Bonding I

OCR A Chemistry A H432 | Specification-led notes

SPEC → CRACK IT → TEST IT → DONE

EVERY SPECIFICATION POINT. EXPLAINED. PRACTISED. CHECKED OFF.

SPECIFICATION COVERAGE

OCR A REF	THIS PACK TEACHES
2.1.2(a)	Ionic charges, required ions and formulae of ionic compounds
2.2.2(a-c)	Ionic bonding, giant lattices and physical properties
2.2.2(d-f)	Covalent, multiple and dative bonds; average bond enthalpy and strength
2.2.2(n-o)	Simple molecular lattices and their physical properties
3.1.1(d-f)	Foundation links: metallic and giant covalent structures; full Periodicity later

Written for first teaching in Year 12

Mapped to OCR A Chemistry A H432, specification version 3.1 (May 2026)

The big picture

YOUR EXPLANATION ROUTE Start with the structure. Then name the particles, attraction, energy or mobility, and only then the property.

OCR explanations score when every link is chemically specific.

THE BIG IDEA Electron transfer creates ions. Sharing electrons creates covalent bonds. Delocalised electrons support metallic bonding. In every case, the attraction must be named precisely.

OCR A BOUNDARY Bonding II covers shapes, bond angles, electronegativity, polarity, dipoles, detailed intermolecular forces and hydrogen bonding. Periodicity later develops the full silicon, graphene and Period 2/3 structure comparison.

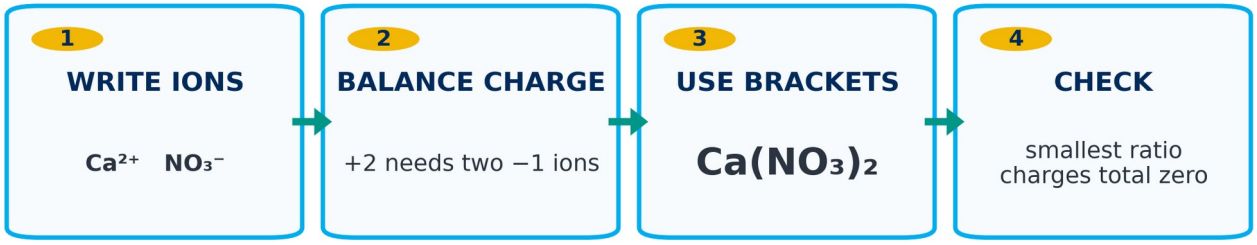
✓ **DONE WHEN** You can build a property explanation without skipping any link in the chain.

1. Ionic formulae and common ions

SPEC 2.1.2(a) Write formulae of ionic compounds from ionic charges. Predict appropriate charges and recall the specified ions.

CRACK IT Balance total positive and negative charge, then write the smallest whole-number ratio.

PREDICT FROM GROUP	ION	REQUIRED OCR ION	FORMULA
Group 1 loses 1 e^-	1+	nitrate	NO_3^-
Group 2 loses 2 e^-	2+	carbonate	CO_3^{2-}
Group 16 gains 2 e^-	2−	sulfate	SO_4^{2-}
Group 17 gains 1 e^-	1−	hydroxide	OH^-
charge supplied if needed	—	ammonium	NH_4^+
recall	—	zinc / silver	Zn^{2+} / Ag^+



The final formula is neutral and uses the smallest whole-number ratio.

EXAM TRAP Brackets are needed only when more than one compound ion is present: $Ca(NO_3)_2$, but $NaNO_3$. Never leave a formula such as Ca_2O_2 that can be simplified.

TEST IT 1 Write the ions formed by calcium and oxygen. Then write formulae for aluminium oxide, calcium nitrate, ammonium sulfate, magnesium hydroxide, zinc carbonate and silver nitrate.

[8 marks]

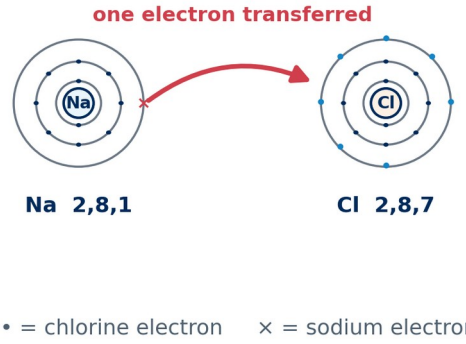
✓ **DONE WHEN** Every formula is neutral, simplified and uses brackets correctly.

2. Ionic bonding and electron origin

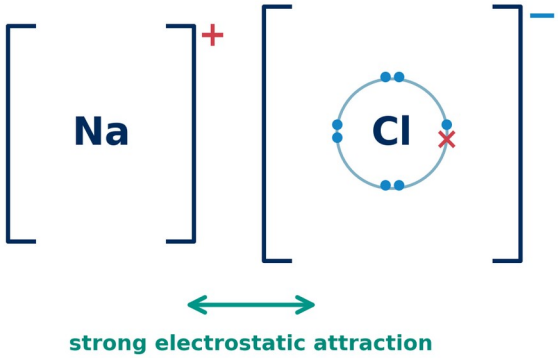
SPEC 2.2.2(a) Explain ionic bonding and construct dot-and-cross diagrams.

CRACK IT Keep the process and the bond separate: electron transfer creates the ions; the electrostatic attraction between positive and negative ions is the ionic bond.

1 ELECTRON TRANSFER CREATES IONS



2 ATTRACTION BETWEEN IONS IS THE BOND



DOT-AND-CROSS CHECKLIST

- Show outer-shell electrons only unless the question says otherwise.
- Use dots and crosses to distinguish electron origin.
- Place each ion in square brackets with its charge outside.
- Check the final electron count and the total charge.

EXAMINER TIP Do not draw a transfer arrow as the ionic bond. The bond is the attraction after the ions have formed.

TEST IT 2 Draw a dot-and-cross diagram for $MgCl_2$. Show electron origin, brackets, charges and complete outer shells. Then state what the ionic bond is.

DIAGRAM SPACE

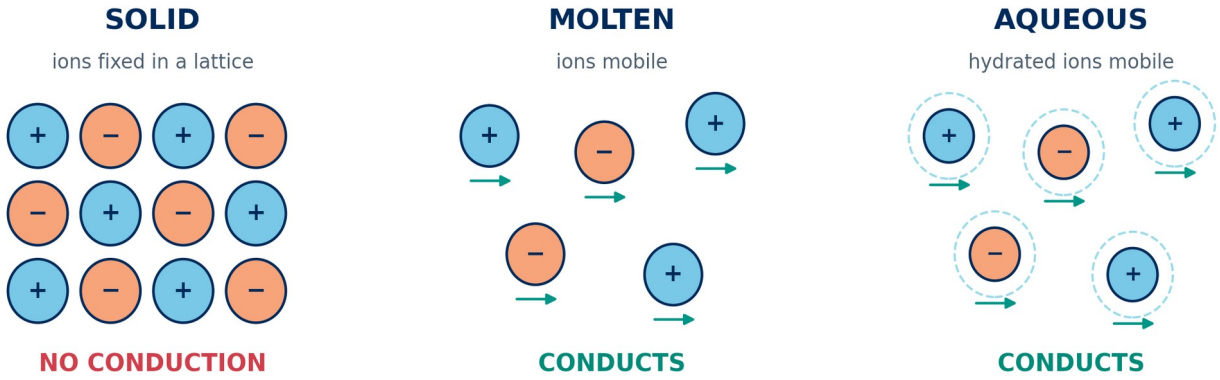
[6 marks]

✓ **DONE WHEN** Your ionic diagram proves where every transferred electron came from.

3. Giant ionic lattices and physical properties

SPEC 2.2.2(b-c) Explain giant ionic lattices and their melting, boiling, solubility and conductivity in solid, liquid and aqueous states.

CRACK IT A giant ionic lattice contains oppositely charged ions strongly attracted in all directions.



PROPERTY	STRUCTURE → PROPERTY EXPLANATION
high mp / bp	many strong electrostatic attractions act throughout the lattice; much energy is needed to overcome them
solid	ions are fixed in position, so there are no mobile charge carriers
molten / aqueous	ions are mobile and carry charge through the liquid or solution
solubility	depends on whether new solvent-ion attractions compensate for separating ions in the lattice

SOLUBILITY LANGUAGE Say ionic compounds are often soluble in water, not always soluble. Solubility depends on the balance of attractions and energy changes.

TEST IT 3 Explain why NaCl has a high melting point, does not conduct as a solid, conducts when molten and conducts when aqueous. Add one careful sentence about solubility in water.

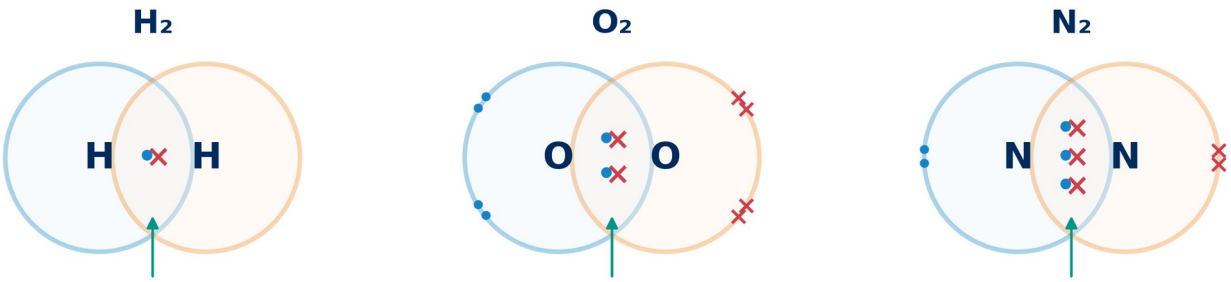
[8 marks]

✓ **DONE WHEN** Every conductivity statement names ions and whether they are mobile.

4. Covalent bonding: single, double and triple

SPEC 2.2.2(d-e)(i-ii) Use the OCR covalent-bond definition and construct electron-origin diagrams for single and multiple bonds.

CRACK IT A covalent bond is the strong electrostatic attraction between a shared pair of electrons and the nuclei of the bonded atoms.



• = electron from left atom × = electron from right atom

BOND	SHARED PAIRS	LINE MODEL	ELECTRON-ORIGIN CHECK
single	1	H-H	one electron from each H
double	2	O=O	two electrons from each O in the bond
triple	3	N≡N	three electrons from each N in the bond

EXAM TRAP 'A pair of shared electrons' is incomplete. OCR expects the electrostatic attraction to both nuclei.

TEST IT 4 State the OCR definition of a covalent bond. Draw complete dot-and-cross diagrams for HCl, O_2 and N_2, including all lone pairs.

DIAGRAM SPACE

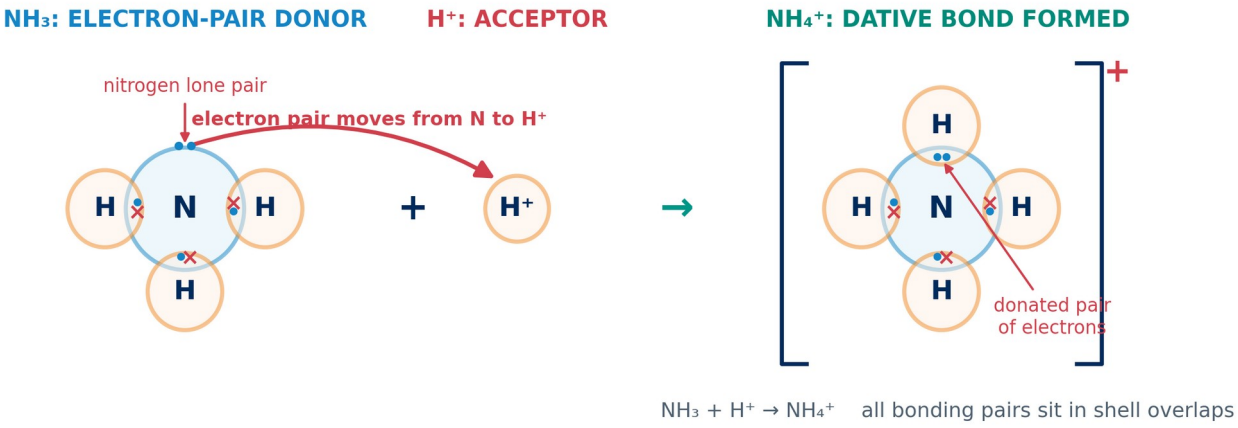
[9 marks]

✓ **DONE WHEN** Every shared pair sits between the nuclei and every lone pair is complete.

5. Dative covalent bonding

SPEC 2.2.2(e)(iii) Describe and represent dative covalent bonding in molecules and ions.

CRACK IT A dative covalent bond is a shared pair of electrons in which both electrons were supplied by the same atom.



$NH_3 + H^+ \rightarrow NH_4^+$ all bonding pairs sit in shell overlaps

ROLE	IN $NH_3 + H^+ \rightarrow NH_4^+$
electron-pair donor	NH_3; the nitrogen supplies its lone pair
electron-pair acceptor	H^+; it accepts the pair
arrow direction	from the donor lone pair towards H^+: N → H
after formation	all four N-H bonds in NH_4^+ are equivalent

EXAMINER TIP Start the arrow at the electron pair, not at the N label. The arrow follows the electrons from donor to acceptor.

TEST IT 5 Explain how NH_4^+ forms from NH_3 and H^+. Name the donor and acceptor, state the arrow direction, and draw the product showing electron origin, brackets and charge.

DIAGRAM SPACE

[7 marks]

✓ **DONE WHEN** You can identify donor, acceptor and arrow direction before drawing the product.

6. Average bond enthalpy and bond strength

SPEC 2.2.2(f) Use average bond enthalpy as a measurement of covalent bond strength.

CRACK IT The larger the average bond enthalpy, the stronger the covalent bond.

RELATIONSHIP TO LEARN higher average bond enthalpy (kJ mol^{-1}) → stronger covalent bond → more energy needed to break it

WORKED EXAMPLE | Comparing bond strength

DATA bond A = 347 kJ mol^{-1}; bond B = 612 kJ mol^{-1}
COMPARE 612 is the larger average bond enthalpy
CONCLUDE bond B is stronger because more energy is needed to break it

OCR A BOUNDARY The formal average-bond-enthalpy lesson and calculations belong in Energetics. No bond-enthalpy calculation is needed here.

TEST IT 6 Bond X has an average bond enthalpy of 436 kJ mol^{-1} and bond Y has 598 kJ mol^{-1}. Identify the stronger bond and justify your answer.

[2 marks]

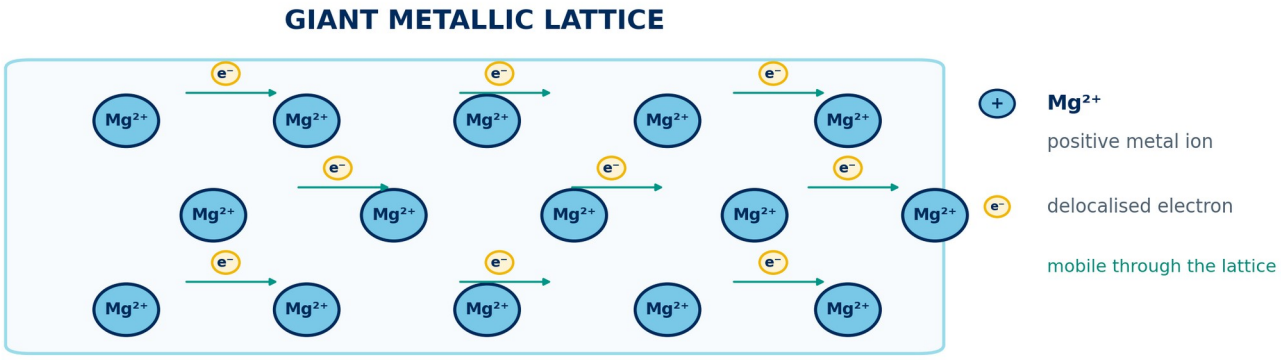
EXAMINER TIP A larger numerical value means a stronger bond. Do not reverse the comparison.

✓ **DONE WHEN** You can compare bond strength from data without attempting a later-topic calculation.

7. Metallic bonding and the metallic lattice

OCR FOUNDATION LINK 3.1.1(d-f) Explain metallic bonding and use particle mobility to explain physical properties. Full Periodicity comparisons come later.

CRACK IT Metallic bonding is the strong electrostatic attraction between cations (positive ions) and delocalised electrons.



Strong electrostatic attraction acts between the cations and the delocalised electrons.

PROPERTY	PARTICLES → ATTRACTION / MOBILITY → PROPERTY
high mp / bp	strong attraction acts throughout the giant lattice; much energy is needed to overcome it
solid metal conducts	delocalised electrons are mobile and carry charge through the solid
liquid metal conducts	the ions are no longer fixed, but delocalised electrons remain mobile
solubility	metals do not normally dissolve as intact metallic lattices in molecular solvents

COMMON LOST MARK Write delocalised electrons, not ‘free electrons’. Name the positive metal ions as well as the electrons.

TEST IT 7 Define metallic bonding. Explain why magnesium conducts electricity as a solid and when molten, and why it has a high melting point.

[7 marks]

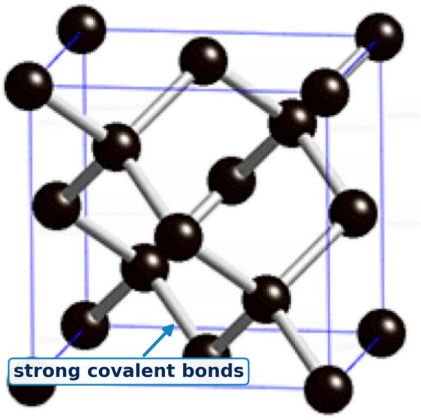
✓ **DONE WHEN** Your conductivity explanation names mobile delocalised electrons in both states.

8. Giant covalent structures: diamond and graphite

OCR FOUNDATION LINK 3.1.1(e-f) Explain giant covalent structures and link their bonding and mobile particles to physical properties.

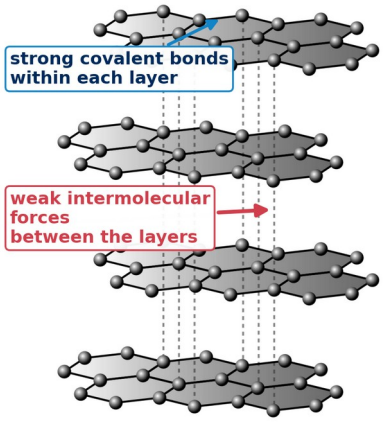
CRACK IT A giant covalent lattice is a network of atoms joined by many strong covalent bonds.

DIAMOND



3D giant covalent network • four bonds per carbon

GRAPHITE



layered network • three bonds per carbon • weak intermolecular forces between layers

FEATURE	DIAMOND	GRAPHITE
carbon bonding	four covalent bonds per carbon	three covalent bonds per carbon
structure	rigid three-dimensional network	layers with weak attractions between layers
melting point	very high: many strong bonds must be broken	very high: many strong bonds must be broken
conductivity	none: no mobile charged particles	conducts: delocalised electrons move along layers

OCR A BOUNDARY Silicon and graphene are developed fully in Periodicity. Here, remember only that they are giant covalent networks; do not bring the later Period 2/3 comparison forward.

TEST IT 8 Explain why diamond has a very high melting point but does not conduct electricity. Then explain why graphite conducts and why its layers can slide.

[8 marks]

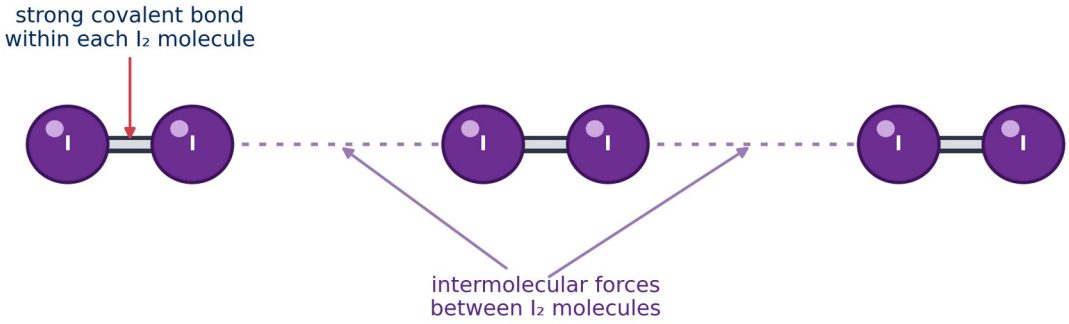
✓ **DONE WHEN** You can compare diamond and graphite without saying graphite contains ions.

9. Simple molecular lattices and state changes

SPEC 2.2.2(n-o) Explain simple molecular lattices and their melting, boiling, solubility and electrical conductivity.

CRACK IT A simple molecular solid contains covalently bonded molecules attracted to one another by intermolecular forces.

SOLID IODINE: DISCRETE I_2 MOLECULES



On melting, intermolecular forces are overcome; the I-I covalent bonds remain intact.

PROPERTY	PARTICLES → ATTRACTION / MOBILITY → PROPERTY
lower mp / bp	intermolecular forces between molecules require less energy to overcome than giant-lattice bonds
does not conduct	neutral molecules provide no mobile ions or delocalised electrons
state change	molecules separate or move; covalent bonds inside each molecule remain intact
solubility	depends on whether new solvent-molecule attractions compensate for attractions being overcome

CRITICAL DISTINCTION Melting iodine overcomes intermolecular forces between I_2 molecules. It does not break the I-I covalent bond.

TEST IT 9 Solid iodine has a much lower melting point than diamond and does not conduct electricity. Explain both statements and state what is overcome when iodine melts.

[6 marks]

✓ **DONE WHEN** You never claim that a covalent bond is broken when a simple molecular substance melts.

10. The four structure types

SPEC SYNTHESIS Use structure and bonding to explain and compare physical properties.

CRACK IT Use the same explanation engine every time: particles → attraction → energy or mobility → property.

Do not jump from the name of a structure straight to the property.

STRUCTURE	PARTICLES	MAIN ATTRACTION	CONDUCTIVITY	MP / BP
ionic	ions	opposite ions	molten / aqueous only	high
metallic	cations + e^-	ions to delocalised e^-	solid and liquid	often high
giant covalent	atoms	covalent bonds	usually none; graphite exception	very high
simple molecular	molecules	intermolecular forces	none	lower

WORKED EXAMPLE | Identifying an unknown solid

DATA high melting point; no conduction as a solid; conducts when molten
MOBILITY charged particles exist but can move only when the solid lattice is broken
IDENTIFY ionic structure

TEST IT 10 Identify A-D: A has a high mp, does not conduct solid and conducts molten; B conducts solid and liquid; C has a very high mp and never conducts; D has a low mp and never conducts.

[4 marks]

✓ **DONE WHEN** You can infer the structure from property evidence and justify the choice using particles.

11. Exam explanations and mastery

EXAMINER ROUTINE Circle the structure, underline the property, then write particles → attraction → energy or mobility → property.

WORKED EXAMPLE | Why does NaCl melt at a much higher temperature than iodine?

STRUCTURES NaCl is giant ionic; iodine is simple molecular

ATTRACTIONS NaCl has strong electrostatic attractions throughout a lattice; iodine has intermolecular forces between I_2 molecules

ENERGY much more energy is needed to overcome the ionic attractions

CONCLUSION NaCl has the higher melting point

EXAM TRAPS Avoid ‘ionic molecules’, ‘free electrons’, ‘all ionic compounds dissolve’, ‘covalent bonds melt’, and explanations that name a structure but not the particles or attraction.

TEST IT 11 A student compares sodium chloride, magnesium, diamond and iodine. For each, state the structure type and predict whether it conducts as a solid. Explain every prediction using the mobile or fixed particles present.

[12 marks]

Final mastery checklist

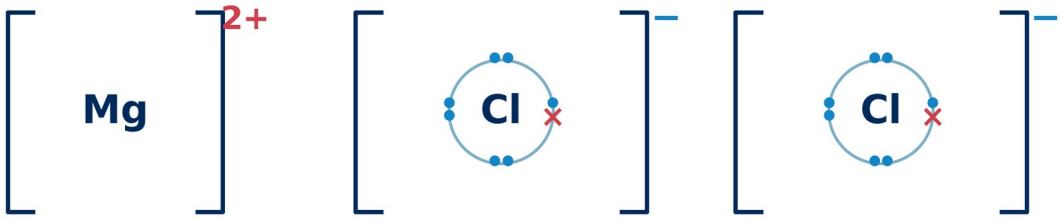
- ☐ I can construct ionic formulae with correct brackets and smallest ratios.
- ☐ I can draw complete electron-origin diagrams with brackets and charges.
- ☐ I can define ionic, covalent, dative and metallic bonding using OCR-ready wording.
- ☐ I can explain mp, bp, solubility and conductivity from structure and mobility.
- ☐ I can compare diamond, graphite, magnesium, sodium chloride and iodine.
- ☐ I can keep Bonding II and full Periodicity content out of this topic.

✓ **DONE WHEN** You can answer the final question without looking back at the comparison table.

TEST IT answers

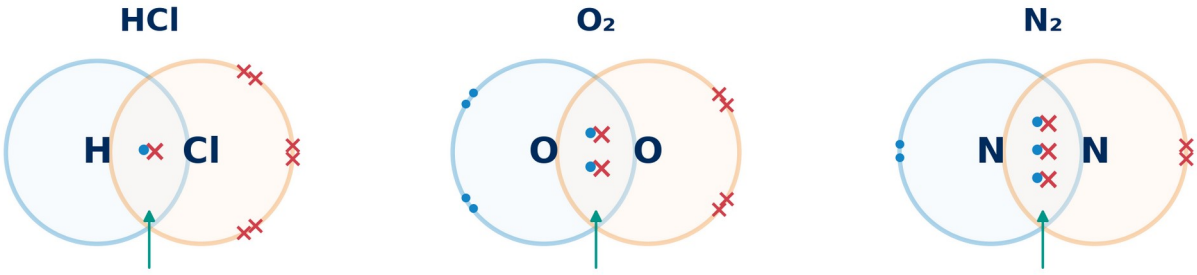
MARKING ROUTINE Award one mark for each distinct correct point or feature shown. Correct diagrams must include electron origin as well as the final electron count.

TEST	CHECK YOUR ANSWER	MARKS
1	Ca^{2+} and O^{2-}. Al_2O_3; $Ca(NO_3)_2$; $(NH_4)_2SO_4$; $Mg(OH)_2$; $ZnCO_3$; $AgNO_3$. Each formula is neutral and simplified.	8
2	Model diagram below. Mg^{2+} and two Cl^- ions are bracketed and charged; each chloride has seven own electrons plus one from Mg. Ionic bond = electrostatic attraction between positive and negative ions.	6



Each chloride ion has seven of its own electrons (•) and one electron from magnesium (×).

TEST	CHECK YOUR ANSWER	MARKS
3	High mp: many strong electrostatic attractions throughout the lattice need much energy. Solid: ions fixed. Molten/aqueous: ions mobile and carry charge. Solubility: often soluble in water when new water-ion attractions compensate for separating the lattice; not all ionic compounds dissolve.	8
4	Definition: strong electrostatic attraction between a shared pair of electrons and the nuclei of the bonded atoms. Model diagrams below; all lone pairs and electron origins shown.	9

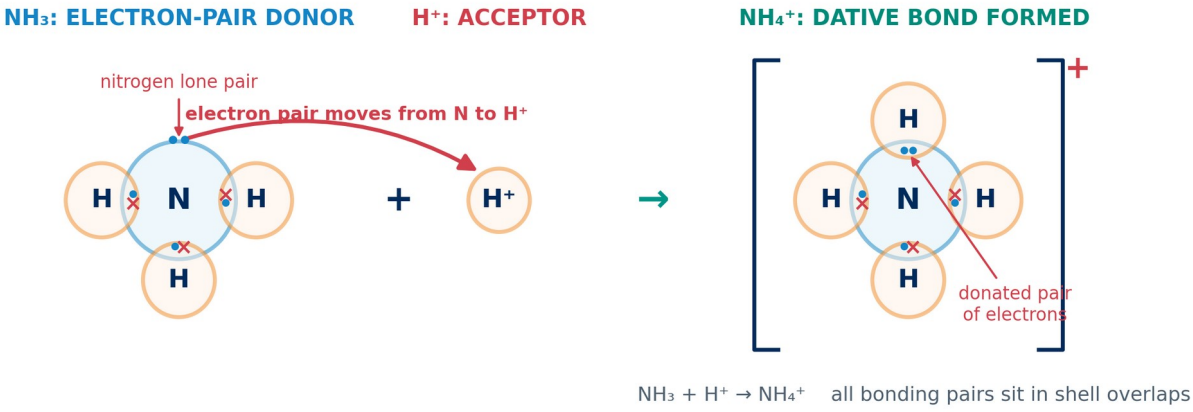


• = electron from left atom × = electron from right atom

SELF-CHECK If a diagram is missing a lone pair, bracket or charge, correct it before awarding the final mark.

TEST IT answers

TEST	CHECK YOUR ANSWER	MARKS
5	NH_3 is the electron-pair donor; H^+ is the acceptor. The arrow starts at the N lone pair and points to H^+. NH_4^+ is bracketed with overall + charge; the new bond pair is shown as two electrons from N.	7
6	Bond Y is stronger because 598 kJ mol^{-1} is the larger average bond enthalpy, so more energy is needed to break it.	2
7	Metallic bonding is the strong electrostatic attraction between positive metal ions and delocalised electrons. Mobile delocalised electrons carry charge in solid and liquid Mg. Strong attraction throughout the giant lattice requires much energy to overcome.	7
8	Diamond: giant 3D covalent network, four bonds per C; many strong bonds require much energy; no mobile charged particles. Graphite: three bonds per C in layers; delocalised electrons conduct; weak attractions between layers allow sliding.	8



$NH_3 + H^+ \rightarrow NH_4^+$ all bonding pairs sit in shell overlaps

TEST	CHECK YOUR ANSWER	MARKS
9	Iodine is simple molecular; only intermolecular forces between I_2 molecules are overcome on melting, so less energy is needed than for diamond's giant covalent network. Neutral molecules provide no mobile charge carriers. The I-I bonds remain intact.	6
10	A ionic; B metallic; C giant covalent; D simple molecular.	4

MARKING NOTE For property explanations, a named structure without particles, attraction and mobility is not a complete answer.

TEST IT answers

TEST	CHECK YOUR ANSWER	MARKS
11	NaCl: ionic; no solid conduction because ions are fixed. Mg: metallic; conducts because delocalised electrons are mobile. Diamond: giant covalent; no mobile charged particles. Iodine: simple molecular; neutral I_2 molecules and no mobile charge carriers. Award one mark for each structure, one for each correct prediction, and one for each particle-based explanation.	12

Mastery map

AREA	TESTS	MARKS
Ions, formulae and ionic diagrams	1-2	14
Ionic structures and properties	3	8
Covalent and dative bonding	4-5	16
Bond strength	6	2
Metallic and giant covalent structures	7-8	15
Simple molecular and structure synthesis	9-11	22
TOTAL	1-11	77

OCR A SCOPE CHECK Covered: 2.1.2(a), 2.2.2(a-f,n-o), with metallic and giant-covalent foundations linked to 3.1.1(d-f). Held back: 2.2.2(g-m) and the full Periodicity treatment of graphene, silicon and Period 2/3 trends.

READY Reattempt the lowest-scoring area without looking at the notes, then mark it again.