Additional Assessment Materials

Summer 2021

Pearson Edexcel GCE in Chemistry 8CH0

Resource Set 2 – Topic Group 1

Topics included:

Topic 1: Atomic Structure and the Periodic Table

Topic 2: Bonding and Structure

(Public release version)

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Additional Assessment Materials, Summer 2021

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- Additional Assessment Materials have come from past papers both published (those materials available publicly) and unpublished (those currently under padlock to our centres) presented in a different format to allow teachers to adapt them for use with candidate.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

2 Which molecule has a linear shape?

- ☐ **A** H_2S
- ☐ **B** SO_2
- ☒ **C** CO_2
- ☐ **D** $CH_2{=}CH_2$

(Total for Question 2 = 1 mark)

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4 This question is about isotopes.

(a) The table shows data for some isotopes of potassium.

Isotope	Relative isotopic mass	Abundance %
^{39}K	38.9637	93.218
^{40}K	39.9340	0.012
^{41}K	40.9618	6.770

(i) State what is meant by the terms 'relative isotopic mass' and 'relative atomic mass'.

(3)

- relative isotopic mass: the mass of an atom of an isotope compared to 1/12 the mass of an atom of C-12.
- relative atomic mass: the weighted average mass of all isotopes of an element, relative to 1/12 the mass of an atom of C-12.

(ii) State what is meant by the term 'isotopes'. Illustrate your answer by referring to the isotopes of potassium.

(2)

atoms of an element with the same number of protons and electrons but a different number of neutrons. Potassium has 3 different isotopes with a mass number of 39, 40 and 41 which have 20, 21 and 22 neutrons respectively. They all have 19 protons.

(iii) Use the data in the table to calculate the relative atomic mass of potassium. Give your answer to 4 significant figures.

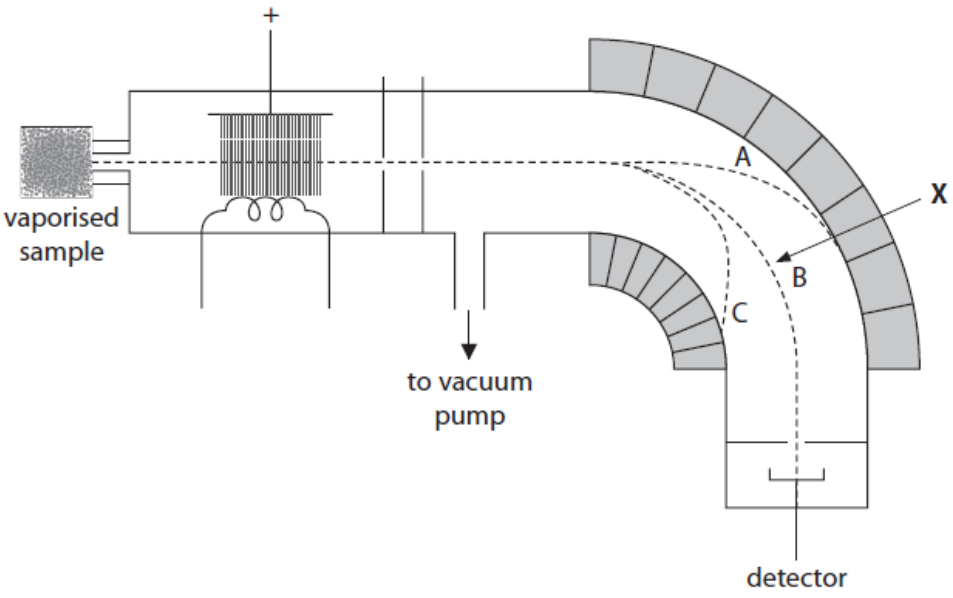
(2)

$$\frac{(38.9637 \times 93.218) + (39.9340 \times 0.012) + (40.9618 \times 6.770)}{100}$$

$A_r = 39.10$

(b) The relative isotopic abundances of an element can be measured using a mass spectrometer.

A simplified and incompletely labelled diagram of a mass spectrometer is shown.



(i) Name the feature of the mass spectrometer responsible for the behaviour of the ions in the region indicated by the arrow **X**.

(1)

magnetic field

(ii) Explain the three ion pathways, A, B and C, shown in the region indicated by the arrow **X**.

(3)

A and C have a 2+ charge so are deflected more strongly by the magnetic field than B, which has a 1+ charge. C is lighter than A and so is deflected more strongly and produces a curved path that has a smaller radius.

(iii) Give a reason why the mass spectrometer must be operated under vacuum.

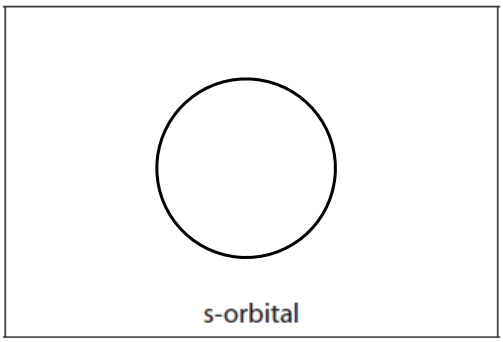
(1)

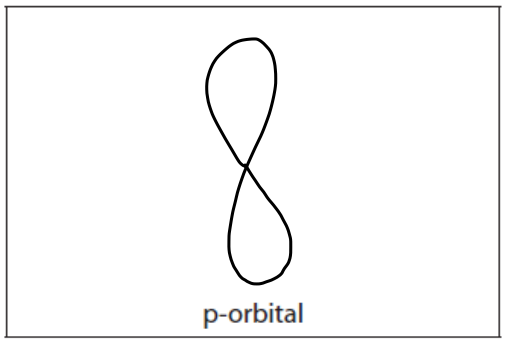
to prevent the ions from colliding with atoms in space

(Total for Question 4 = 12 marks)

3 Electrons in atoms occupy orbitals.

(a) Draw in the boxes the shape of an s-orbital and a p-orbital.





(2)

(b) State what is meant by the term **first ionisation energy**.

(3)

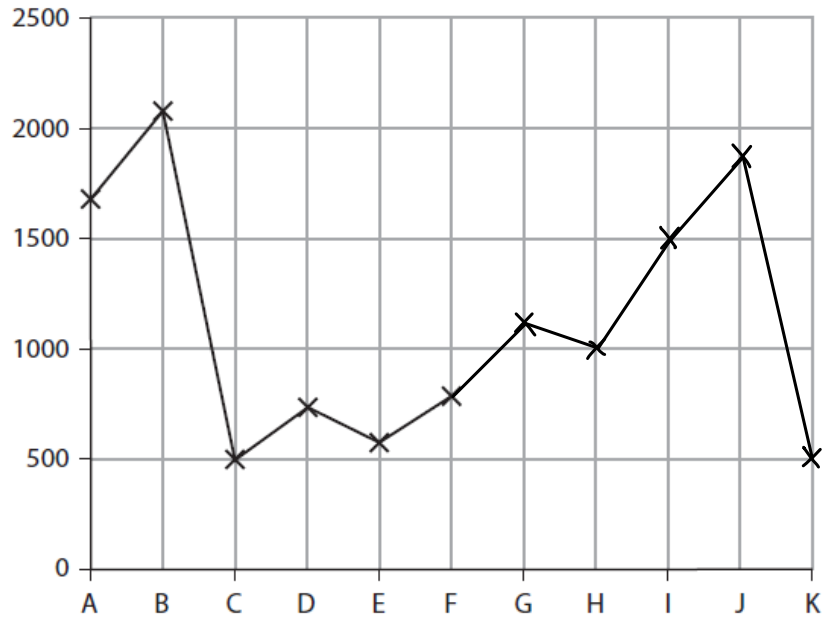
enthalpy change when each atom in one mole of gaseous atoms loses an electron to form one mole of gaseous 1+ ions. The outermost electron is lost.

example: $X(g) \longrightarrow X^{+}(g) + e^{-}$

(c) (i) The graph shows the first ionisation energies for a series of six consecutive elements **A–F**. The letters are not their chemical symbols.

Complete the graph of the first ionisation energies for the next five elements. (3)

(first 20 elements)



(ii) Explain why the value of the first ionisation energy for **D** is **greater** than for **C**. (2)

D has more protons in the nucleus than C so there's a higher nuclear charge and stronger attraction between the nucleus and outer electron so more energy is required to remove the outer electron.

(iii) Explain why the value of the first ionisation energy of **E** is **less** than for **D**. (2)

the outer electron is being removed from the p orbital in E compared to the s orbital in D. The p orbital is of a higher energy than s and so less energy is required to remove the outer electron in E. This is because the distance of the p orbital from the nucleus is greater than that of the s orbital.

(d) Successive ionisation energies can give information about the electronic structure of an element.

Which of the following sets of data showing the first four ionisation energies, in $kJ\,mol^{-1}$, of four elements is most likely to belong to boron?

(1)

- ☐ **A** 1086, 2353, 4621, 6223.
- ☐ **B** 900, 1757, 14849, 21007.
- ☒ **C** 801, 2427, 3660, 25026.
- ☐ **D** 578, 1817, 2745, 11578.

(Total for Question 3 = 13 marks)

8 This question is about ionic bonding.

(a) The elements sodium and fluorine react together to form an ionic compound.

(i) Select the correct equation for this reaction.

(1)

☐ **A** $Na(s) + F(g) \rightarrow NaF(s)$

☒ **B** $2Na(s) + F_2(g) \rightarrow 2NaF(s)$

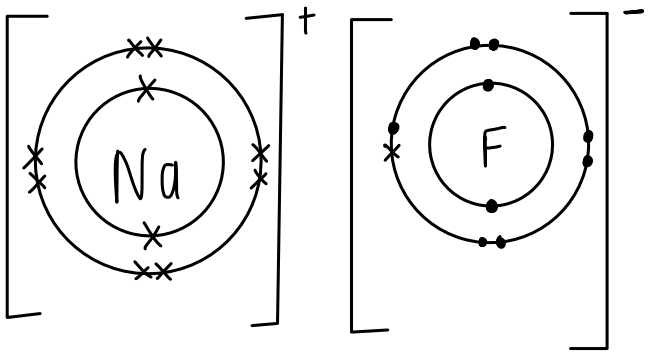
☐ **C** $Na(s) + F_2(g) \rightarrow NaF_2(s)$

☐ **D** $2Na(s) + F(g) \rightarrow Na_2F(s)$

(ii) Draw dot-and-cross diagrams of the ions in sodium fluoride, showing all the electrons.

Use your diagram to explain why the ions are described as isoelectronic.

(3)



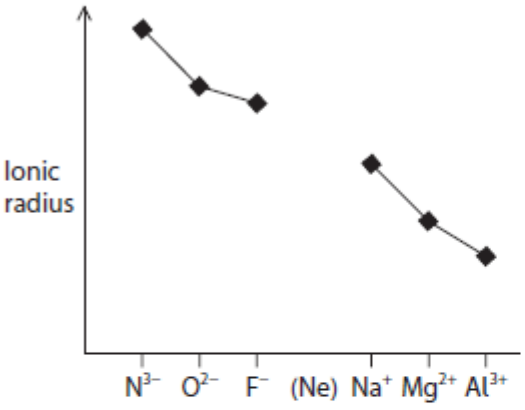
isoelectronic : same number of electrons.

Na^+ and F^- both have 10 electrons, so are isoelectronic.

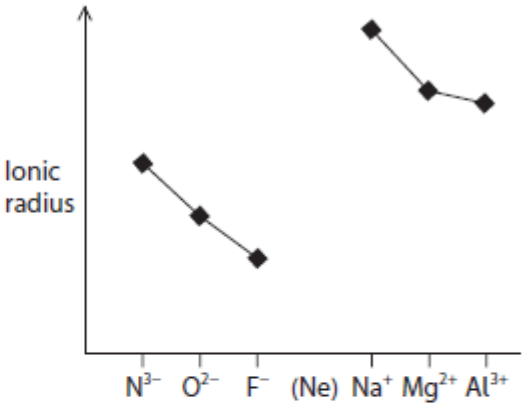
(iii) Which diagram shows the trend in ionic radius for the isoelectronic ions N^{3-} to Al^{3+}?

(1)

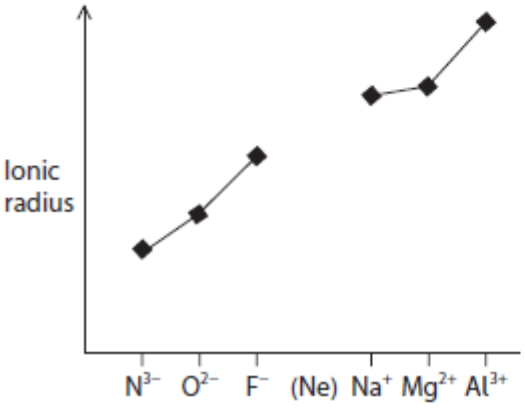
☒ A



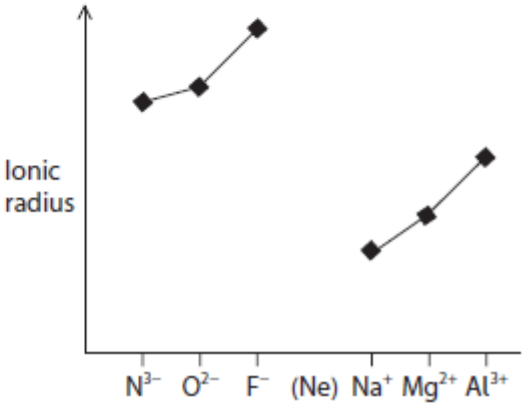
☐ B



☐ C



☐ D



(iv) Explain your answer to (a)(iii) in terms of the structure of the ions.

(2)

N^{3-} and Al^{3+} have the same number of electrons, but N^{3-} has a larger ionic radius because adding 3 electrons adds a whole extra energy level to the atom.

(b) The strength of ionic bonding in different compounds can be compared by using the amount of energy required to separate the ions. Some values for this energy are given in the table.

Compound	Amount of energy required to separate the ions / $kJ\,mol^{-1}$
LiF	1031
KF	817
CaF_2	2957

Using the data provided, explain how changes in the cation affect the bond strength in an ionic compound.

(2)

the smaller the cation, and the more highly charged it is (i.e. a larger positive charge) the stronger its attraction to the anion and so the larger the amount of energy needed to separate the ions. For example, K^+ is larger than Li^+ as so the strength of the ionic bond is greater. Ca^{2+} is more highly charged than K^+ and Li^+, and smaller than K^+, so its attraction to F^- is greater. In each case, the anion is the fluoride ion, so the changes in the bond strength are only due to the changes in the cations.

(Total for Question 8 = 9 marks)

2 This question is about water.

(a) Water is a polar covalent molecule. The strongest intermolecular forces between water molecules are hydrogen bonds.

(i) The O—H bond in water is polar because, when compared with the hydrogen atom, the oxygen atom has

(1)

☐ **A** a higher mass number

☐ **B** a larger atomic radius

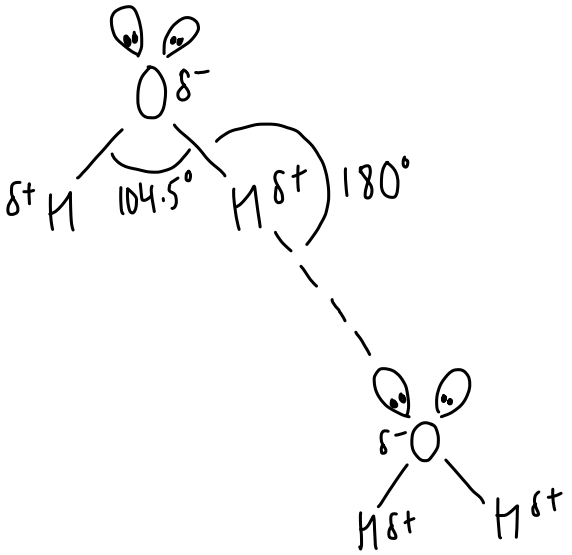
☒ **C** greater electronegativity

☐ **D** more electrons

(ii) Draw a diagram of a hydrogen bond between two water molecules in ice.

Show the value of the H—O—H angle within a molecule and the value of the O—H—O angle between the two molecules.

(2)



(iii) Explain why hydrogen bonding causes ice to be less dense than liquid water.

(2)

the hydrogen bonds become fixed in place when water freezes, so water expands and the molecules become fixed in place at set distances from each other, so ice is less dense than water.

Total for Question 2 = 5 marks

Total for Test = 40 marks