Atomic Structure and Isotopes

1. This question is about the properties and reactions of the Group 2 element strontium.

The relative atomic mass of strontium can be determined using a mass spectrometer.

i. Explain what is meant by the term **relative atomic mass** of an element.

---**[2]**

ii. A sample of strontium has a relative atomic mass of 87.73.

The sample consists of:

- 82.9% Sr-88
- 6.9% Sr-87
- one other isotope.

Determine the other isotope of strontium in the sample.

isotope of strontium = ... **[2]**

2(a). This question is about atomic structure and the compounds of calcium, nitrogen and oxygen.

Most elements contain different isotopes.

State **two** differences between isotopes of the same element.

---**[1]**

(b). Complete the table for an atom and an ion of two different elements.

Element	Mass number	Protons	Neutrons	Electrons	Charge
.....	.....	26	28	.....	0
.....	80	.....	.....	36	2−

[2]

3. This question 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 ^{30}Si.

	Protons	Neutrons	Electrons
^{30}Si	.....	.....	.....

[1]

ii. A sample of silicon is analysed by mass spectrometry.

The mass spectrum shows peaks with the relative abundances below.

- ^{28}Si 92.23%
- ^{29}Si 4.68%
- ^{30}Si 3.09%

Calculate the relative atomic mass of silicon in the sample.

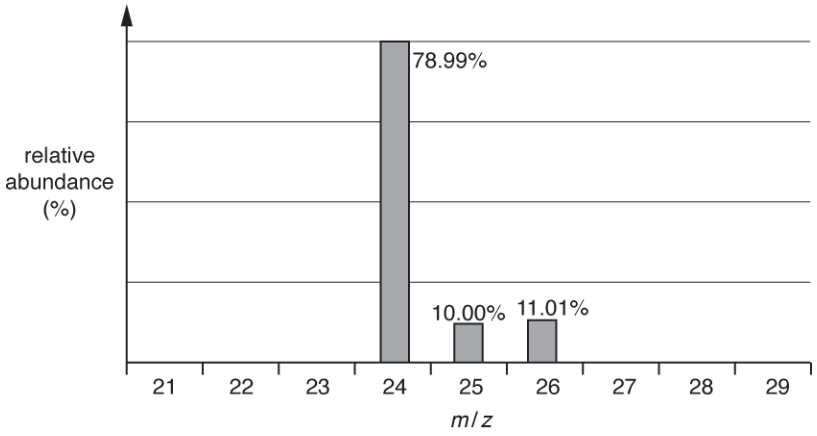
Give your answer to **two** decimal places.

relative atomic mass = _____

[2]

4. This question is about elements from the s-block and p-block of the periodic table.

A sample of magnesium is analysed by mass spectrometry. The mass spectrum is shown below.



i. The species causing the peaks in the mass spectrum are 1+ ions of magnesium.
Complete the table to show the number of protons, neutrons and electrons in each **1+ ion** of magnesium.

m* / *z	**protons**	**neutrons**	**electrons**
24			
25			
26			

ii. Calculate the relative atomic mass of the magnesium in the sample.
Give your answer to **two** decimal places.

relative atomic mass = …… **[2]**

5(a). A twenty pence coin contains copper and nickel.

Copper and nickel each exist as a mixture of isotopes.

State the similarities and differences between the atomic structure of isotopes of the **same** element.

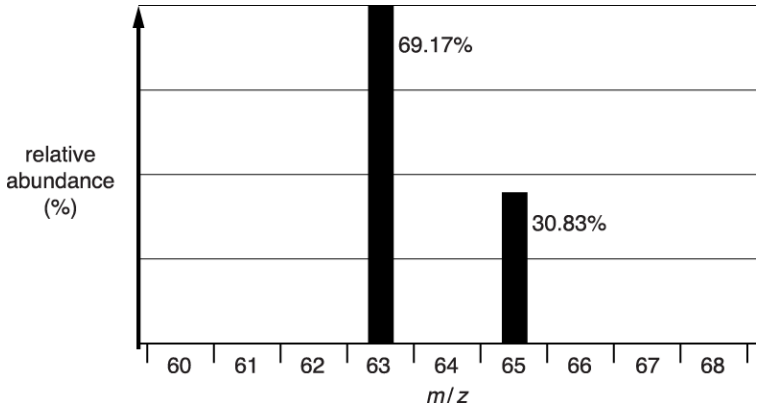
Similarities

……

Differences……

[2]

(b). The copper used to make a batch of coins is analysed by mass spectrometry. The mass spectrum is shown below.



i. Calculate the relative atomic mass of the copper used to make the coins.

Give your answer to **two** decimal places.

relative atomic mass = …… **[2]**

ii. One coin has a mass of 5.00 g and contains 84.0% of copper, by mass.

Calculate the number of copper atoms in one coin.

Give your answer in standard form and to **three** significant figures.

number of copper atoms = …… **[2]**

6. A sample of zinc was found to contain four isotopes with the abundances shown in the table.

Isotope	Abundance (%)
^{64}Zn	49.0
^{66}Zn	27.9
^{67}Zn	4.3
^{68}Zn	18.8

i. Define the term *relative atomic mass*.

---**[3]**

ii. Calculate the relative atomic mass of zinc in this sample.

Give your answer to **two** decimal places.

relative atomic mass of zinc = …… **[2]**

7. Nitrogen is the most common gas in the atmosphere.

Atoms of nitrogen consist of protons, neutrons and electrons.

Complete the table below.

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

[2]

8. Bromine has two isotopes, Br–79 and Br–81. The relative atomic mass of bromine is 79.9.

Calculate the percentage of Br–79 atoms in a sample of bromine.

Answer = ... % **[2]**

9. This question is about the elements with atomic numbers between 58 and 70.

Cerium, atomic number 58, is a metal.

Complete the table to show the relative charge of each particle and the number of each particle found in a $^{140}Ce^{2+}$ ion.

Particle	Relative charge of each particle	Number of each particle present in a $^{140}Ce^{2+}$ ion
proton		
neutron		
electron		

[2]

10(a). Antimony, Sb, has atomic number 51.

Antimony exists as a mixture of isotopes.

i. What is meant by the term *isotopes?*

---

[1]

ii. Different isotopes of antimony have the same chemical properties.

Explain why.

---

[1]

iii. Complete the table below to show the atomic structure of ^{121}Sb.

Protons	Neutrons	Electrons

[1]

(b). The relative atomic mass of antimony is 121.8.

i. Define the term *relative atomic mass*.

---**[3]**

ii. A sample of antimony, A_r = 121.8, was analysed and was found to consist of 60% ^{121}Sb and one other isotope.

Determine the mass number of the other isotope in the sample of antimony.

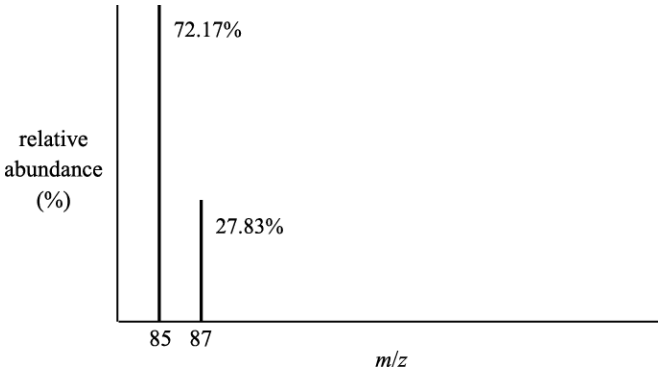
mass number of the other antimony isotope = …… **[1]**

11. Bromine and mercury are the only two naturally occurring elements that are liquids at room temperature and pressure. Some physical properties of these two elements are given below.

	Appearance at room temperature	Melting point / °C	Boiling point / °C	Electrical conductivity of the liquid
Bromine	dark orange liquid	−7.2	58.8	very low
Mercury	shiny silver liquid	−38.8	356.7	good

Element **X** melts at temperatures reached on very hot summer days.

A sample of element **X** was analysed by mass spectrometry. The mass spectrum is shown below.



i. Calculate the relative atomic mass of element **X**.

Give your answer to **two** decimal places.

relative atomic mass = ... **[2]**

ii. Suggest the identity of element **X**.

_____ **[1]**

12(a). Europium, atomic number 63, has two isotopes, ^{151}Eu and ^{153}Eu.

Complete the table to show the number of protons, neutrons and electrons in the $^{153}Eu^{3+}$ ion of europium.

	protons	**neutrons**	**electrons**
$^{153}Eu^{3+}$			

[1]

(b). Atoms of europium have electrons in orbitals within the first five shells. The first three shells of europium are full.

Complete the table to show the number of electrons in the following regions of a europium atom.

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

[3]

END OF QUESTION PAPER