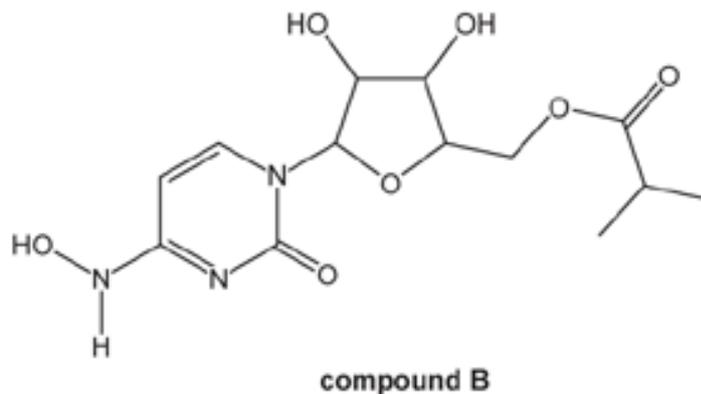**1.** Compound **B**, shown below, is an antiviral medicine

compound B

   i.   What is the molecular formula of compound **B**

_____**[1]**

   ii.   How many chiral carbon atoms are there in one molecule of compound **B**?

_____**[1]**

   iii.   A research chemist synthesises two related compounds, compound **C** and compound **D**, from compound **B**.

      •   In compound **C**, the N atoms in compound **B** had been replaced by P atoms.
      •   In compound **D**, the O atoms in compound **B** had been replaced by S atoms.

    What is the difference between the relative molecular masses of compound **C** and compound **D**?

                                   difference = ... **[2]**

2. α-Amino acids have the general formula $RCH(NH_2)COOH$.

The R group in an α-amino acid contains C and H only.

This R group has a molar mass of 91 g mol^{-1}.

A polymer is formed from 500 molecules of this α-amino acid.

Determine the molar mass of this polymer.

Give your answer to the nearest whole number.

                         molar mass of polymer = ... g mol^{-1} **[3]**

3. 1.35 g of ethylamine gas, $CH_3CH_2NH_2$ ($M_r = 45.0$), is reacted with 20 cm³ of 2.0 mol dm⁻³ hydrochloric acid forming a solution of ethylammonium chloride.

$CH_3CH_2NH_2(g) + HCl(aq) \rightarrow CH_3CH_2NH_3^+(aq) + Cl^-(aq)$
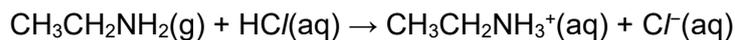
What is the concentration of ethylammonium chloride in mol dm⁻³?

A   0.03
B   0.67
C   1.50
D   2.00

Your answer ☐   **[1]**

4. This question is about iron.

A sample of iron is isolated from a meteorite and analysed by mass spectrometry.

The mass spectrum shows peaks with the relative abundances below.

Isotope	^{54}Fe	^{56}Fe	^{57}Fe	^{58}Fe
Relative abundance	78.54%	8.88%	5.10%	7.48%

Calculate the relative atomic mass of the iron in the sample.

Give your answer to **2** decimal places.

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

5. Which row shows the atomic structure of $^{25}Mg^{2+}$?

	Protons	**Neutrons**	**Electrons**
A	10	12	13
B	10	15	12
C	12	13	10
D	12	13	14

Your answer ☐   **[1]**

6. This question is about periodicity and the reaction of some Group 2 metals.

Periodicity is the repeating trend in properties of elements across different periods in the periodic table.

    i.   Complete the table below with the electron configurations and blocks.

	Group 2	**Group 17 (7)**
Period 2	Be $1s^2$	F $1s^2$ ....
Period 3	Mg $1s^2$	Cl $1s^2$ ....
Block	....	....

[3]

    ii.   Use your answers to **(i)** to explain why electron configuration is an example of a periodic trend.

[2]

    iii.   Mg forms 2+ ions but Cl usually forms 1− ions in their reactions. Explain why.

[2]

    iv.   Magnesium reacts with oxygen in the air.

     Write the equation for this reaction.

[1]

7. A mixture of concentrated nitric and hydrochloric acid is called 'aqua regia'. Aqua regia can dissolve gold.

The reaction of aqua regia with gold is a redox reaction which forms chlorauric acid, HAuCl_4.

    i.   Balance the half-equation for the oxidation process in this reaction.

     Au + ...HCl → ....H$^+$ + AuCl_4 $^-$ + ...e$^-$

[1]

ii. In the reduction process in this reaction, HNO_3 and H^+ react together to form 2 oxides:
X (M_r = 30) and **Z** (M_r = 18).

Determine the formulae of **X** and **Z** and write the half-equation for this reduction.
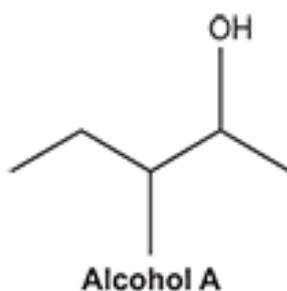
X = ...

Z = ...

half-equation _____ **[3]**

8. This question is about alkenes.

A mixture of alkenes is produced when water is eliminated from alcohol **A**.

Alcohol A

i. What is the systematic name of alcohol **A**?

---**[1]**
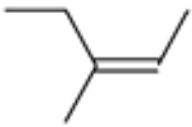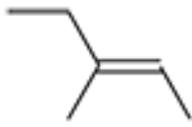
ii. Alcohol **A** is refluxed with an acid catalyst.

- A mixture of alkene isomers **B**, **C** and **D** is formed.
- Alkenes **B** and **C** show *E/Z* isomerism but alkene **D** does not.

Construct the equation for the formation of alkene **D** from alcohol **A**.
Show the structure of the organic product.

[2]

iii.   The skeletal formulae of alkenes **B** and **C** are shown below.

	Alkene B	Alkene C
Skeletal formula		
Isomer	*Z*	*E*

Use the Cahn-Ingold-Prelog priority rules to explain why alkene **B** is the *Z* isomer.

_____

_____

_____

_____ **[2]**

9. This question is about titanium (atomic number 22) and its compounds.

Titanium exists as a mixture of five isotopes.

A chemist analyses a sample of titanium using mass spectrometry.

The results are shown in the table below.

Isotope	Abundance (%)
^{46}Ti	8.30
^{47}Ti	7.40
^{48}Ti	73.70
^{49}Ti	5.40
^{50}Ti	5.20

    i.   Calculate the relative atomic mass of titanium in the sample.

    Give your answer to **2** decimal places.

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

    ii.   Complete the electron configuration of a titanium atom.

    $1s^2$

---

    iii.   Complete the table to show the number of protons, neutrons and electrons in a $^{48}Ti^{2+}$ ion.

	Protons	Neutrons	Electrons
$^{48}Ti^{2+}$ ion			

[1]

10(a). This question is about atomic structure and formulae.

The relative atomic mass of a sample of osmium can be determined from its mass spectrum, shown below.
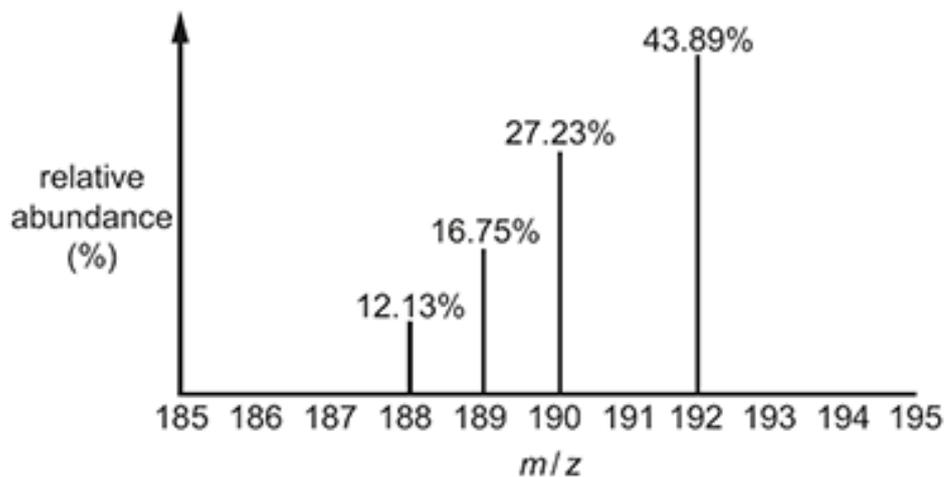
Calculate the relative atomic mass of osmium in the sample.
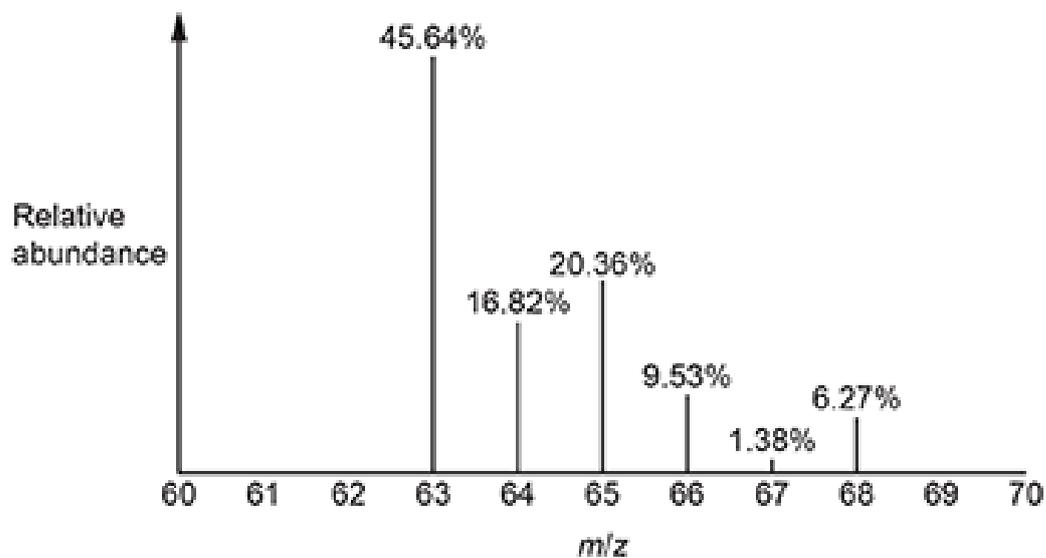Give your answer to **two** decimal places.

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

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

Element	Mass number	Protons	Neutrons	Electron configuration	Charge
....	....	28	34	....	0
....	33	....	....	$1s^2 2s^2 2p^6 3s^2 3p^6$	3-

[2]

11. Brass is an alloy of copper and zinc.

The mass spectrum of a sample of brass is shown below.

The peaks at *m/z* = 63 and *m/z* = 65 are from the ^{63}Cu and ^{65}Cu isotopes of copper.

The remaining four peaks are from isotopes of zinc.

   i.   What are the percentage compositions of copper and zinc in the brass sample?

Cu = ... % Zn = ... % **[1]**

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

        Give your answer to **2** decimal places.

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

END OF QUESTION PAPER

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

        Give your answer to **2** decimal places.