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

REVISE.wales

CHEMISTRY — UNIT 1 · PERIODIC TRENDS &MDASH; PERIODS 2 & 3

Topic 1.6 — Trends across Periods 2 and 3 (incl. melting temperature, atomic radius and Group 1 reactivity)

Trends across Periods 2 and 3 in melting temperature, atomic radius, ionisation energy and bonding type. Includes Group 1 trends in reactivity with water as a contrasting down-group comparison.

Legacy 2008 specification · CH2 source

Estimated time for entire question pack: ~1 h 34 min

Derived from the legacy CH2 paper's pace of ~1.1 min/mark, padded for long-prose answers (59 marks over 6 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 1.6 — 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 11 Q11	13	
2	Jun 11 Q4	1	
3	Jun 11 Q11	14	

Q	Source	Max	Mark
4	Jan 12 Q2	2	
5	Jun 12 Q10	16	
6	Jun 15 Q9	13	
Total		**59**	

Periodic Trends — Periods 2 & 3 — 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 1.6.

Atomic radius trend

- Decreases across a period (more protons, same shell).
- Increases down a group (extra filled shells, more screening).
- Ionic radii: cations smaller than parent atom; anions larger.

Melting temperature across Period 3

- Na < Mg < Al: metallic bonding strengthens (more delocalised e⁻, smaller cation).
- Si: giant covalent ⇒ very high m.p.
- P_4, S_8, Cl_2: simple molecular ⇒ low m.p. (S_8 > P_4 > Cl_2 by molecular size).
- Ar: monatomic, lowest m.p.

First ionisation energy trend

- Generally increases across a period (Z_{eff} ↑, atom smaller).
- Dips at Group 3 (new p-subshell) and Group 6 (p^4 repulsion).
- Decreases down a group (outer e⁻ further from nucleus, more screening).

Group 1 reactivity (contrast)

- Reactivity ↑ down the group: outer e⁻ lost more easily.
- Li: steady fizz with water; Na: vigorous, melts to ball; K: ignites lilac; Rb/Cs: explosive.
- All form M^+ hydroxides + H_2(g); solutions strongly alkaline.

Crib sheet »

Periodic Trends — Periods 2 & 3 in one page

Quick-reference notes — revisit before each question.

Period 3 m.p.

Na 98°C → Mg 650 → Al 660 → Si **1410** → P 44 → S 119 → Cl_2 −101 → Ar −189.

Why Si is anomalously high

Giant covalent network — must break Si–Si bonds. Above and below it the structure type changes (metallic → simple molecular).

Atomic radius

Across Period: r ↓ (same shell, more p^+).
Down Group: r ↑ (extra shell, more screening).
Cation < atom < anion (same e⁻ config).

1st IE pattern

General ↑ across period. Dips: Group 3 (new p, higher energy) & Group 6 (paired p e⁻ repulsion).
O < N; Al < Mg.

Group 1 reactivity

Li < Na < K < Rb < Cs. Outer e⁻ further from nucleus & more screening ⇒ easier to lose ⇒ faster reaction with water.

Successive IEs

Big jump indicates new shell. E.g. Mg: IE1 ≈ 738, IE2 ≈ 1450, IE3 jumps to ~7733 ⇒ confirms 2 outer e⁻ (Group 2).

Examiner only

11. Part of the Periodic Table is shown below.

Group	1	2	3	4	5	6
	Li		B	C		O
	Na	Mg	Al	Si	P	S
	K	Ca				

(a) Answer the following questions about the elements shown.

Each element may be used once, more than once or not at all.

Write the symbol of

(i) the element with one electron in its 2s orbital, ... [1]

(ii) the element with the lowest first ionisation energy, ... [1]

(iii) an element that forms a basic oxide, ... [1]

(iv) the element with the lowest melting temperature. ..... [1]

Examiner only

(b) Graphite, aluminium and caesium chloride are three substances whose structures allow them to conduct electricity under appropriate conditions.

Briefly describe the structure and bonding adopted by **each** and explain how these lead to their ability to conduct electricity. Your answer should include:

- A **brief** description of the structures found in **each** of the three materials;
- An indication of the conditions required for electrical conduction in **each**;
- An explanation of how **each** material conducts electricity. [6]

QWC [2]

(c) Carbon nanotubes have similar conducting abilities to graphite. Suggest a use for carbon nanotubes that relies on this property. [1]

Total [13]

Total Section B [70]

Examiner only

Rough Work

WJEC CBAC

GCE AS/A level

1092/01-A

CHEMISTRY CH2
DATA SHEET

P.M. THURSDAY, 20 January 2011

VP*(W11-1092-01-A)

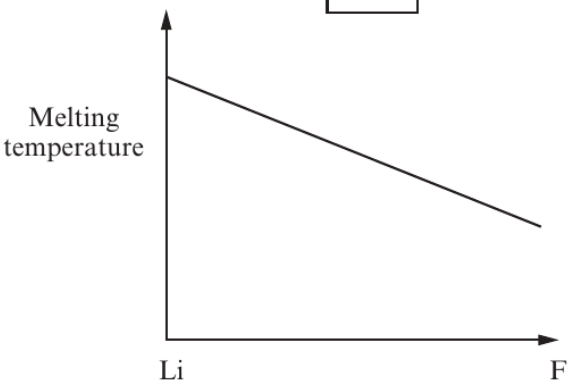
Infrared Spectroscopy characteristic absorption values

Bond	Wavenumber / cm^{-1}
C—Br	500 to 600
C—Cl	650 to 800
C—O	1000 to 1300
C═C	1620 to 1670
C═O	1650 to 1750
C≡N	2100 to 2250
C—H	2800 to 3100
O—H	2500 to 3550
N—H	3300 to 3500

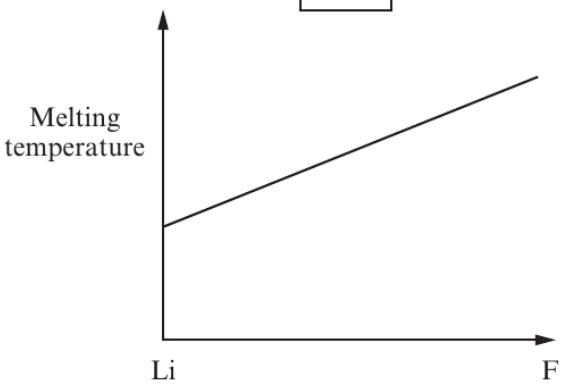
Examiner only

4. State which one of the following graphs best shows how melting temperature changes across period 2 in the Periodic Table. [1]

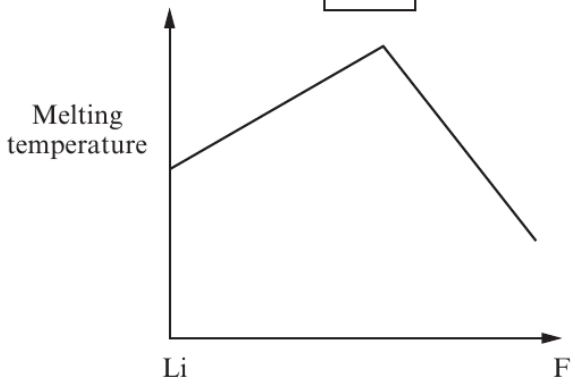
A



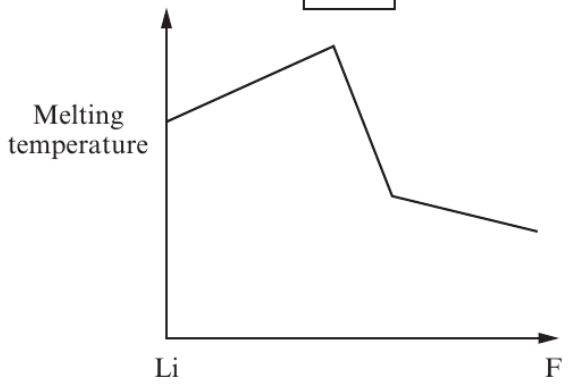
B



C



D



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5. In recent years scientists have developed a range of materials known as smart materials. State what is meant by a *smart material*. [1]

.....

.....

Examiner only

11. Dr Ballard carries out a series of experiments in the laboratory using Group 1 metals.

(a) In the first experiment, he ignites potassium and puts it in a gas jar containing oxygen to form potassium oxide.

(i) State what he would **see** as the reaction proceeds. [2]

.....

.....

.....

(ii) Write a balanced equation for the reaction. [1]

.....

(iii) He repeats the experiment with rubidium.
State whether you would expect rubidium to be more reactive or less reactive than potassium. Give a reason for your answer. [2]

.....

.....

.....

(b) In the second experiment, Dr Ballard reacts sodium with water at room temperature.

$$2Na(s) + 2H_2O(l) \longrightarrow 2NaOH(aq) + H_2(g)$$

(i) If the mass of sodium is 0.098 g, calculate the number of moles of sodium used in the experiment. [1]

.....

.....

(ii) Calculate the volume of hydrogen produced in this reaction at room temperature. [2]

(1 mole of gas occupies 24.0 dm^3 at room temperature)

.....

.....

(iii) If the volume of water used was 200 cm^3 calculate the concentration, in mol dm^{-3}, of the sodium hydroxide solution formed. [2]

.....

.....

Examiner only

(c) In the final experiment, Dr Ballard heats a piece of sodium and puts it in a gas jar containing chlorine to form sodium chloride.

(i) Apart from wearing safety goggles, give **one** precaution that Dr Ballard should take when using chlorine. [1]

.....

(ii) Sodium chloride is a solid with a melting temperature of 801°C.

I State the crystal co-ordination numbers for sodium chloride. [1]

.....

II Explain in terms of bonding why its melting temperature is high. [2]

.....

.....

.....

.....

Total [14]

Section B Total [70]

Rough Work

WJEC
CBAC

GCE AS/A level

1092/01-A

CHEMISTRY CH2
DATA SHEET

P.M. FRIDAY, 27 May 2011

Infrared Spectroscopy characteristic absorption values

Bond	Wavenumber / cm^{-1}
C—Br	500 to 600
C—Cl	650 to 800
C—O	1000 to 1300
C═C	1620 to 1670
C═O	1650 to 1750
C≡N	2100 to 2250
C—H	2800 to 3100
O—H	2500 to 3550
N—H	3300 to 3500

Examiner only

SECTION A

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

1. 'Smart' alloys have an increasing importance in many applications.
State how 'smart' alloys differ from other alloys in the way in which they act when used for a particular purpose. [2]

.....

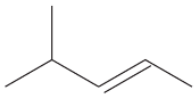
.....

2. A small piece of sodium metal is added to water.
Give the equation for this reaction and suggest a pH value for the resulting solution. [2]

Equation .....

pH of solution .....

3. The skeletal formula of a hydrocarbon is shown below.



Give the **systematic name** of this hydrocarbon. [1]

.....

4. Police use a breathalyser to test motorists for the presence of alcohol.

(a) An early type of breathalyser required the motorist to breathe into a tube that contained acidified potassium dichromate. The alcohol in their breath was oxidised to ethanal and ethanoic acid. State the colour change that occurred if the test was positive. [1]

..... to .....

(b) Modern breathalysers use infrared spectroscopy to detect and measure the concentration of alcohol in breath. An absorption frequency at 2940 cm^{-1} is used rather than the frequency caused by the O—H bond, as this is also present in water.

(i) Use the Data Sheet to identify the bond that causes the absorption at 2940 cm^{-1}. [1]

.....

Examiner only

10. *(a)* Explain the fact that the melting temperature of sodium is much lower than the melting temperature of magnesium.

You should include reference to the type(s) of bonding involved and how this bonding affects melting temperatures. You may include a diagram if you consider it helpful.

[3]

(b) In an experiment, 1-chlorobutane was heated with aqueous sodium hydroxide and the resulting solution was acidified. Aqueous silver nitrate was then added and a white precipitate was observed.

The experiment was repeated using 1-bromobutane and in this case a cream precipitate was observed.

Explain these observations.

You should include:

- the type of reaction that occurs between the halogenoalkane and sodium hydroxide
- an equation for this reaction
- the identity of the coloured precipitates
- an equation to show the formation of these precipitates. [4]

QWC [1]

Examiner only

(c) Describe how the structures of sodium chloride and caesium chloride are similar and how they are different. Give a reason for any difference.
You may include a diagram if you consider it helpful. [3]

(d) When hydrogen bromide, HBr, is added to propene, C_3H_6, two different products are possible. In practice, however, more of one of the products is formed.
Explain why more of one product is formed.

You should:

- state the type of reaction involved
- identify the two possible products
- state which of the two products predominates
- give the reason why more of this product is formed. [4]

QWC [1]

Total [16]

Examiner only

SECTION B

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

9. *(a)* Sodium and potassium both react with cold water but their reactivities are different. The first ionisation energy affects the reactivity of Group 1 elements.

(i) Give an observation that shows the difference in reactivity with cold water between sodium and potassium. [1]

.....

.....

(ii) Describe the trend in the first ionisation energy of Group 1 elements and explain why this trend occurs. [2]

.....

.....

.....

(iii) Explain how this trend affects the reactivity of Group 1 elements. [1]

.....

.....

Examiner only

(b) A GCSE student said that, apart from metallic bonding, bonds were either ionic or covalent. An A level student said that this was not really true and that bonds could be intermediate between ionic and covalent.

(i) State **one** factor that governs what type of bond elements form and explain how this leads to different types of bonding. [2]

(ii) Describe the electron density in each type of bond. [3]

Ionic

Covalent

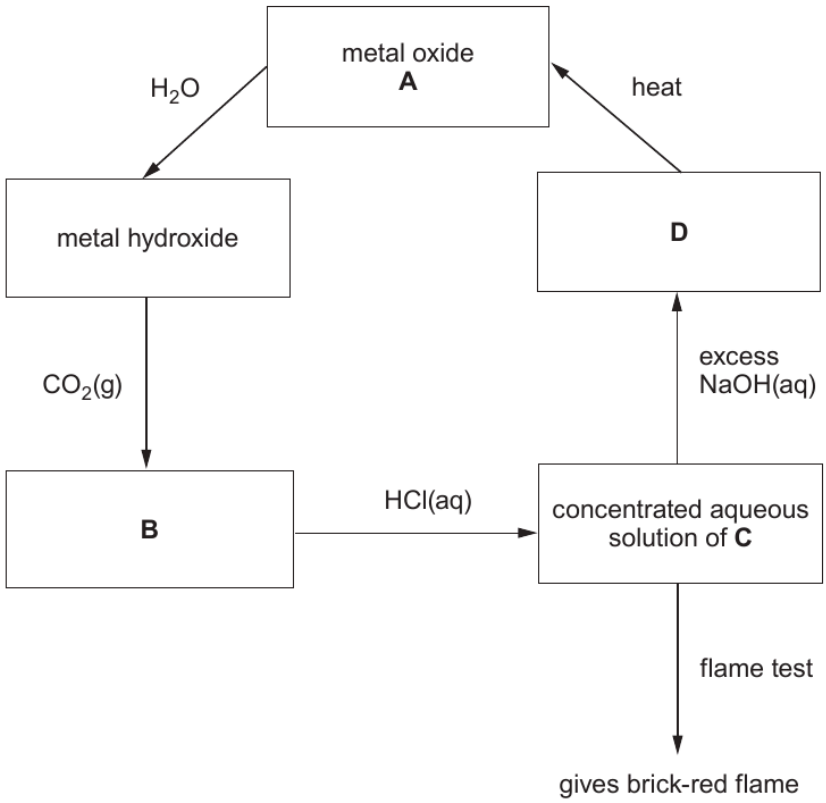
Intermediate

1092 010005

Examiner only

(c) Compound **A** is the oxide of a metal.

The diagram shows some reactions of compound **A**, and associated compounds, that can be carried out in the laboratory.



(i) What metal is present in compound **A**? [1]

.....

(ii) What compound containing the metal is present in the aqueous solution **C**? [1]

.....

(iii) Describe the appearance of the contents of the test tube with compound **D**. [1]

.....

(iv) Write the **ionic** equation for the reaction between solution **C** and aqueous sodium hydroxide. [1]

.....

Total [13]

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PLEASE DO NOT WRITE ON THIS PAGE

END OF QUESTION PACK

6 questions · 59 marks · ~1 h 34 min
Source: WJEC CH2 (2008 modular spec, Jun 2009 – Jun 2016)
Curated for WJEC Chemistry 2015 spec AS Unit 1 — Topic 13 (1.6)