1 A mass spectrometer was used to analyse a sample of oxygen gas in which the most abundant isotope was ^{16}O. The oxygen was ionized and the ions were accelerated by an electric field.

(a) (i) Suggest the formulae of **two** different ions containing only the ^{16}O isotope, which might be formed in the mass spectrometer.

(2)

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(ii) Which part of the mass spectrometer separates ions of different mass?

(1)

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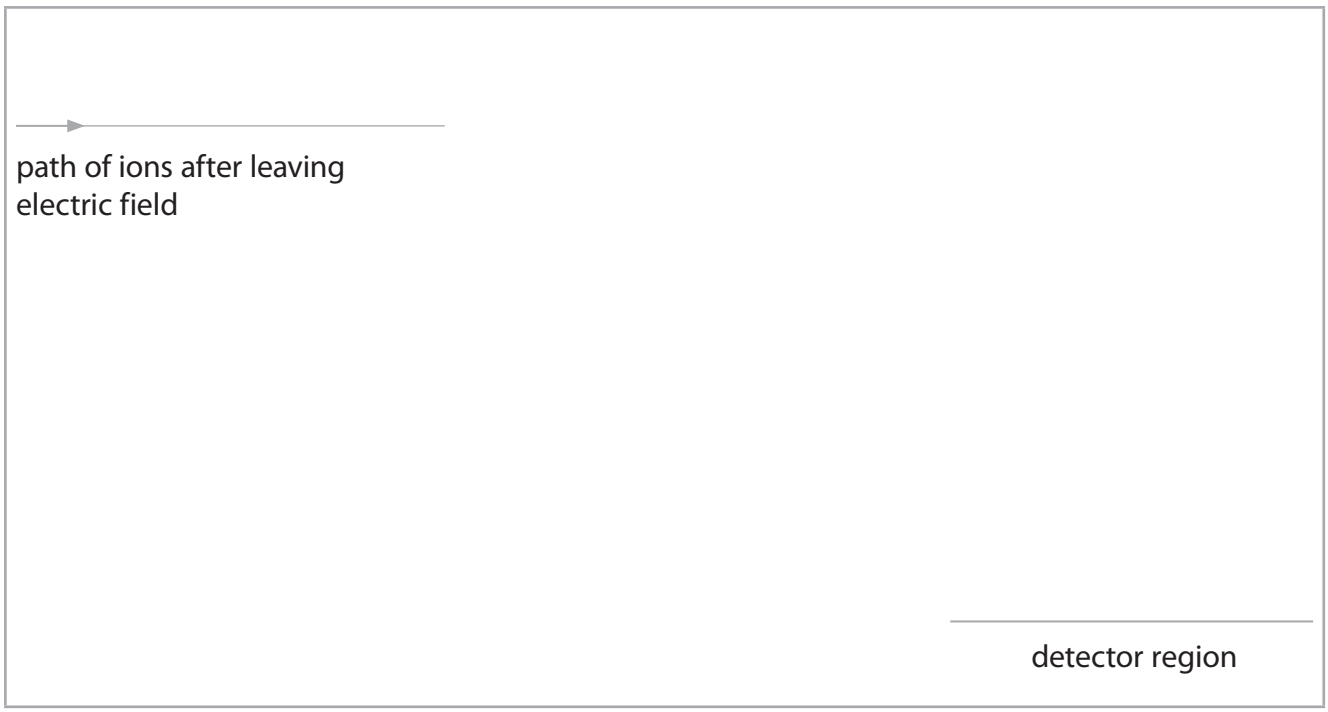
(iii) For the two ions you have chosen in (a)(i), sketch their paths in the mass spectrometer after leaving the electric field and as they approach the detector region. Label each path with the formula of the ion.

(2)



(b) The following results were obtained for the atoms of oxygen in the sample.

Relative isotopic mass	Relative abundance
16	99.759
17	0.037
18	0.204

Calculate the relative atomic mass of oxygen atoms. Show your working and give your answer to **three** decimal places.

(2)

(c) In the first half of the twentieth century, oxygen was used as the standard for relative atomic mass. The unit of atomic mass was defined as 1/16 the mass of an oxygen atom. This was based on samples of oxygen obtained from the air which consisted of a mixture of oxygen isotopes.

Suggest **one** reason why the use of this standard was discontinued.

(1)

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(d) Would you expect the first electron affinities of ^{16}O and ^{18}O to differ? Justify your answer.

(1)

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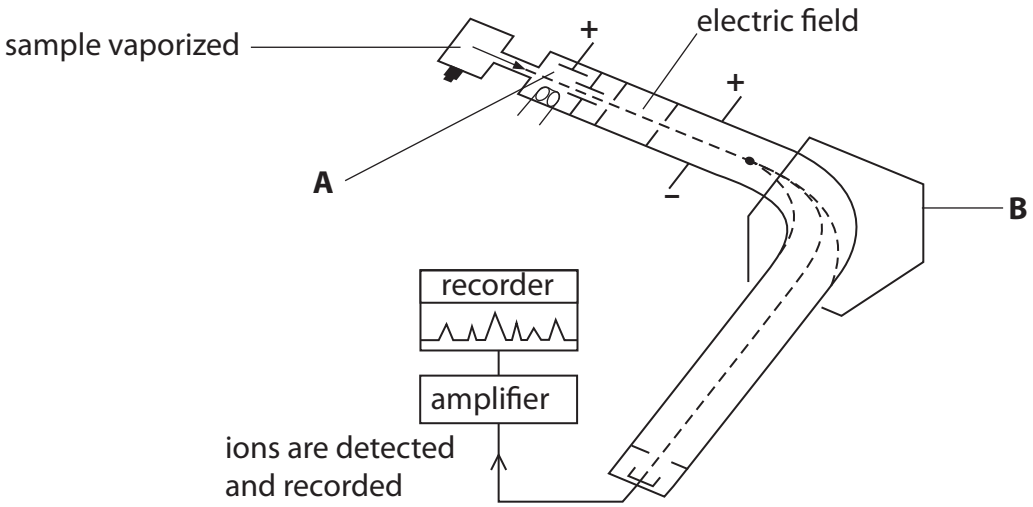
(Total for Question = 9 marks)

2 This question is about the use of mass spectrometers.

(a) Bromine has two isotopes, ^{79}Br and ^{81}Br. Explain the term **isotopes**, by reference to sub-atomic particles.

(1)

(b) The presence and abundance of these isotopes can be determined by using a mass spectrometer such as that shown in the diagram below.



(i) Explain how ions are produced in the area labelled **A**.

(2)

(ii) State what is used to deflect the ions moving through the mass spectrometer in the area labelled **B**.

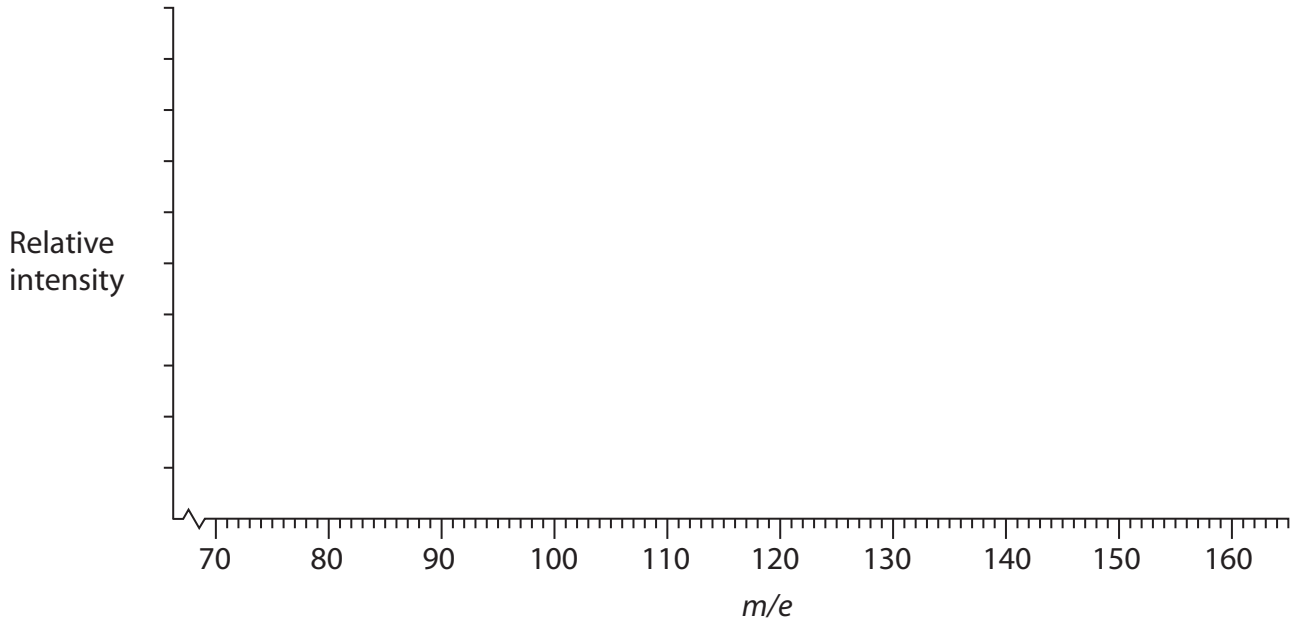
(1)

(iii) Explain why there is a vacuum in a mass spectrometer.

(1)

(c) Complete the mass spectrum below for a sample of bromine **gas** that contains approximately half ^{79}Br isotope and half ^{81}Br isotope.

(4)



(d) Calculate the relative atomic mass of bromine for a sample which was found to contain 47.0% ^{79}Br and 53.0% ^{81}Br.

Give your answer to **three** significant figures.

(2)

(e) What would be the effect, if any, on the *m/e* value of the peak if the ion detected had lost two electrons rather than one electron?

(1)

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*(f) One of the uses of mass spectrometers is for the detection of banned substances, such as anabolic steroids, in a blood or urine sample taken from competitors in sports events.

(i) Suggest **two** precautions that are necessary to ensure that the result of any analysis would be valid.

(2)

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(ii) These substances can give competitors an unfair advantage. Suggest why the use of these substances may be of concern to the user.

(1)

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(g) Suggest **one** other use for mass spectrometers.

(1)

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(Total for Question = 16 marks)

3 (a) In a mass spectrometer being used to determine relative atomic masses, gaseous atoms are ionized. The ions are then accelerated and deflected before being detected.

(i) Explain how atoms are **ionized** in a mass spectrometer.

(1)

(ii) How are the ions **accelerated** in a mass spectrometer?

(1)

(iii) How are the ions **deflected** in a mass spectrometer?

(1)

(b) The following data were obtained from the mass spectrum of a sample of platinum.

Peak at *m/e*	%
194	32.8
195	30.6
196	25.4
198	11.2

Calculate the relative atomic mass of platinum in this sample. Give your answer to **one** decimal place.

(2)

(c) In which block of the Periodic Table is platinum found?

(1)

(d) Most solids exist as lattice structures.

(i) Complete the table, using a tick (✓) if the substance conducts electricity or a cross (✗) if the substance does not conduct electricity.

(2)

Substance	Conducts electricity in the SOLID state? (✓ or ✗)	Conducts electricity in the LIQUID state? (✓ or ✗)
Sodium, Na		
Sodium oxide, Na_2O		

*(ii) Explain the electrical conductivities of sodium and of sodium oxide in the solid and liquid states.

(3)

(Total for Question = 11 marks)