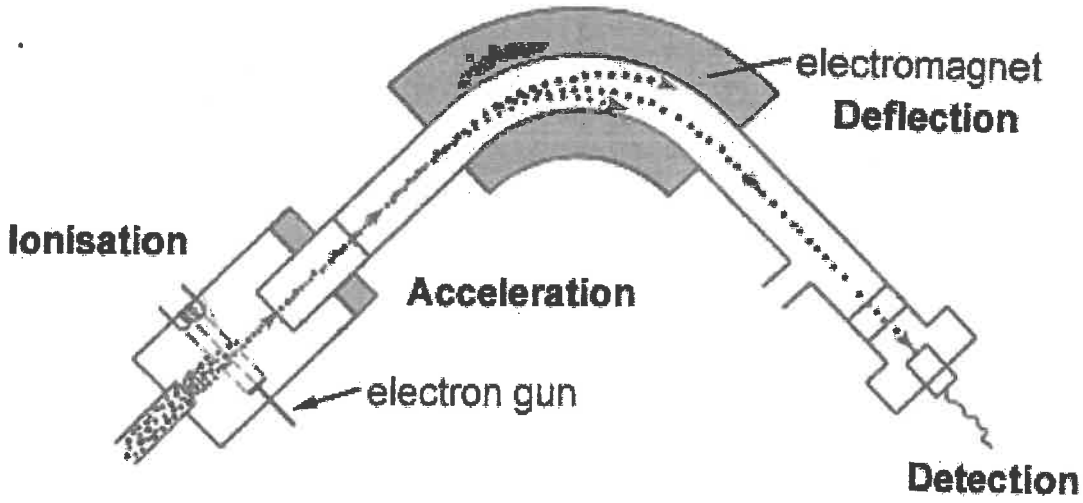
Name

Extended response

Mass Spectroscopy and Separation /45

Shown below is a simplified image of a mass spectrometer.



Answer the questions below outlining the processes that occur in each section of the mass spectrometer.

1. Explain how ions are produced in the ionization chamber? Use a simple diagram to help explain you answer. (2 marks)

2. What is the function of the deflection chamber in the mass spectrometer? (1 mark)

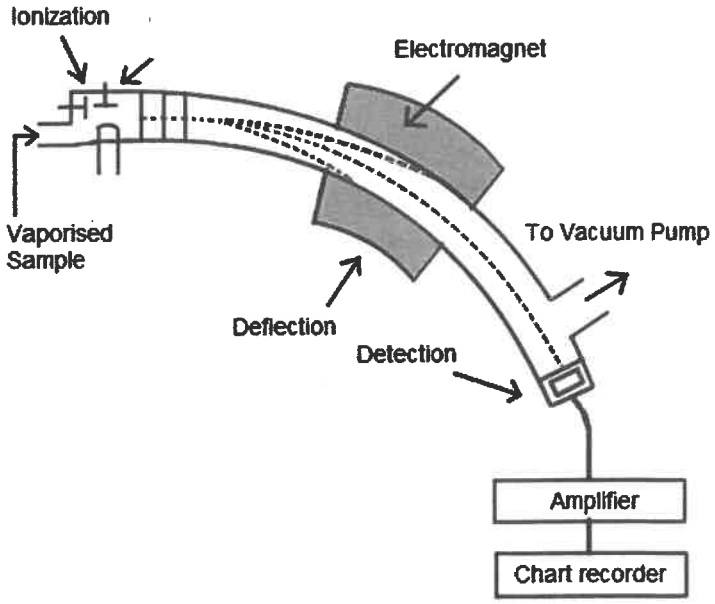
3. Explain why the mass spectrometry process is conducted in a vacuum. (2 marks)

4. Describe the measurement/s that can be detected and recorded by the mass spectrometer. (2 marks)

5. Complete the table below using the information provided to indicate numbers of subatomic particles found in the following species. (7 marks)

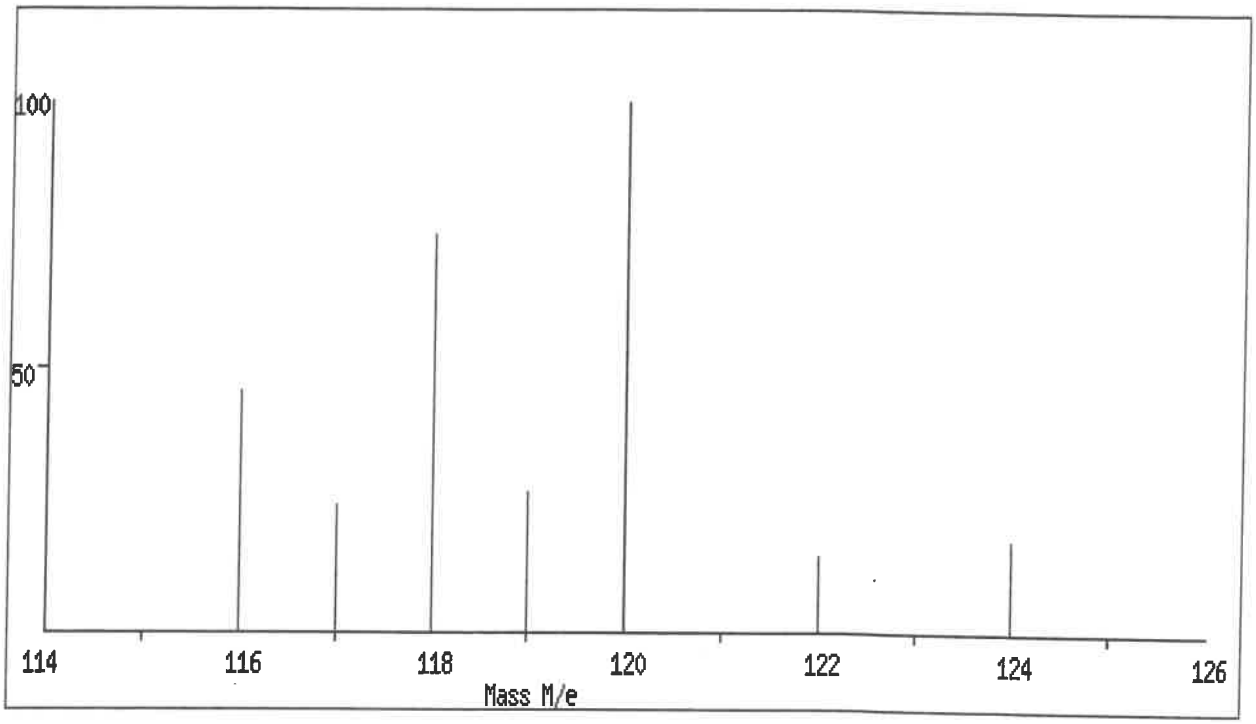
Species name	Species symbol	Atomic number	Number of neutrons	Number of electrons
Chlorine – 37 atom			20	
		19	21	19
	^{11}B			
Neon – 20 atom		10		
Iron III ion		26		
Sodium ion	Na^+			10
	O^{2-}	8	8	

Consider the diagram below showing three different particle types passing through the electromagnet in the deflection chamber. The path of each particle type is shown in a different colour.



6. Which of the particles shown (red, green or blue) would be the heaviest? Explain your answer. (2 marks)

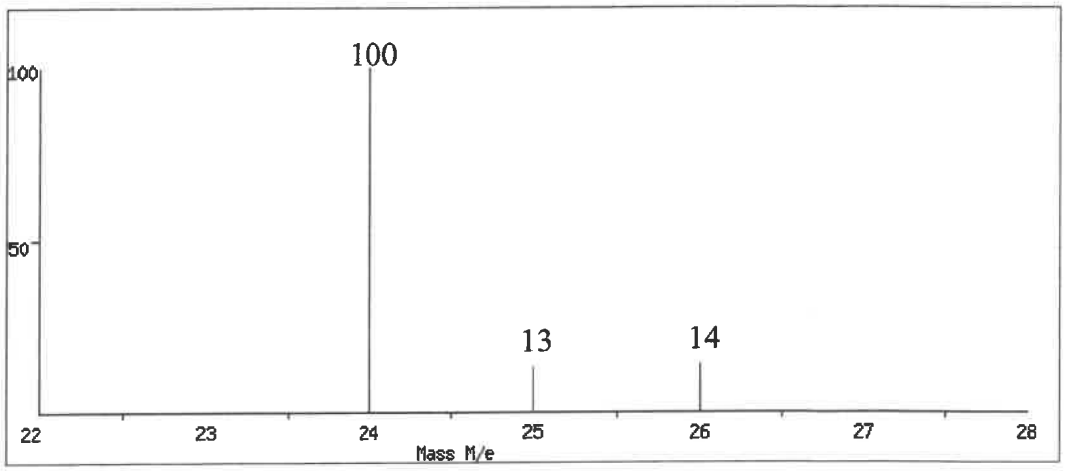
7. A sample of tin is injected and analysed by mass spectroscopy. The mass spectrum obtained is shown below.



Create a **table** to show the *isotopes present* and their *relative abundance.*

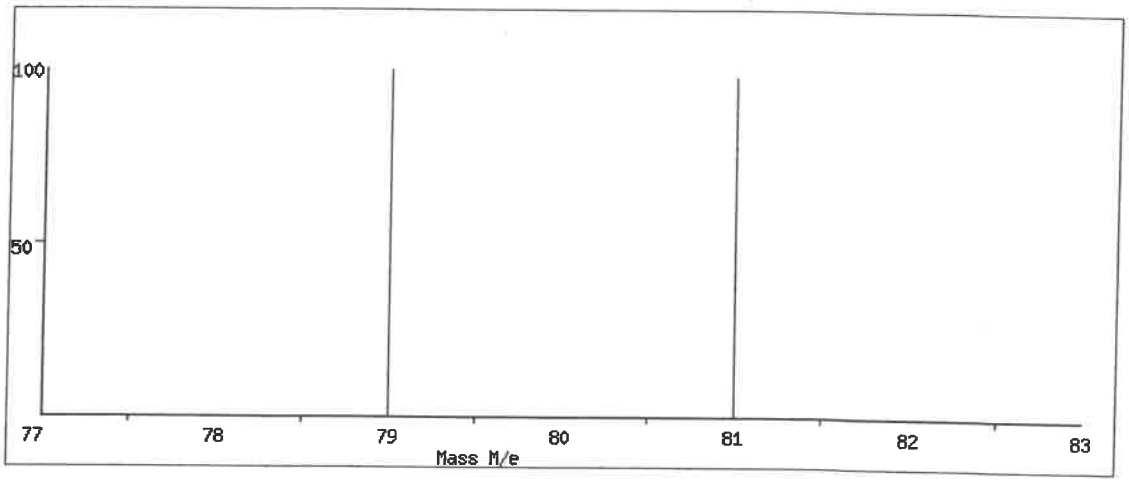
(2 marks)

8. The mass spectrum obtained from a sample of magnesium is shown below.



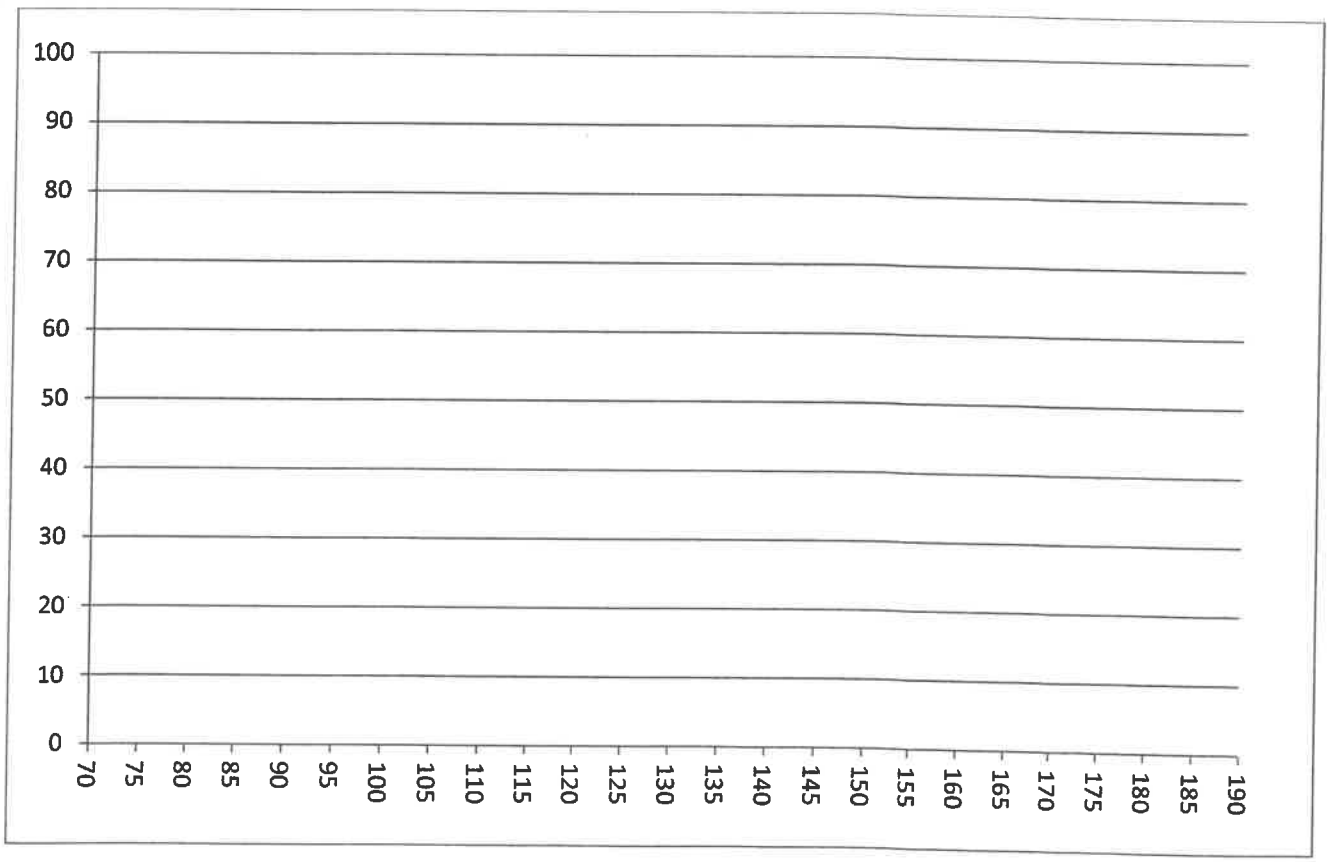
The numbers assigned to each peak indicate the relative abundance of that isotope. Use *this* information to determine the relative atomic mass of Magnesium in this sample. (3 marks)

9. Bromine atoms exist as 2 isotopes with atomic masses of 79 and 81 a.m.u. as shown in the spectrum below. Each of the isotopes occurs with equal abundance.



Bromine vapour is a diatomic molecule with the formula Br_2. If mass spectrometry was carried out on a sample of bromine vapour **sketch** the spectrum you would most likely attain from this sample. Assume that the diatomic molecule is not broken into single atoms during the ionisation phase.

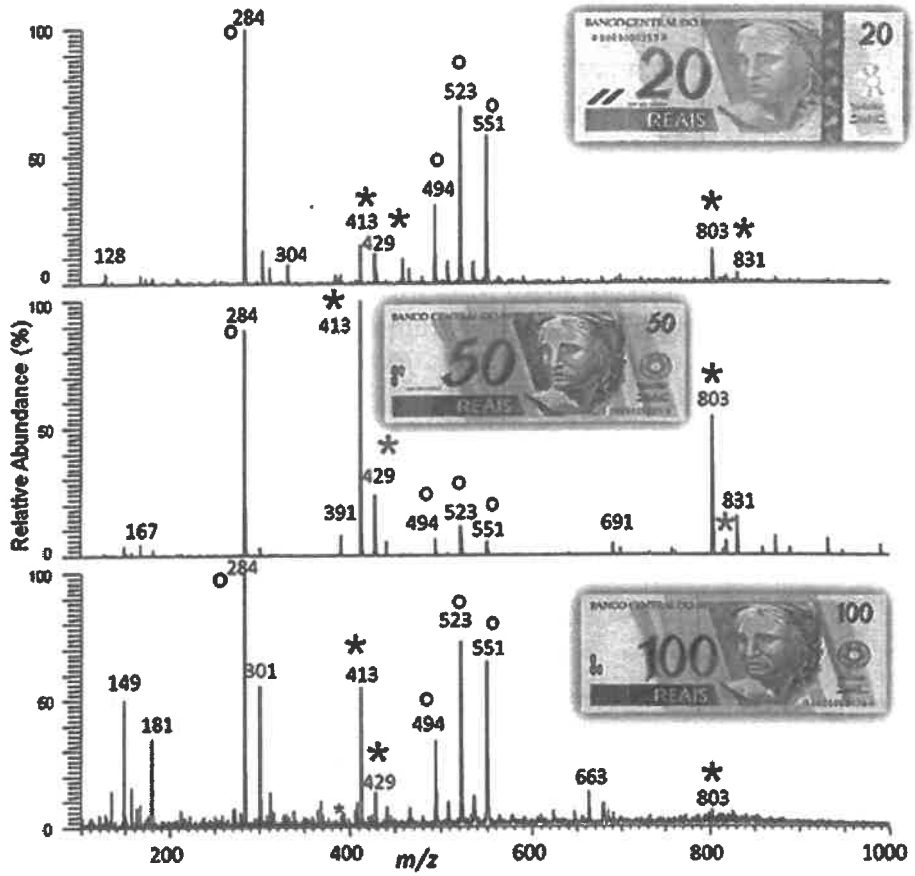
(4 marks)



10. Banknote counterfeiting is a growing problem for fraud investigators across the globe and criminals involved in this highly profitable system are constantly developing their techniques to stay one step ahead of the authorities and their forensic detection methods. Now, researchers in Brazil and the US have taken a mass spectrometric approach that can produce a near-instantaneous chemical profile of a banknote to check against database entries and spot counterfeit notes very quickly.

The team first tested the techniques using genuine Brazilian banknotes and compared the fingerprints with "homemade" banknotes produced on a readily available paper using different types of computer printer.

Genuine banknotes produced the spectra shown below:



Explain how such spectra could be used to successfully detect forgeries

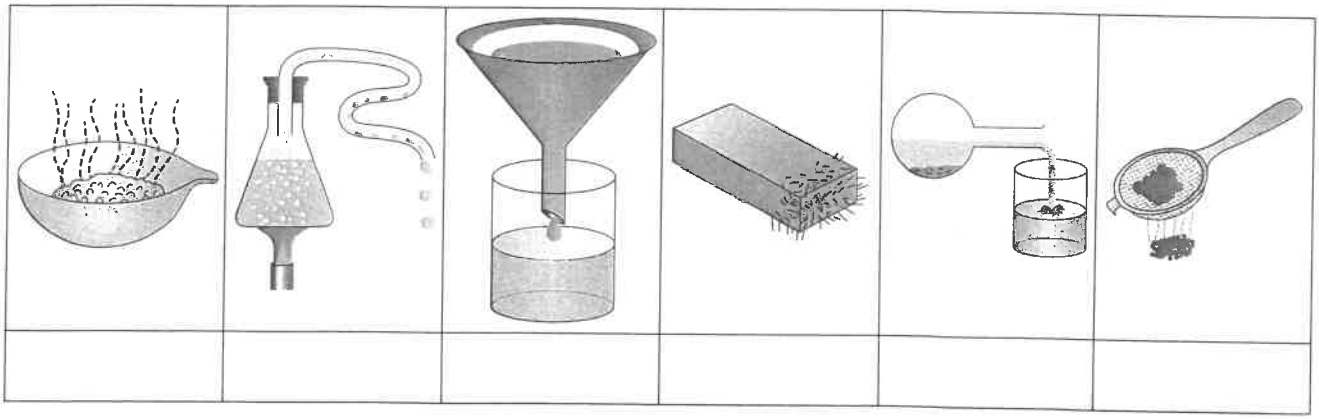
(2 marks)

11. Choose the word or phrase from the left hand column that **best** suits the description/definition in the right hand column.

Write the lower case letter next to the chosen description/definition. (5 marks)

a chemical change	A homogeneous mixture ...(an example of..)
b chemical property	B change in the composition of a substance, giving a new substance
c compound	C change not involving the chemical composition of a substance
d distillate	
e distillation	E dissolved substance
f electrostatic attraction	
g element	G having a non-uniform composition
h filtrate	
i filtration	
j fractional distillation	J liquid or solution that passes through filter paper during filtration
k heterogeneous mixture	
l homogeneous mixture	
m magnetic separation	
n material	N pure substance made up of only one type of atom
o matter	
p mixture	P separating an undissolved solid from a liquid
q physical change	
r physical property	
s residue	S solid remaining in the filter paper after filtration
t separating funnel	
u sieving	
v solute	
w solution	
x solvent	X technique for retrieving the liquid component of a solution
y substance	
z vaporisation	

12. Identify each of the separation techniques shown below. (3 marks)

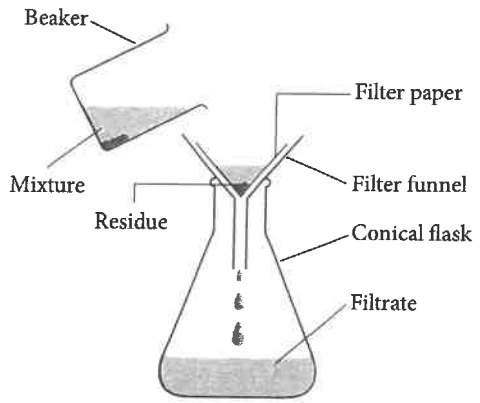


13. Circle items on the list below that are physical properties of substances. (2 marks (-½ for each error))

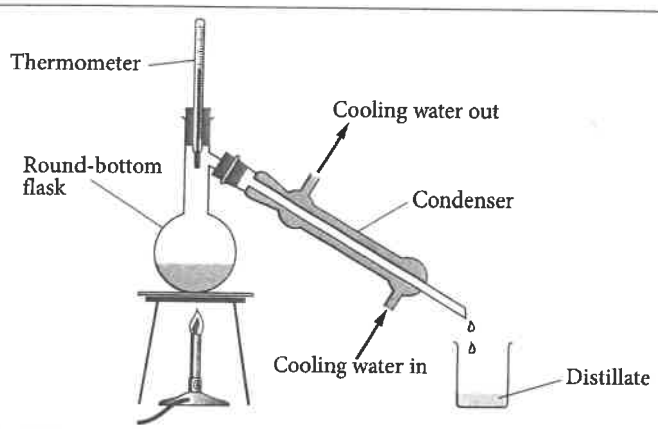
- strength
- density
- colour
- reaction with acids
- conductivity
- reaction with oxygen
- state
- decomposition by heat
- solubility
- melting point
- reaction with bases
- boiling point

14. Explain how the apparatus in each diagram results in the separation of substances in a mixture. (8marks)

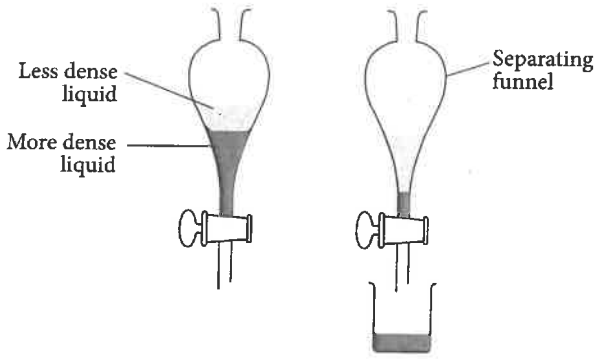
a



b



c



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