NAME DATE STARTED TARGET END DATE

GCE AS / A LEVEL — CHEMISTRY UNIT 1 SUPPLEMENTARY QUESTION PACK

Sourced from legacy 1092-02 (CH2) papers · New spec Unit 1 Topic 9 · AS unit, 80 marks, 1h 30min paper

REVISE.wales

CHEMISTRY — UNIT 1 · IONIC, COVALENT & METALLIC BONDING

Topic 1.4 — Bonding types: ionic, covalent (incl. dative), metallic, and heterolytic/homolytic fission

Recognising the three primary bonding types, drawing dot-and-cross diagrams for ionic and covalent compounds (including dative covalent), and explaining why some pairs of elements bond ionically while others bond covalently.

Legacy 2008 specification · CH2 source

Estimated time for entire question pack: ~1 h 38 min

Derived from the legacy CH2 paper's pace of ~1.1 min/mark, padded for long-prose answers (61 marks over 8 questions).

*You are advised to **not** attempt to complete all of this in one sitting.*

ABOUT THIS QUESTION PACK

This is a **supplementary practice question pack** for new-spec Unit 1. It contains every legacy WJEC CH2 question (2008 modular spec, Jun 2009 – Jun 2016) that maps onto 2015 AS Unit 1 Topic 1.4 — bonding, intermolecular forces, solid structures and periodicity were assessed in the old CH2 module but now belong in Unit 1 under the 2015 specification.

Questions are ordered by source paper date.

INSTRUCTIONS

Use black ink or black ball-point pen. Show all working — quality of written communication will affect marks. A calculator is allowed. You may need the WJEC Periodic Table / Data Booklet.

For Examiner's use only

Q	Source	Max	Mark
1	Jan 10 Q4	2	
2	Jun 13 Q6	12	
3	Jan 14 Q7	12	
4	Jun 14 Q3	2	

Q	Source	Max	Mark
5	Jun 15 Q2	2	
6	Jun 15 Q10	16	
7	Jun 16 Q3	2	
8	Jun 16 Q9	13	
Total		**61**	

Ionic, Covalent & Metallic Bonding — what the new spec asks

WJEC GCE AS / A Level Chemistry (from 2015) · Unit 1: The Language of Chemistry, Structure of Matter & Simple Reactions · Topic 1.4.

Ionic bonding

- Electrostatic attraction between oppositely charged ions.
- Forms between metal + non-metal: e– transferred.
- Dot-and-cross: show outer e– transferred and final charges, e.g. $Na^{+}[O]^{2-}$.
- Strong, omnidirectional ⇒ high m.p., conducts when molten/aqueous.

Covalent bonding

- Shared pair of electrons between atoms (typically non-metals).
- Sigma (σ) head-on overlap; pi (π) sideways for double/triple bonds.
- Dot-and-cross: show shared pairs in overlap region.
- Single (C–C), double (C=C), triple (N≡N).

Dative (coordinate) covalent

- Both electrons supplied by *one* atom (the donor).
- Examples: NH_4^{+}, H_3O^{+}, $AlCl_4^{-}$, $NH_3{\cdot}BF_3$.
- Once formed, indistinguishable from a normal covalent bond.
- Shown with an arrow from donor to acceptor.

Metallic bonding & fission

- Lattice of positive ions in a ‘sea’ of delocalised valence e–.
- Explains conductivity, malleability, lustre.
- **Homolytic fission:** bond breaks evenly ⇒ two radicals.
- **Heterolytic fission:** bond breaks unevenly ⇒ cation + anion.

Crib sheet »

Ionic, Covalent & Metallic Bonding in one page

Quick-reference notes — revisit before each question.

Ionic dot-cross

Show metal losing e⁻ (no e⁻ in outer shell of M^+); non-metal gaining e⁻ (full octet, often with brackets and charge label).

Covalent dot-cross

Each atom contributes e⁻ to overlap. Show shared pair(s) in middle; non-bonded e⁻ on outside. Both atoms gain a noble-gas configuration.

Spotting ionic vs covalent

Compare $\Delta\chi$ (electronegativity). Large ⇒ ionic (NaCl, MgO). Small ⇒ covalent (Cl_2, CH_4). Borderline cases ($AlCl_3$) often covalent.

Dative bond pointer

Look for atom with lone pair donating to atom with empty orbital. Drawn as arrow donor → acceptor. Once formed, identical to ordinary covalent.

Metallic

Cations + delocalised e⁻. More valence e⁻ or smaller cation ⇒ stronger bond. Al > Mg > Na.

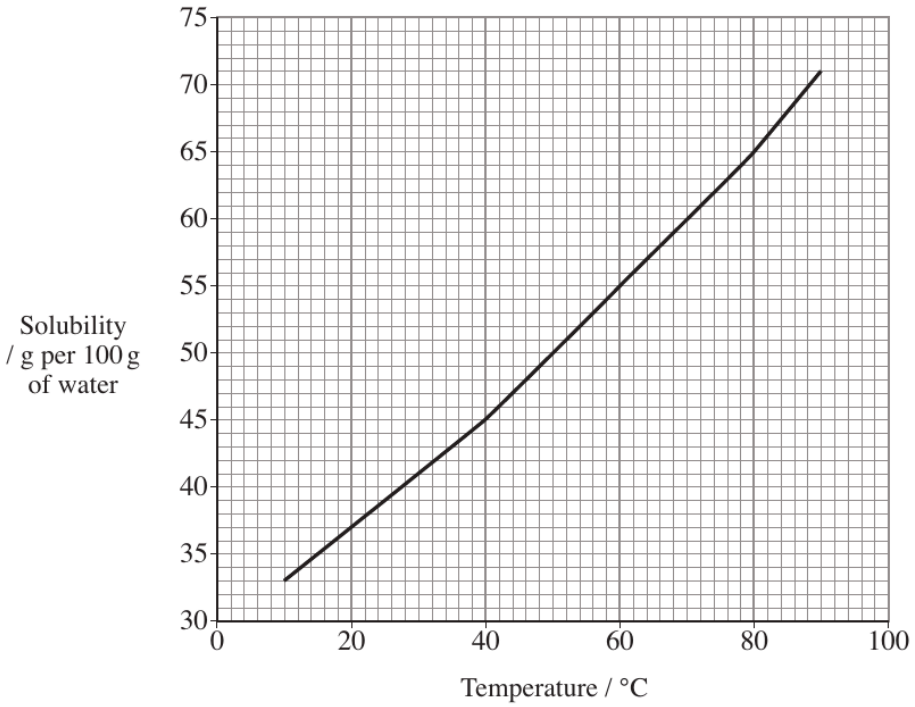
Bond fission

Homolytic = radicals (UV / heat, non-polar bonds). Heterolytic = ions (polar bonds, polar solvents).

Examiner only

4. Using **outer** electrons only, draw a dot and cross diagram to show the bonding in sodium oxide. Show the charges on the ions formed. [2]

5. The solubility curve for ammonium chloride is shown below.



Calculate the mass of ammonium chloride that dissolves in 50 g of water to form a saturated solution at 30 °C. [2]

.....

.....

6. Draw the skeletal formula of 2-chloro-3-methylhexane. [1]

Section A Total [10]

Examiner only

4. Classify the following species as electrophile, nucleophile or radical by completing the table below. [2]

Species	Cl•	NH_3
Classification		

5. Nanoscience involves the study of very small particles. Nano-sized silver particles have antibacterial and antifungal properties. Give **one** use of nano-sized silver particles. [1]

.....

.....

6. State and explain which two of the following elements combine to form the **most** ionic bond. [2]

chlorine magnesium potassium sulfur

.....

.....

Total Section A [10]

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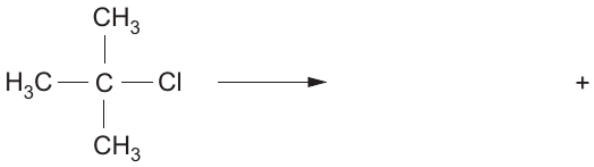
Examiner only

7. *(a)* State the meaning of the term *heterolytic fission*. [1]

.....

.....

(b) Complete the equation below to show the products of the heterolytic fission of the C — Cl bond in 2-methyl-2-chloropropane. [1]



Total Section A [10]

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SECTION A

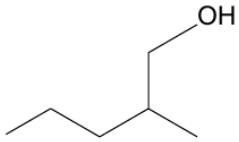
Answer **all** *questions in the spaces provided.*

1. Put the following in order of increasing strength. [1]

covalent bonds *hydrogen bonds* *van der Waals' forces*

weakest ..... *strongest*

2. Give the **systematic** name of the compound whose structure is shown below. [1]



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3. Draw dot-and-cross diagrams to show the formation of calcium chloride from atoms of chlorine and calcium. [2]

Examiner only

SECTION A

Answer **all** *questions in the spaces provided.*

1. Complete the electronic structure for the oxide ion present in magnesium oxide. [1]

$1s^2$ .....

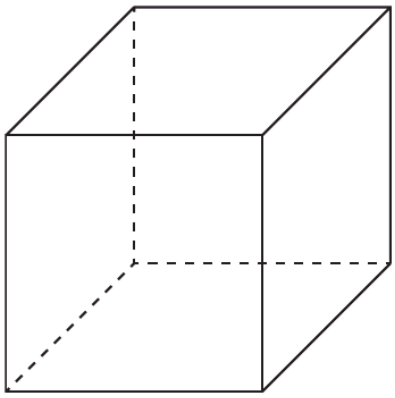
2. Draw a dot and cross diagram to show the bonding in calcium fluoride. You should include outer electrons only and give any charges. [2]

3. Give the meaning of the term *electronegativity*. [1]

.....

.....

4. Complete and label the diagram to show the positions of the ions present in caesium chloride, CsCl. [1]



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10. *(a)* State why nitrogen is described as a *p*-block element. [1]

.....

.....

(b) (i) Draw a dot and cross diagram to show the electrons in the ammonium ion, NH_4^+. You should include outer electrons only. [1]

(ii) State the bond angle in the ammonium ion. Explain why this is the case. [2]

.....

.....

.....

(iii) Ammonia reacts with oxygen to give nitrogen(II) oxide and water. Complete the equation for this reaction. [1]

$$4NH_3 + \text{.....}\ O_2 \longrightarrow \text{.....}\ NO + \text{.....}\ H_2O$$

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(c) When sodium nitrate is heated it decomposes.

$$2NaNO_3(s) \longrightarrow 2NaNO_2(s) + O_2(g)$$

(i) Use oxidation numbers to complete the following.

In this reaction ..... has been reduced because its oxidation state has changed from ..... to ..... . [2]

(ii) What volume of oxygen, measured at room temperature and pressure, could be obtained by heating 4.40 g of sodium nitrate? [3]

[The volume of 1 mol of oxygen is 24.0 dm^3 under these conditions]

Volume of oxygen = ... dm^3

(d) A sample of sodium nitrate of mass 65 g was added to 50 g of cold water and the mixture was heated until it all dissolved.

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The table gives information about the solubility of sodium nitrate at various temperatures.

Solubility of $NaNO_3$ / g per 100 g water	Temperature / °C
88	20
96	30
103	40
112	50
122	60
133	70

Use the data in the table to calculate the mass of sodium nitrate that crystallised when the solution was cooled to 30 °C. [2]

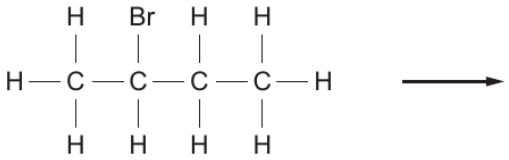
Mass that crystallised = ... g

Total [12]

Examiner only

11. 2-Bromobutane, C_4H_9Br, is a halogenoalkane that behaves in a similar way to 1-chlorobutane.

(a) (i) Complete the diagram below to show the mechanism for the reaction between 2-bromobutane and aqueous sodium hydroxide. You should include relevant charges, dipoles, lone pairs and curly arrows to show the movement of electron pairs. [4]



(ii) What **type** of mechanism is shown in *(a)*(i)? [1]

.....

(iii) The reaction involves heterolytic bond fission.

What is meant by *heterolytic bond fission*? [1]

.....

.....

Examiner only

(b) Bromoethane can be converted into ethene.

(i) Name the reagent and solvent needed to convert bromoethane into ethene. [1]

.....

(ii) What **type** of reaction occurs in *(b)*(i)? [1]

.....

(iii) 2-Bromobutane behaves in a similar way to bromoethane in this type of reaction. When 2-bromobutane is reacted as described in *(b)*(i) two alkenes that are **structural** isomers are formed.

Draw the displayed formulae of these two alkenes. [2]

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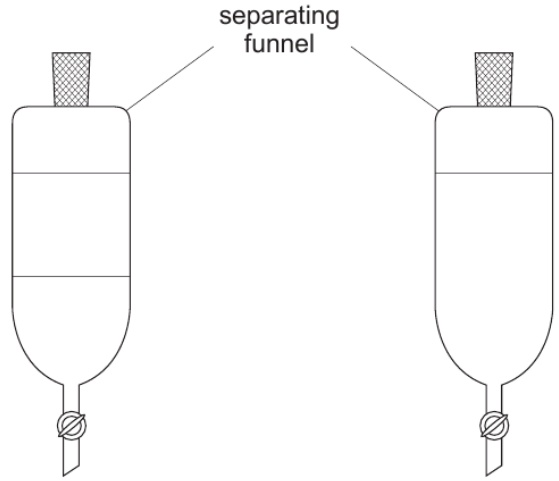
(c) Two students were each given a different alcohol. They each added their alcohol to water in a separating funnel, shook the mixture and then left it to stand.

The diagrams show the results.



What can be deduced about the alcohols given to each student? You should explain why the alcohols behave differently in this experiment. [5]
QWC [1]

Total [16]

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SECTION A

Answer **all** *questions in the spaces provided.*

1. Barium chloride is used to test for sulfate ions in solution. Give the observation expected for a positive result. [1]

.....

2. Draw the **displayed** structure of 2,3-dichloropropene. [1]

3. *(a)* State what is meant by the term *covalent bond*. [1]

.....

.....

(b) Give a reason why atoms of aluminium and chlorine form covalent bonds in aluminium chloride, whilst aluminium and oxygen form ionic bonds in aluminium oxide. [1]

.....

.....

Examiner only

9. Modern artificial fertilisers contain many ions that are used by plants to help their growth. These include potassium ions, ammonium ions, nitrate ions and phosphate ions.

(a) Ammonium ions are tetrahedral.

(i) Draw a dot-and-cross diagram to show the bonding in an ammonium ion. [1]

(ii) State the bond angle in a tetrahedral ion. [1]

.....

(iii) State and explain the shape of a molecule of ammonia. [3]

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.....

(b) Nitrate ions can be prepared from ammonia. The first step in this process is given below.

$$4NH_3 + 5O_2 \longrightarrow 4NO + 6H_2O$$

Use oxidation states to show that this is a redox reaction. [2]

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Examiner only

(c) Phosphates form an essential part of fertilisers, and most of the phosphate minerals in the world are found in Morocco. Many of these phosphate minerals are a mixture of calcium phosphate and calcium carbonate.

(i) Calcium and potassium ions may be distinguished using a flame test. State the colours seen for each of these ions. [1]

Potassium ions .....

Calcium ions .....

(ii) One way to convert calcium carbonate to calcium phosphate is to use phosphoric acid. Balance the equation below for this reaction. [1]

..... $CaCO_3$ + ... H_3PO_4 ⟶ ..... $Ca_3(PO_4)_2$ + ... CO_2 + ... H_2O

(iii) A 1.202 g sample of powdered phosphate mineral was treated with excess acid, and 92.2 cm^3 of carbon dioxide gas were produced. Calculate the percentage of calcium carbonate by mass in the original sample giving your answer to **three** significant figures. [4]

[1 mol of gas occupies 24.0 dm^3 under these conditions]

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Percentage = ... %

Total [13]

END OF QUESTION PACK

8 questions · 61 marks · ~1 h 38 min
Source: WJEC CH2 (2008 modular spec, Jun 2009 – Jun 2016)
Curated for WJEC Chemistry 2015 spec AS Unit 1 — Topic 9 (1.4)