



AQA CHEMISTRY 7405

BONDING I

SPECIFICATION-LED STUDENT NOTES

			
SPEC	CRACK IT	TEST IT	DONE WHEN

SPECIFICATION AND STUDENT NOTES

AQA SECTION	YOU WILL MASTER
3.1.3.1	Ionic bonding, common ions and ionic formulae
3.1.3.2	Covalent and dative covalent bonding
3.1.3.3	Metallic bonding
3.1.3.4	Four crystal structures and physical properties

STRUCTURE → PARTICLES → ATTRACTION → ENERGY OR MOBILITY → PROPERTY

THE. BIG PICTURE

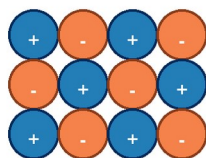
WHY IT MATTERS

Bonding questions reward exact particle language. If you identify what is present, what attracts what, and what can move, the property explanation usually follows.

YOU WILL MASTER

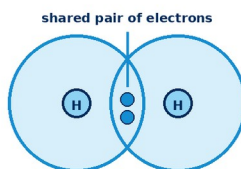
Ionic, covalent, dative and metallic bonding; four structure types; the six named AQA crystals; specified-particle diagrams and exam-ready explanations.

IONIC



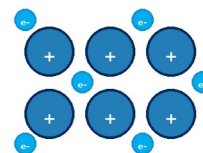
Positive: positive ions
Negative: negative ions
OPPOSITE IONS ATTRACT

COVALENT



Positive: both nuclei
Negative: shared pair of electrons
BOTH NUCLEI ATTRACT THE PAIR

METALLIC



Positive: metal ions
Negative: delocalised electrons
IONS ATTRACT THE ELECTRONS

THE EXPLANATION ENGINE STRUCTURE → PARTICLES → BOND / ATTRACTION → ENERGY OR MOBILITY → PROPERTY. Name every particle and every attraction. Never hide behind 'strong bonds' or 'electrons can move'.

FULL-MARK DEFINITION BANK

TERM	EXAM-READY DEFINITION
Ionic bonding	Strong electrostatic attraction between oppositely charged ions in a lattice.
Single covalent bond	A shared pair of electrons.
Dative covalent bond	A shared pair of electrons with both electrons supplied by one atom.
Metallic bonding	Strong electrostatic attraction between positive metal ions and delocalised electrons.
Giant ionic lattice	A regular, repeating three-dimensional arrangement of oppositely charged ions.
Delocalised electron	An electron that is not attached to one atom or one bond and can move through the structure.



DONE WHEN you can state all four bonding definitions without using vague words such as 'transfer' or 'free electrons'.

1. Ionic bonding: formation first, attraction second



SPEC 3.1.3.1 Ionic bonding involves electrostatic attraction between oppositely charged ions in a lattice. Predict simple-ion charges from Periodic Table position.



CRACK IT Keep two ideas separate. The electron transfer makes the ions. The electrostatic attraction between the ions is the ionic bonding.

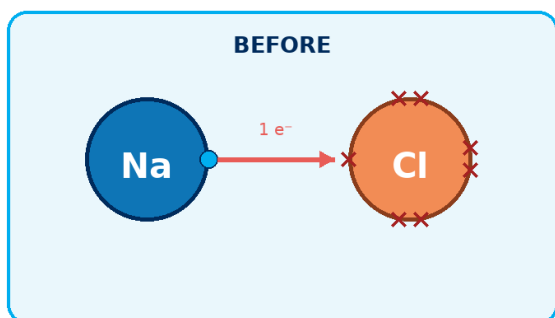
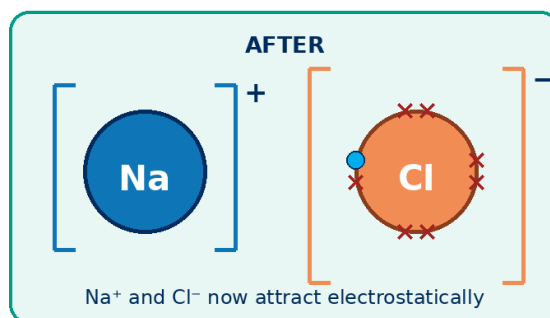
ION FORMATION

Electrons are transferred. Metals lose electrons to form positive ions (cations). Non-metals gain electrons to form negative ions (anions).

IONIC BONDING

After the ions form, every positive ion attracts surrounding negative ions and vice versa throughout the lattice.

ION FORMATION: electron transfer



Predicting common simple-ion charges

GROUP	ELECTRON CHANGE	TYPICAL CHARGE	EXAMPLE
1	loses 1 e ⁻	1+	Na ⁺
2	loses 2 e ⁻	2+	Mg ²⁺
13 / 3	loses 3 e ⁻	3+	Al ³⁺
15 / 5	gains 3 e ⁻	3-	N ³⁻
16 / 6	gains 2 e ⁻	2-	O ²⁻
17 / 7	gains 1 e ⁻	1-	Cl ⁻



TEST IT 1

For potassium, magnesium, nitrogen and sulfur: state the ion formed. Then explain why 'ionic bonding is the transfer of electrons' is not a correct definition. [6 marks]

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DONE WHEN you can distinguish electron transfer from the electrostatic attraction that exists after ions form.

2. Ionic formulae: balance charge, then simplify



SPEC 3.1.3.1 Recall the specified compound ions and construct formulae for ionic compounds.



CRACK IT A compound is neutral. Choose the smallest whole-number ratio for which total positive charge equals total negative charge.

AQA compound ions to know

ION	FORMULA	ION	FORMULA
sulfate	SO_4^{2-}	hydroxide	OH^-
nitrate	NO_3^-	carbonate	CO_3^{2-}
ammonium	NH_4^+		

BRACKET RULE Use brackets when more than one compound ion is needed: $\text{Ca}(\text{NO}_3)_2$, $\text{Mg}(\text{OH})_2$ and $(\text{NH}_4)_2\text{SO}_4$. Never change the formula inside a compound ion.

WORKED EXAMPLE A reliable four-step route

- 1 Write the ions with charges: Al^{3+} and SO_4^{2-} .
- 2 Find the smallest balanced total: $2 \times (+3) = +6$ and $3 \times (-2) = -6$.
- 3 Write the ratio, adding brackets around sulfate: $\text{Al}_2(\text{SO}_4)_3$.
- 4 Charge-check and simplify. The final formula contains no ion charges.

IONS	FIRST RATIO	FINAL FORMULA + CHECK
$\text{Mg}^{2+} + \text{Cl}^-$	1 : 2	MgCl_2 ; $+2 + 2(-1) = 0$
$\text{Al}^{3+} + \text{O}^{2-}$	2 : 3	Al_2O_3 ; $2(+3) + 3(-2) = 0$
$\text{Ca}^{2+} + \text{NO}_3^-$	1 : 2	$\text{Ca}(\text{NO}_3)_2$; $+2 + 2(-1) = 0$
$\text{Ca}^{2+} + \text{O}^{2-}$	2 : 2	simplify Ca_2O_2 to CaO

EXAM TRAP 'Drop and swap' is only a shortcut. It can produce a non-simplified formula. Charge balance is the rule that decides the answer.



TEST IT 2

Write the formulae of aluminium sulfate, ammonium carbonate and calcium hydroxide. Repair these incorrect formulae: Na_2Cl , AlO and CaNO_{32} . [6 marks]

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DONE WHEN you can use charges, brackets and the smallest whole-number ratio without changing a compound ion.

3. Giant ionic lattices and conductivity

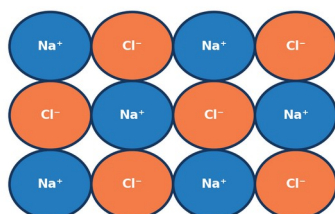


SPEC 3.1.3.4 Relate melting point and conductivity to crystal structure and bonding; represent structures using specified numbers of particles.



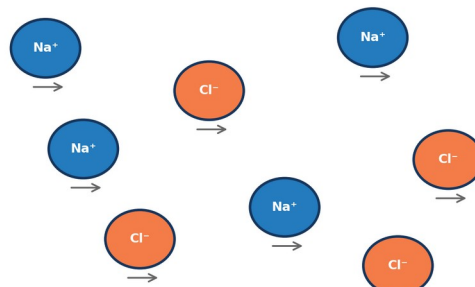
CRACK IT Ask two questions: how strong are the attractions, and can the charged particles move?

SOLID: ions touching and fixed



no mobile charged particles → does not conduct

MOLTEN: ions separated and mobile



mobile ions carry charge → conducts

STATE	WHERE ARE THE IONS?	CONDUCTS?	WHY?
solid	fixed in lattice positions	no	charged ions cannot move; no mobile charge carriers
molten	separated and mobile	yes	mobile ions carry charge through the liquid
aqueous	separated and mobile if dissolved	yes	hydrated ions move through the solution

SOLUBILITY SENSE CHECK Many ionic compounds dissolve in water, but not all do. Do not claim that every ionic compound is soluble. If it is aqueous, its ions are free to move.



TEST IT 3

Explain why solid sodium chloride does not conduct electricity but molten sodium chloride does. Your answer must identify the mobile or immobile charged species. [4 marks]

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DONE WHEN you can explain conductivity by naming ions and stating whether those ions can move.

4. Build full-mark ionic property explanations



SPEC 3.1.3.4 Relate melting point and conductivity to the type of structure and the bonding present.



CRACK IT Use the complete chain. Naming the structure or saying 'strong bonds' is not enough.

THE ROUTE GIANT IONIC LATTICE → OPPOSITELY CHARGED IONS → STRONG ELECTROSTATIC ATTRACTIONS THROUGHOUT → MUCH ENERGY NEEDED → HIGH MELTING POINT

WORKED EXAMPLE Why sodium chloride has a high melting point

Sodium chloride has a giant ionic lattice.

There are strong electrostatic attractions between oppositely charged Na^+ and Cl^- ions throughout the lattice.

A large amount of energy is required to overcome these attractions, so the melting point is high.

WEAK ANSWER

'NaCl has strong bonds, so lots of energy is needed.' This does not identify the particles, the attraction or the giant lattice.

REPAIRED ANSWER

'Strong electrostatic attractions act between oppositely charged ions throughout the giant lattice, so much energy is required to overcome them.'

PROPERTY	WHAT MUST YOUR EXPLANATION NAME?
high melting point	giant lattice; oppositely charged ions; strong electrostatic attractions; much energy
solid non-conductor	ions are charged but fixed; no mobile charge carriers
molten conductor	ions are mobile and carry charge



TEST IT 4

Repair this answer so it would earn full marks: 'Magnesium oxide has a high melting point because it has lots of strong bonds.' [3 marks]

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DONE WHEN your explanation identifies the structure, ions, electrostatic attractions and energy required.

5. Covalent bonding: shared pairs inside molecules



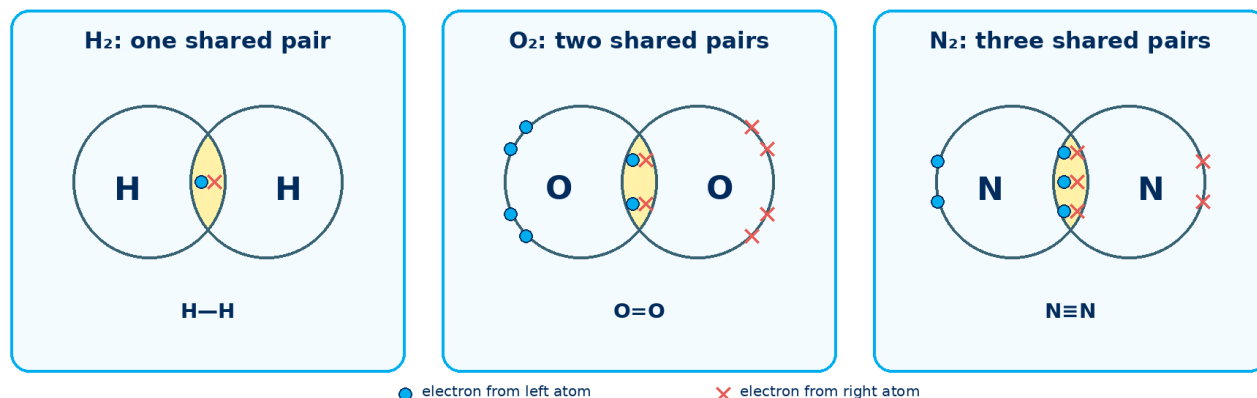
SPEC 3.1.3.2 A single covalent bond contains a shared pair of electrons. Multiple bonds contain multiple shared pairs. Represent a covalent bond using a line.



CRACK IT One line represents one shared pair: single = one pair, double = two pairs, triple = three pairs.

FULL-MARK DEFINITION A single covalent bond is a shared pair of electrons. The shared pair is attracted to both positive nuclei.

DOT-AND-CROSS: outer-shell electrons



WITHIN A MOLECULE

Atoms are joined by strong covalent bonds. Melting a molecular solid does not break these bonds.

BETWEEN MOLECULES

Separate forces act between molecules. These are the attractions overcome when iodine or ice melts.

EXAM TRAP Do not say that covalent bonds are broken when a simple molecular substance melts. The molecules remain chemically intact.



TEST IT 5

State the number of shared pairs in H₂, O₂ and N₂. Write their line representations and explain what a dot-and-cross diagram shows. [5 marks]

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DONE WHEN you can move between dot-and-cross and line representations without confusing bonds with forces between molecules.

6. Dative covalent bonding: donor → acceptor

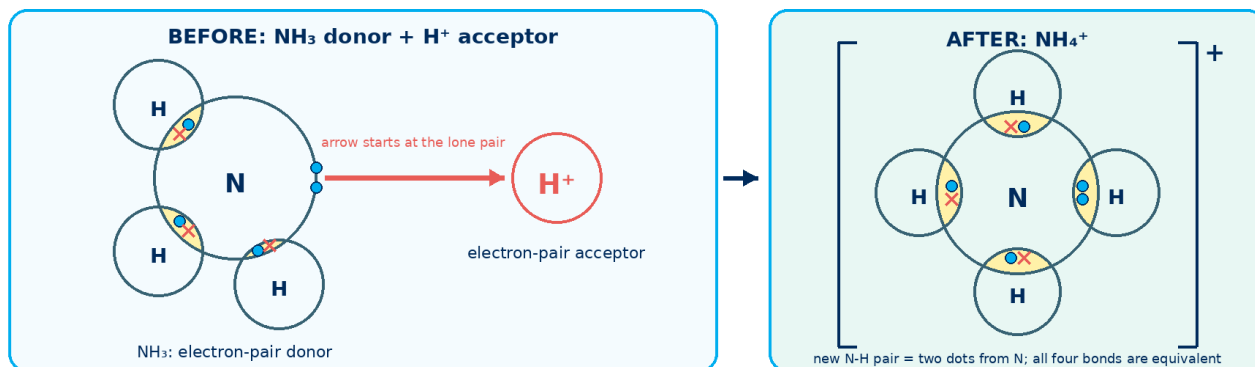


SPEC 3.1.3.2 A co-ordinate (dative covalent) bond contains a shared pair with both electrons supplied by one atom. Represent the bond using an arrow.



CRACK IT The arrow points from the electron-pair donor to the electron-pair acceptor. It begins at the lone pair.

DATIVE BOND: a lone pair is donated to H^+



ROLE	IN $NH_3 + H^+ \rightarrow NH_4^+$	WHY?
electron-pair donor	NH_3 , through nitrogen	nitrogen has a lone pair available
electron-pair acceptor	H^+	H^+ has no electrons and accepts the pair
arrow direction	$N \rightarrow H$	the arrow follows the movement of the donated pair

CRITICAL FACT Once NH_4^+ has formed, the dative $N-H$ bond is equivalent to the other three $N-H$ covalent bonds. The origin of the pair does not make a different kind of bond afterwards.



TEST IT 6

For $NH_3 + H^+ \rightarrow NH_4^+$, identify the donor and acceptor, state the arrow direction, and explain the status of the four $N-H$ bonds after formation. [4 marks]

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DONE WHEN your arrow starts at the lone pair, points to the acceptor and you know all four $N-H$ bonds become equivalent.

7. Metallic bonding and mobile electrons



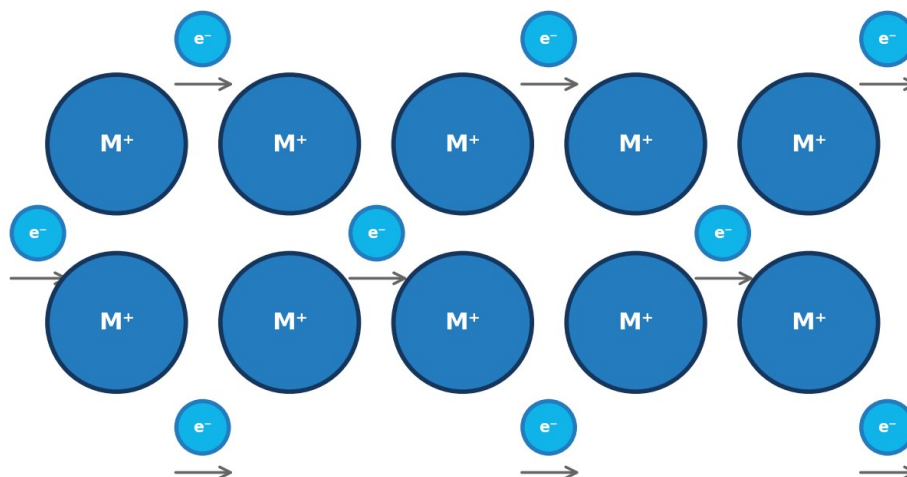
SPEC 3.1.3.3 Metallic bonding involves attraction between delocalised electrons and positive ions arranged in a lattice.



CRACK IT Name both charged components: positive metal ions and delocalised electrons.

FULL-MARK DEFINITION Metallic bonding is the strong electrostatic attraction between positive metal ions and delocalised electrons.

GIANT METALLIC LATTICE



positive ions are close together; mobile delocalised electrons carry charge

PROPERTY	STRUCTURE-TO-PROPERTY EXPLANATION
conducts as a solid	delocalised electrons are mobile and carry charge through the lattice
conducts as a liquid	delocalised electrons remain mobile and carry charge
often high melting point	strong attraction between positive ions and delocalised electrons requires substantial energy to overcome

LANGUAGE TRAP Use delocalised electrons, not 'free electrons'. Do not say the metal conducts because the positive ions move through the solid.



TEST IT 7

Define metallic bonding and explain why solid magnesium conducts electricity. Identify the mobile charged particles. [4 marks]

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DONE WHEN you explain metallic properties using positive ions, delocalised electrons and mobile charge carriers.

8. The four structure types: particles and attractions



SPEC 3.1.3.4 Know ionic, metallic, macromolecular (giant covalent) and molecular crystal structures.



CRACK IT First identify the particles. Then name exactly what holds those particles together.

STRUCTURE	PARTICLES PRESENT	BOND / ATTRACTION	WHAT MUST BE OVERCOME?
giant ionic	positive and negative ions	electrostatic attractions between oppositely charged ions	ionic lattice attractions
metallic	positive metal ions and delocalised electrons	electrostatic attraction between ions and electrons	metallic attractions
giant covalent	atoms	many strong covalent bonds throughout a network	many covalent bonds
simple molecular	molecules	forces between molecules	intermolecular forces, not covalent bonds within molecules

One explanation frame for every property

STEP	QUESTION TO ASK	EXAMPLE LANGUAGE
1 Structure	What type of structure is it?	'Diamond is giant covalent...'
2 Particles	What particles are present?	'...carbon atoms...'
3 Attraction	What holds them together?	'...joined by many strong covalent bonds...'
4 Energy / mobility	What must be overcome, or what can move?	'...much energy is needed...' / '...ions are mobile...'
5 Property	What observation follows?	'...so the melting point is very high.'

EXAMINER TIP Do not jump from structure name straight to property. The marks usually sit in the middle of the chain: particles, attraction, energy or mobility.



DONE WHEN you can name the particles and attractions in all four structures without looking at the table.

9. The four structure types: mobility and properties



SPEC 3.1.3.4 Relate melting point and conductivity to structure and bonding, including unfamiliar materials.



CRACK IT Conductivity needs mobile charged particles. A high melting point needs strong attractions and substantial energy to overcome them.

STRUCTURE	MOBILE CHARGED PARTICLES?	MELTING POINT	CONDUCTIVITY
giant ionic	solid: none; molten/aqueous: ions	high	no when solid; yes when molten or aqueous
metallic	delocalised electrons	often high	yes as solid and liquid
giant covalent	usually none; graphite is an exception	very high	usually no; graphite conducts
simple molecular	none	usually low compared with giant structures	no

Use property data to identify an unknown

SOLID	MELTING POINT	CONDUCTS AS SOLID?	CONDUCTS WHEN MOLTEN?
A	high	no	yes
B	high	yes	yes
C	very high	no	no
D	low	no	no



TEST IT 8

Identify the most likely structure type of A, B, C and D. For each, quote the decisive evidence from the table. [8 marks]

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DONE WHEN you identify structures from evidence and justify the choice with energy or mobility, not guesswork.

10. Named examples: sodium chloride and magnesium



SPEC 3.1.3.4 Know sodium chloride and magnesium as examples of ionic and metallic crystal structures.



CRACK IT These solids can both have high melting points, but their particles and mobile charge carriers are different.

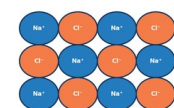
SODIUM CHLORIDE: GIANT IONIC

Particles: Na^+ and Cl^- ions. Attraction: electrostatic attraction between oppositely charged ions throughout a lattice. Solid ions are fixed; molten or aqueous ions are mobile.

MAGNESIUM: METALLIC

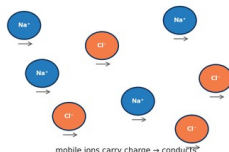
Particles: Mg^{2+} ions and delocalised electrons. Attraction: electrostatic attraction between positive ions and electrons. The electrons are mobile in both solid and liquid metal.

SOLID: ions touching and fixed



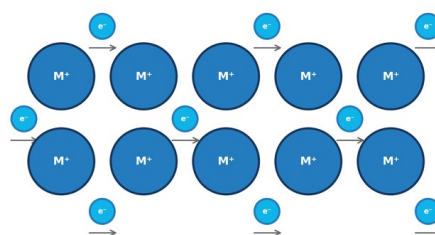
no mobile charged particles → does not conduct

MOLTEN: ions separated and mobile



mobile ions carry charge → conducts

GIANT METALLIC LATTICE



positive ions are close together; mobile delocalised electrons carry charge

QUESTION	NaCl	Mg
particles	Na^+ and Cl^- ions	Mg^{2+} ions + delocalised electrons
solid conductor?	no: ions fixed	yes: electrons mobile
molten conductor?	yes: ions mobile	yes: electrons mobile



TEST IT 9

Compare the electrical conductivity of solid and molten sodium chloride with solid magnesium. Name the charge carrier in every conducting case. [6 marks]

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DONE WHEN you distinguish mobile ions from mobile delocalised electrons in the two named lattices.

11. Diamond: a rigid giant covalent network

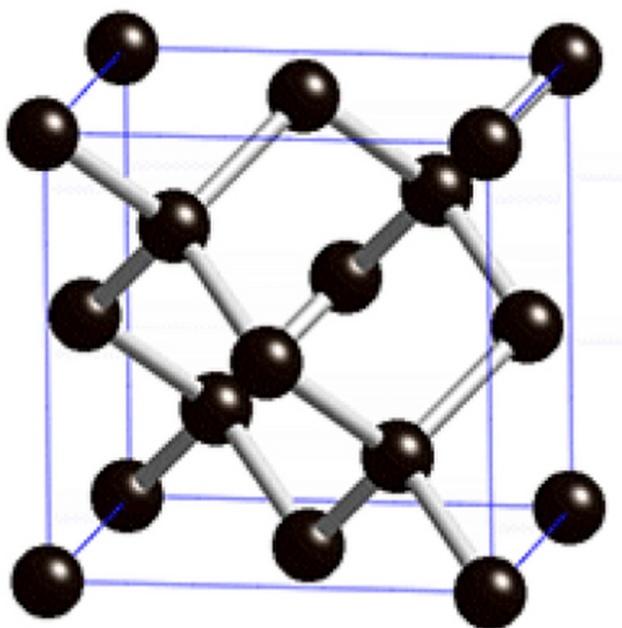


SPEC 3.1.3.4 Know diamond as an example of a macromolecular (giant covalent) crystal and relate structure to properties.



CRACK IT Diamond is not made of molecules. It is one continuous network of carbon atoms.

Diamond: 3D giant covalent



each C forms 4 strong covalent bonds
no mobile charged particles

FEATURE	STRUCTURE	PROPERTY LINK
bonding	each carbon forms four strong covalent bonds	a rigid three-dimensional network forms
melting point	many strong covalent bonds extend throughout the lattice	much energy is needed to break them; very high melting point
hardness	each atom is held in a fixed network	the structure is very hard
conductivity	all four outer electrons are used in bonds	no mobile charged particles; does not conduct

WORKED EXAMPLE Why diamond has a very high melting point

Diamond has a giant covalent lattice of carbon atoms.
Each carbon is covalently bonded to four other carbon atoms.
Many strong covalent bonds must be broken, requiring a large amount of energy.

EXAM TRAP Do not write 'intermolecular forces' for diamond. There are no discrete diamond molecules.



DONE WHEN you can explain diamond's very high melting point, hardness and lack of conductivity from its carbon network.

12. Graphite: layers plus delocalised electrons

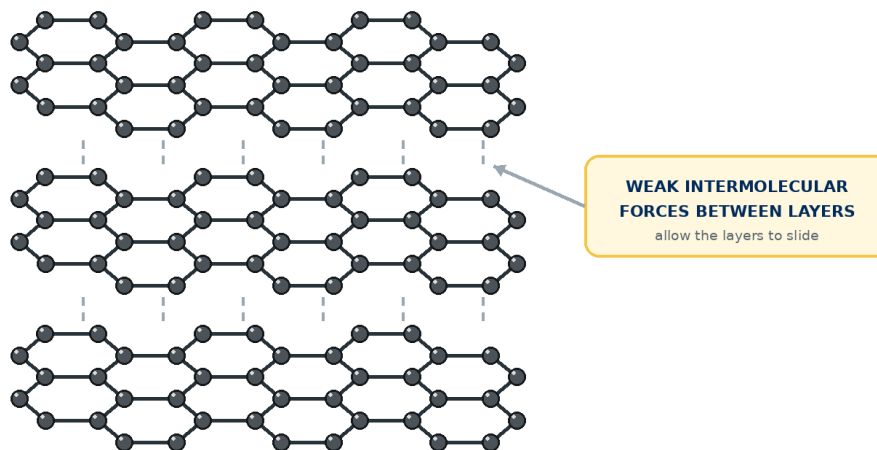


SPEC 3.1.3.4 Know graphite as a giant covalent crystal and relate its layered structure to conductivity and physical properties.



CRACK IT Graphite has strong covalent bonds within each layer and weak forces between layers. Keep those two attractions separate.

Graphite: layered giant covalent



each carbon forms 3 covalent bonds in a flat layer
one electron per carbon is delocalised and mobile within each layer

FEATURE	STRUCTURE	PROPERTY LINK
bonding	each carbon forms three covalent bonds	flat layers of hexagonal rings form
conductivity	one electron per carbon is delocalised	mobile electrons carry charge along the layers
layers slide	weak forces act between layers	layers can move over one another
melting point	many strong covalent bonds exist within layers	much energy is needed; melting point is very high

COMMON LOST MARK Graphite conducts because delocalised electrons are mobile. 'Electrons can move' is incomplete unless you identify them as delocalised charge carriers.



TEST IT 10

Compare diamond and graphite. Explain why both have very high melting points, why only graphite conducts, and why graphite's layers can slide. [7 marks]

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DONE WHEN you can compare diamond and graphite without confusing covalent bonds within layers with forces between layers.

13. Molecular crystals: iodine and ice



SPEC 3.1.3.4 Know iodine and ice as molecular crystals; relate changes of state to the attractions present.



CRACK IT Melting separates molecules. It does not split I_2 molecules into atoms or break O—H covalent bonds in H_2O .

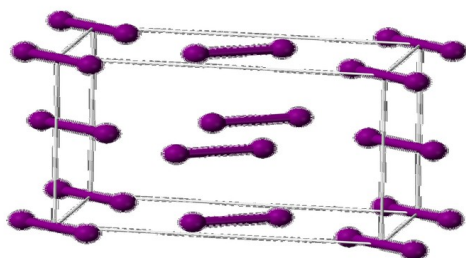
SOLID IODINE

Particles: I_2 molecules. Strong I—I covalent bonds hold each molecule together. Weaker forces act between molecules and are overcome during melting.

ICE

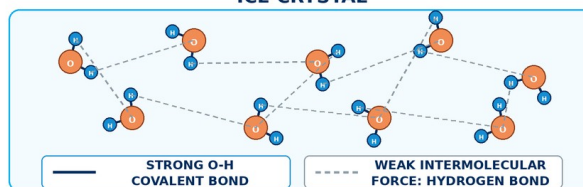
Particles: H_2O molecules in a regular lattice. Forces between molecules hold the lattice together. Melting overcomes some of these forces, not O—H bonds.

Solid iodine: I_2 molecular lattice



strong I—I bonds inside each molecule
weaker forces between molecules

ICE CRYSTAL



CHANGE	ENERGY	WHAT HAPPENS TO ATTRACTIONS?
melting / boiling	energy is absorbed	forces between particles are overcome
freezing / condensing	energy is released	forces between particles form

BOUNDARY The detailed types and relative strengths of intermolecular forces are taught in Bonding II. Here, the key distinction is between covalent bonds inside molecules and forces between molecules.



TEST IT 11

Explain why iodine melts without breaking I—I bonds. Then state the particles in ice and what is overcome when ice melts. [6 marks]

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DONE WHEN you identify molecules as the particles and state that melting overcomes forces between molecules.

14. Specified-particle diagrams and final explanation checks



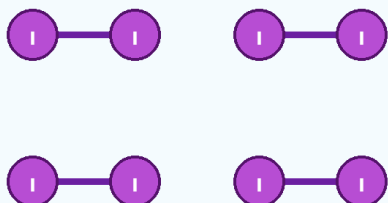
SPEC 3.1.3.4 Draw diagrams to represent structures involving specified numbers of particles.



CRACK IT Read the entity word before drawing: ions, atoms or molecules. Then count every entity twice.

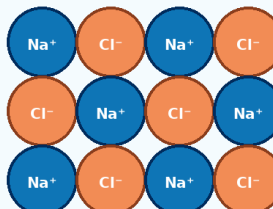
SPECIFIED PARTICLES: count the requested entities

exactly 4 I₂ molecules



Each touching I—I pair is one molecule.

exactly 6 Na⁺ and 6 Cl⁻ ions



Neighbouring ions touch and alternate.

IF THE QUESTION ASKS FOR...	DRAW...	CHECK...
4 I₂ molecules	four separate touching I—I pairs	8 iodine atoms arranged as 4 molecules
6 Na⁺ and 6 Cl⁻ ions	12 touching circles in an alternating pattern	exactly 6 of each charge; neighbours opposite
a molecular solid	discrete molecules with gaps/forces between	do not join all atoms into one covalent network

DIAGRAM TRAP AQA can specify an exact number. A chemically sensible pattern with the wrong count can still lose the mark.



TEST IT 12

Draw exactly five I₂ molecules. Beside it, draw a touching alternating lattice containing exactly four Na⁺ ions and four Cl⁻ ions. Label the particles and charges. [4 marks]

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DONE WHEN your diagram contains the requested entity, exact count, correct charges and correct lattice pattern.

FINAL. MASTERY CHECK

THE METHOD For every explanation, move through STRUCTURE → PARTICLES → BOND / ATTRACTION → ENERGY OR MOBILITY → PROPERTY.

	I CAN...	SPEC	CONFIDENCE
☐	separate ion formation from ionic bonding	3.1.3.1	R / A / G
☐	predict simple-ion charges	3.1.3.1	R / A / G
☐	recall the five specified compound ions	3.1.3.1	R / A / G
☐	construct and charge-check ionic formulae	3.1.3.1	R / A / G
☐	define single and dative covalent bonds	3.1.3.2	R / A / G
☐	use lines and dative arrows correctly	3.1.3.2	R / A / G
☐	define metallic bonding precisely	3.1.3.3	R / A / G
☐	identify particles and attractions in all four structures	3.1.3.4	R / A / G
☐	explain melting point using energy and attractions	3.1.3.4	R / A / G
☐	explain conductivity using mobile charged particles	3.1.3.4	R / A / G
☐	compare diamond and graphite	3.1.3.4	R / A / G
☐	explain melting in iodine and ice without breaking covalent bonds	3.1.3.4	R / A / G
☐	draw a structure containing an exact number of particles	3.1.3.4	R / A / G
☐	repair vague explanations into exam-ready chemistry	3.1.3.4	R / A / G

SIX SENTENCES WORTH MEMORISING

- Ionic bonding is the strong electrostatic attraction between oppositely charged ions in a lattice.
- A single covalent bond is a shared pair of electrons.
- A dative covalent bond is a shared pair with both electrons supplied by one atom.
- Metallic bonding is the strong electrostatic attraction between positive metal ions and delocalised electrons.
- Conductivity requires mobile charged particles.
- A change of state overcomes attractions between particles; it does not change the particles' chemical identity.



DONE WHEN every box is green and you can complete TEST IT 1–12 without using the notes.

TEST IT. ANSWERS 1–6

MARKING RULE Award one mark for each distinct correct point unless stated otherwise. Equivalent precise chemical wording is acceptable.

- 1. Ion formation and ionic bonding** K^+ ; Mg^{2+} ; N^{3-} ; S^{2-} . Electron transfer forms the ions. Ionic bonding is the strong electrostatic attraction between the oppositely charged ions after formation. [6]
- 2. Ionic formulae** $Al_2(SO_4)_3$; $(NH_4)_2CO_3$; $Ca(OH)_2$. Repairs: $NaCl$; Al_2O_3 ; $Ca(NO_3)_2$. Formulae are neutral and use the smallest whole-number ratio. [6]
- 3. Conductivity** In solid $NaCl$, Na^+ and Cl^- ions are fixed in lattice positions, so there are no mobile charge carriers. When molten, the ions are free to move and carry charge through the liquid. [4]
- 4. Repair the melting-point answer** Magnesium oxide has a giant ionic lattice. Strong electrostatic attractions act between oppositely charged Mg^{2+} and O^{2-} ions throughout the lattice. A large amount of energy is needed to overcome these attractions, so its melting point is high. [3]
- 5. Covalent bonds** H_2 has one shared pair and is $H-H$. O_2 has two shared pairs and is $O=O$. N_2 has three shared pairs and is $N\equiv N$. A dot-and-cross diagram shows outer-shell electrons and which atom each electron originated from. [5]
- 6. Dative bonding** Nitrogen in NH_3 is the electron-pair donor; H^+ is the acceptor. The arrow points from nitrogen's lone pair to H^+ , $N \rightarrow H$. After NH_4^+ forms, all four $N-H$ bonds are equivalent. [4]

SELF-CHECK: DEFINITIONS

TERM	NON-NEGOTIABLE WORDS
ionic	electrostatic attraction; oppositely charged ions; lattice
single covalent	shared pair of electrons
dative	shared pair; both electrons supplied by one atom
metallic	positive metal ions; delocalised electrons; electrostatic attraction



DONE WHEN you can explain why each marking point earns a mark, not merely copy the final sentence.

TEST IT. ANSWERS 7–12

- 7. Metallic bonding** Strong electrostatic attraction between positive metal ions and delocalised electrons. In solid magnesium, delocalised electrons are mobile and carry charge through the lattice. [4]
- 8. Unknown structures** A: giant ionic, because it conducts only when molten. B: metallic, because it conducts as a solid and liquid. C: giant covalent, because it has a very high melting point and does not conduct. D: simple molecular, because it has a low melting point and does not conduct. [8]
- 9. NaCl and magnesium** Solid $NaCl$ does not conduct because its ions are fixed. Molten $NaCl$ conducts because Na^+ and Cl^- ions are mobile. Solid magnesium conducts because delocalised electrons are mobile. The charge carriers are ions in molten $NaCl$ and electrons in magnesium. [6]
- 10. Diamond and graphite** Both are giant covalent and contain many strong covalent bonds, so much energy is needed to melt them. Diamond has four bonds per carbon and no mobile charge carriers. Graphite has three bonds per carbon; one electron per carbon is delocalised and carries charge. Weak forces between layers allow the layers to slide. [7]
- 11. Iodine and ice** Solid iodine contains I_2 molecules. Melting overcomes forces between I_2 molecules; the $I-I$ covalent bonds remain. Ice contains H_2O molecules. Melting overcomes some forces between water molecules, not the $O-H$ covalent bonds. [6]
- 12. Specified particles** Diagram contains five separate $I-I$ pairs. The ionic diagram contains exactly four Na^+ and four Cl^- ions in a touching alternating pattern, with every charge shown. [4]

FINAL EXAMINER CHECK For melting-point explanations, name the attraction and the energy needed. For conductivity, name the mobile charged species. For diagrams, count the specified entities twice.



DONE WHEN your TEST IT answers use precise particles, attractions, energy and mobility throughout.