Name.....

A level Chemistry Preparatory Work for Atomic Structure Topic

Use the Chemistry Preparatory work (page 5 onwards).

Do NOT use your GCSE notes. You probably will not have a college username and password, login as a "guest" if prompted.

You will need to bring to your first lesson: a ring binder A4 folder, a highlighter, a pen, a pencil, lined paper, a ruler, a scientific calculator.

What are atoms like?

Fundamental Particles

	Relative mass	Relative Charge

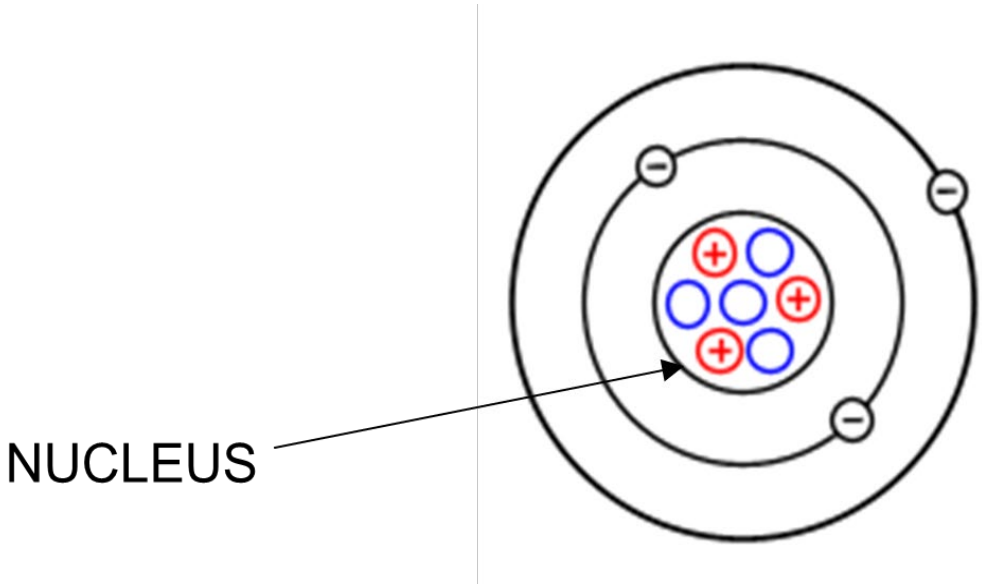
Atoms are **neutral** particles they have no overall charge.

Complete: In an atoms number of protons = number of .....

This atom is fully represented as $^{7}_{3}Li$

3 is called the **atomic number** (Z)

7 is called the **mass number** (A)



Label the particles in the nucleus.

Write the (GCSE) electron configuration for this atom

.....

Define ***Atomic number***

Define ***Mass number***

How would you calculate the number of neutrons from the atomic number and the mass number?

Number of neutrons =

Isotopes

Examples of isotopes of hydrogen are: ^{1}H ^{2}H ^{3}H

Notice there is no need to give the atomic number the element symbol tells you what this is anyway.

Define ***isotopes*** in terms of numbers of fundamental particles.

Another element with isotopes is chlorine (use the Periodic Table to find the number of protons).

	Number of		
	protons	**neutrons**	**electrons**
^{35}Cl			
^{37}Cl			

Write the (GCSE) electron configuration for chlorine …….

Chlorine is a halogen which group of the periodic table does it belong to?

……

How does the group number relate to the electronic configuration?

……

The **CHEMICAL properties of isotopes of the same element** like ^{35}Cl and ^{37}Cl are always **IDENTICAL because**……...

Ions

- An ion is a …….. particle.
- The number of …… and …… are NOT equal.
- When an atom loses one or more …… it forms a ……. charged ion called a …….. Give an example ……..
- When an atom gains one or more ……..it forms a ……. charged ion called an ……. Give an example ……
- Often ions have electron arrangements with a full outer shell like the ……..…... gases which should be stable.

The Mass Spectrometer

A mass spectrometer is a machine used to analyse atoms and molecules.

Use the "Mass Spectrometer Preparatory" **PowerPoint at** at
https://www.solihullsfc.ac.uk/student-zone/welcome-to-college-day/summer-homework/

to answer the following questions.

You can either answer the questions on a separate piece of paper or design a poster.

1. What information about atoms or molecules can be found using a Mass Spectrometer?

_____

_____

_____

_____

_____(3)

2. List the four processes which occur in a Mass Spectrometer.

_____

_____

_____

_____(4)

3. Describe how ionisation occurs.

_____

_____

_____

_____

_____

_____(3)

4. Describe how ions are accelerated.

_____

_____ (2)

5. Ions are separated according to their m/z. What does the symbol m/z stand for?

_____(1)

6. Describe how ions are detected.

_____

_____

_____

_____(3)

7. Look at the mass spectrum of molybdenum on the PowerPoint. This is how the Mass Spectrometer machine displays the information it finds.

Find a **different** example of a mass spectrum of an element using the following link http://www.chemguide.co.uk/analysis/masspec/elements.html#top

Sketch one example of a spectrum you have found using this link. (3)

The wider world of Chemistry

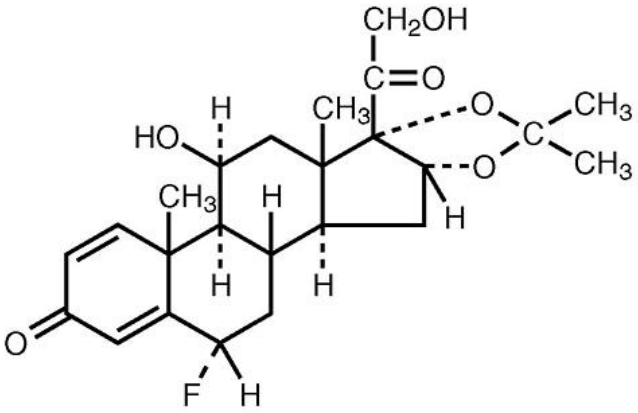
Visit http://www.periodicvideos.com/ pick two elements and watch the videos about them. On a separate piece of paper give the name of your elements and list interesting information you have discovered – this can be bullet points it does not have to be whole sentences.

The Mass Spectrometer

Used to find

- **The relative mass of isotopes**
- **Their relative abundance**
- **Can identify elements e.g. on other planets like Mars**

- **The relative molecular mass of a covalent compound**
- **To identify complex molecules e.g. drugs (this one is for hayfever)**

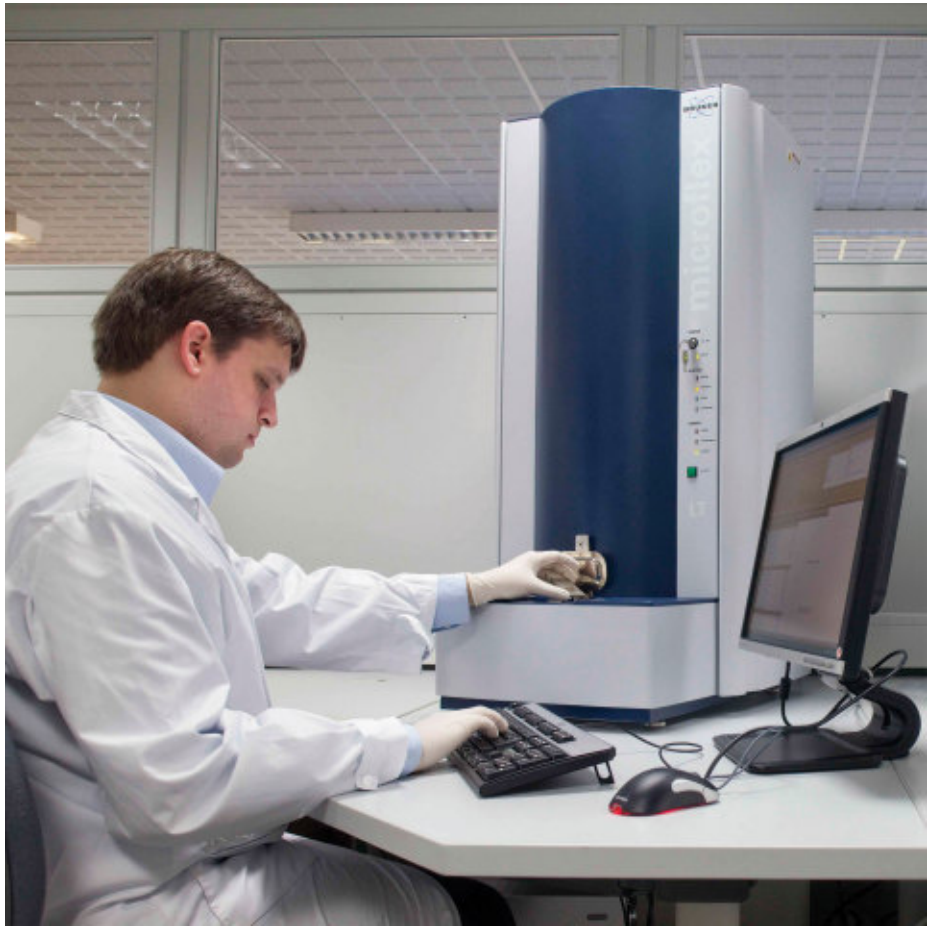


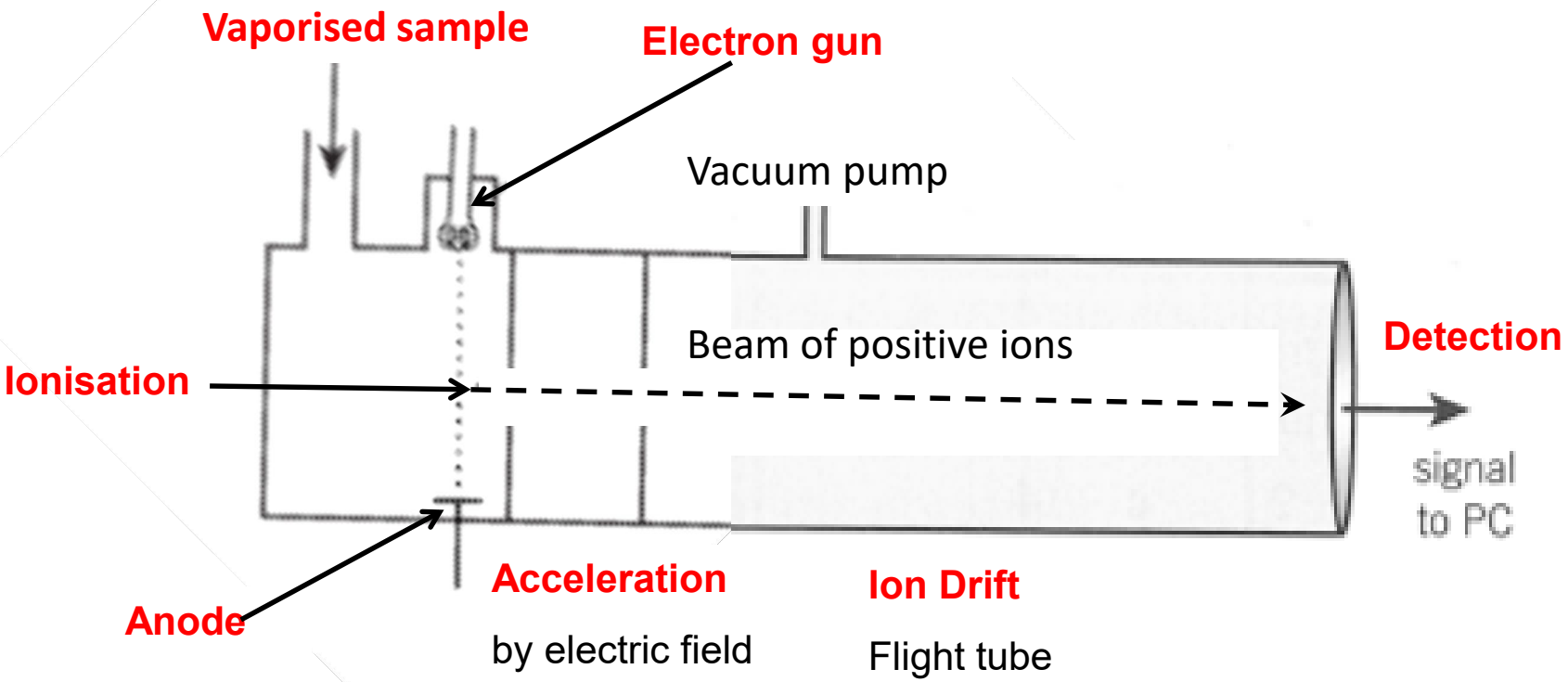
Elements (atoms)

- The mass spectrometer separates atoms of different isotopes of an element.

- This enables the **relative atomic mass** to be calculated.

MASS SPECTROMETER



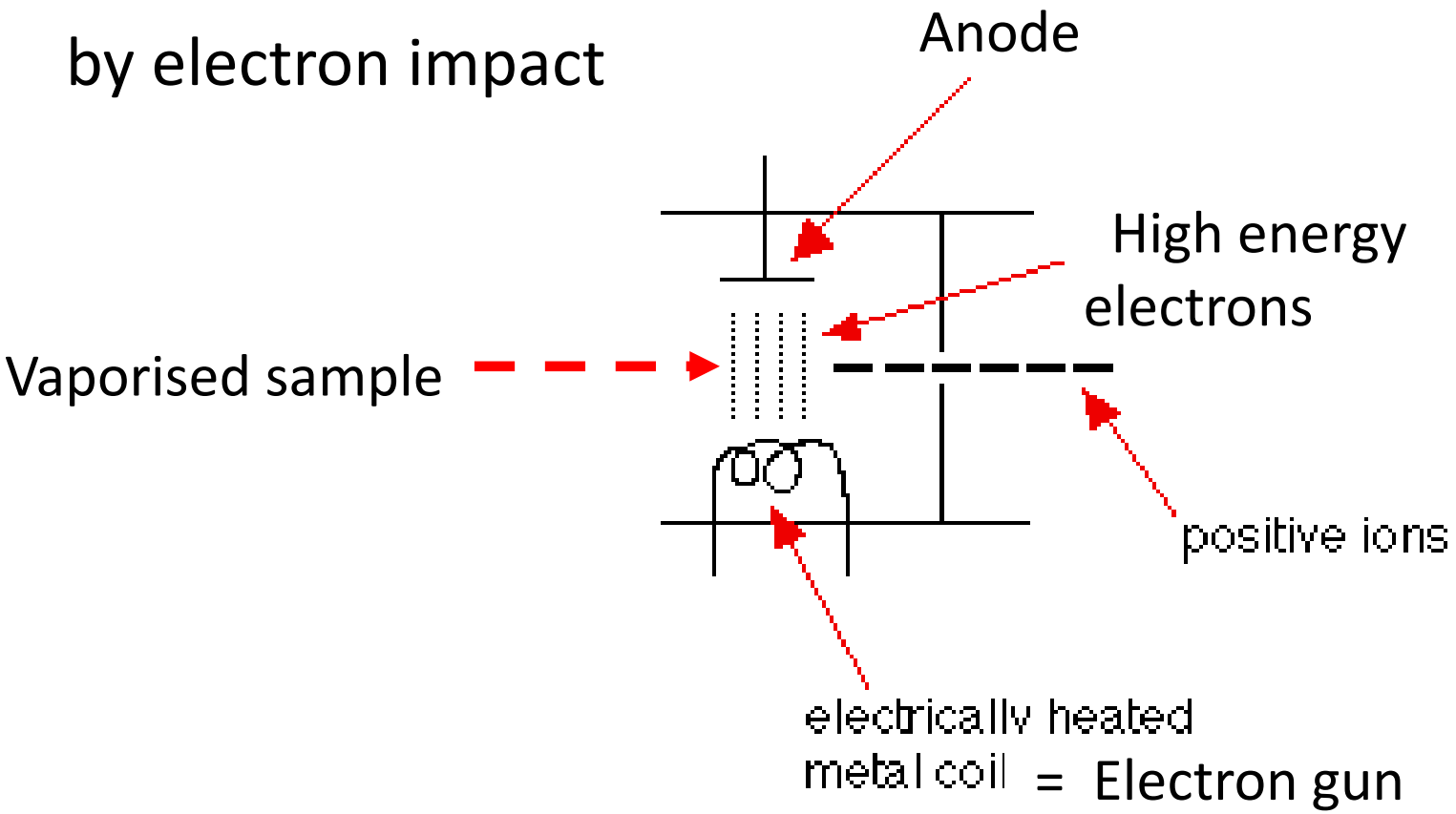

Vaporised sample
Electron gun
Vacuum pump
Beam of positive ions
Detection
Ionisation
signal
to PC
Acceleration
by electric field
Ion Drift
Flight tube
Anode

Processes

- Ionisation
- Acceleration
- Ion drift
- Detection

Ionisation

by electron impact



The atoms of the element are bombarded (hit) with a **stream of high energy electrons** fired from an electron gun.

Ionisation (continued)

When a high energy electron hits an atom, **an electron is knocked out of the atom** to produce a **positive ion.**

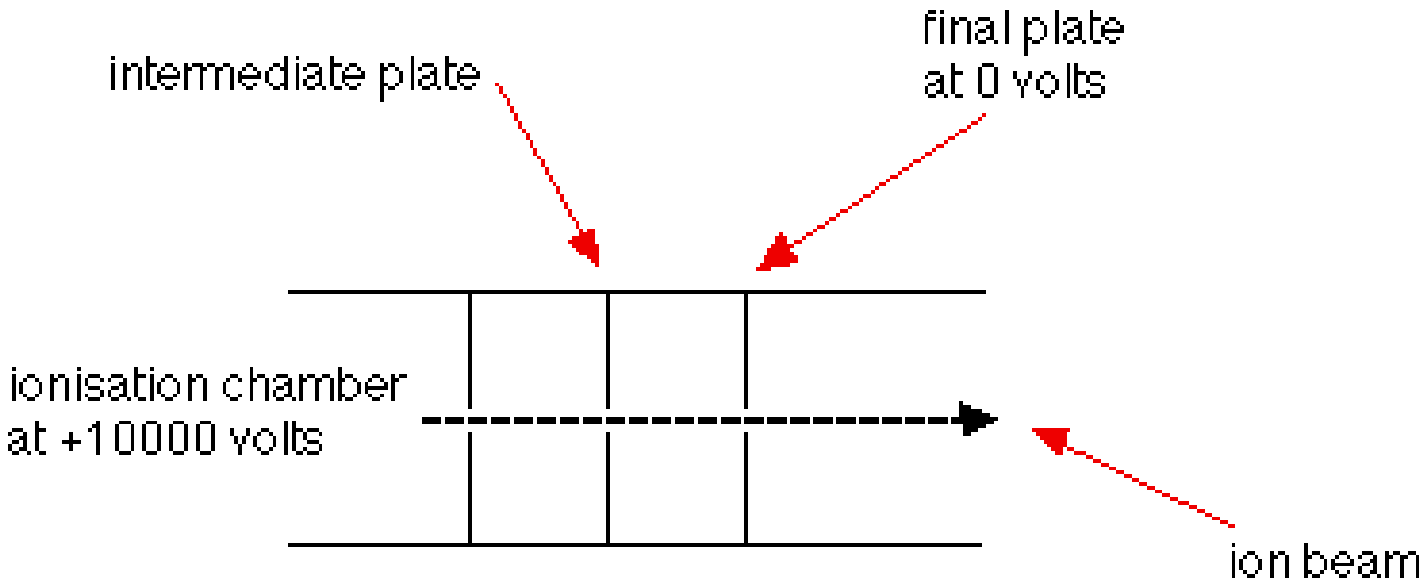
$$e^- + X_{(g)} \rightarrow X^+_{(g)} + 2e^-$$

There are other methods of causing the sample to become ionised: you will learn about “electrospray ionisation” later in the course.

Acceleration

The positive ions are attracted towards a **negatively charged plate** and accelerate towards it.

They are focussed into a beam by passing through a hole.



All ions with the same charge have the same kinetic energy.

Lower mass ions achieve faster speeds.

Ion Drift

The ions travel along a tube, called the flight tube to a detector.

The velocity of an ion and so how much time it takes to reach the detector depends on:

- the mass of the ion.
- the charge on the ion.

Separating the ions

The two important factors that determine separation are combined into: ***mass/charge ratio*** given the symbol m/z

Ions with a smaller mass/charge ratio have higher velocities.

They arrive at the detector first.

Detection

The ions hit a negatively **charged plate. Electrons flow from the plate to the positive ion** to neutralise the ion and therefore a small **current is produced**.

The size of the current is proportional to the number (abundance) of the ions. The information is fed to a computer and displayed as a chart.

The whole apparatus is kept under a high vacuum, why?

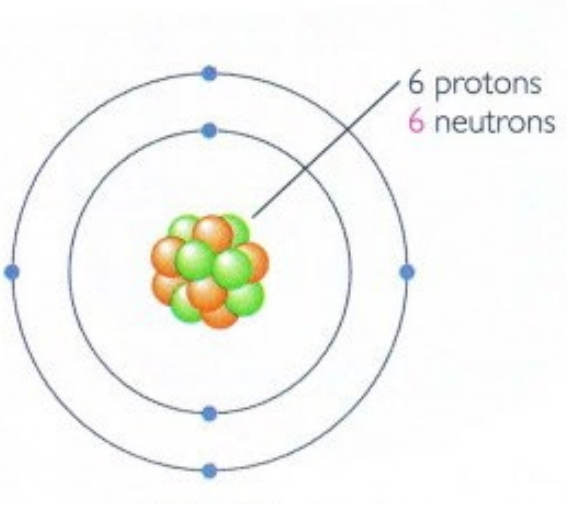
All the air is removed from a mass spectrometer

Reasons

- The ions may collide with the air molecules
- The final spectrum would include peaks due to the substances in the air

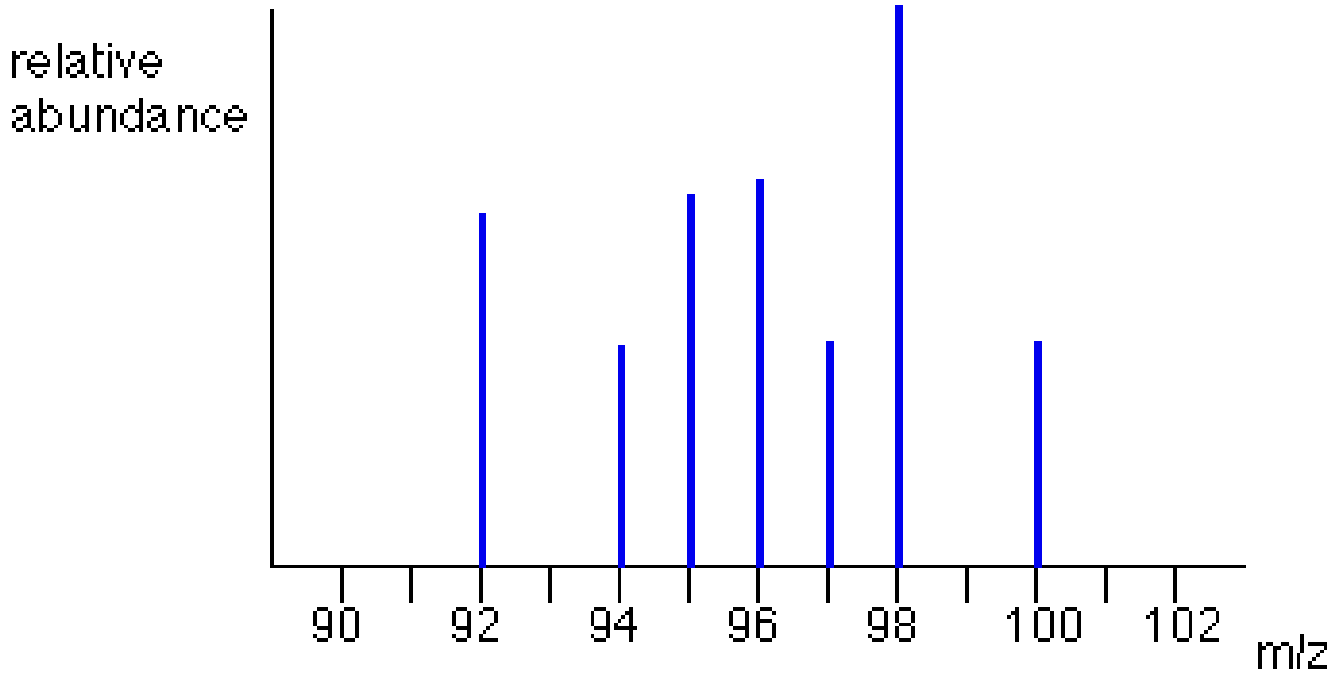
Calibrating a Mass Spectrometer

- Involves passing a **standard substance** through the machine where the exact m/z is known
- The mass is measured on the ^{12}C scale.
- A scale on which the ^{12}C isotope has a mass of exactly 12 units.



- Carbon-12 was chosen in 1961, before that date Chemists and Physicists disagreed on the standard, some had used hydrogen and some oxygen.
- Advantages: carbon-12 is common, therefore cheap, not dangerous and everyone (i.e. Chemists **and** Physicists) agreed to use it as the standard.

Mass spectrum of Molybdenum



The vertical scale is related to the current produced at the detector.
As you can see from the diagram, the commonest ion has a mass/charge ratio of 98.
Other ions have mass/charge ratios of 92, 94, 95, 96, 97 and 100.
That means that molybdenum consists of 7 different isotopes.

Find a **different** example of a mass spectrum of an element; explain what information the mass spectrum is giving about that element. This link will help answer this question: http://www.chemguide.co.uk/analysis/masspec/elements.html#top

Include a sketch of the spectrum you have found

ATOMIC STRUCTURE

Complete the atomic structure preparation work using this PowerPoint to help you complete the questions.
Bring the completed worksheet to your first chemistry lesson of the A level course when we will go over the answers so that they can form part of your notes on this topic.

You should find this piece of work fairly straightforward as it is based on work that you have probably covered at GCSE. Nevertheless the A level examiners do set questions on it.
Obviously you can choose when you do the work but we suggest you leave it until you are fairly close to starting your A level Chemistry course.

Fundamental Particles

	Relative Mass	Relative charge
Proton		
Neutron		
Electron		

The actual masses and charges are very small
e.g. a proton is 1.7 x 10^{-27}kg

NOTE

The relative mass of an electron is so small that it is often taken to be ZERO.

Fundamental Particles

	Relative Mass	Relative charge
Proton	1	+1
Neutron	1	0
Electron	$\frac{1}{1836}$	-1

The actual masses and charges are very small
e.g. a proton is 1.7×10^{-27}kg

NOTE

The relative mass of an electron is so small that it is often taken to be ZERO.

Atoms

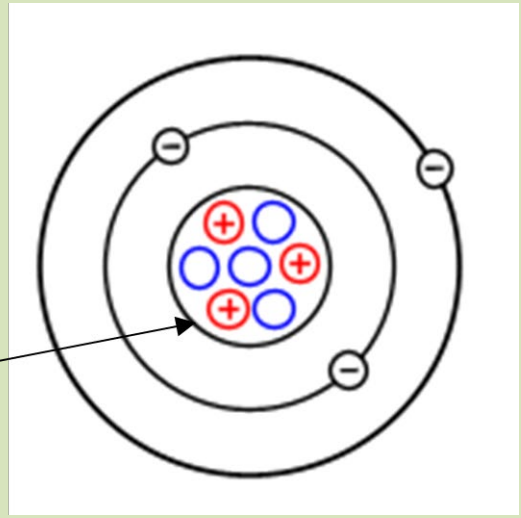
An atom is a neutral particle, it has no overall charge.

In an atom

number of protons = number of electrons

An atom of lithium

Atoms can be represented as follows: -



At GCSE

This electronic configuration is written 2,1

Atomic Number (Z)

The number of protons in the nucleus (of an atom).

Mass Number (A)

The number of protons plus the number of neutrons in the nucleus (of an atom).

Calculating the Number of Neutrons in the Nucleus

Mass number = number of protons + number of neutrons

Therefore:-

Number of neutrons = mass number - atomic number

Isotopes

Isotopes

Atoms with the same number of protons but a different number of neutrons.

Examples of isotopes of hydrogen are : ^{1}H ^{2}H ^{3}H

Examples of isotopes of chlorine are : ^{35}Cl ^{37}Cl

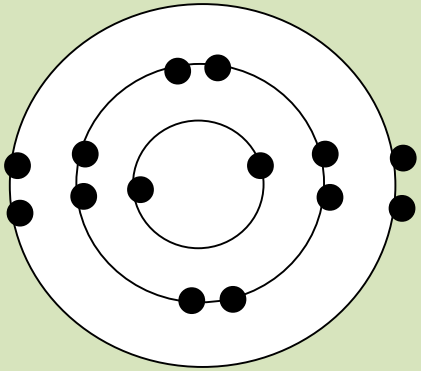
Notice there is no need to give the atomic number the element symbol tells you what this is anyway

Isotopes

	Number of		
	protons	neutrons	electrons
$^{35}_{17}$			
$^{37}_{17}$			

Isotopes

The electronic arrangement of chlorine is 2, 8, 7



Chlorine is a halogen (Group 7).

The number of outer shell electrons is the same as the group number.

Why do chlorine-35 and chlorine-37 have identical **chemical** reactions?

See the next slide for the answer.

Isotopes

- The **chemical** properties of isotopes of the same element like ^{35}Cl and ^{37}Cl are **identical** because they have the **same number of electrons.**

- The only differences between isotopes of the same element are **physical** properties such as **rates of diffusion**, which depend on the mass of the particles, or **nuclear properties** such as radioactivity.

IONS

- An **ion** is a _____ particle.
- The number of _____ and _____ are **NOT** equal.
- When an atom loses one or more _____ it forms a _____ charged ion called a _____.
- When an atom gains one or more _____ it forms a _____ charged ion called an _____.
- Often ions have electron arrangements with a full outer shell like the _____ gases which should be stable.

Use these words once/ more than once or not at all to fill the gaps

negatively	charged	electrons	anion
positively	Noble	neutrons	cation
	Diatomic	protons	