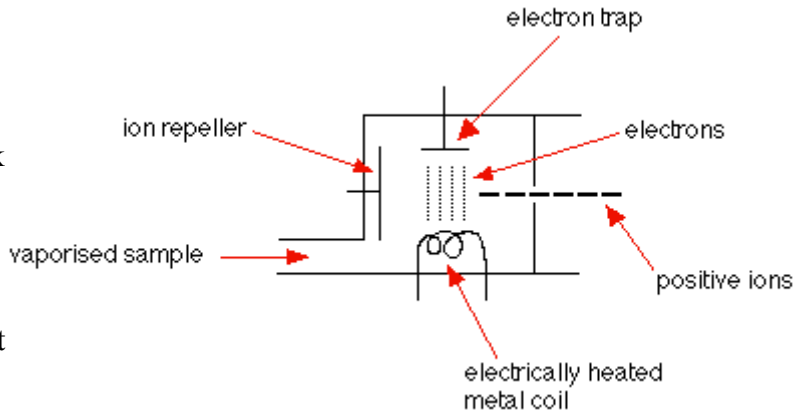
THE MASS SPECTROMETER

1. a) The hot metal coil releases electrons which are attracted to the electron trap which is positively charged. On their way, they hit atoms or molecules in the sample, and knock one or more electrons off to give positive ions.



Those ions are repelled by another positively charged plate on the left out of the slit on the right-hand side.

b) The ionisation chamber is held at +10,000 volts. After leaving the chamber, the beam passes through two more slits, the last of which is at 0 volts. The positive ions are accelerated by repulsion from the very positively charged ionisation chamber.

c) (i) Mass and charge. The heavier the ion, the less it is deflected. The higher the positive charge, the more it is deflected.

(ii) Assuming that all of the ion streams have the same charge, then this must have the heaviest ions. To be more general about it, the least deflected ion stream will be the one with the highest mass/charge ratio.

(iii) You would need to increase the magnetic field.

d) To avoid the possibility of the ions hitting, and being deflected by, air molecules.

e) The detector is made of metal connected to a wire. When an ion hits the metal, an electron jumps off the metal to neutralise the ion. Electrons flow from the wire to replace those removed from the detector, and this flow is seen as an electric current which can be amplified and recorded. The greater the number of ions arriving, the greater the current.

2. a) m/z is the mass/charge ratio - the mass of the ion divided by its charge.

b) Zirconium has 5 isotopes with relative isotopic masses of 90, 91, 92, 94 and 96.

The most abundant one is Zr-90, followed by Zr-94 and Zr-92 which have similar abundances. Then Zr-91, and the least abundant is Zr-96

c) You would find a similar set of peaks but at exactly half the m/z values. The heights of the peaks are likely to be much less than the corresponding ones with 1+ ions, because a 2+ ion is less likely to form than a 1+ ion.