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— TUITION —

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CHEMISTRY

PHYSICAL CHEMISTRY

Level & Board	OCR (A-LEVEL)
TOPIC:	ATOMIC STRUCTURE
PAPER TYPE:	QUESTION PAPER -3
TOTAL QUESTIONS	12
TOTAL MARKS	43

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Atomic Structure and Isotopes

1. This query is about elements and isotopes.

(a) Silver Ag, has an atomic number of 47.

- i. Explain the concept of isotopes in the context of silver. [1]
- ii. Discuss whether different isotopes of silver have the same chemical properties. [1]
- iii. Complete the table below to show the atomic structure of $^{107.87}\text{Ag}$ [1]

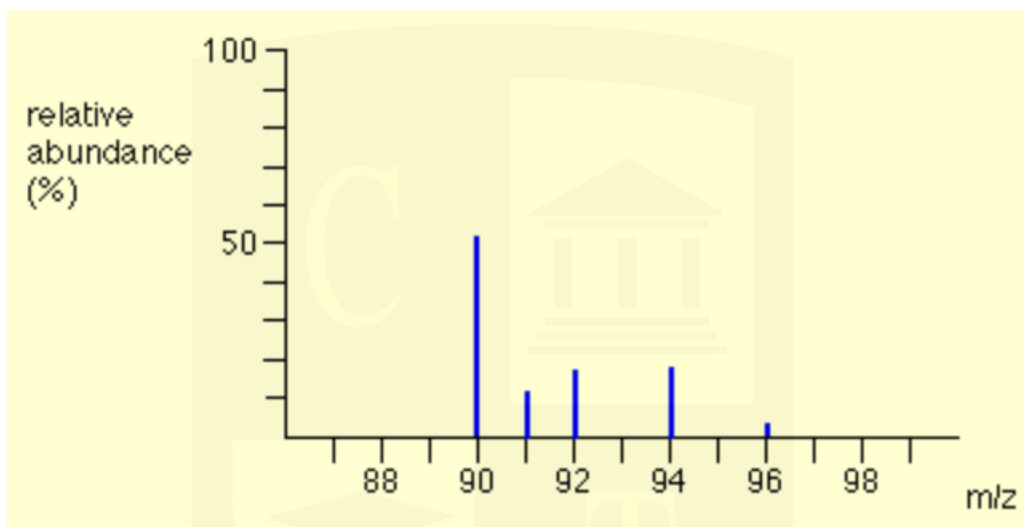
Protons	Neutrons	Electrons

(b) The relative atomic mass of silver (Ag) is 107.87

- i. Explain relative atomic mass. [3]
- ii. A sample of silver, $A_r = 107.87$, was analyzed and was found to consist of 65% ^{107}Ag and one other isotope. Determine the mass number of the other isotope in the sample of silver. [1]

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2. A sample of element Z was analyzed by mass spectrometry. The mass spectrum is shown below.



<u>Isotope</u>	<u>Abundance</u>
90	51.5
91	11.2
92	17.1
94	17.4
96	2.8

- i. Find the relative atomic mass of element Z. [2]

- ii. Suggest the identity of element Z. [1]

3. Neptunium, with an atomic number of 93, has two isotopes, ^{235}Np and ^{237}Np .

- (a) Complete the table to show the number of protons, neutrons, and electrons in the $^{235}\text{Np}^{2+}$ ion of neptunium. [1]

	Protons	Neutrons	Electrons
$^{235}\text{Np}^{2+}$			

- (b) Neptunium atoms have electrons distributed across different energy levels. The first four energy levels of neptunium are completely filled. Complete the table to show the number of electrons in the following regions of a neptunium atom. [3]

	number of electrons
the 1s sub-shell	
a 3p orbital	
the 3rd shell	

4. This This question relates to the characteristics and reactions of the Group 8 element argon.

Using a mass spectrometer, it is possible to calculate the relative atomic mass of argon.

- i. Describe the meaning of the phrase "relative atomic mass of an element". [2]
- ii. A sample of argon has a relative atomic mass of 39.95. The sample consists of: [2]
 - 90.5% Ar-40
 - 0.27% Ar-38
 - one other isotope.

Find the other isotopic mass of third argon in the sample.

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5. This inquiry concerns the structure and compounds of Carbon, Oxygen, and Silicon, emphasizing isotopes and their differences. Most elements contain different isotopes.

(a) Define Isotopic mass. [1]

(b) Complete the table for a positive ion and atom of two different elements. [1]

Element	Mass number	Protons	Neutrons	Electrons	Charge
		6	6		
	28			14	0

6. This inquiry is about elements from the p-block of the periodic table. Silicon exists as a mixture of three isotopes, ^{28}Si , ^{29}Si , and ^{30}Si .

i. Complete the table to show the atomic structure of ^{29}Si . [1]

	Protons	Neutrons	Electrons
^{29}Si			

ii. A sample of Silicon is analyzed by mass spectrometry. The mass spectrum shows peaks with the relative abundances below.

- ^{28}Si : 92.23%
- ^{29}Si : 4.67%
- ^{30}Si : 3.10%

Calculate the relative atomic mass of Silicon in the sample.

Give your answer to two decimal places. [2]

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7. This inquiry is about elements from the s-block and p-block of the periodic table. A sample of Argon is analyzed by mass spectrometry.

The information from mass spectrum is shown below.

Isotope	Isotopic molar mass	Abundance
^{36}Ar	$35.96755 \text{ g mol}^{-1}$	0.337%
^{38}Ar	$37.96272 \text{ g mol}^{-1}$	0.063%
^{40}Ar	$39.9624 \text{ g mol}^{-1}$	99.600%

- (a) Calculate the relative atomic mass of the element by taking rounded off masses.

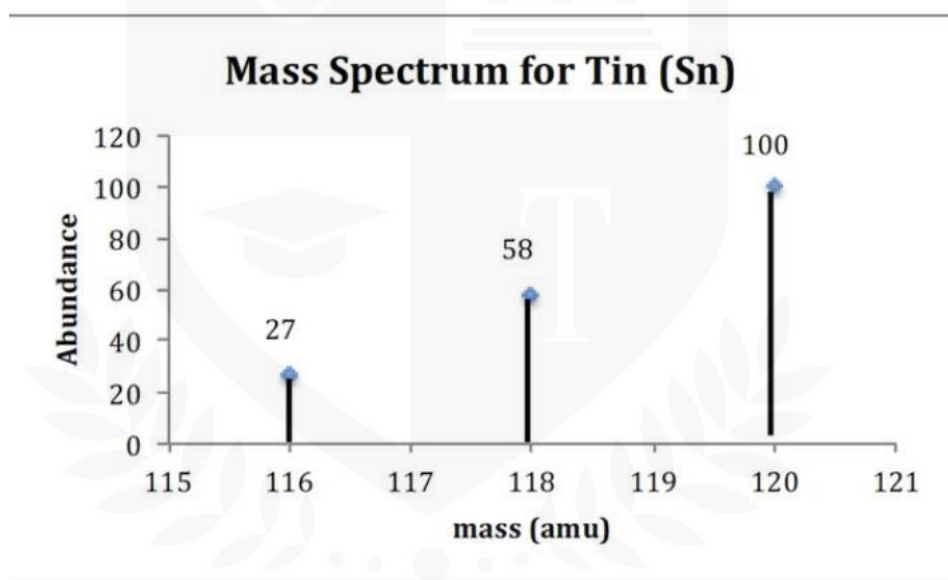
- (b) The species causing the peaks in the mass spectrum are $1+$ ions of Ar. Complete the table to show the number of protons, neutrons, and electrons in each $1+$ ion of Ar. [2]

m / z	protons	neutrons	electrons
40			
38			
36			

8. A piece of bronze is made from tin and aluminum. Tin and aluminum exist as a mixture of isotopes.

(a) How the atomic structures of various isotopes of the same element differ and are similar. [2]

(b) The tin is analyzed by mass spectrometry. The mass spectrum is shown below.



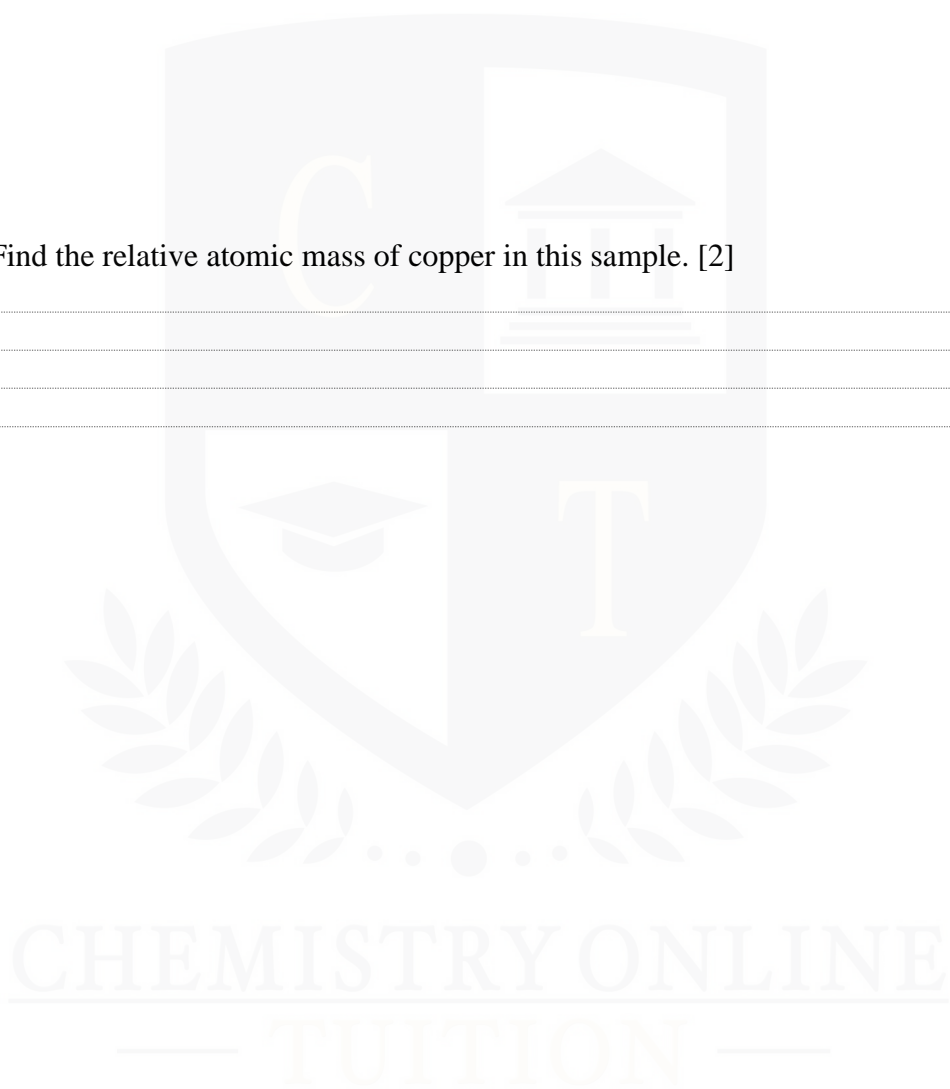
i. Find the relative atomic mass of the tin. Give your answer to two decimal places. [2]

ii. One piece has a mass of 5.00 g and contains 80.0% of tin, by mass. Calculate the number of tin atoms in one piece. [2]

9. Naturally occurring copper consists of two isotopes: ^{63}Cu (69.17%) with an isotopic mass of 62.9296 and ^{65}Cu (30.83%) with an isotopic mass of 64.9278.

i. Explain relative atomic mass. [3]

ii. Find the relative atomic mass of copper in this sample. [2]



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10. Nitrogen is the gas in the atmosphere. Atoms of nitrogen consist of protons, neutrons, and electrons. Complete the table below. [2]

Particle	Relative mass	Relative charge	Position within the atom
Proton			
Neutron			
Electron			shell

11. Oxygen has two isotopes, O-16 and O-18. The relative atomic mass of oxygen is 16.5. Calculate the percentage of O-18 atoms in a sample of oxygen. [2]

12. This question is about the elements with atomic numbers between 13 and 26. Aluminum, atomic number 13, is a metal. Complete the table to show the relative charge of each particle and the number of each particle found in a $^{26.98}\text{Al}^{3+}$ ion. [2]

Particle	Relative charge of each particle	Number of each particle present in a $^{27}\text{Al}^{2+}$ ion
proton		
neutron		
electron		

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