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 12 · AS unit, 80 marks, 1h 30min paper

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CHEMISTRY — UNIT 1 · SOLID STRUCTURES & PROPERTIES

Topic 1.5 — Giant ionic, giant covalent, metallic and simple molecular solids

The four solid-state structures (giant ionic, giant covalent, metallic, simple molecular) — their bonding, packing, and how structure determines properties like melting point, conductivity, hardness and solubility.

Legacy 2008 specification · CH2 source

Estimated time for entire question pack: ~2 h 14 min

Derived from the legacy CH2 paper's pace of ~1.1 min/mark, padded for long-prose answers (84 marks over 9 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 1.5 — 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	Jun 09 Q1	1	
2	Jun 09 Q6	13	
3	Jun 11 Q2	2	
4	Jan 12 Q6	14	
5	Jun 12 Q6	13	
6	Jan 13 Q11	12	
7	Jan 14 Q11	12	
8	Jun 15 Q4	1	
9	Jun 16 Q11	16	
Total		**84**	

Solid Structures & Properties — 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 1.5.

Giant ionic

- Regular 3D lattice of cations & anions (e.g. NaCl 6:6, CsCl 8:8).
- Bonding: strong electrostatic attraction throughout structure.
- High m.p., hard but brittle, conducts when molten/aqueous, often water-soluble.

Giant covalent (macromolecular)

- Diamond: every C tetrahedral, 4 sigma bonds ⇒ hardest natural material.
- Graphite: sheets of hexagonal C; delocalised e− between sheets ⇒ conducts along sheets.
- Silicon, SiO_2 — very high m.p., insoluble.
- Differences arise from C bonding mode, not the atoms themselves.

Metallic solids

- Cations in a sea of delocalised valence e−.
- Strength ↑ with charge and packing (Na < Mg < Al < ...).
- Conduct (free e−), malleable / ductile (layers slide), shiny (reflect light).
- Often high m.p. (W, Fe); low for s-block (Na 98°C).

Simple molecular

- Small covalent molecules held together by weak IMFs (vdW, H-bond, dipole).
- Iodine I_2, ice H_2O, sulfur S_8, CO_2 (dry ice).
- Low m.p., do not conduct (no mobile charges), often soluble in non-polar solvents.
- Sublimation common when IMFs especially weak (I_2, CO_2).

Solid Structures & Properties in one page

Quick-reference notes — revisit before each question.

Identify structure

High m.p. + conducts only when molten = ionic.
Very high m.p. + non-conductor (except graphite) = giant covalent.
High m.p. + conducts solid = metallic.
Low m.p. + non-conductor = simple molecular.

NaCl vs CsCl

NaCl: 6:6 coordination (face-centred cubic).
CsCl: 8:8 coordination (body-centred cubic). Cs^+ bigger ⇒ higher coord no.

Carbon allotropes

Diamond: 4-coord, sp^3, hardest, insulator.
Graphite: 3-coord planes, sp^2, conducts (delocalised π system), soft (planes slide).
Fullerene C_{60}: molecular, soluble in non-polar solvents.

Iodine vs diamond

Iodine sublimes at low temp (vdW only between I_2). Diamond doesn't melt until ~3500°C (covalent bonds must break).

Conductivity

Metals: solid & molten.
Ionic: molten / aqueous only.
Giant covalent: usually no (graphite yes).
Simple molecular: no.

Solubility hint

Ionic dissolve in polar solvents (water).
Simple molecular dissolve in non-polar (hexane).
Giant covalent & metallic generally insoluble in any solvent.

SECTION A

Answer all questions in the spaces provided.

1. Complete the table below by putting a tick (✓) in the boxes that correctly describe graphite. [1]

Conducts electricity		Melting temperature		Bonding	
Yes	No	High	Low	Covalent	Ionic

2. (i) Give the equation for the reaction of barium metal with water. [1]

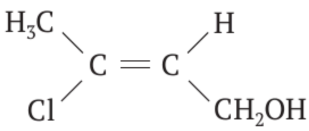
....

(ii) The solution obtained in (i) contains barium ions.
State a reagent that would be added to this solution to show the presence of barium ions, giving the result of the test.

Reagent .... [1]

Observation .... [1]

3. (i) Explain why Compound T has E-Z (trans-cis) isomers. [1]

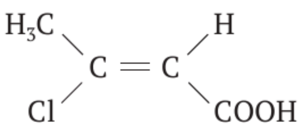


Compound T

....

....

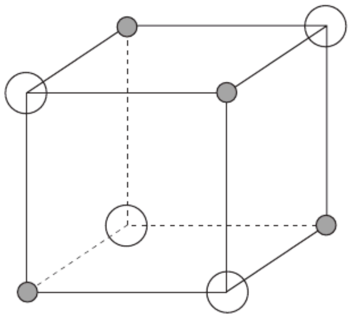
(ii) State a reagent, used in acid solution, that reacts with Compound T to give Compound Y. [1]



Compound Y

....

6. (a) The following diagram shows the crystal structure of sodium chloride.



(i) Write the formula of the species represented as

● .... , ○ .... [1]

(ii) State the crystal co-ordination numbers for sodium chloride. .... [1]

(iii) State the crystal co-ordination numbers for caesium chloride and explain why these are different from those of sodium chloride. [2]

....

....

(b) (i) Explain why sodium chloride is soluble in water. [2]

....

....

....

(ii) A student was finding the solubility of sodium chloride in water.
He heated a saturated solution of sodium chloride to dryness, using an evaporating basin.
The following table of results was obtained.

Mass of evaporating basin + sodium chloride solution	=	140.57 g
Mass of evaporating basin	=	72.00 g
∴ Mass of sodium chloride solution	=	.... g
Mass of evaporating basin + dry sodium chloride	=	90.57 g
Mass of evaporating basin	=	72.00 g
∴ Mass of dry sodium chloride	=	.... g

I. Calculate and record the missing values in the table of results. [1]

II. State the mass of water in the sodium chloride solution .... g [1]

III. Calculate the solubility of sodium chloride in water in g / 100 g of water.

....

....

Solubility = ... g / 100 g water [1]

IV. State what should have been recorded so that the solubility obtained can be compared against known values. [1]

....

(c) State why sodium is described as an s-block element. [1]

....

(d) Titanium metal is obtained by heating titanium(IV) chloride with sodium.

$$4Na + TiCl_4 \longrightarrow Ti + 4NaCl$$

State the oxidation number (state) of each element present and use these to explain which species has been oxidised in this reaction. [2]

....

....

Total [13]

SECTION A

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

1. barium sulfate

calcium carbonate

magnesium hydroxide

sodium carbonate

From the list above, choose the compound that

(a) gives a brick-red flame test, [1]

....

(b) is the **most** soluble in water. [1]

....

2. Complete the table below to show the type or types of bonding present in the following solids. [2]

Solid	Type or types of bonding
calcium	
iodine	

3. Calcium phosphate is found widely in nature, e.g. in bones and in the leaves of plants. The formula for the phosphate ion is PO_4^{3-}. Write the formula for calcium phosphate. [1]

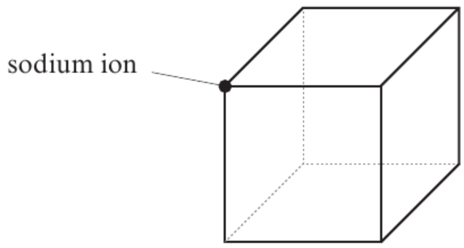
....

Examiner only

SECTION B

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

6. *(a)* A section of the crystal structure of sodium chloride is shown below.



(i) Indicate, with a cross, the position of any chloride ion on this diagram. [1]

(ii) State the crystal co-ordination number of a **chloride** ion in the structure of sodium chloride. [1]

....

(b) 'Rock salt', used on roads in winter, consists mainly of crystalline sodium chloride that is contaminated by a small quantity of insoluble mudstone.
Gwen added powdered rock salt to water and filtered out the insoluble material. She then evaporated the filtrate to dryness to produce pure white crystals of sodium chloride.
State **two** steps that she should have carried out to ensure that she obtained the **maximum** amount of sodium chloride from her rock salt crystals. [2]

....

....

(c) The minerals 'rock salt', NaCl, and kainite, $KCl.MgSO_4.3H_2O$, both contain chloride ions.

(i) Give a chemical test that produces the same result for both of these compounds. You should state the reagent(s) used and the result of the test. [2]

....

....

(ii) Give a chemical test, other than a flame test, that will show that these two compounds are different. You should assume that they are present as aqueous solutions.
Give the reagent(s) used and the result of the test for each compound. [2]

....

....

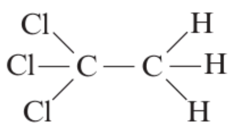
....

(d) A common reaction of the halogens is the formation of the anion, X^-.

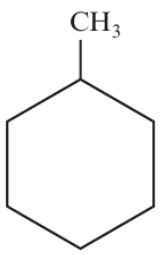
(i) State, in terms of electronic structure, why this occurs. [1]

(ii) Give a reason why the tendency to form the X^- ion decreases down the halogen group. [1]

(e) One compound previously used in correction fluid was 1,1,1-trichloroethane, but this has been replaced by compounds such as methylcyclohexane, which has a much less adverse effect on the environment.



1,1,1-trichloroethane



methylcyclohexane

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(i) Explain, in terms of bond strengths, why 1,1,1-trichloroethane has an effect on the ozone layer but methylcyclohexane does not. [2]

(ii) Hept-1-ene is an isomer of methylcyclohexane.

$$CH_3—CH_2—CH_2—CH_2—CH_2—CH═CH_2$$

Describe a chemical test that gives a positive result for hept-1-ene but not for methylcyclohexane. [2]

Reagent(s) ....

Observation ....

Total [14]

Examiner only

6. When the temperature is increased, both solid iodine and diamond change directly into their gaseous state – they sublime.

(a) In each case, name the force or bond that is being overcome when the solid changes into a gas. [2]

Iodine ....

Diamond ....

(b) State, with a reason, which solid would have the higher sublimation temperature. [1]

....

....

Total Section A [10]

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Examiner only

11. *(a)* Both sodium chloride and caesium chloride have giant ionic structures.

(i) Draw a labelled diagram to show the arrangement of ions in a crystal of caesium chloride. [2]

(ii) Give a reason why sodium chloride has a different structure from caesium chloride. [1]

....

....

Examiner only

(b) Both diamond and graphite have giant covalent structures.

(i) Describe the structure and bonding in graphite. [3]
QWC [1]

....

....

....

....

....

(ii) Explain why graphite can conduct electricity whilst diamond cannot. [2]

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....

(iii) Iodine, I_2, also contains covalent bonds. Explain why solid iodine can be converted into a vapour at a much lower temperature than diamond. [3]

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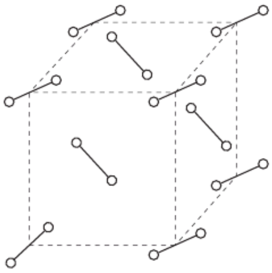
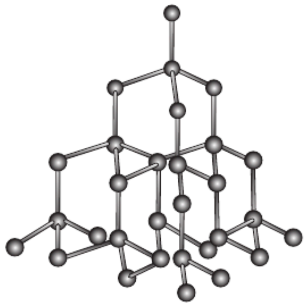
Total [12]

Examiner only

11. *(a)* The structures of solid iodine and diamond are shown below.



Iodine



Diamond

Use these diagrams to help you explain why
- iodine vapourises easily but diamond does not vapourise until about 3550 °C
- neither iodine nor diamond conduct electricity [4]

QWC [1]

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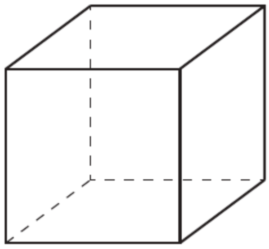
Examiner only

(b) Potassium iodide has the same cubic structure as sodium chloride. Use the diagram below to identify and show the positions of the species involved. [2]



(c) You are given an aqueous solution containing 0.05 mol of barium chloride and a supply of potassium sulfate solution.

Devise a method to obtain the maximum amount of pure dry barium sulfate.
You should assume that a risk assessment has been carried out. [4]
QWC [1]

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....

....

Total [12]

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]

$1s^2$ ....

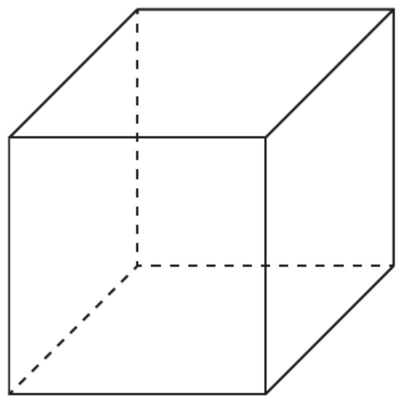
2. Draw a dot and cross diagram to show the bonding in calcium fluoride. You should include outer electrons only and give any charges. [2]

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]



Examiner only

11. *(a)* (i) Draw the arrangement of ions in solid caesium chloride, labelling the diagram clearly. [2]

(ii) Explain why the coordination numbers of the ions in caesium chloride and sodium chloride are different. [1]

....

....

(b) Explain why the boiling temperature of hydrogen fluoride is much greater than that of hydrogen chloride. [2]

....

....

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....

....

Examiner only

(c) Sodium chloride and sodium metal can both conduct electricity under different conditions. Give the conditions needed for each to conduct and explain how each conducts electricity. [4]
QWC [1]

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Examiner only

(d) Chlorofluorocarbons (CFCs) are molecules containing only carbon, fluorine and chlorine. They have many uses, although their use has reduced significantly due to the environmental harm they cause.

(i) Give **one** major use of CFCs. [1]

....

(ii) Use the data given in the table to explain why CFCs damage the ozone layer whilst hydrofluorocarbons and chlorobromocarbons are less damaging. [4]
QWC [1]

Bond	Average bond enthalpy / kJ mol^{-1}
C—F	544
C—Cl	338
C—Br	276
C—H	410

....

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....

Total [16]

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END OF QUESTION PACK

9 questions · 84 marks · ~2 h 14 min
Source: WJEC CH2 (2008 modular spec, Jun 2009 – Jun 2016)
Curated for WJEC Chemistry 2015 spec AS Unit 1 — Topic 12 (1.5)