Section B: Periodicity and properties of elements

Answer ALL questions. Write your answers in the spaces provided.

1 Bromine is a fuming red–brown liquid at room temperature. It is a mixture of two isotopes, ^{79}Br and ^{81}Br.

(a) Which of the following is the number of neutrons in the isotope ^{79}Br? **1 mark**

- ☐ **A** 42
- ☐ **B** 44
- ☐ **C** 46
- ☐ **D** 48

(b) Identify **two** correct statements about the isotopes. **2 marks**

- ☐ **A** ^{79}Br and ^{81}Br have the same number of atoms.
- ☐ **B** ^{79}Br and ^{81}Br have the same number of electrons.
- ☐ **C** ^{79}Br and ^{81}Br have the same number of ions.
- ☐ **D** ^{79}Br and ^{81}Br have the same number of neutrons.
- ☐ **E** ^{79}Br and ^{81}Br have the same number of protons.

Isotopes are atoms with the same atomic number but different mass numbers.

Guided

(c) The electronic configuration of a bromine atom can be written in terms of sub-shells.

(i) Complete the electronic configuration of a bromine atom. **1 mark**

Remember that bromine is in group 7 of the periodic table.

$1s^2\ 2s^2\ 2p^6\ 3s^2\ 3p^6$ .....

(ii) State why bromine is classified as a p-block element. **1 mark**

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Bromine fluoride is a polar molecule.

(d) Describe the charge distribution in a polar molecule. **1 mark**

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Bromine forms three compounds with phosphorus.
The compounds have the molecular formulae PBr_3, PBr_5 and P_2Br_4

(e) (i) Give the meaning of molecular formula. 2 marks

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PBr_3 can be prepared by heating phosphorus (P_4) in bromine vapour.

Guided

(ii) Write a chemical equation for this reaction. State symbols are not required. 1 mark

P_4 + ... Br_2 → ..... PBr_3

(iii) One of the three phosphorus bromides has the following percentage composition by mass:

P = 16.2% Br = 83.8%

Calculate the empirical formula of this bromide. 2 marks

The percentages are the same as the mass, in grams, in 100 g of the compound. The calculation should be carried out in three stages:
1. Calculate the amount, in moles, of each element in 100 g (divide the mass by the relative atomic mass, Ar).
2. Calculate the ratio of moles, by dividing both by the smaller value.
3. Calculate, if necessary, the simplest whole number ratio of moles of each element.
Now write the empirical formula using this ratio.

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empirical formula .....

(iv) Determine the identity of the bromide. 1 mark

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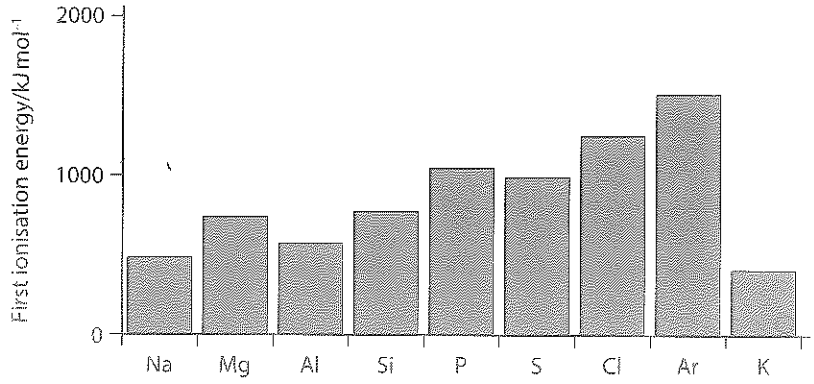
Links You can revise moles on page 22 of the Revision Guide.

Total for Question 1 = 12 marks

2 The bar chart shows the first ionisation energies of the elements sodium to potassium.



Guided

(a) State what is meant by the term first ionisation energy. 3 marks

The energy required to remove one electron from .....

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(b) Explain why the first ionisation energy shows a general increase from Na to Ar. 3 marks

Think about how the following affect the attraction between the nucleus and the outer electrons:
- The change in the charge of the nucleus from Na to Ar.
- The change in the shielding of the outer electrons from Na to Ar.

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(c) Explain why the first ionisation energy of Al is lower than that of Mg. 2 marks

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Consider the orbital that the outer electron occupies in the atom of each element.

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(d) Explain why the first ionisation energy of K is much lower than that of Ar, even though it has a higher nuclear charge.

4 marks

Include the following in your answer:
- In which quantum shell each outer electron can be found.
- How much shielding the outer electron experiences in each atom.

Total for Question 2 = 12 marks

Guided

3 Chlorine, bromine and iodine are known as halogens.

Discuss how van der Waals forces are responsible for the trend in boiling temperature of these halogens.

6 marks

To 'discuss', you need to show a clear understanding of the topic, consider all aspects of the topic, make connections between different aspects and discuss the extent or importance of features.

Consider the following points:

- How an instantaneous dipole is created in a molecule.
- How this instantaneous dipole affects a neighbouring molecule.
- How the number of electrons in a molecule affects the size of the instantaneous dipole and hence the size of the attraction between molecules.
- How the number of electrons in the molecule changes from chlorine to bromine to iodine.
- How the size of the attraction between the molecules affects the amount of energy required to separate the molecules to form a gas.
- How the amount of energy required to separate the molecules affects the boiling temperature.

Links You can revise intermolecular forces on page 20 of the Revision Guide.

Total for Question 3 = 6 marks

END OF SECTION **TOTAL FOR SECTION B = 30 MARKS**