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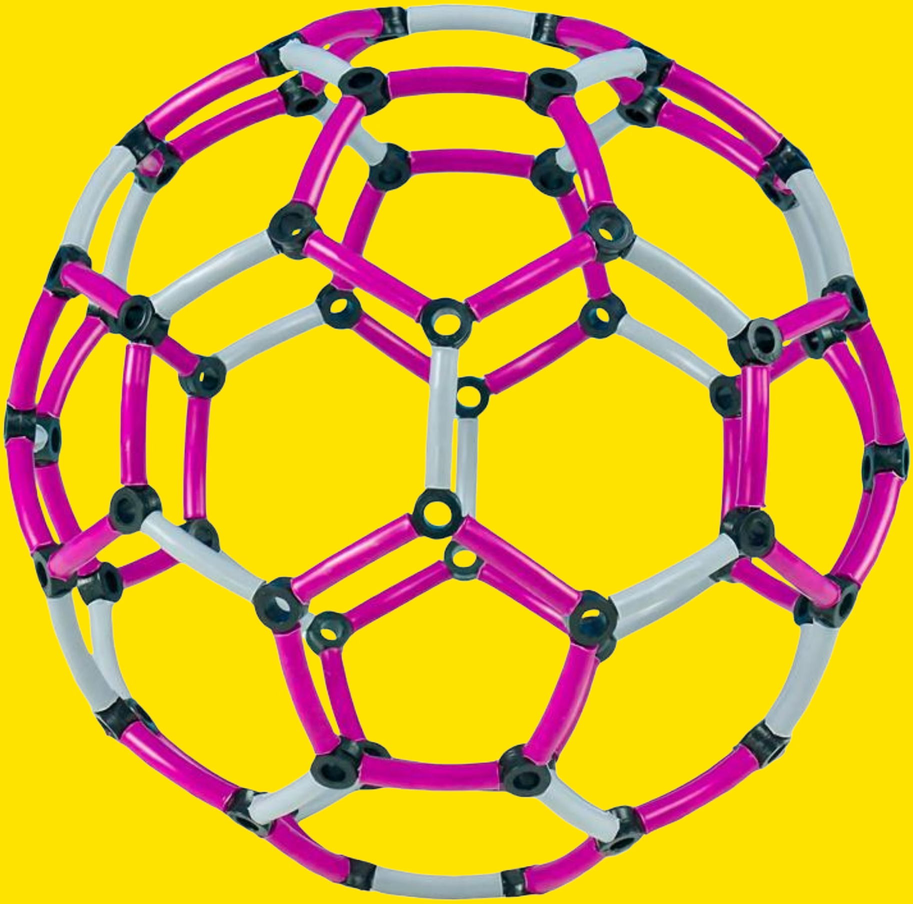
AS Chemistry



Unit 1
Advanced Practice
2019 - 2026

Edexcel International Advanced Level

CHEMISTRY

Unit 1 · Structure, Bonding and Introduction to Organic Chemistry

WCH11/01

Questions & Answers by Topic

Every past-paper question June 2019 - January 2026, solved in full, organised under the 21 chapters of the course notes.

21 chapters · 20 papers · every question classified

chem-bio.info

IGCSE & IAL subject resources

Chapter 7

Ionic Bonding

Revise from your notes: pp. 17-18

21 questions · 18 multiple choice · 3 structured

Edexcel IAL - Solved Past Paper

June 2019 · Unit 1: Structure, Bonding and Introduction to Organic Chemistry (WCH11/01) · Question 1 ·

● hard ● medium ● easy

● 1

Select · [1 mark]

Which statement is NOT true for sodium chloride?

Answer

- [ ] **A** sodium chloride conducts electricity in aqueous solution
- [ ] **B** sodium chloride conducts electricity when molten
- [x] **C** **sodium chloride has a molecular structure**
- [ ] **D** sodium chloride has a giant structure

The logic

✓ Sodium chloride is a giant ionic lattice — a continuous 3-D network of Na^+ and Cl^- ions, so it has no molecules at all.

✓ A and B really are true: once the ions are freed (dissolved or molten) they can move and carry charge, and D is exactly what an **ionic crystal** is.

Why the others fail

A true statement - mobile ions in solution do conduct
B true statement - molten NaCl conducts because the lattice is broken up
D true statement - NaCl is a giant ionic structure

Examiner's insight

Read the stem twice when it contains NOT - most slips here came from picking a true statement.

Revise from your notes

- Ionic bonds - notes p. 17 7.1
- Covalent bond - notes p. 20 9.1
- Polar molecules - notes p. 26 12.4

Edexcel IAL - Solved Past Paper

● hard ● medium ● easy

● 5

Select · [1 mark]

Which pair of ions gives the strongest ionic bonding?

Answer

- [ ] **A** Na^+ and F^-
- [ ] **B** K^+ and Br^-
- [x] **C** **Mg^{2+} and O^{2-}**
- [ ] **D** Ca^{2+} and S^{2-}

The logic

✓ Ionic bond strength rises with bigger charges and smaller ions — both increase the attraction between the ions.

✓ Mg^{2+} and O^{2-} carry double charges AND are the smallest of the doubly-charged pairs offered, so the attraction is strongest.

Why the others fail

A only single charges (1+ / 1·)
B single charges and even larger ions
D same 2+/2· charges but Ca^{2+} and S^{2-} are larger, so the attraction is weaker

Examiner's insight

Under 55% got this - compare charge FIRST, then size. Two ions can have the same charges yet very different attractions.

Revise from your notes

- Ionic bonds - notes p. 17 7.1
- Covalent bond - notes p. 20 9.1
- Polar molecules - notes p. 26 12.4

Edexcel IAL - Solved Past Paper

hard medium easy

8

Select · [1 mark]

Some ionic radii are shown. Which compound has the strongest ionic bonding?

Ion	Ionic radius / nm
Na^+	0.102
K^+	0.138
F^-	0.133
Cl^-	0.180

The ionic radii

Answer

- [x] **A** sodium fluoride
- [ ] **B** sodium chloride
- [ ] **C** potassium fluoride
- [ ] **D** potassium chloride

The logic

✓ All four compounds pair a 1+ ion with a 1− ion, so the charges are equal — the deciding factor is size.

✓ Na^+ (0.102 nm) and F^- (0.133 nm) are the smallest cation and the smallest anion in the table, so their centres get closest and the electrostatic attraction is strongest.

Why the others fail

B Cl^- is larger than F^-, so the ions sit further apart
C K^+ is larger than Na^+
D the largest pair of all - the weakest bonding here

Examiner's insight

Same charges everywhere, so this is purely a size comparison - smallest ions, strongest attraction.

Revise from your notes

- Counting particles - notes p. 2 1.6
- Strength of ionic bonding - notes p. 17 7.2
- Isoelectronic particles - notes p. 10 4.5
- Dative covalent bond - notes p. 20 9.2

8

Select · [1 mark]

Which of these ionic compounds would be expected to have the highest melting temperature?

Answer

- ☐ **A** NaF
- ☑ **B** MgO
- ☐ **C** KCl
- ☐ **D** CaS

The logic

✓ Melting temperature rises with stronger ionic bonding – bigger ion charges and smaller ionic radii give a stronger electrostatic attraction.

✓ MgO has 2+ and 2– charges AND the smallest ions of the doubly-charged options, so its lattice needs the most energy to break.

Why the others fail

A only 1+ and 1- charges
C 1+/1- charges and even larger ions than NaF
D same 2+/2- charges as MgO but Ca^{2+} and S^{2-} are larger, so the attraction is weaker

Examiner's insight

Compare the charges first, then the sizes - charge doubles count for more than a small size change.

Revise from your notes

- Essential definitions & the mole - notes p. 1 1.1
- Writing ionic equations - notes p. 1 1.2
- Atom economy - notes p. 2 1.5
- Solutions and concentrations - notes p. 3 1.8
- Strength of ionic bonding & polarisation - notes p. 17-18 7.2 7.5

Edexcel IAL - Solved Past Paper

October 2020 · Unit 1: Structure, Bonding and Introduction to Organic Chemistry (WCH11/01) · Question

hard medium easy

2 (a)

Select · [1 mark]

When zinc is added to copper(II) sulfate solution, copper is formed. Which is the best name for this type of reaction?

Answer

- [ ] **A** addition
- [x] **B** **displacement**
- [ ] **C** neutralisation
- [ ] **D** substitution

The logic

✓ The more reactive metal (zinc) pushes the less reactive metal (copper) out of its compound — that is a displacement reaction.

Why the others fail

A addition describes organic reactions across a C=C bond
C no acid or base is involved here
D substitution describes organic reactions such as halogenation of alkanes

2 (b)

Select · [1 mark]

Which is the ionic half-equation for a process that takes place during this reaction?

Answer

- [ ] **A** $Cu^{2+} + e^- \longrightarrow Cu^+$
- [ ] **B** $Cu^+ + e^- \longrightarrow Cu$
- [ ] **C** $Zn \longrightarrow Zn^+ + e^-$
- [x] **D** $Zn \longrightarrow Zn^{2+} + 2e^-$

The logic

✓ Zinc atoms are oxidised: each loses TWO electrons to form the 2+ ion, $Zn \longrightarrow Zn^{2+} + 2e^-$.

✓ The other real process is $Cu^{2+} + 2e^- \longrightarrow Cu$, but that option is not offered with two electrons.

Why the others fail

A Cu^+ is never formed in this reaction
B Cu^+ is not a reactant - the solution contains Cu^{2+}
C zinc forms Zn^{2+}, not Zn^+

Examiner's insight

Check the charge AND the electron count balance on every half-equation - both sides must carry equal total charge.

Revise from your notes

- The empirical formula - notes p. 2 1.4
- Counting particles - notes p. 2 1.6
- Percentage composition - notes p. 1 1.3
- Writing ionic equations - notes p. 1 1.2

Edexcel IAL - Solved Past Paper

October 2020 · Unit 1: Structure, Bonding and Introduction to Organic Chemistry (WCH11/01) · Question

● hard ● medium ● easy

● 5

Select · [1 mark]

The formula of barium chloride is $BaCl_2$. Which is correct for barium chloride? [A_r: Ba = 137.3, Cl = 35.5]

Answer

- [ ] **A** barium chloride exists as a molecule
- [x] **B** **barium chloride is a compound**
- [ ] **C** the empirical formula of barium chloride is BaCl
- [ ] **D** the M_r of barium chloride is 172.8

The logic

✓ Barium chloride contains two different elements chemically bonded together, so it is a compound — true whatever its structure.

✓ It is a giant ionic lattice of Ba^{2+} and Cl^- ions, so it has no molecules; the 1 : 2 ratio is already the simplest, and M_r = 137.3 + (2 x 35.5) = 208.3.

Why the others fail

A ionic compounds form giant lattices, not molecules

C $BaCl_2$ is already the simplest whole-number ratio - you cannot halve the 2

D 172.8 forgets the second chlorine; the correct M_r is 208.3

Examiner's insight

Ionic formula traps repeat every session: no molecules in ionic lattices, and count EVERY atom when you add up M_r.

Revise from your notes

- The empirical formula - notes p. 2 1.4
- Counting particles - notes p. 2 1.6
- Percentage composition - notes p. 1 1.3
- Writing ionic equations - notes p. 1 1.2

1 (a)

Select · [1 mark]

Element X is in Group 2 and element Y is in Group 7. What is the formula of the compound formed from X and Y?

Answer

- [ ] **A** XY
- [ ] **B** X_2Y
- [x] **C** XY_2
- [ ] **D** X_2Y_2

The logic

✓ A Group 2 metal loses 2 electrons to form X^{2+}; a Group 7 non-metal gains 1 electron to form Y^-.

✓ To balance the charges you need two Y^- for every X^{2+}, giving the formula XY_2.

Why the others fail

A XY balances only if both ions were singly charged - X is 2+

B X_2Y is the ratio you would get for a 1+ metal with a 2- non-metal, the opposite way round

D X_2Y_2 is just XY doubled - it is not the simplest ratio

Examiner's insight

Over 90% scored this - the easiest question on the paper. Work out each ion charge first, then balance them.

1 (b)

Select · [1 mark]

Under what conditions does the compound formed from X and Y conduct electricity?

Answer

- [ ] **A** in the solid state and in the liquid state and in aqueous solution
- [ ] **B** in the solid state and in aqueous solution only
- [ ] **C** in the solid state and in the liquid state only
- [x] **D** in the liquid state and in aqueous solution only

The logic

✓ XY_2 is an ionic solid. To conduct, the ions must be free to move and carry charge.

✓ In the solid the ions are locked in the lattice, so it does NOT conduct. Only when molten (liquid) or dissolved (aqueous) are the ions free - so conduction happens in those two states only.

Why the others fail

A includes the solid state - the ions are fixed in the lattice there

B includes the solid state, and misses the molten (liquid) state

C includes the solid state, and misses the aqueous state

Examiner's insight

An ionic solid never conducts - the ions cannot move. Any option that includes 'solid state' must be wrong.

Revise from your notes

- Ionic bonds - notes p. 17 7.1
- Strength of ionic bonding - notes p. 17 7.2
- Isoelectronic particles - notes p. 10 4.5
- Polarisation of anions - notes p. 18 7.5

Edexcel IAL - Solved Past Paper

hard medium easy

2

Select · [1 mark]

Which of these compounds would you expect to have the highest melting temperature?

Answer

- [ ] A NaCl
- [x] B NaF
- [ ] C KCl
- [ ] D KF

The logic

✓ All four are ionic solids with 1+/1- charges, so the melting temperature is set by ion SIZE - smaller ions sit closer, giving stronger attraction and a higher melting point.

✓ NaF pairs the smallest cation (Na^+ < K^+) with the smallest anion (F^- < Cl^-), so its lattice is the strongest of the four.

Why the others fail

A NaCl - Cl^- is larger than F^-, so the bonding is weaker than in NaF
C KCl - both ions are the larger of each pair, so it is the weakest here
D KF - F^- is small but K^+ is larger than Na^+, so weaker than NaF

Examiner's insight

With equal charges, compare ion size. The compound of the two smallest ions has the strongest lattice.

Revise from your notes

- Ionic bonds - notes p. 17 7.1
- Strength of ionic bonding - notes p. 17 7.2
- Isoelectronic particles - notes p. 10 4.5
- Polarisation of anions - notes p. 18 7.5

3

Predict · [1 mark]

A drop of green copper(II) chromate(VI) solution is placed at the centre of a strip of damp filter paper connected to a DC supply. What is observed after a few minutes?

Answer

- [ ] **A** a green colour has moved to the negative end
- [ ] **B** a green colour has moved to the positive end
- [x] **C** **a yellow colour has moved to the positive end and a blue colour to the negative end**
- [ ] **D** a blue colour has moved to the positive end and a yellow colour to the negative end

The logic

✓ The green solution is a mixture of blue Cu^{2+} cations and yellow CrO_4^{2-} anions – two separate coloured ions, not one green ion.

✓ In the electric field the ions separate: the positive blue Cu^{2+} moves to the negative electrode, and the negative yellow CrO_4^{2-} moves to the positive electrode. This movement of ions towards opposite electrodes is direct evidence that ions exist and carry charge.

Why the others fail

A the green colour would only stay together if it were a single ion - it is not
B same mistake - the colour splits into blue and yellow
D the colours are the right two but swapped: Cu^{2+} is positive so it goes to the NEGATIVE end

Examiner's insight

This is the classic 'evidence for ions' experiment. Match each ion's charge to the opposite electrode, and remember green is really blue + yellow.

Revise from your notes

- Ionic bonds - notes p. 17 7.1
- Strength of ionic bonding - notes p. 17 7.2
- Isoelectronic particles - notes p. 10 4.5
- Polarisation of anions - notes p. 18 7.5

Edexcel IAL - Solved Past Paper

June 2022 · Unit 1: Structure, Bonding and Introduction to Organic Chemistry (WCH11/01) · Question 10

● hard ● medium ● easy

● 10

Select · [1 mark]

Which row shows the correct forces in a crystal of lithium iodide?

	Attractive forces between ions with opposite charges	Repulsive forces between ions with like charges	Some covalent bonding forces
A	✓	×	×
B	✓	✓	×
C	✓	×	✓
D	✓	✓	✓

The four rows of ticks and crosses for the three types of force

Answer

- ☐ **A** attractive forces only
- ☐ **B** attractive + repulsive forces (no covalency)
- ☐ **C** attractive forces + some covalency (no repulsion)
- ☑ **D** **attractive + repulsive forces + some covalent bonding**

The logic

✓ LiI is an ionic lattice, so it has BOTH attractions between oppositely charged ions AND repulsions between like-charged ions – every ionic solid has both.

✓ On top of that, the small, high-charge-density Li^+ polarises the large, easily distorted I^-, giving some covalent character. All three forces are present – row D.

Why the others fail

A leaves out both the like-charge repulsion and the covalent character
B misses the covalent character that Li^+ distorting I^- produces
C misses the repulsion between like-charged ions

Where marks are lost

Forgetting the like-charge repulsions, or missing the covalent character from a small cation polarising a large anion.

Examiner's insight

A small cation with a large anion (Li^+ / I^-) always brings some covalency on top of the ionic forces.

Revise from your notes

- Structure of the atom - notes p. 5 2.1
- Mass spectrometer calculations - notes p. 7 3.3
- Rules for electron configuration - notes p. 9 4.3
- First ionisation energy - notes p. 11 5.1

Edexcel IAL - Solved Past Paper

June 2022 · Unit 1: Structure, Bonding and Introduction to Organic Chemistry (WCH11/01) · Question 11

hard medium easy

11 (a)

Select · [1 mark]

The table gives properties of five substances (the letters are not element symbols). Which of these substances could be metals?

Substance	Electrical conductivity			Melting temperature / °C
	Solid	Liquid	Solution in water	
L	poor	good	good	770
M	good	good	reacts	98
N	good	good	insoluble	1083
P	poor	poor	insoluble	113
Q	poor	poor	good	10

Conductivity as solid, liquid and in solution, plus melting temperature, for substances L to Q

Answer

- ☐ **A** N only
- ☐ **B** L and M only
- ☑ **C** **M and N only**
- ☐ **D** L, M and N only

The logic

✓ A metal conducts electricity BOTH as a solid and as a liquid, because its **delocalised electrons** are always free to move.

✓ Only M (good/good) and N (good/good) do that. L is a poor conductor as a solid, so it cannot be a metal – it is ionic. So the answer is M and N.

Why the others fail

A N only - forgets that M also conducts as both solid and liquid
B L is a poor solid conductor, so it is ionic, not a metal
D again includes L, which cannot be a metal

Where marks are lost

Judging by only one row of the table - a metal must conduct as a solid AND as a liquid.

Examiner's insight
This one caught many out. Check solid conductivity first: metals conduct while solid; ionic solids do not.

11 (b)

Select · [1 mark]

Using the same table, which substance changes from a molecular structure to ions when it dissolves in water?

Answer

- [ ] **A** L
- [ ] **B** M
- [ ] **C** P
- [x] **D** Q

The logic

✓ A molecule that ionises only in water is a poor conductor as a solid AND as a liquid, but conducts once dissolved – like hydrogen chloride forming H^+ and Cl^-.

✓ Q fits exactly: poor / poor / good in solution. So the answer is Q.

Why the others fail

A L already conducts as a liquid, so it is ionic - it does not start off molecular
B M conducts as a solid and a liquid - that is a metal
C P is insoluble, so it never forms ions in water

Where marks are lost
Choosing a substance that already conducts when molten - a molecular acid conducts only after it dissolves and ionises.

Examiner's insight
Look for poor-poor-good across the row: no ions until it meets water.

Revise from your notes

- The metallic lattice - notes p. 19 8.1
- Dative covalent bond - notes p. 20 9.2
- Safety in chemistry experiments - notes p. 27 13.1
- Bond fission - notes p. 33 17.1

Edexcel IAL - Solved Past Paper

hard medium easy

11

Select · [1 mark]

Which combination of ions would form the compound with the highest melting temperature?

Answer

- [ ] **A** Li^{+} and Br^{-}
- [x] **B** Mg^{2+} and O^{2-}
- [ ] **C** Sr^{2+} and S^{2-}
- [ ] **D** Rb^{+} and Cl^{-}

The logic

✓ A higher melting temperature means stronger ionic bonding, which comes from higher charges and smaller ions.

✓ Mg^{2+} and O^{2-} both carry 2+/2- charges AND are the smallest doubly-charged pair offered, so the lattice is hardest to break.

Why the others fail

A only 1+/1- charges
C same 2+/2- charges, but Sr^{2+} and S^{2-} are much larger ions
D only 1+/1- charges and large ions

Examiner's insight

Compare charge first, then ionic size - both decide the lattice strength.

Revise from your notes

- Strength of ionic bonding - notes p. 17 7.2
- Graphene - notes p. 22 10.6
- Bond angle - notes p. 23 11.3
- Polar molecules - notes p. 26 12.4
- Safety in chemistry experiments - notes p. 27 13.1

Edexcel IAL - Solved Past Paper

June 2023 · Unit 1: Structure, Bonding and Introduction to Organic Chemistry (WCH11/01) · Question 1 ·

hard   medium   easy

1

Select · [1 mark]

Which compound has the greatest covalent character?

Answer

- [x] **A** $MgBr_2$
- [ ] **B** MgF_2
- [ ] **C** NaBr
- [ ] **D** NaF

The logic

✓ Covalent character grows when a small, highly-charged cation pulls the electron cloud of a large, easily distorted anion – that is polarisation.

✓ Mg^{2+} is the most polarising cation on offer (2+ and small) and Br^- is the most polarisable anion (big and floppy), so $MgBr_2$ sits furthest towards the covalent end.

Why the others fail

B same Mg^{2+} cation, but F^- is small and holds its electrons tightly - much less polarisable than Br^-

C Na^+ is 1+ and larger, so it polarises Br^- far less than Mg^{2+} does

D the weakest case - a poorly polarising Na^+ with a barely polarisable F^-

Where marks are lost

Comparing only the cation OR only the anion. You must weigh both: charge density of the cation AND size of the anion.

Examiner's insight

This was one of the hardest questions on the paper - rank by cation charge density first, then by how polarisable the anion is.

Revise from your notes

- Polarisation of anions - notes p. 18 7.5
- Bond classification by electronegativity - notes p. 25 12.3
- Isoelectronic particles - notes p. 10 4.5
- Successive ionisation energies - notes p. 11 5.3
- Writing electron configurations - notes p. 8 4.2

Edexcel IAL - Solved Past Paper

June 2023 · Unit 1: Structure, Bonding and Introduction to Organic Chemistry (WCH11/01) · Question 11

● hard ● medium ● easy

● 11

Select · [1 mark]

Green copper(II) chromate(VI) crystals are placed on damp filter paper connected to a 20 V DC supply. What colours appear at the positive and negative electrodes after a few minutes?

Answer

- ☐ **A** positive blue · negative yellow
- ☐ **B** positive green · negative blue
- ☐ **C** positive yellow · negative green
- ☑ **D** **positive yellow · negative blue**

The logic

✓ Copper(II) chromate is green because it contains blue Cu^{2+} cations and yellow CrO_4^{2-} anions.

✓ In the field, the yellow chromate anion migrates to the positive electrode and the blue copper cation migrates to the negative electrode – so positive is yellow, negative is blue. This movement is direct evidence that the compound is made of ions.

Why the others fail

A swaps the electrodes - it sends the anion to the negative and the cation to the positive
B only the copper ion has moved; no separate chromate colour appears
C only the chromate ion has moved to an electrode

Examiner's insight

Split the green into its two ions: yellow chromate anion goes to +, blue copper cation goes to -.

Revise from your notes

- Solutions and concentrations - notes p. 3 1.8
- Electrolysis is evidence of ions - notes p. 18 7.4
- Melting points in metallic elements - notes p. 15 6.8
- Bond angle and electron pair repulsion - notes p. 23 11.3
- Polar molecules - notes p. 26 12.4

Edexcel IAL - Solved Past Paper

June 2023 · Unit 1: Structure, Bonding and Introduction to Organic Chemistry (WCH11/01) · Question 20

hard medium easy

20 (a)(i)

Write · [1 mark]

Barium chloride is prepared from barium carbonate and hydrochloric acid: BaCO3(s) + 2HCl(aq) ⟶ BaCl2(aq) + CO2(g) + H2O(l). Write the ionic equation. State symbols are not required.

Ionic equation

The chloride ions are spectators (aqueous on both sides), so cancel them; HCl and the salts are fully ionised in solution: ✓ $BaCO_3 + 2H^+ \longrightarrow Ba^{2+} + CO_2 + H_2O$

Mark scheme 1 mark

- ✓ $BaCO_3 + 2H^+ \longrightarrow Ba^{2+} + CO_2 + H_2O$ (1)

Ignore: state symbols, even if incorrect

Where marks are lost

Charges not balancing - writing 'H^{+}' instead of '$2H^+$', or 'Ba^+' instead of 'Ba^{2+}'.

Examiner's insight

Remove the spectator chloride ions, then check both mass and charge balance across the arrow.

20 (a)(ii)

Calculate · [2 marks]

Calculate the atom economy by mass for this preparation of barium chloride. [A_r: H 1.0, C 12.0, O 16.0, Cl 35.5, Ba 137.3]

Working

✓ M_r of the desired product $BaCl_2$ = 137.3 + 2 x 35.5 = 208.3

total M_r of all products = $BaCl_2 + CO_2 + H_2O$ = 208.3 + 44.0 + 18.0 = 270.3

✓ atom economy = (M_r of $BaCl_2$ / total M_r of products) x 100 = (208.3 / 270.3) x 100 = 77.06 %

$\boxed{\text{atom economy} = 77.06\ \%}$

Mark scheme 2 marks

- ✓ M_r of $BaCl_2$ (208.3) and total M_r of products (270.3) (1)
- ✓ (208.3 / 270.3) x 100 = 77.06 % (1)

Accept: correct answer with no working scores 2

Ignore: significant figures except 1 sf

Where marks are lost

Forgetting the '× 100' so the answer is a fraction, not a percentage.

Examiner's insight

Show the M_r of the wanted product over the total mass of all products, then multiply by 100 to give a percentage.

20 (a)(iii)

Explain · [4 marks]

Barium chloride melts at 962 C, caesium chloride at 646 C. Explain, by considering the ions involved, the difference between the melting temperatures of these Period 6 chlorides.

Model answer

✓ The barium ion has a greater charge than the caesium ion (Ba^{2+} versus Cs^+). ✓ The barium ion is also smaller than the caesium ion, so it has a higher charge density. ✓ So the electrostatic attraction between the ions is greater in barium chloride, ✓ which means more energy is needed to break the ionic bonding, giving $BaCl_2$ the higher melting temperature.

Mark scheme 4 marks · M4 depends on M3

- ✓ Ba^{2+} has a greater charge than Cs^+ (1)
- ✓ Ba^{2+} is smaller than Cs^+ (1)
- ✓ Greater electrostatic attraction between the ions in barium chloride (1)
- ✓ So more energy is required to break the ionic bonding / higher lattice energy (1)

Ignore: polarisation, atomic radius, electronegativity

Do not accept: references to intermolecular forces

Where marks are lost

Confusing ionic charge with nuclear charge, or talking about attraction of electrons to the nucleus instead of between the ions.

Examiner's insight

Stay with the ions: compare their charge and size, then link the stronger attraction to more energy to break the lattice.

20 (a)(iv)

Explain · [2 marks]

Covalent and ionic bonding are extremes of a continuum. Explain the difference in bonding between barium chloride and beryllium chloride using the electronegativities: Ba 0.9, Be 1.5, Cl 3.0.

Model answer

✓ The electronegativity difference is larger for Ba–Cl (3.0 – 0.9 = 2.1) than for Be–Cl (3.0 – 1.5 = 1.5). ✓ So the Ba–Cl bond has more ionic (less covalent) character than the Be–Cl bond – both sit on the same bonding continuum, just at different points.

Mark scheme 2 marks · reverse argument allowed

✓ Electronegativity difference is greater for Ba-Cl (2.1) than Be-Cl (1.5) (1)
✓ Ba-Cl is more ionic / less covalent (more polar) than Be-Cl (1)

Accept: Be-Cl bonds are polar covalent

Do not accept: simply 'BaCl2 is ionic, BeCl2 is covalent' - they are two points on one scale

Where marks are lost

Labelling one as purely ionic and the other purely covalent, instead of comparing where each sits on the bonding continuum.

Examiner's insight

Work out both electronegativity differences, then conclude comparatively - the larger difference is the more ionic bond.

20 (b)

Identify · [4 marks]

A Group 1 sulfate M2SO4 reacts: M2SO4(aq) + BaCl2(aq) ⟶ BaSO4(s) + 2MCl(aq). 7.98 g of the sulfate gives 10.72 g of BaSO4 precipitate. Identify the Group 1 element. [A_r: Ba 137.3, S 32.1, O 16.0]

Working

✓ M_r of $BaSO_4$ = 137.3 + 32.1 + 4 x 16.0 = 233.4

✓ moles of $BaSO_4$ = 10.72 / 233.4 = 0.045930 mol

mole ratio M_2SO_4 : $BaSO_4$ = 1 : 1, so moles of M_2SO_4 = 0.045930 mol

✓ M_r of M_2SO_4 = mass / moles = 7.98 / 0.045930 = 173.7

mass of 2 M atoms = 173.7 – 96.1 (SO_4) = 77.6, so A_r of M = 77.6 / 2 = 38.8

✓ A_r approx 39, so M is potassium, K.

$\boxed{\text{M = potassium (K)}}$

Mark scheme 4 marks · TE throughout

✓ M_r of $BaSO_4$ = 233.4 (1)
✓ Amount of $BaSO_4$ = 0.04593 mol (1)
✓ M_r of M_2SO_4 = 173.7 (or mass of metal 3.57 g) (1)
✓ A_r of M = 38.8 / 39 and identify as potassium / K (1)

Accept: alternative: subtract sulfate mass 4.414 g from 7.98 g first

How to reach full marks

Four linked marks: M_r of $BaSO_4$, moles, then M_r of the sulfate (or the metal mass), then A_r of the metal AND its name. The final mark needs the identification, so remember to DIVIDE the two-metal mass by 2.

Where marks are lost

Getting 38.8 but naming it rubidium (confusing atomic number with mass number), or forgetting to divide the M2 mass by 2.

Examiner's insight

Many banked the first marks but stopped early - subtract the sulfate, halve for one metal atom, then match A_r 39 to potassium.

Revise from your notes

- Writing ionic equations - notes p. 1 1.2
- Atom economy - notes p. 2 1.5
- Strength of ionic bonding - notes p. 17 7.2
- Classification of bonds using electronegativity - notes p. 25 12.3

Edexcel IAL - Solved Past Paper

● hard ● medium ● easy

● 7

Select · [1 mark]

A direct current is passed through a green solution of copper(II) chromate(VI). Which colours are seen at each electrode after several minutes?

Answer

- [ ] **A** negative electrode blue, positive electrode green
- [ ] **B** negative electrode green, positive electrode blue
- [x] **C** **negative electrode blue, positive electrode yellow**
- [ ] **D** negative electrode yellow, positive electrode blue

The logic

✓ The green solution is really a mixture of blue Cu^{2+} ions and yellow CrO_4^{2-} (chromate(VI)) ions.

✓ Positive Cu^{2+} ions move to the NEGATIVE electrode, turning it blue; negative chromate(VI) ions move to the POSITIVE electrode, turning it yellow. This migration is itself evidence that the compound is made of ions.

Why the others fail

A chromate(VI) is yellow, not green, so the positive electrode cannot go green
B the two ions are placed at the wrong electrodes
D colours reversed - Cu^{2+} is blue and moves to the NEGATIVE electrode

Revise from your notes

- Dative covalent bond - notes p. 20 9.2
- First ionisation energy trend - notes p. 13 6.5
- Exceptions to the trend - notes p. 14 6.6
- Electrolysis is evidence of ions - notes p. 18 7.4
- Mass spectrometer of diatomic molecules - notes p. 7 3.4

Edexcel IAL - Solved Past Paper

January 2024 · Unit 1: Structure, Bonding and Introduction to Organic Chemistry (WCH11/01) · Question

● hard ● medium ● easy

● 20 (a)(i)

Calculate · [4 marks]

A sample of magnesium (A_r = 24.32) has three isotopes. Two are mass 24 (78.99%) and mass 25 (10.00%). Calculate the relative abundance and hence the mass number of the third isotope, to the appropriate number of significant figures.

Working

✓ abundance of 3rd isotope = 100 – 78.99 – 10.00 = 11.01%

✓ A_r = [(24 x 78.99) + (25 x 10.00) + (y x 11.01)] / 100 = 24.32

✓ y = [2432 – (24 x 78.99) – (25 x 10.00)] / 11.01 = 286.24 / 11.01 = 25.998

✓ mass number = 26 (to 2 significant figures)

$\boxed{\text{abundance 11.01\%, mass number = 26}}$

Mark scheme 4 marks

- ✓ % abundance of the third isotope = 11.01% (1)
- ✓ substitutes into the A_r equation (1)
- ✓ calculates the mass of the 3rd isotope (25.998) (1)
- ✓ answer given to 2 significant figures (26) (1)

Accept: a correct answer with some correct working beyond M1 scores 4

How to reach full marks

Find the missing abundance (11.01%), put it into the weighted-mean equation, solve for y = 25.998, then round to a mass number of 26 (2 s.f.).

Where marks are lost

Quoting the final mass number to more than 2 significant figures (e.g. 26.00 or 25.998) instead of 26.

Examiner's insight

Familiar to most - the common slip was giving the final answer to too many significant figures.

● 20 (a)(ii)

State · [1 mark]

State one similarity and one difference between these isotopes.

Model answer

✓ Similarity: they have the same number of protons (same atomic number). Difference: they have different numbers of neutrons (different mass number).

Mark scheme 1 mark - both needed

- ✓ same number of protons AND different number of neutrons (1)

Accept: same atomic number / electrons / configuration; different nucleons / mass number
Do not accept: 'different relative atomic mass'; 'they are the same element' alone

Where marks are lost
Giving a difference of 'relative atomic mass' (that is an average for the element, not a per-isotope property).

Examiner's insight
Well known by almost all candidates.

20 (a)(iii)

State · [1 mark]

State which of these isotopes would be deflected most in a mass spectrometer. Justify your answer.

Model answer

✓ ^{24}Mg is deflected most because it has the lowest mass (lowest m/z ratio), so it is deflected more by the magnetic field.

Mark scheme 1 mark

✓ ^{24}Mg and lowest mass / lowest m/z ratio (1)
Accept: '^{24}Mg is the lightest'; $^{24}Mg^+$
Ignore: just 'the lowest mass' without naming ^{24}Mg

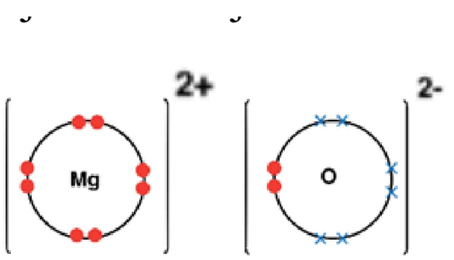
Where marks are lost
Choosing the heaviest isotope, or answering that abundance affects the deflection (it does not).

Examiner's insight
Most correctly chose ^{24}Mg for its lowest mass; some wrongly picked the heaviest or brought in abundance.

20 (b)(i)

Draw · [2 marks]

Draw a dot-and-cross diagram to show the bonding in magnesium oxide, MgO. Show outer electrons only.



Magnesium loses its 2 outer electrons to oxygen, giving $[Mg]^{2+}$ and $[O]^{2-}$.

Model answer

✓ Mg^{2+}: the magnesium atom loses its 2 outer electrons – drawn as $[Mg]^{2+}$ with an empty outer shell and a 2+ charge. ✓ O^{2-}: the oxide ion has a full outer shell of 8 electrons (the 2 gained shown as crosses) – drawn as $[O]^{2-}$ with a 2- charge.

Mark scheme 2 marks

- ✓ correct structure of the Mg ion and its charge (1)
- ✓ correct structure of the O ion (8 outer electrons) and its charge (1)

Accept: any combination/position of dots and crosses, or just dots or just crosses

Accept: Mg drawn with a charge but no electrons and/or no circle; penalise lack of charges once only

Where marks are lost

Drawing covalent bonding (shared electrons) even though the question says the compound is ionic, or leaving the charges off both ions.

Examiner's insight

Answered well by nearly all - but a surprising number wrongly showed covalent bonding between Mg and O.

20 (b)(ii)

Explain · [2 marks]

The melting temperatures of MgO and $MgSO_4$ are 2852 degrees C and 1124 degrees C. Explain why MgO melts at a significantly higher temperature.

Model answer

✓ The oxide ion O^{2-} is smaller than the sulfate ion SO_4^{2-}. ✓ so there is a stronger electrostatic attraction between the Mg^{2+} and O^{2-} ions (a stronger ionic bond) – more energy is needed to break it, giving the higher melting temperature.

Mark scheme 2 marks

- ✓ oxide / O^{2-} is smaller than sulfate / SO_4^{2-} (1)
- ✓ stronger electrostatic attraction between the Mg^{2+} and O^{2-} ions (1)

Accept: 'stronger ionic bond'; 'more energy to break the ionic bond'; reverse argument

Do not accept: comparison with sulfur / sulfide rather than sulfate; any mention of intermolecular forces / covalent bonds scores 0

Where marks are lost

Comparing the oxide ion with sulfur/sulfide instead of sulfate, comparing MgO with $MgSO_4$ as whole compounds, or bringing in electronegativity / polarisation / intermolecular forces.

Examiner's insight

Unexpectedly one of the hardest parts - keep it to ion size (oxide vs sulfate) and the strength of the ionic attraction.

20 (c)

Explain · [2 marks]

Magnesium conducts as a solid and a liquid; MgO conducts only as a liquid (not as a solid). Explain the similarities and differences in their electrical conductivity.

Model answer

✓ Magnesium has delocalised electrons that are free to move in both the solid and the liquid, so it conducts in both states. ✓ In magnesium oxide the ions are only free to move when it is liquid (molten), so it conducts when liquid but not when solid, where the ions are held in fixed positions.

Mark scheme 2 marks

- ✓ Mg has delocalised electrons free to move when solid and liquid (1)
- ✓ MgO: ions are only free to move when liquid (1)

Accept: 'has electrons that are free to move'; 'ions are not free to move when solid'

Ignore: ions/electrons 'carrying charge' without saying they move

Where marks are lost

Misreading 'explain' as 'state' and just repeating the table, or swapping the carriers (saying MgO conducts by delocalised electrons, or Mg by mobile ions).

Examiner's insight

Often misread as 'state the differences' - explain WHY, and note that Mg's electrons let it conduct in BOTH states.

20 (d)(i)

Write · [2 marks]

Magnesium sulfate can be made from magnesium and dilute sulfuric acid. Write an equation for the reaction, including state symbols.

Model answer

✓ Mg(s) + H2SO4(aq) ⟶ MgSO4(aq) + H2(g) ✓ All state symbols correct: Mg (s), acid (aq), magnesium sulfate (aq), hydrogen (g).

Mark scheme 2 marks

- ✓ correct balanced equation (1)
- ✓ correct state symbols (1)

Accept: multiples; the ionic equation Mg(s) + 2H$^+$(aq) ⟶ Mg^{2+}(aq) + H2(g)

Do not accept: M2 (state symbols) depends on M1 being balanced (or having the correct species)

Where marks are lost

Writing water as a product instead of hydrogen, or losing the state-symbol mark by calling $MgSO_4$ a solid or the acid a liquid.

Examiner's insight

Most wrote it correctly; the state-symbol mark was lost by making $MgSO_4$ (s) or H_2SO_4 (l), or by giving water as a product.

20 (d)(ii)

State · [2 marks]

Give two observations you would make when the reaction is taking place.

Model answer

✓ Bubbles / fizzing / effervescence (of hydrogen gas) are seen. ✓ The magnesium gets smaller / disappears / dissolves (or the mixture gets warmer).

Mark scheme 2 marks

- ✓ bubbles / fizzing / effervescence (1)
- ✓ Mg disappears / gets smaller / dissolves OR the mixture gets warmer (1)

Ignore: 'hydrogen gas produced' alone (that is an inference, not an observation)

Do not accept: a white precipitate

Where marks are lost

Giving an inference ('hydrogen is produced') rather than an observation ('bubbles'), or wrongly saying a white precipitate forms.

Examiner's insight

Many scored both - watch the observation vs inference distinction and avoid the phantom 'white precipitate'.

20 (e)(i)

Calculate · [1 mark]

Magnesium was added to 30.0 cm^3 of 0.500 mol dm^{-3} sulfuric acid. Calculate the moles of sulfuric acid used.

Working

✓ moles = concentration x volume = 0.500 x (30.0 / 1000) = 0.0150 mol

0.0150 mol (1.50×10^{-2} mol)

Mark scheme 1 mark

- ✓ moles of sulfuric acid = 0.0150 mol (1)

Do not accept: an answer given to 1 significant figure

Where marks are lost

Forgetting to divide the 30.0 cm^3 by 1000, or rounding to just 1 significant figure.

Examiner's insight

Done well by the majority.

20 (e)(ii)

Calculate · [1 mark]

Calculate the mass of magnesium needed to react with the sulfuric acid. [A_r: Mg = 24.3]

Working

Mg : H2SO4 react 1 : 1, so moles Mg = 0.0150 mol

✓ mass Mg = moles x A_r = 0.0150 x 24.3 = 0.365 g

0.365 g

Mark scheme 1 mark

- ✓ mass of Mg = 0.0150 x 24.3 = 0.365 g (1)

Accept: transferred error from (e)(i); ignore significant figures except 1 s.f.

Where marks are lost
Using the wrong (not 1 : 1) ratio, or an answer to only 1 significant figure.

Examiner's insight
Well done by most candidates.

20 (e)(iii)

Give · [1 mark]

Give a reason why slightly more than this mass of magnesium was used.

Model answer

✓ So that all the sulfuric acid is used up (the acid is the limiting reagent) – the small excess of solid magnesium is easy to remove afterwards.

Mark scheme 1 mark

✓ to ensure all the sulfuric acid is used up / the acid is limiting (1)

Accept: 'all the sulfuric acid is neutralised'; 'the Mg is easy to remove from the mixture'

Ignore: 'so that the Mg is in excess' on its own

Where marks are lost
Just restating that the magnesium is in excess without saying WHY (to react all the acid).

Examiner's insight
The practical reasoning was less familiar - the excess Mg guarantees the acid all reacts.

20 (e)(iv)

State · [1 mark]

State how the magnesium sulfate solution could be separated from the mixture produced.

Model answer

✓ (Gravity) filtration – to remove the excess solid magnesium from the magnesium sulfate solution.

Mark scheme 1 mark

✓ (gravity) filtration (1)

Ignore: any heating step mentioned after the filtration

Where marks are lost
Suggesting evaporation or fractional distillation - the leftover here is solid magnesium, so it is simply filtered off.

Examiner's insight
A variety of wrong techniques (evaporation, fractional distillation) were seen - the leftover solid Mg is just filtered out.

20 (e)(v)

Calculate · [2 marks]

The mass of hydrated crystals, $MgSO_4.7H_2O$, obtained was 2.78 g. Calculate the percentage yield. [M_r: $MgSO_4.7H_2O$ = 246.4]

Working

✓ maximum (theoretical) mass = moles x M_r = 0.0150 x 246.4 = 3.696 g

✓ % yield = (actual / theoretical) x 100 = 2.78 / 3.696 x 100 = 75.2%

75.2% yield

Mark scheme 2 marks

- ✓ maximum mass of $MgSO_4.7H_2O$ = 3.696 g (1)
- ✓ % yield = 2.78 / 3.696 x 100 = 75.2% (1)

Accept: TE on (e)(i); a correct answer with some working scores 2; ignore s.f. except 1 s.f.

How to reach full marks

Multiply the acid moles (0.0150) by the M_r of the hydrated salt (246.4) for the theoretical mass, then divide the actual 2.78 g by it and x 100.

Where marks are lost

Using the M_r of anhydrous $MgSO_4$ instead of the hydrated $MgSO_4.7H_2O$, or a yield over 100%.

Examiner's insight

The calculation parts (i), (ii) and (v) were well done, with many scoring full marks.

Revise from your notes

- Isotopes - notes p. 5 2.2
- Ionic bonds - notes p. 17 7.1
- Strength of ionic bonding - notes p. 17 7.2
- The metallic lattice - notes p. 19 8.1
- Percentage yield - notes p. 2 1.7

Edexcel IAL - Solved Past Paper

June 2024 · Unit 1: Structure, Bonding and Introduction to Organic Chemistry (WCH11/01) · Question 12

● hard ● medium ● easy

● 12

Select · [1 mark]

Which pair of compounds will NOT react to form a precipitate?

Answer

- ☐ **A** $AgNO_3$(aq) and $CaCl_2$(aq)
- ☐ **B** $Ca(OH)_2$(aq) and CO_2(g)
- ☑ **C** **$Ba(OH)_2$(aq) and HCl(aq)**
- ☐ **D** KI(aq) and $Pb(NO_3)_2$(aq)

The logic

✓ $Ba(OH)_2 + 2HCl \longrightarrow BaCl_2 + 2H_2O$ – an acid-base neutralisation.

✓ $BaCl_2$ is soluble, so everything stays in solution and no precipitate forms.

Why the others fail

A insoluble AgCl(s) precipitates
B insoluble $CaCO_3$(s) precipitates
D insoluble PbI_2(s) precipitates

Examiner's insight

Check each pair against the solubility rules - only the soluble-salt pair gives no solid.

Revise from your notes

- Writing ionic equations - notes p. 1 1.2
- Essential definitions - notes p. 1 1.1
- Types of organic reactions - notes p. 28 13.4

Edexcel IAL - Solved Past Paper

● hard ● medium ● easy

● 11

Select · [1 mark]

Which row shows properties consistent with the bonding type shown? Columns: bonding | solubility | melting temp | conductivity of solid.

Answer

- [x] **A** **ionic | soluble | high | poor**
- [ ] **B** ionic | soluble | low | good
- [ ] **C** metallic | soluble | low | good
- [ ] **D** metallic | insoluble | high | poor

The logic

✓ An ionic solid has a high melting temperature (strong lattice), is often water soluble, and does NOT conduct as a solid because its ions are locked in place.

✓ Row A matches all four properties, so it is the consistent set.

Why the others fail

B ionic solids do not have low melting points, and they do not conduct while solid
C metals are insoluble in water, not soluble
D metals conduct well in the solid state - 'poor' is wrong for a metal

Revise from your notes

- Atomic and ionic radius - notes p. 13 6.3 6.4
- Melting points of non-metals - notes p. 15 6.9
- Isoelectronic particles - notes p. 10 4.5
- Free radical substitution - notes p. 33 17.3

12

Deduce · [1 mark]

Which cation would be the most polarising - one with a small or large radius, and a small or large charge?

Answer

- [x] **A** **small radius, large charge**
- [ ] **B** small radius, small charge
- [ ] **C** large radius, small charge
- [ ] **D** large radius, large charge

The logic

✓ Polarising power (charge density) is greatest when the positive charge is packed into the smallest space.

✓ So the most polarising cation has a small radius and a large charge – its concentrated charge distorts a nearby anion's electron cloud most strongly.

Why the others fail

B a small charge gives a weaker pull on the anion's electrons
C large radius and small charge is the least polarising combination
D the large charge helps, but a large radius spreads it out and weakens it

Examiner's insight

The most polarising cation has the highest charge density: small radius plus large charge.

Revise from your notes

- Ionic radius - notes p. 13 6.4
- Polarisation of anions - notes p. 18 7.5
- Polar molecules - notes p. 26 12.4
- Safety in chemistry experiments - notes p. 27 13.1
- Naming organic compounds - notes p. 28 13.3

Edexcel IAL - Solved Past Paper

hard   medium   easy

21 (a)

Describe · [2 marks]

Describe the metallic bonding in sodium.

Model answer

✓ Metallic bonding is the strong electrostatic attraction... ✓ ...between the positive sodium ions (cations) and the sea of delocalised electrons.

Mark scheme 2 marks

- ✓ (strong) electrostatic attraction (1)
- ✓ between sodium ions / cations and delocalised electrons (1)

Accept: positive ions / metal ions for cations

Ignore: references to protons / nuclei

Do not accept: any mention of another type of bonding - scores 0

Where marks are lost

Saying the attraction is between the nucleus and the electrons (it is the whole positive ion), or using 'anions' by mistake.

Examiner's insight

Most scored well. The two lost marks came from writing 'anions' instead of cations, or 'nucleus' instead of the positive ion.

21 (b)

Explain · [2 marks]

Explain how the melting temperature of magnesium compares to that of sodium.

Model answer

✓ Magnesium has the higher melting temperature, because its ions are Mg^{2+} (2+) while sodium's are Na^{+} (only 1+), so the charge on the metal ion is greater. ✓ Magnesium also releases more delocalised electrons per atom (2 versus 1), so the attraction between the delocalised electrons and the cations is stronger and more energy is needed to melt it.

Mark scheme 2 marks

- ✓ higher melting temperature because the ions are Mg^{2+} and Na^{+} (greater charge) (1)
- ✓ more delocalised electrons in magnesium, so a stronger attraction to the cations (1)

Accept: Mg^{2+} has a higher charge density than Na^{+}

Ignore: references to the size of the ions or the atomic radius

Do not accept: any reference to covalency, or to sodium being higher - scores 0

Where marks are lost

Explaining it only as a 'trend across the period' using extra protons and smaller radius - those points are ignored here.

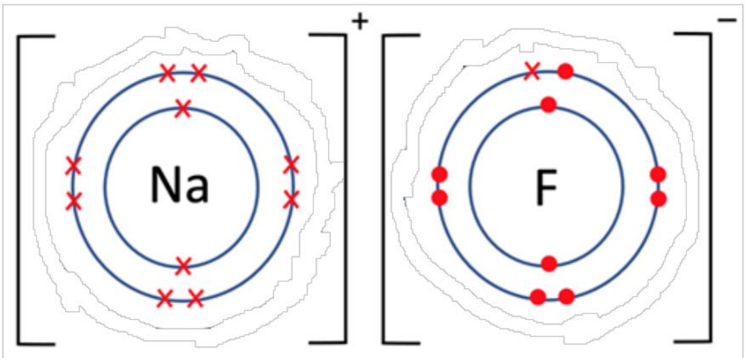
Examiner's insight

Most named magnesium correctly, but few explained the KEY point - that magnesium donates more delocalised electrons per ion.

21 (c)

Draw · [2 marks]

Draw a dot-and-cross diagram showing the ionic bonding in sodium fluoride. Use dots for fluorine electrons and crosses for sodium electrons, and include all electron shells.



$[Na]^+$ loses its outer electron (2,8); $[F]^-$ gains it (2,8). All shells shown, with the ionic charges.

Mark scheme 2 marks

- ✓ correct Na^+ ion diagram with the + charge (1)
- ✓ correct F^- ion diagram with the - charge (1)

Accept: circles and square brackets are not required; Na^+ may show 8 or 0 outer electrons

Accept: 1 mark if only outer shells are drawn, or if dots/crosses are all the same / reversed, or charges missing

Ignore: working arrows between the ions

Where marks are lost

Not reading the question - about half the candidates left out the inner shells that were specifically asked for.

Examiner's insight

Dot-and-cross was well known, but many ignored the instruction to show ALL shells; occasional slips reversed the dots and crosses.

21 (d)

Explain · [2 marks]

Explain how the sodium ion and the fluoride ion compare in size.

Model answer

✓ The sodium ion Na^+ is smaller than the fluoride ion F^-, even though the two ions are isoelectronic (both have 10 electrons). ✓ This is because Na^+ has more protons (11 vs 9), so its greater nuclear charge pulls the electrons in closer to the nucleus.

Mark scheme 2 marks (M2 has two ideas)

- ✓ Na^+ is smaller (despite having the same number of electrons) (1)

✓ because Na^+ has more protons, so the electrons are pulled closer to the nucleus (1)

Accept: greater nuclear charge / greater proton-to-electron ratio

Do not accept: 'smaller atomic radius'; saying the ions have different numbers of electrons; 0 if Na is called larger

Ignore: shielding; greater atomic number

Where marks are lost

Calling this an 'atomic radius', or claiming fluoride is smaller / the ions are similar because you forgot the extra protons in sodium.

Examiner's insight

One of the harder parts. Many missed that the ions are isoelectronic, so the answer turns entirely on sodium's two extra protons.

21 (e)

Explain · [4 marks]

Explain the electrical conductivities of sodium and sodium fluoride in the solid and liquid states.

Model answer

✓ Sodium conducts electricity in BOTH the solid and the liquid state. ✓ because it has delocalised electrons that are free to move and carry the charge. ✓ Sodium fluoride only conducts when it is liquid (molten), not when solid. ✓ because in the solid its ions are fixed in place, but when molten the ions are free to move and carry the charge.

Mark scheme 4 marks (M1 and M2 stand alone; M4 depends on M3)

✓ Na conducts when solid AND liquid (1)

✓ because it has (delocalised) electrons that move (1)

✓ NaF only conducts when liquid / molten (1)

✓ because its ions are free to move (1)

Accept: 'in both states' for M1; 'NaF does not conduct when solid' for M3

Ignore: 'free electrons' / 'electrons carry charge' on their own; aqueous solutions

Do not accept: M2 if it says ions move in sodium; M4 if it mentions delocalised electrons moving in NaF

How to reach full marks

Deal with both substances AND both states: sodium (electrons, both states) then sodium fluoride (ions, molten only). The mobility of the carrier earns the mark, not just its presence.

Where marks are lost

Only discussing one substance or one state, or saying electrons carry charge in sodium fluoride (it is the ions).

Examiner's insight

Strong topic overall, but marks slipped where the mobility of the electrons was not stated, or where NaF was wrongly said to conduct via electrons.

21 (f)

Calculate · [3 marks]

A 1.00 g sample of toothpaste contains 5.68×10^{-5} mol of sodium fluoride. Calculate the concentration of fluoride ions in ppm, to an appropriate number of significant figures. [A_r:

F = 19.0]

Working

each mole of NaF gives one mole of F^-, so use the mass of fluorine only

✓ mass of F = moles x A_r = $5.68 \times 10^{-5} \times 19.0 = 1.0792 \times 10^{-3}$ g

✓ ppm = (mass of F / mass of sample) x 10^6 = $(1.0792 \times 10^{-3} / 1.00) \times 10^6 = 1079.2$

✓ round to an appropriate number of significant figures

1080 ppm (or 1100 ppm to 2-3 s.f.)

Mark scheme 3 marks

- ✓ mass of F in 1 g of toothpaste (x 19.0) (1)
- ✓ ppm calculation (x 10^6) (1)
- ✓ answer to 2 or 3 significant figures (1)

Accept: 1080 or 1100 ppm; correct answer with no working scores 3

Accept: TE from an attempt at M1; ignore early rounding

Do not accept: M3 (the s.f. mark) unless a mass was multiplied by 5.68×10^{-5} and then by 10^6

How to reach full marks

Use the A_r of fluorine (19.0), NOT the M_r of NaF (42) or F_2 (38). Multiply the fluorine mass by 10^6, then give 2-3 s.f.

Where marks are lost

Using the mass of NaF or F_2, dividing by 10^6 (giving an answer below 1), or quoting 4-5 significant figures.

Examiner's insight

Challenging for many. The classic errors were using the molar mass of sodium fluoride instead of fluorine, and quoting too many significant figures.

Revise from your notes

- The metallic lattice - notes p. 19 8.1
- Melting points in metals - notes p. 15 6.8
- Ionic bonds - notes p. 17 7.1
- Ionic radius - notes p. 13 6.4
- Electrolysis is evidence of ions - notes p. 18 7.4