Additional Assessment Materials

Summer 2021

Pearson Edexcel GCE in Chemistry 9CH0

Resource Set 2 – Topic Group 1

Topics included:

Topic 1: Atomic Structure and the Periodic Table

Topic 2: Bonding and Structure

Topic 3: Redox I

Topic 4: Inorganic Chemistry and the Periodic Table

(Public release version)

Pearson: helping people progress, everywhere

Pearson aspires to be the world's leading learning company. Our aim is to help everyone progress in their lives through education. We believe in every kind of learning, for all kinds of people, wherever they are in the world. We've been involved in education for over 150 years, and by working across 70 countries, in 100 languages, we have built an international reputation for our commitment to high standards and raising achievement through innovation in education. Find out more about how we can help you and your students at: www.pearson.com/uk

Additional Assessment Materials, Summer 2021

General guidance to Additional Assessment Materials for use in 2021

Context

- Additional Assessment Materials are being produced for GCSE, AS and A levels (with the exception of Art and Design).
- The Additional Assessment Materials presented in this booklet are an **optional** part of the range of evidence teachers may use when deciding on a candidate's grade.
- 2021 Additional Assessment Materials have been drawn from previous examination materials, namely past papers.
- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.

Purpose

- The purpose of this resource to provide qualification-specific sets/groups of questions covering the knowledge, skills and understanding relevant to this Pearson qualification.
- This document should be used in conjunction with the mapping guidance which will map content and/or skills covered within each set of questions.
- These materials are only intended to support the summer 2021 series.

Answer ALL questions.

Some questions must be answered with a cross in a box ☒. If you change your mind about an answer, put a line through the box ☒ and then mark your new answer with a cross ☒.

1 (a) Which equation shows the third ionisation energy of aluminium?

(1)

☒ **A** $Al(g) \rightarrow Al^{3+}(g) + 3e^-$

☒ **B** $Al^{2+}(g) \rightarrow Al^{3+}(g) + e^-$

☒ **C** $Al^{3+}(g) + 3e^- \rightarrow Al(g)$

☒ **D** $Al^{3+}(g) + e^- \rightarrow Al^{2+}(g)$

(b) Which element in this table is in Group 2?

	Ionisation energy / kJ mol^{-1}			
Element	First	Second	Third	Fourth
W	1086	2353	4621	6223
X	653	1592	2987	4740
Y	590	1145	4912	6474
Z	496	4563	6913	9544

(1)

☒ **A** W

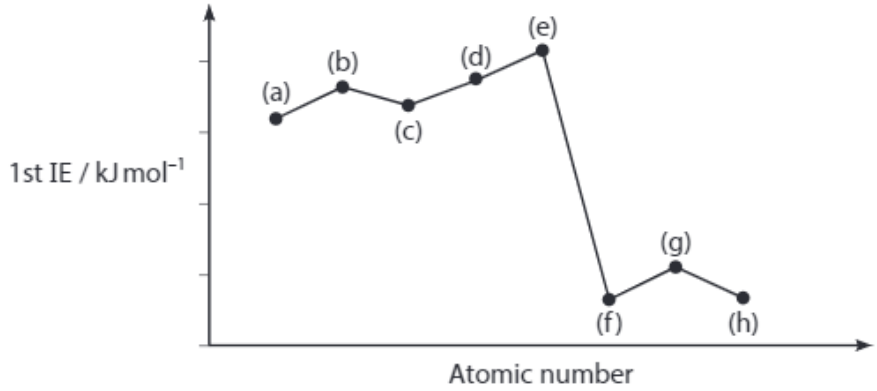
☒ **B** X

☒ **C** Y

☒ **D** Z

(c) The graph shows the first ionisation energies (IE) of eight successive elements from the first 20 elements in the Periodic Table.

Which letter represents the first ionisation energy of oxygen?



(1)

- ☐ **A** (a)
- ☐ **B** (b)
- ☒ **C** (c)
- ☐ **D** (h)

(d) Give the formula of a stable **ion** that is isoelectronic with the magnesium ion, Mg^{2+}.

(1)

F^-

Total for Question 1 = 4 marks

2 This question is about atoms, molecules and ions.

(a) Lithium exists as two isotopes.

Complete the table to show the numbers of subatomic particles in a ^{6}Li **atom** and a $^{7}Li^{+}$ **ion**.

(2)

Particle	Protons	Neutrons	Electrons
^{6}Li	3	3	3
$^{7}Li^{+}$	3	4	2

(b) The mass spectrum of a diatomic molecule, X_2, has peaks at the following m/z values for the X_2^+ ion:

32, 33, 34, 35, 36

Deduce the formulae of all the species responsible for **each** of the peaks in the mass spectrum of X_2, identifying element X and showing clearly the isotopes present.

(3)

Element is oxygen

32 → $^{16}O = {}^{16}O^{+}$

33 → $^{17}O = {}^{16}O^{+}$

34 → $^{17}O = {}^{17}O^{+}$ and $^{16}O = {}^{18}O^{+}$

35 → $^{17}O = {}^{18}O^{+}$

36 → $^{18}O = {}^{18}O^{+}$

(c) Complete the table to show the maximum number of electrons which can fill each region of an atom.

(3)

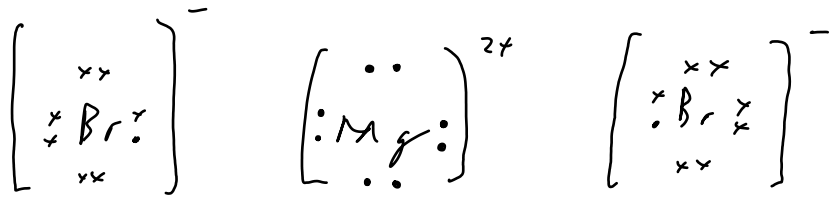
Region	Maximum number of electrons
the 1s orbital	2
the 2p subshell	6
the third quantum shell	18

(Total for Question 2 = 8 marks)

6 Magnesium bromide, $MgBr_2$, is an ionic compound.

(a) (i) Draw a dot-and-cross diagram to show the bonding in magnesium bromide.
Only outer shell electrons are required.

(1)



(ii) State all the conditions under which magnesium bromide conducts electricity.

(1)

When in molten state or dissolved in water.

(Total for question 6 = 2 marks)

2 This question is about some redox reactions of chlorine, bromine and iodine.

(a) An **excess** of aqueous potassium bromide was added to chlorine water and the solution turned orange.

(i) Write an equation for this reaction. State symbols are not required.

(1)

$2KBr + Cl_2 \rightarrow 2KCl + Br_2$

(ii) Silver nitrate solution was added to the mixture in (a) and excess dilute ammonia solution was then added to the precipitate formed. Only some of the precipitate dissolved.

Deduce why only **some** of the precipitate dissolved.

(3)

Silver nitrate reacts with Cl^- ions that are in solution to form a silver chloride precipitate. This precipitate will dissolve in the dilute ammonia that is then added. The precipitate that does not dissolve is silver bromide that formed from the silver nitrate and the left over Br^- from the initial excess of KBr

(iii) Aqueous potassium bromide was added to aqueous iodine, instead of chlorine water. There was no reaction.

Give a reason why no reaction occurred.

(1)

Iodine is less reactive than bromine and so will not displace the bromide in potassium bromide.

(b) Chlorine undergoes disproportionation when it reacts with **hot** aqueous sodium hydroxide solution.

(i) Complete the ionic equation for this reaction.
State symbols are not required.

(1)

$$2\ Cl_2 + 6\ OH^- \rightarrow 3\ Cl^- + \ ClO_3^- + 3\ H_2O$$

(ii) Explain, in terms of oxidation numbers, why this is a disproportionation reaction.

(2)

Oxidation numbers of chlorine in : $Cl_2 = 0$

$Cl^- = -1$

$ClO_3^- = +5$

Chlorine has been both oxidised $Cl_2(0) \rightarrow ClO_3^-(+5)$ and reduced $Cl_2(0) \rightarrow Cl^-(-1)$. This is a disproportionation reaction.

(Total for Question 2 = 8 marks)

$x - 6 = -1$
$x = +5$

2 Magnesium nitrate decomposes on heating as shown by the equation.

$$\overset{-2}{\overset{+2}{2Mg(NO_3)_2}} \rightarrow \overset{-2}{\overset{+2}{2MgO}} + \overset{-2}{\overset{+4}{4NO_2}} + \overset{0}{O_2}$$

$y - 4 = 0$
$y = +4$

(a) Explain, in terms of all the relevant oxidation numbers, why this is a redox reaction.

(3)

Initially, nitrogen has oxidation number +5, and finally it has oxidation number +4. This is reduction.
Initially, oxygen has oxidation number −2, and finally it has oxidation number 0 (in O_2). This is oxidation.
One species has been reduced and one has been oxidised, simultaneously
hence this is a redox reaction.

(b) Calcium nitrate decomposes in a similar way to magnesium nitrate, but requires a higher temperature for decomposition.

Explain this observation in terms of the charge and size of the cations.

(3)

Ca^{2+} have the same charge as the Mg^{2+} ions. Ca^{2+} ions have a larger ionic radius than Mg^{2+}, and so a lower charge density. This means the Ca^{2+} ions cause less polarisation and distortion of the nitrate ion electron cloud. This makes decomposition harder, so it requires a higher temperature.

(Total for Question 2 = 6 marks)

5 This question is about the chemistry of hydrated magnesium nitrate, $Mg(NO_3)_2.xH_2O$.

(a) Group 2 nitrates decompose when heated.

(i) State **two** observations you would see when hydrated magnesium nitrate is heated.

(2)

White solid is formed

Brown fumes given off

(ii) Explain the trend in thermal stability of Group 2 nitrates.

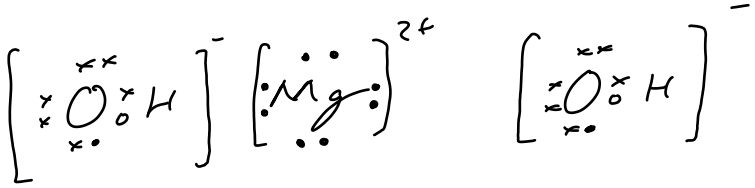
(3)

Down group 2, atomic radius increases. However they all form 2+ ions. This means the charge density decreases down the group. The lower density ions cause less polarisation and distortion of the nitrate ion. This makes decomposition harder down the group, and so thermal stability increases down the group.

(b) In an experiment, a sample of hydrated magnesium nitrate, $Mg(NO_3)_2.xH_2O$, with a mass of 0.765 g, was dissolved in water and reacted with an excess of sodium hydroxide solution, NaOH(aq).
The precipitate of magnesium hydroxide, $Mg(OH)_2$, produced was removed and dried. The mass of the dried sample was 0.174 g.

(i) Draw dot-and-cross diagrams for the ions in magnesium hydroxide.
Show the outer electrons only.

(2)



(ii) Use the experimental data to calculate the value for x in the formula $Mg(NO_3)_2.xH_2O$.
You **must** show all your working.

(5)

$n = \frac{m}{mr} = \frac{0.174}{58} = 3 \times 10^{-3}$ mol

$\Rightarrow$ n of hydrated nitrate $= 3 \times 10^{-3}$ mol

$mr = \frac{m}{n} = \frac{0.765}{3 \times 10^{-3}} = 255$

$Mg(NO_3)_2 . xH_2O$

mass = 148

$\therefore$ mass $= 255 - 148$
$= 107$

$\frac{107}{18} \simeq 6 \Rightarrow x = 6$

(Total for Question 5 = 12 marks)

Total for paper = 40 Marks