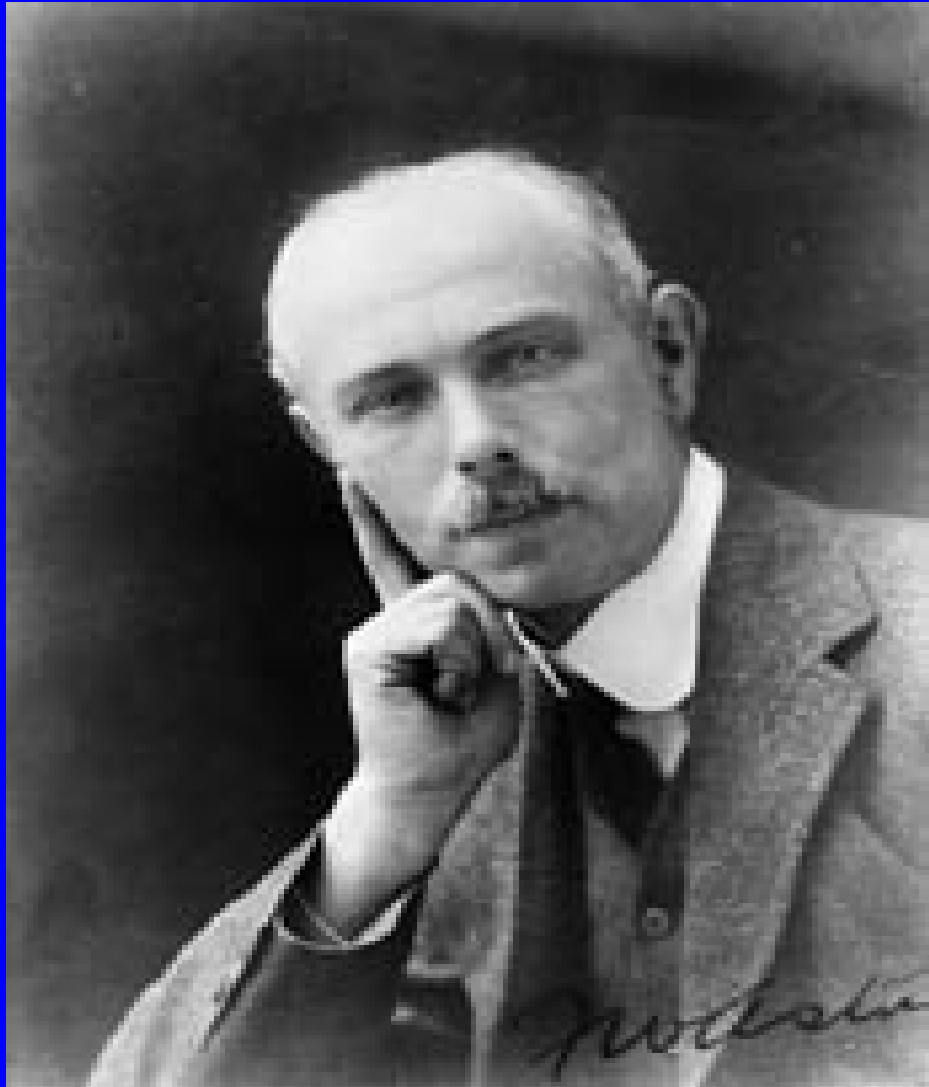
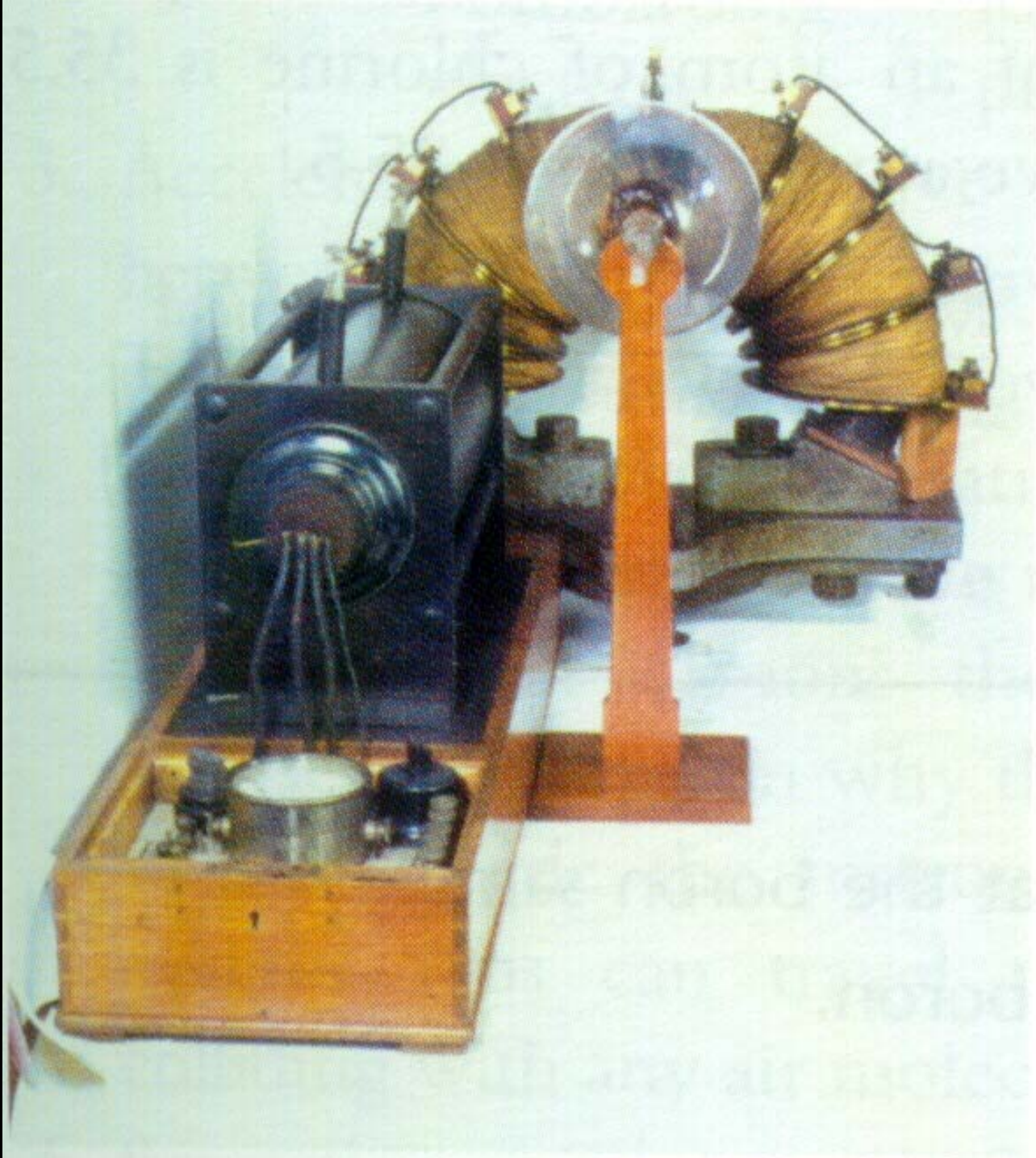
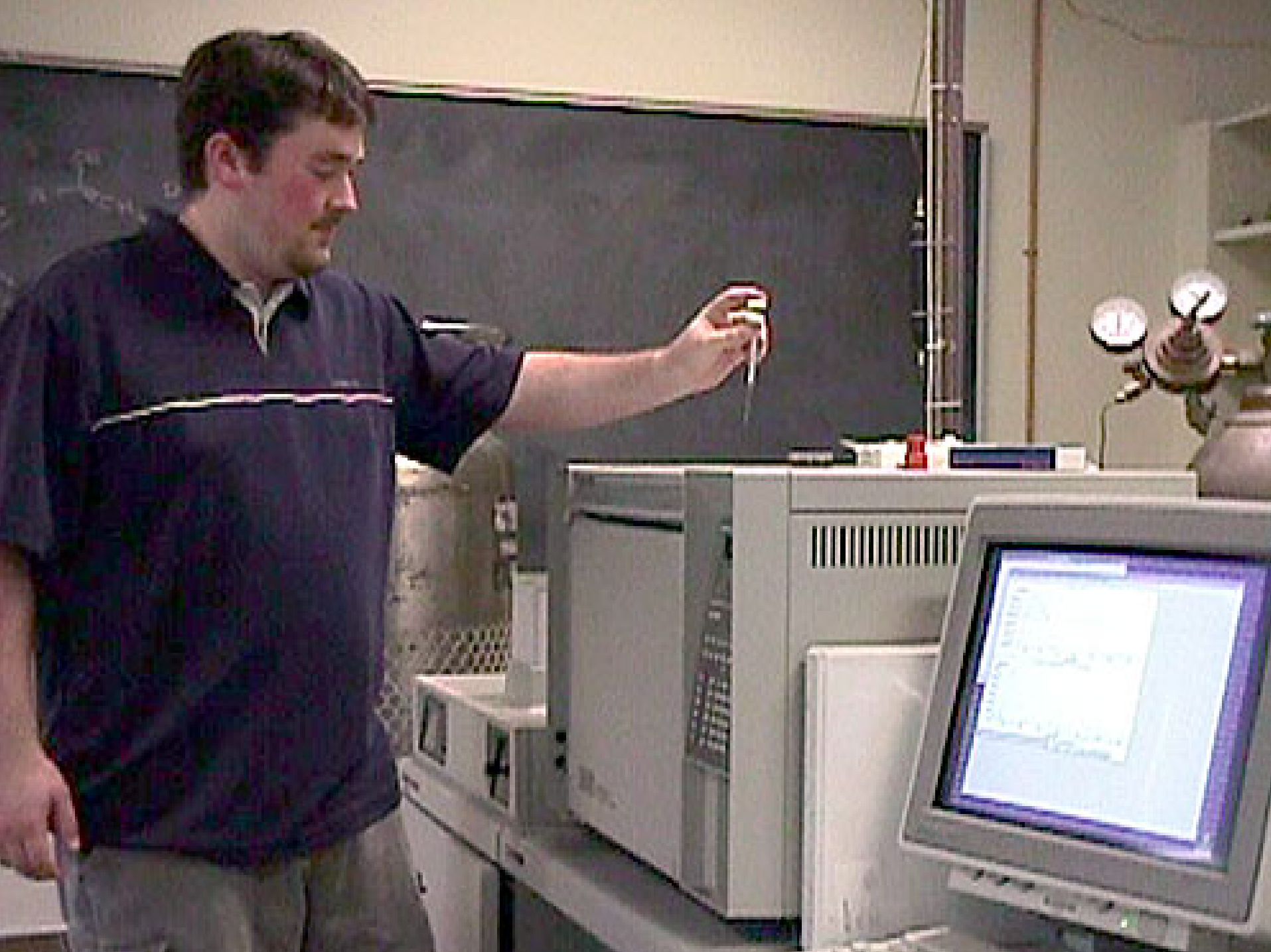


F W Aston

1875 - 1945







Mass Spectrometer

- Invented by F W Aston in 1919
- Working on separating the isotopes of Neon
- Discovered two types of atom
- One type of mass 20
- Another type of mass 22

- Both had 10 protons
- The first type had 10 neutrons
- Second type had 12 neutrons
- *Isotopes [Greek for same place]*
- *Atoms of the same element that have the same atomic number but different mass numbers due to different numbers of neutrons*
- *Fredrick Soddy coined phrase working with lead 206,207 and 208 formed when uranium decayed radioactively – Nobel Prize 1921*

The Mass Spectrometer

works on the principal that

positive ions

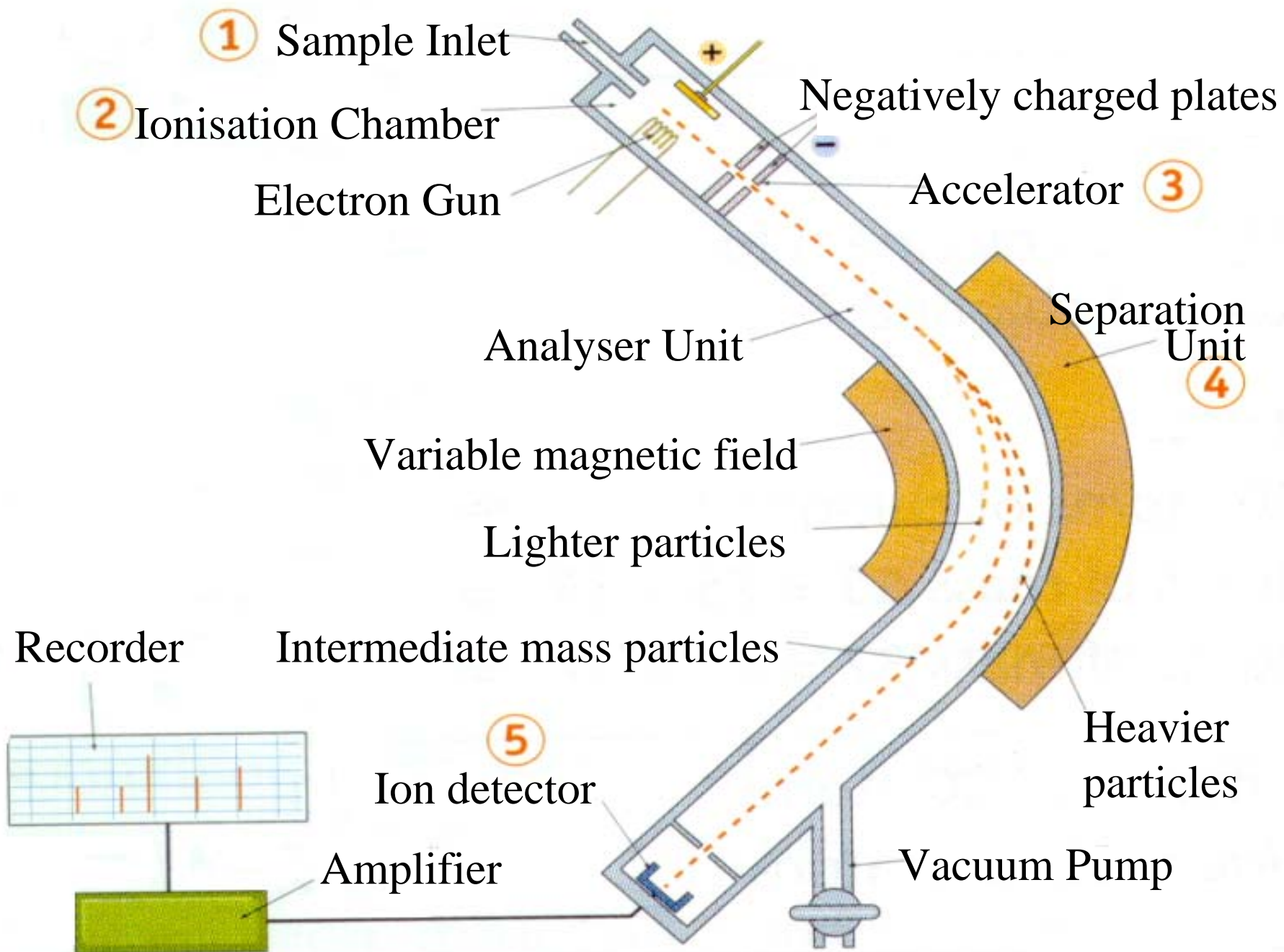
are separated

by mass

when moving in a magnetic

field

Structure of the Mass Spectrometer



5 Stages

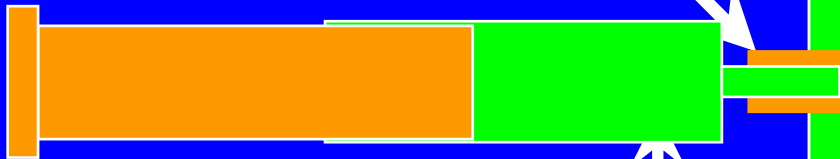
- 1) Vaporisation
- 2) Ionisation
- 3) Acceleration
- 4) Separation
- 5) Detection, Amplification and Display

1. Vaporisation

- Sample must be vaporised
- There is a Vacuum in the instrument so liquids vaporise easily
- Solids may have to be heated in a special unit

Vaporisation Chamber

Sample inlet A



Sample in syringe
injected into chamber

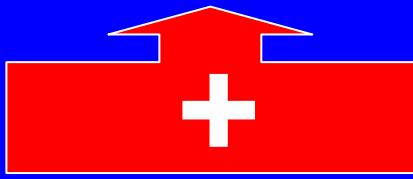
Sample may need to be
heated to vaporise it

2. *Ionisation*

- Turns atoms and molecules into ions
- Using an “electron gun”
- Fires high energy electrons at atoms
- These high energy electrons knock off normal electrons forming positive ions



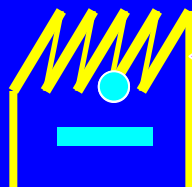
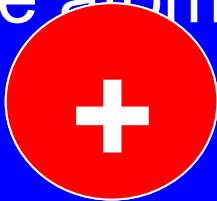
- These ions can then be accelerated and deflected using electric charge and a magnetic field



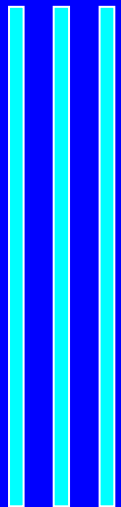
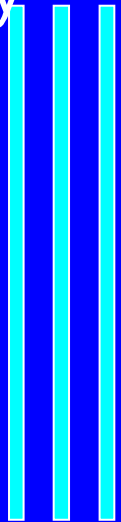
The positive ions are attracted by the negative charge of the accelerator plates and those other electrons from the which pass through the hole are accelerated to high speeds and

IONISATION CHAMBER

Now vaporised atoms are sprayed into the ionisation chamber and are hit by the high speed electrons



Hot wire is negatively charged and boils off electrons which are repelled by negative and attracted to the anode at high speed



A
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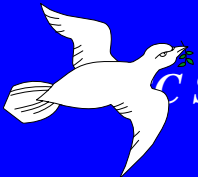
3. Accelerator

- Made of a series of Negative plates with a hole in the centre
- These attract the positive ions
- Some of these ions pass through the holes in the centre of the plates
- And as they do so are accelerated to high speeds
- This produces a fine beam of positive ions which pass into analyser
- Vacuum allows the ions to move [*no air molecules to stop or deflect them*]

4. *Separation*

- Magnetic field does the separation.
- In the *Analyser*
- All ions have the same kinetic energy
- light particles are deflected most
- heavy particles are deflected least
- *Beam of particles is separated according to their masses*

*Effect of the magnetic
field in the analyser unit
on ions of differing
Mass*



Separator or Analyser Unit

Magnetic Field on
Magnetic Field off



Height Ion



No deflection *No magnetic field*



Small deflection *Heavy Ion*



Large deflection *Light Ion*



Effect of changing the Magnetic Field



Separator or Analyser Unit

Magnetic Field ~~STRONG~~

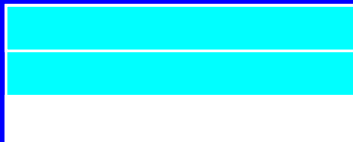


Ion of one mass



No deflection

No Magnetic Field



Small deflection

Weak Field



Large deflection *Strong Field*



5a. *Detector*

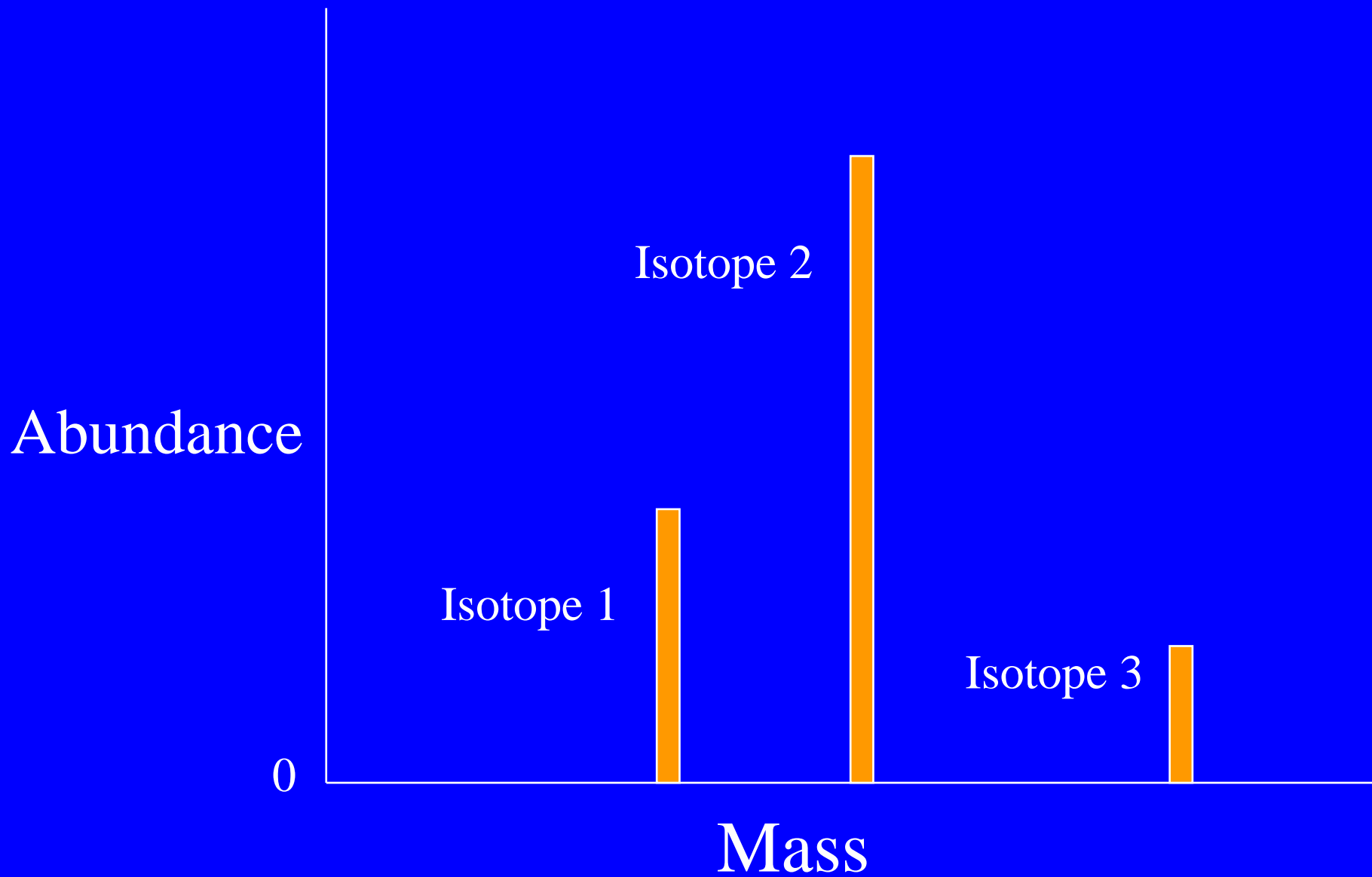
- Very sensitive instrument.
- Responds to the number of ions hitting it.
- The more ions that hit it the bigger the reading
- Changing the magnetic field brings particles of different masses to focus on the detector.
[Stronger the field the greater the particle mass]
- Detector needs to be calibrated

5b. Amplifier

- The signal is amplified
[made bigger]
electronically

5c. Display

- On computer screen
- Trace recorded as a series of peaks
- Trace called a **Mass Spectrum**
- When printed called a **Mass Spectrogram**



- Aston discovered ^{35}Cl and ^{37}Cl
- Determined the percentage of each isotope present
- Won the Nobel Prize for Chemistry 1922
- Discovered 212 of the 287 naturally occurring nuclides

Uses

- Determining the Relative molecular mass of atoms [isotopes] till 1970
- Determining mass of unknown organic compounds and thus help determine their structures
 - Gases from waste dumps
 - Trace organic pollutants in water