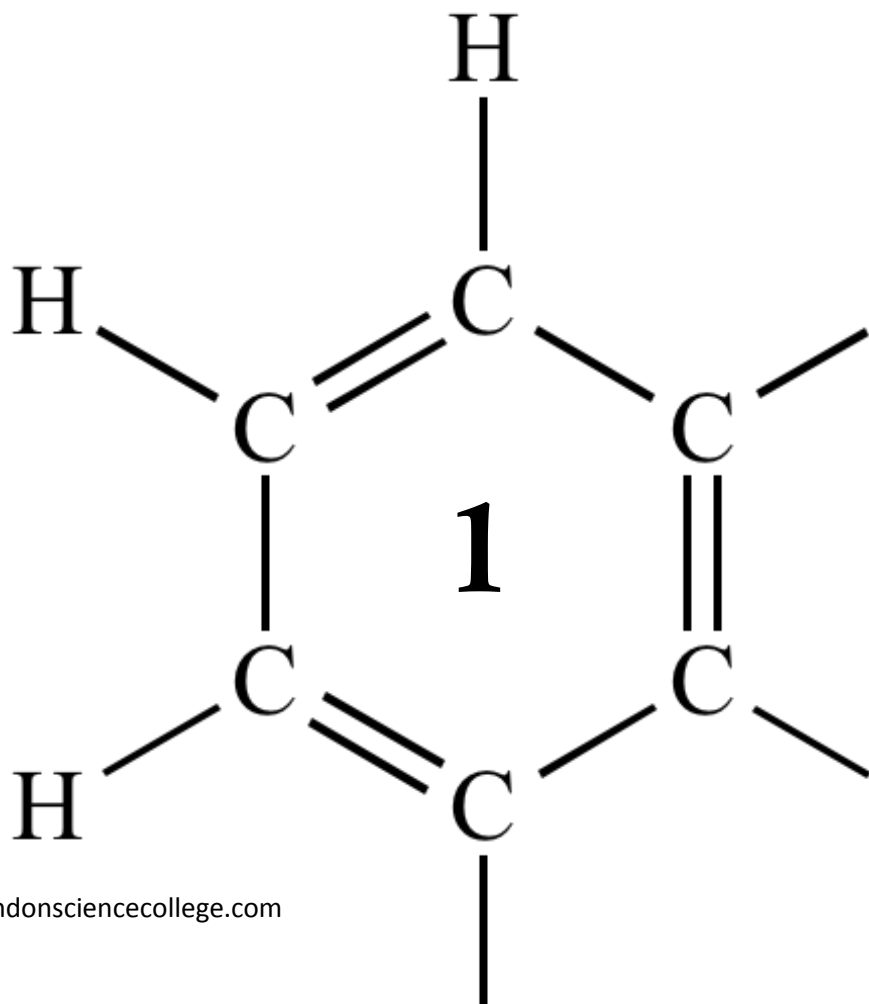


AQA AS CHEMISTRY
ATOMIC STRUCTURE



1

This question is about electron configuration.

(a) Give the full electron configuration of an Al atom and of a Cr³⁺ ion.

Al atom.....

Cr³⁺ ion

(2)

(b) Deduce the formula of the ion that has a charge of 2+ with the same electron configuration as krypton.

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(1)

(c) Deduce the formula of the compound that contains 2+ ions and 3- ions that both have the same electron configuration as argon.

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(1)

(Total 4 marks)

2

This question is about Period 3 of the Periodic Table.

(a) Deduce which of Na⁺ and Mg²⁺ is the smaller ion.
Explain your answer.

Smaller ion

Explanation

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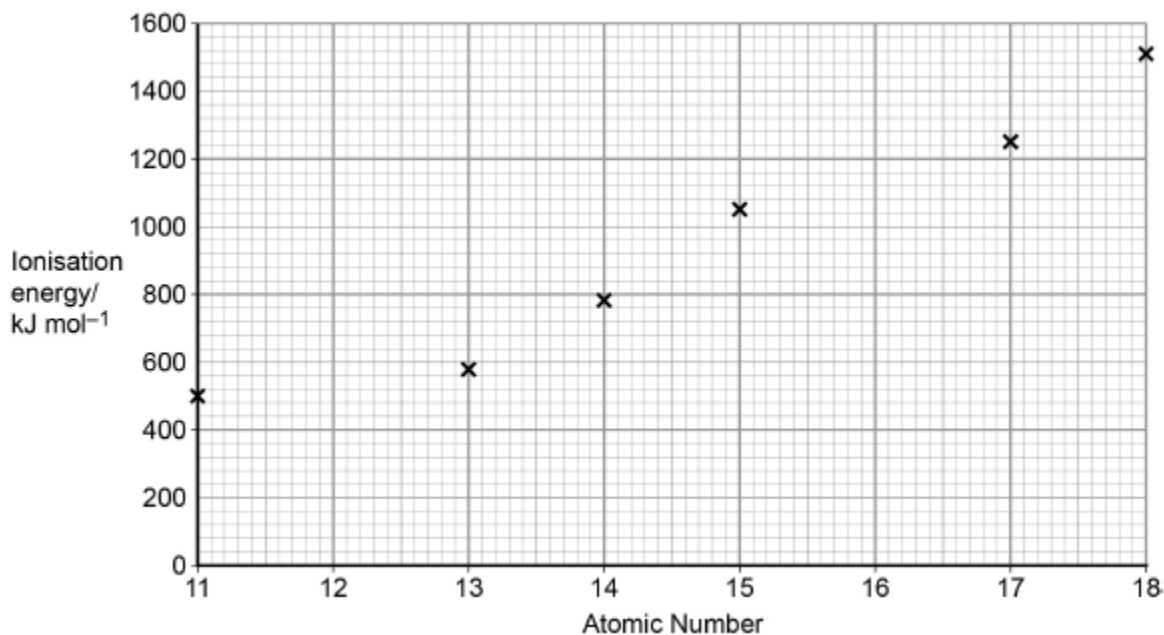
(2)

(b) Write an equation to represent the process that occurs when the first ionisation energy for sodium is measured.

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(1)

(c) The first ionisation energies of some Period 3 elements are shown in the following graph.



Complete the graph by plotting the approximate first ionisation energy values for magnesium and sulfur.

Explain why the first ionisation energy of sulfur is different from that of phosphorus.

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(4)
(Total 7 marks)

3

(a) Explain how ions are accelerated, detected and have their abundance determined in a time of flight (TOF) mass spectrometer.

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(3)

(b) Calculate the mass, in kg, of a single $^{52}\text{Cr}^+$ ion.
Assume that the mass of a $^{52}\text{Cr}^+$ ion is the same as that of a ^{52}Cr atom.

(The Avogadro constant $L = 6.022 \times 10^{23} \text{ mol}^{-1}$)

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(1)

(c) In a TOF mass spectrometer the kinetic energy (KE) of a $^{52}\text{Cr}^+$ ion was $1.269 \times 10^{-13} \text{ J}$

Calculate the velocity of the ion using the equation.

$$\text{KE} = \frac{1}{2}mv^2$$

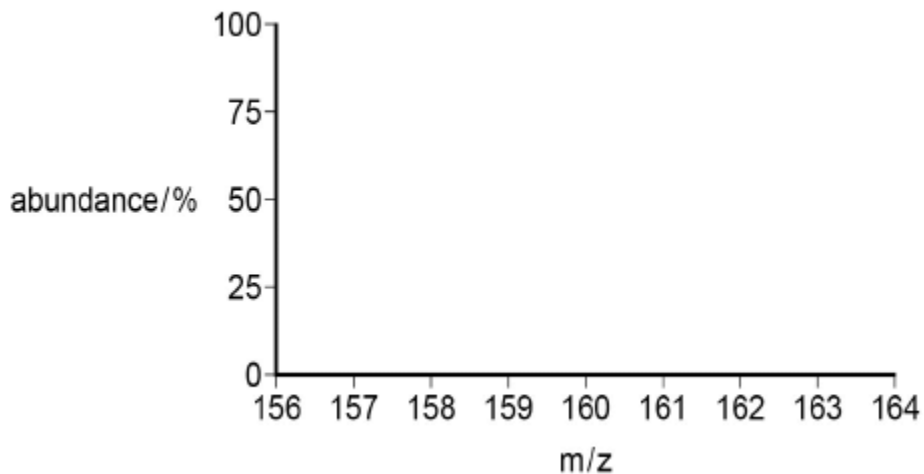
($m = \text{mass/kg}$ and $v = \text{velocity/ms}^{-1}$)

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(2)

- (d) Bromine has two isotopes, ^{79}Br and ^{81}Br , in approximately equal abundance. In a TOF mass spectrometer bromine forms ions with formula $[\text{Br}_2]^+$

Sketch the pattern of peaks you would expect to see in the mass spectrum of a sample of bromine.



(2)

- (e) A sample of xenon has $A_r = 131.31$. The sample consists of four isotopes. The abundances of three of the isotopes are shown in the table below. The data for one of the isotopes, ^mXe , is missing.

Isotope	^{129}Xe	^{131}Xe	^{132}Xe	^mXe
% abundance	28.0	25.0	27.0	To be calculated

Use the data to calculate the abundance of isotope ^mXe and calculate m , the mass number of ^mXe . Show your working.

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(4)
(Total 12 marks)

4

Ions of two isotopes of iron are



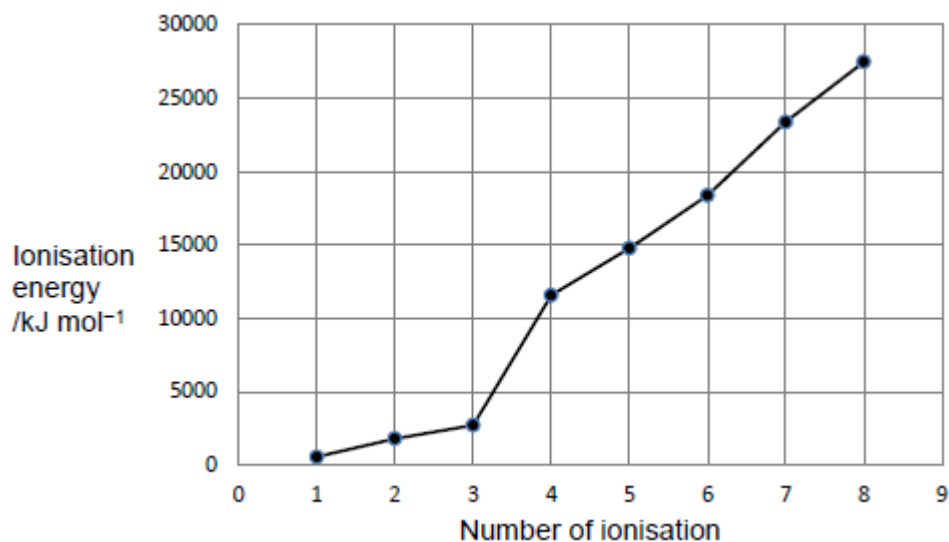
Which statement is correct?

- A The ions of both the isotopes have the electronic configuration $1s^2 2s^2 2p^6 3s^2 3p^6 4s^2 3d^6$
- B The ions of both the isotopes contains 26 neutrons
- C $^{53}\text{Fe}^{2+}$ has fewer protons than $^{56}\text{Fe}^{2+}$
- D After acceleration to the same kinetic energy $^{56}\text{Fe}^{2+}$ will move more slowly than $^{53}\text{Fe}^{2+}$

(Total 1 mark)

5

The successive ionisation energies for element X are shown in the following graph.



Which element is X?

- A Nitrogen
- B Phosphorus
- C Aluminium
- D Boron

(Total 1 mark)

6

This question is about the periodicity of the Period 3 elements.

(a) State and explain the general trend in first ionisation energy across Period 3.

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(4)

(b) Give one example of an element which deviates from the general trend in first ionisation energy across Period 3.

Explain why this deviation occurs.

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(3)

(c) The table shows successive ionisation energies of an element Y in Period 3.

Ionisation number	1	2	3	4	5	6	7	8
Ionisation energy / kJ mol^{-1}	1000	2260	3390	4540	6990	8490	27 100	31 700

Identify element Y.

Explain your answer using data from the table.

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(2)

(d) Identify the Period 3 element that has the highest melting point.

Explain your answer by reference to structure and bonding.

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(4)

(Total 13 marks)

7

This question is about the elements in Group 2 and their compounds.

(a) Use the Periodic Table to deduce the full electron configuration of calcium.

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(1)

(b) Write an ionic equation, with state symbols, to show the reaction of calcium with an excess of water.

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(1)

(c) State the role of water in the reaction with calcium.

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(1)

(d) Write an equation to show the process that occurs when the first ionisation energy of calcium is measured.

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(1)

(e) State and explain the trend in the first ionisation energies of the elements in Group 2 from magnesium to barium.

Trend

Explanation

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(3)

(Total 7 marks)

8

(a) A sample of sulfur consisting of three isotopes has a relative atomic mass of 32.16. The following table gives the relative abundance of two of these isotopes.

Mass number of isotope	32	33
Relative abundance / %	91.0	1.8

Use this information to determine the relative abundance and hence the mass number of the third isotope.
Give your answer to the appropriate number of significant figures.

Mass number =

(4)

(b) Describe how ions are formed in a time of flight (TOF) mass spectrometer.

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(2)

(c) A TOF mass spectrometer can be used to determine the relative molecular mass of molecular substances.

Explain why it is necessary to ionise molecules when measuring their mass in a TOF mass spectrometer.

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(2)

(Total 8 marks)

9

Which of these atoms has the largest atomic radius?

A Ar **B** Cl **C** Mg **D** Na **(Total 1 mark)****10**

Which of these atoms has the smallest number of neutrons?

A ^3H **B** ^4He **C** ^5He **D** ^4Li **(Total 1 mark)**