Additional Assessment Materials

Summer 2021

Pearson Edexcel GCE in Chemistry 9CH0

Resource Set 1 – 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)

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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- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.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.

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 This question is about atoms, molecules and ions.

(a) The numbers of subatomic particles in an ^{18}O atom are

(1)

☒ **A** 8 protons, 10 neutrons and 8 electrons

☐ **B** 9 protons, 9 neutrons and 9 electrons

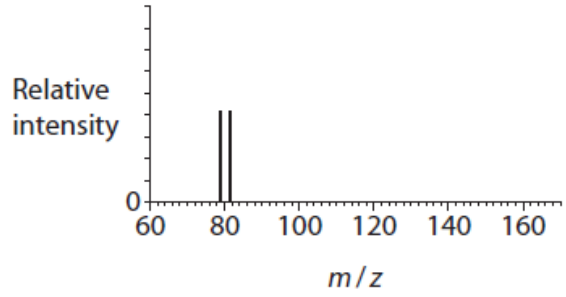
☐ **C** 10 protons, 8 neutrons and 10 electrons

☐ **D** 18 protons, 18 neutrons and 18 electrons

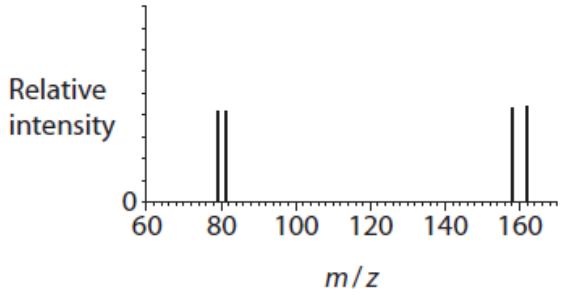
(b) The mass spectrum of a sample of bromine **molecules** with approximately equal proportions of the ^{79}Br and ^{81}Br isotopes is

(1)

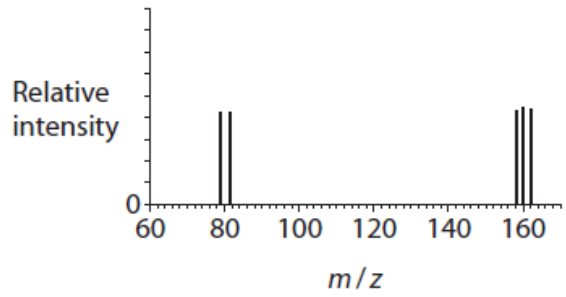
☐ **A**



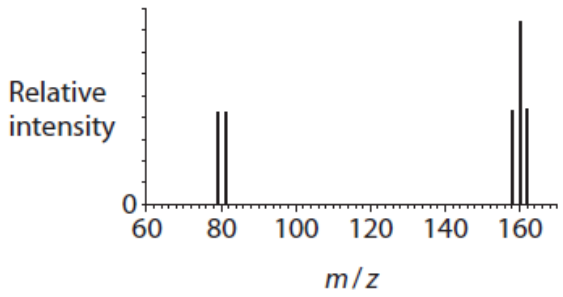
☐ **B**



☐ **C**



☒ **D**



(c) The total number of electrons in **all** the occupied **p** orbitals in a chloride ion, Cl^-, is

(1)

☐ **A** 5

☒ **B** 6

☐ **C** 12

☐ **D** 18

(d) Which of these isoelectronic ions has the largest ionic radius?

(1)

☒ **A** N^{3-} ← lowest nuclear charge

☐ **B** O^{2-}

☒ **C** Na^+

☐ **D** Al^{3+}

* All have structure of Ne

(Total for Question 1 = 4 marks)

31 P
15

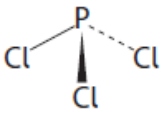
1 A phosphorus atom has mass number 31.

(a) How many of each sub-atomic particle are present in the phosphide ion, P^{3-}?

(1)

	Number of protons	Number of neutrons	Number of electrons
☐ **A**	15	16	12
☒ **B**	15	16	18
☐ **C**	16	15	12
☐ **D**	16	15	18

(b) Phosphorus(III) chloride molecules are pyramidal with a bond angle less than 109.5°.



(i) Explain why a phosphorus(III) chloride molecule has this shape and bond angle.

(2)

there is one lone pair of electrons and three bonding pairs. lone-pair bond-pair repulsion is greater than bp-bp repulsion so the bond angle is reduced from 109.5 to 100° by the lone pair, and all of the electron pairs repel to be as far apart as possible.

(ii) Which describes the polarity of the P—Cl bond and the polarity of the phosphorus(III) chloride molecule?

(1)

	Polarity of P—Cl bond	Polarity of molecule
☐ A	non-polar	non-polar
☐ B	non-polar	polar
☐ C	polar	non-polar
☒ D	polar	polar

(c) Phosphorus has one naturally occurring isotope with mass number 31. Chlorine exists as two isotopes with mass numbers 35 and 37.

Give the formulae and mass/charge ratio of the ions responsible for the molecular ion peaks in the mass spectrum of phosphorus(III) chloride, PCl_3.

(2)

$P^{35}Cl_3$ – m/z = 136 — $31 + 3\times35$

$P^{35}Cl^{37}Cl_2$ – m/z = 140 — $31 + 35 + 2\times37$

$P^{35}Cl_2{}^{37}Cl$ – m/z = 138 — $31 + 37 + 2\times35$

$P^{37}Cl_3$ – m/z = 142 — $31 + 3\times37$

(Total for Question 1 = 6 marks)

3 This question is about halogens and redox reactions.

(a) The boiling temperatures of three halogens are shown in the table.

Halogen	Boiling temperature / °C
chlorine	−35
bromine	59
iodine	184

Explain why the boiling temperatures increase from chlorine to iodine.

(2)

the bp increases down group 7 as the atoms get larger and the number of electrons increases so the strength of the van der waal's forces between the molecules also increases.

$KCl + H_2SO_4 \rightarrow KHSO_4 + HCl$

$Br^- \rightarrow 2e^- + 2H^+ + \overset{+6}{H_2SO_4} \rightarrow \overset{+4}{SO_2} + 2H_2O$

(b) Potassium halides react with concentrated sulfuric acid to form potassium hydrogensulfate and the different products shown in the table.

Potassium halide	Products
potassium chloride	hydrogen chloride
potassium bromide	hydrogen bromide, bromine and sulfur dioxide
potassium iodide	hydrogen iodide, iodine, hydrogen sulfide and sulfur

By referring to any changes in oxidation numbers when these halides react with concentrated sulfuric acid, explain which halide is the strongest reducing agent.

(3)

KI is the strongest reducing agent as it is able to reduce H_2SO_4 to H_2S, with a change in oxidation number from +6 to −2 for the S atom. KBr is able to reduce H_2SO_4 to S and SO_2, with changes in oxidation state from +6 to 0 (for S) and +6 to +4 (for SO_2). KCl is not able to reduce H_2SO_4. The I^- ion is the strongest reducing agent because it has the largest atomic radius thus there is a weak attraction between the nucleus and the outer electrons of I^- so they are more easily lost and transferred to sulfur.

(Total for Question 3 = 5 marks)

7 Boric acid, H_3BO_3, is a weak acid with antiseptic properties.

(a) Boric acid can be prepared by reacting borax, $Na_2B_4O_7.10H_2O$, with hydrochloric acid.

Write the equation for this reaction. State symbols are not required.

(1)

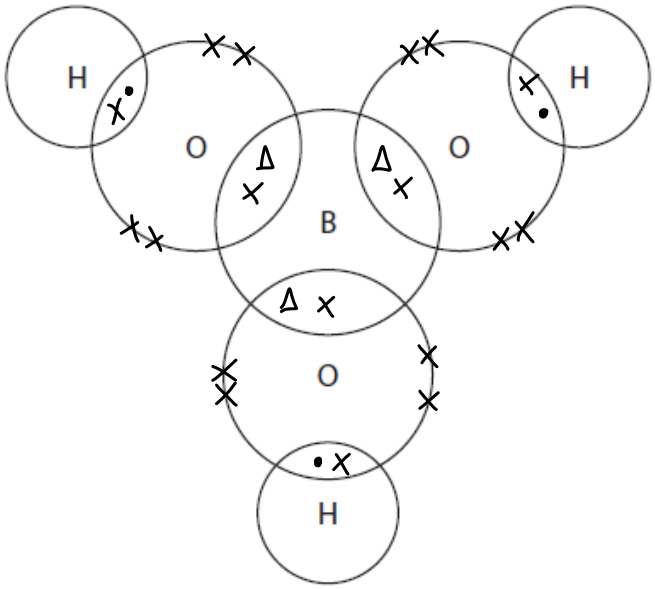
$Na_2B_4O_7.10H_2O + 2HCl \longrightarrow 4H_3BO_3 + 2NaCl + 5H_2O$

(b) The formula of boric acid can also be written as $B(OH)_3$.

(i) Complete the dot-and-cross diagram of a molecule of boric acid. Show the outer shell electrons only.

Use dots (•) for the hydrogen electrons, crosses (×) for the oxygen electrons and triangles (△) for the boron electrons.

(2)



(ii) What are the O—B—O and B—O—H bond angles in a molecule of boric acid?

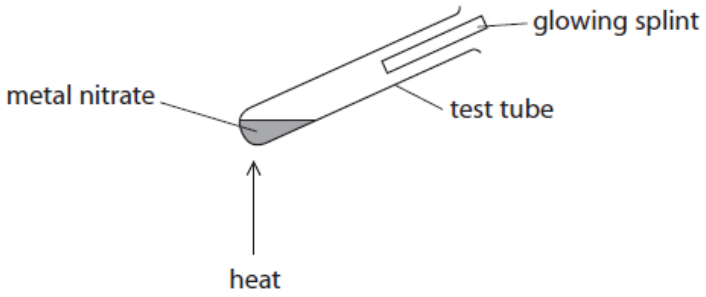
(1)

	O—B—O bond angle	B—O—H bond angle
☒ **A**	109.5°	104.5°
☒ **B**	109.5°	180°
☒ **C**	120°	104.5°
☒ **D**	120°	180°

(Total for Question 7 = 4 marks)

4 Thermal decomposition is the breaking down of a substance by heat.

(a) An experiment was carried out to investigate the thermal decomposition of a metal nitrate using the apparatus shown.



(i) The glowing splint is used as a test for one of the gases given off in this experiment.

Identify this gas and the positive result of the test.

(1)

oxygen - glowing splint relights when inserted into test tube

(ii) Give the name and appearance of the other gas given off in this experiment when a Group 2 nitrate is heated.

(1)

nitrogen dioxide - brown gas

(iii) Write the equation for the decomposition if the Group 1 compound, sodium nitrate, was used in this experiment.
State symbols are not required.

(1)

$2NaNO_3 \longrightarrow 2NaNO_2 + O_2$

(iv) Describe the apparatus that would be used to compare the decomposition of metal carbonates. Include how the rate of decomposition would be compared.

(2)

The metal carbonate would be put into a boiling tube which would be heated above a Bunsen burner. The CO_2 given off is then bubbled through limewater. The quicker the limewater turns cloudy, the greater the rate of decomposition of the carbonate and the less stable it is.

(b) Explain why magnesium carbonate decomposes much more readily on heating than barium carbonate.

(3)

barium carbonate is much more stable than magnesium carbonate because it is larger and so the 2+ charge of the metal ion is spread out over a greater area, and so doesn't polarize the carbonate ion as much as magnesium does, therefore it's easier to break the carbonate ion into the oxide and carbon dioxide from magnesium carbonate.

(Total for Question 4 = 8 marks)

Total for Test = 40