Q1. The manufacturer supplying concentrated ethanoic acid for the production of vinegar also supplied other acids. The label had come off a batch of one of these other acids.
A sample of this unknown acid was analysed and found to contain 54.5% of carbon and 9.10% of hydrogen by mass, the remainder being oxygen.

(a) Use these data to calculate the empirical formula of the unknown acid.
Show your working.

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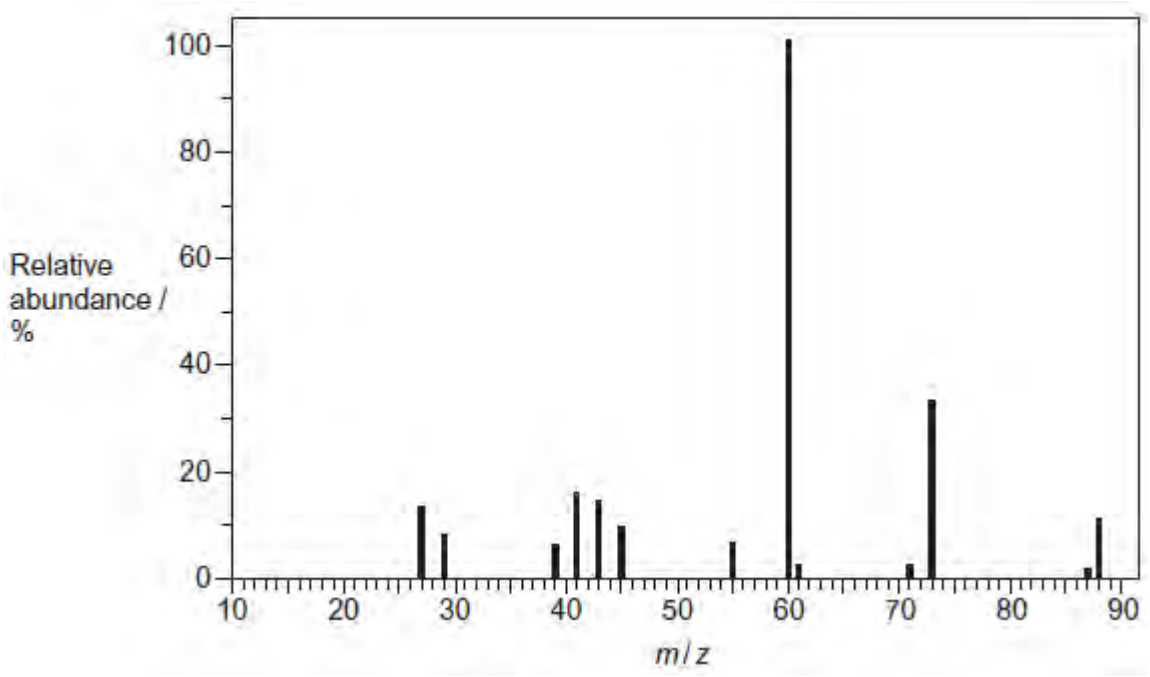
(3)

(b) A sample of the unknown acid was analysed in a mass spectrometer. The mass spectrum obtained is shown below.



Use the mass spectrum to determine the M_r of the unknown acid.

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(1)

(c) Use your answers from parts (a) and (b) to determine the molecular formula of the

unknown acid.
(If you could not answer part (b), you should assume that the M_r of the acid is 132.0 but this is **not** the correct value.)
Show your working.

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(2)
(Total 6 marks)

Q2. A mass spectrometer can be used to investigate the isotopes in an element.

(a) Define the term *relative atomic mass* of an element.

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(2)

(b) Element **X** has a relative atomic mass of 47.9

Identify the block in the Periodic Table to which element **X** belongs and give the electron configuration of an atom of element **X**.

Calculate the number of neutrons in the isotope of **X** which has a mass number 49

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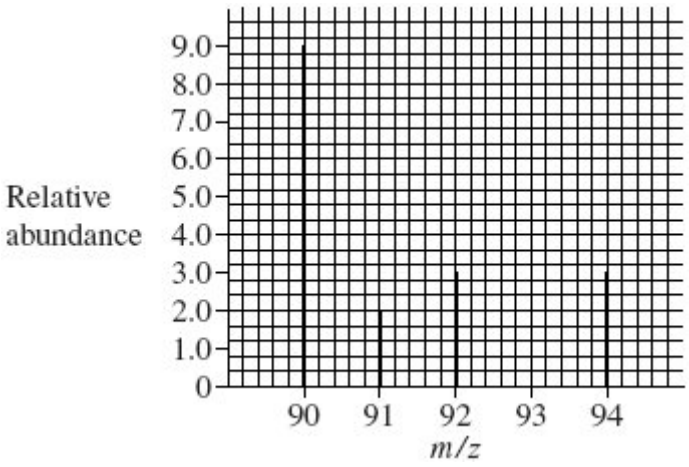
(3)

(c) The mass spectrum of element **Z** is shown below.

Use this spectrum to calculate the relative atomic mass of **Z**, giving your answer to one decimal place.

Identify element **Z**.



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(4)

(d) State how vaporised atoms of **Z** are converted into $\mathbf{Z}^+$ ions in a mass spectrometer.

State and explain which of the $\mathbf{Z}^+$ ions formed from the isotopes of **Z** in part (c) will be deflected the most in a mass spectrometer.

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(4)

(e) Explain briefly how the relative abundance of an ion is measured in a mass spectrometer.

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(2)
(Total 15 marks)

Q3. In 1913 Niels Bohr proposed a model of the atom with a central nucleus, made up of protons and neutrons, around which electrons moved in orbits. After further research, the model was refined when the existence of energy levels and sub-levels was recognised.

(a) Complete the following table for the particles in the nucleus.

Particle	Relative charge	Relative mass
proton		
neutron		

(2)

(b) State the block in the Periodic Table to which the element tungsten, W, belongs.

.....

(1)

(c) Isotopes of tungsten include ^{182}W and ^{186}W

(i) Deduce the number of protons in ^{182}W

.....

(1)

(ii) Deduce the number of neutrons in ^{186}W

.....

(1)

(d) In order to detect the isotopes of tungsten using a mass spectrometer, a sample containing the isotopes must be vaporised and then ionised.

(i) Give **two** reasons why the sample must be ionised.

1 .....

2 .....

(2)

(ii) State what can be adjusted in the mass spectrometer to enable ions formed by the different isotopes to be directed onto the detector.

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(1)

(e) State and explain the difference, if any, between the chemical properties of the isotopes ^{182}W and ^{186}W

Difference .....

Explanation .....

.....

(2)

(f) The table below gives the relative abundance of each isotope in the mass spectrum of a sample of tungsten.

m/z	182	183	184	186
Relative abundance /%	26.4	14.3	30.7	28.6

Use the data above to calculate a value for the relative atomic mass of this sample of tungsten. Give your answer to 2 decimal places.

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(2)
(Total 12 marks)

Q4. (a) Complete the following table.

	Relative mass	Relative charge
Proton		
Electron		

(2)

(b) An atom of element **Q** contains the same number of neutrons as are found in an atom of ^{27}A1. An atom of **Q** also contains 14 protons.

(i) Give the number of protons in an atom of ^{27}A1.

.....

(ii) Deduce the symbol, including mass number and atomic number, for this atom of element **Q**.

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(3)

(c) Define the term *relative atomic mass* of an element.

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(2)

(d) The table below gives the relative abundance of each isotope in a mass spectrum

of a sample of magnesium.

m/*z*	24	25	26
Relative abundance (%)	73.5	10.1	16.4

Use the data above to calculate the relative atomic mass of this sample of magnesium.
Give your answer to one decimal place.

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(2)

(e) State how the relative molecular mass of a covalent compound is obtained from its mass spectrum.

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(1)
(Total 10 marks)

Q5. In one model of atomic structure, the atom has a nucleus surrounded by electrons in levels and sub-levels.

(a) Define the term *atomic number*.

.....

(1)

(b) Explain why atoms of an element may have different mass numbers.

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(1)

(c) The table below refers to a sample of krypton.

Relative *m/z*	82	83	84	86
Relative abundance / %	12	12	50	26

(i) Name an instrument which is used to measure the relative abundance of isotopes.

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(ii) Define the term *relative atomic mass*.

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(iii) Calculate the relative atomic mass of this sample of krypton.

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(5)

(d) Give the complete electronic configuration of krypton in terms of s, p and d sub-levels.

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(1)

(e) In 1963, krypton was found to react with fluorine. State why this discovery was unexpected.

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(1)

(f) Use a suitable model of atomic structure to explain the following experimental observations.

(i) The first ionisation energy of krypton is greater than that of bromine.

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(ii) The first ionisation energy of aluminium is less than the first ionisation energy of magnesium.

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(4)
(Total 13 marks)