

2.1 The Nuclear Atom

Past Exam Questions (Paper 1, 2)

1. [1 mark]

How many protons, neutrons and electrons are present in each atom of ^{31}P ?

	Protons	Neutrons	Electrons
A.	16	15	16
B.	15	16	15
C.	15	31	15
D.	16	31	16

2. [1 mark]

What is the atomic number of a neutral atom which has 51 neutrons and 40 electrons?

- A. 40
- B. 51
- C. 91
- D. 131

3. [1 mark]

Which statement about the species $^{63}\text{Cu}^{2+}$ and $^{65}\text{Cu}^{+}$ is correct?

- A. Both species have the same number of protons.
- B. Both species have the same number of electrons.
- C. Both species have the same number of neutrons.
- D. Both species have the same electron arrangement.

4. [1 mark]

Which statement about the isotopes of an element is correct?

- A. They have the same mass number.
- B. They have a different atomic number.
- C. They have the same chemical properties.
- D. They are located in different places in the periodic table.

5. [1 mark]

How many electrons does the ion ${}_{15}^{31}\text{P}^{3-}$ contain?

- A. 12
- B. 15
- C. 16
- D. 18

6. [1 mark]

A sample of zinc has the following composition:

Isotope	% abundance
${}^{64}\text{Zn}$	55
${}^{66}\text{Zn}$	40
${}^{68}\text{Zn}$	5

What is the relative atomic mass of the zinc in this sample?

- A. 64.5
- B. 65.0
- C. 65.9
- D. 66.4

7. [1 mark]

Which statement about the numbers of protons, electrons and neutrons in an atom is always correct?

- A. The number of neutrons minus the number of electrons is zero.
- B. The number of protons plus the number of neutrons equals the number of electrons.
- C. The number of protons equals the number of electrons.
- D. The number of neutrons equals the number of protons.

8. [1 mark]

Which statements about the isotopes of chlorine, $^{35}_{17}\text{Cl}$ and $^{37}_{17}\text{Cl}$, are correct?

- I. They have the same chemical properties.
 - II. They have the same atomic number.
 - III. They have the same physical properties.
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

9. [1 mark]

What is the correct number of each particle in an oxygen ion, $^{18}\text{O}^{2-}$?

	Protons	Neutrons	Electrons
A.	8	8	10
B.	8	10	8
C.	8	8	6
D.	8	10	10

10. [1 mark]

Which subatomic particles are located in the nucleus of an atom?

- A. Protons and electrons
- B. Neutrons and electrons
- C. Protons and neutrons
- D. Protons, neutrons and electrons

11. [1 mark]

What are the numbers of neutrons and electrons in the iodine ion, $^{125}_{53}\text{I}^{+}$?

	Neutrons	Electrons
A.	53	53
B.	72	52
C.	72	53
D.	125	52

12. [1 mark]

Which statements about the isotopes of an element are correct?

- I. They have the same chemical properties.
 - II. They have different physical properties.
 - III. They have the same number of protons and electrons.
- A. I and II only
- B. I and III only
- C. II and III only
- D. I, II and III

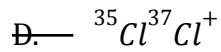
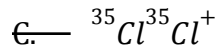
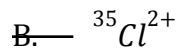
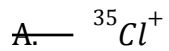
13. [1 mark]

Which is an isotope of $^{24}_{12}\text{Mg}$?

- A. $^{24}_{11}\text{Na}$
- B. $^{24}_{21}\text{Mg}^{2+}$
- C. $^{26}_{12}\text{Mg}$
- D. $^{22}_{10}\text{Ne}$

14. [1 mark]

~~Which ion will show the least deflection in a mass spectrometer?~~



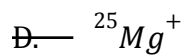
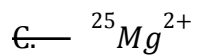
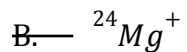
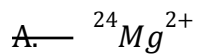
15. [1 mark]

What does $^{52}_{24}\text{X}$ represent?

- A. An isotope of Te with 24 neutrons
- B. An isotope of Te with 24 electrons
- C. An isotope of Cr with 28 protons
- D. An isotope of Cr with 28 neutrons

16. [1 mark]

~~Which species would be deflected most in a mass spectrometer?~~



17. [1 mark]

Which statement about the isotopes of nitrogen is correct?

	Number of electrons	Number of neutrons	Mass number
A.	same	same	same
B.	same	same	different
C.	same	different	different
D.	different	different	different

18. [1 mark]

Which statement is correct for the ion ${}^9_4\text{Be}^{2+}$?

- A. The ion contains 15 subatomic particles in the nucleus.
- B. The ion contains more protons than neutrons in the nucleus.
- C. The ion has an electron arrangement of 2,2.
- D. Most of the total volume of the ion is empty space.

19. [1 mark]

Which ion will be deflected most in a mass spectrometer?

- A. ${}^{16}\text{O}^+$
- B. ${}^{16}\text{O}^{2+}$
- C. ${}^{18}\text{O}^+$
- D. ${}^{18}\text{O}^{2+}$

20. [2 marks]

Strontium exists as four naturally-occurring isotopes. Calculate the relative atomic mass of strontium to two decimal places from the following data.

Isotope	Percentage abundance
Sr-84	0.56
Sr-86	9.90
Sr-87	7.00
Sr-88	82.54

21a. [1 mark]

Define the term *isotopes*.

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21b. [2 marks]

A sample of silicon contains three isotopes.

Isotope	Percentage abundance / %
^{28}Si	92.23
^{29}Si	4.68
^{30}Si	3.09

Calculate the relative atomic mass of silicon using this data.

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22a. [2 marks]

Iron has three main naturally occurring isotopes which can be investigated using a mass spectrometer.

A sample of iron has the following isotopic composition by mass.

Isotope	^{54}Fe	^{56}Fe	^{57}Fe
Relative abundance / %	5.95	91.88	2.17

Calculate the relative atomic mass of iron based on this data, giving your answer to **two decimal places**.

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22b. [1 mark]

Calculate the number of electrons in the ion $^{56}\text{Fe}^{2+}$.

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23a. [2 marks]

The relative atomic mass of naturally occurring copper is 63.55. Calculate the abundances of ^{63}Cu and ^{65}Cu in naturally occurring copper.

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23b. [1 mark]

The isotopes of some elements are radioactive. State a radioisotope used in medicine.

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24. [2 marks]

Isotopes are atoms of the same element with different mass numbers. Two isotopes of cobalt are Co-59 and Co-60.

Deduce the missing information and complete the following table.

Symbol	$^{59}\text{Co}^{3+}$	^{60}Co	
Number of protons	27		53
Number of neutrons		33	72
Number of electrons		27	53

25a. [1 mark]

Explain why the relative atomic mass of argon is greater than the relative atomic mass of potassium, even though the atomic number of potassium is greater than the atomic number of argon.

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25b. [1 mark]

Deduce the numbers of protons and electrons in the K^+ ion.

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26. [2 marks]

Carbon and silicon belong to the same group of the periodic table.

Silicon has three stable isotopes, ^{28}Si , ^{29}Si and ^{30}Si . The heaviest isotope, ^{30}Si , has a percentage abundance of 3.1%. Calculate the percentage abundance of the lightest isotope to one decimal place.

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27a. [2 marks]

Rubidium contains two stable isotopes, ^{85}Rb and ^{87}Rb . The relative atomic mass of rubidium is given in Table 5 of the Data Booklet.

Calculate the percentage of each isotope in pure rubidium. State your answers to **three** significant figures.

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27b. [2 marks]

State the number of electrons and the number of neutrons present in an atom of ^{87}Rb .

Number of electrons:

Number of neutrons:

28a. [1 mark]

^{131}I is a radioactive isotope of iodine.

Define the term *isotope*.

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28b. [1 mark]

Determine the number of neutrons in one atom of iodine-131.

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29a. [1 mark]

The element boron has two naturally occurring isotopes, ^{10}B and ^{11}B .

Define the term *isotopes of an element*.

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29b. [2 marks]

Calculate the percentage abundance of **each** isotope, given that the relative atomic mass of B is 10.81.

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30a. [2 marks]

Chlorine occurs in Group 7, the halogens.

Two stable isotopes of chlorine are ^{35}Cl and ^{37}Cl with mass numbers 35 and 37 respectively.

Define the term *isotopes of an element*.

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30b. [2 marks]

Calculate the number of protons, neutrons and electrons in the isotopes ^{35}Cl and ^{37}Cl .

Isotope	Number of protons	Number of neutrons	Number of electrons
^{35}Cl			
^{37}Cl			

30c. [2 marks]

Using the mass numbers of the two isotopes and the relative atomic mass of chlorine from Table 5 of the Data Booklet, determine the percentage abundance of each isotope.

Percentage abundance ^{35}Cl :

Percentage abundance ^{37}Cl :

31. [2 marks]

A sample of magnesium contains three isotopes: magnesium-24, magnesium-25 and magnesium-26, with abundances of 77.44%, 10.00% and 12.56% respectively.

Calculate the relative atomic mass of this sample of magnesium correct to **two** decimal places.

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32a. [2 marks]

Boron is most often encountered as a component in borosilicate glass (heat resistant glass).

The naturally occurring element contains two stable isotopes, $^{10}_5\text{B}$ and $^{11}_5\text{B}$.

The relative atomic mass of boron is 10.8, to three significant figures. Calculate the percentage of $^{10}_5\text{B}$ in the naturally occurring element.

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32b. [1 mark]

Isotopes of boron containing 7 and 8 neutrons also exist. Suggest why releasing isotopes containing more neutrons than the stable isotope into the environment can be dangerous.

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33. [2 marks]

State the relative mass and charge of the subatomic particles of an atom.

	Relative mass	Relative charge
Proton		+1
Electron	5×10^{-4}	
Neutron		

34a. [2 marks]

A sample of vaporized elemental magnesium is introduced into a mass spectrometer.

One of the ions that reaches the detector is $^{26}\text{Mg}^+$.

Calculate the number of protons, neutrons and electrons in the $^{26}\text{Mg}^+$ ion.

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34b. [2 marks]

The sample contained the three isotopes ^{24}Mg , ^{25}Mg and ^{26}Mg . The relative percentage abundances of ^{25}Mg and ^{26}Mg are 10.00% and 11.01% respectively. Calculate the relative atomic mass (A_r) of magnesium, accurate to **two** decimal places.

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