structure, particles, attraction and mobility

HARDER MIXED 19

(a) M^{3+}. [1]

(b) Giant ionic. [1]

(c) M_2O_3 contains M^{3+} and O^{2-} ions in a giant lattice. [1] Strong electrostatic attractions act between oppositely charged ions. [1] Much energy is needed, giving the high melting point. [1] In the solid the ions are fixed, so it does not conduct. [1] When molten the ions are mobile and carry charge. [1]

(d) $M(NO_3)_3$ [1] and $M(OH)_3$. [1]

HARDER MIXED 20

(a) A is giant covalent. [1] B is simple molecular. [1]

(b) A contains atoms joined by many strong covalent bonds throughout a network. [1] Many covalent bonds must be broken. [1] This needs much energy. [1] B contains discrete X_8 molecules. [1] Melting B overcomes forces between molecules rather than X-X covalent bonds. [1]

(c) A has no mobile charged particles. [1] B also has no mobile charged particles. [1]

HARDER MIXED 21

(a) Giant covalent. [1]

(b) C should have a very high melting point. [1] It contains many strong covalent bonds within continuous layers [1] and much energy is needed to break them. [1]

(c) It should conduct electricity [1] because mobile delocalised electrons carry charge. [1]

(d) Its layers should slide [1] because only weak forces act between the layers. [1]

(e) The particles are atoms in continuous covalent layers [1], not separate molecules. [1]

SECTION D

STRETCH / SYNOPTIC answers

Connect bonding models without importing Bonding II

STRETCH / SYNOPTIC 22

(a) F^- is the electron-pair donor. [1] BF_3, through boron, is the acceptor. [1] The arrow begins at a fluoride lone pair [1] and points towards boron. [1]

(b) $Mg(BF_4)_2$. [1]

(c) The bonds within BF_4^- are covalent. [1] The attraction between Mg^{2+} and BF_4^- ions is ionic. [1]

(d) In the solid, the ions are fixed in lattice positions. [1] When molten, the ions are mobile [1] and carry charge. [1]

(e) The solid has a giant ionic lattice. [1] Strong electrostatic attractions act between oppositely charged ions. [1] Much energy is required to overcome them. [1]

Examiner insight

One species can contain covalent bonds internally and still form an ionic lattice with oppositely charged ions.

STRETCH / SYNOPTIC 23

(a) A magnesium [1]; B graphite [1]; C diamond [1]; D iodine. [1]

(b) B and C are giant covalent structures containing many strong covalent bonds. [1] Much energy is needed to break these bonds, so both have very high melting points. [1] In graphite, one electron per carbon is delocalised [1] and mobile, so it carries charge. [1] Diamond has no mobile charged particles because all four outer electrons are used in bonds. [1]

(c) D consists of discrete I_2 molecules. [1] Melting overcomes forces between molecules [1], which requires far less energy than breaking many covalent bonds in diamond. [1]

Common trap

Do not write that iodine has weak covalent bonds. Its low melting point is controlled by the forces between I_2 molecules.

Final review

For every explanation, check the five-link chain: structure → particles → attraction → energy or mobility → property. For every diagram, recount the exact entities and charges.