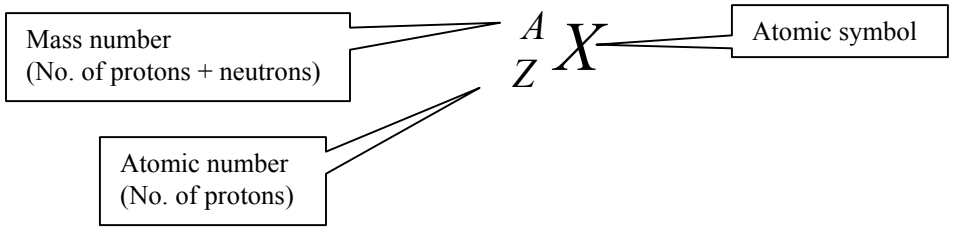
1.3 Understanding Atomic Mass

Definitions to Know

- Atomic number (Z)
- Mass number (A)
- Isotope
- Atomic mass (A_r)
- Unified atomic mass unit (u)
- Mass spectrometer
- Radioisotope
- Radioactive
- Half-life
- Carbon-14 dating
- Fission

Standard Atomic Notation



- E.g. Silicon

$^{28}_{14}Si$

$p^+ =$

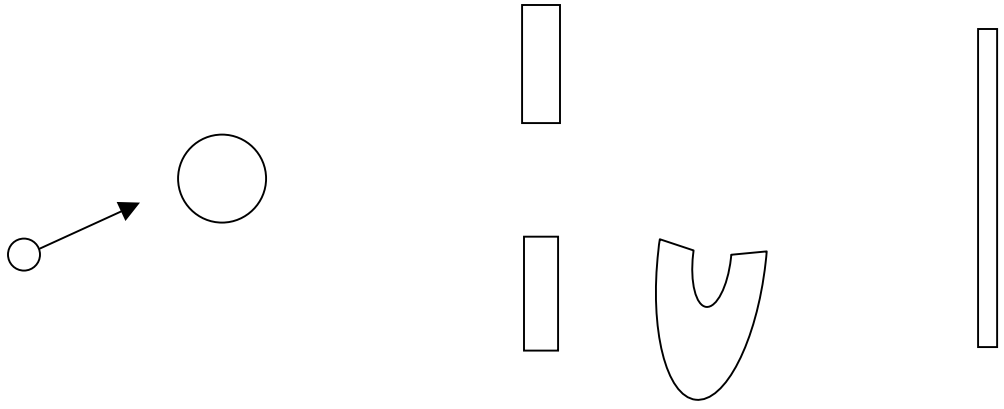
$n^0 =$

$e^- =$

Isotopes

- The number of neutrons in an element can vary. This gives us isotopes. Elements with the same atomic number but different mass numbers.
- What does this mean → different numbers of neutrons give different masses but all have the same number of protons therefore the same element.
- E.g. Cl-35 and Cl-37

- Hydrogen is found 99% of the time as hydrogen but it also exists as deuterium and tritium.
- Since the number of protons and electrons stay the same in isotopes they will have similar chemical properties…however, they can have different physical properties (e.g. bp)
- The masses used for atoms is the unified atomic mass unit which is 1/12 the mass of a carbon-12 atom.
- Protons and neutrons have a mass of 1 u while electrons have a mass of 0.00055 u.
- A mass spectrometer is used to determine mass and abundance of a gaseous element.



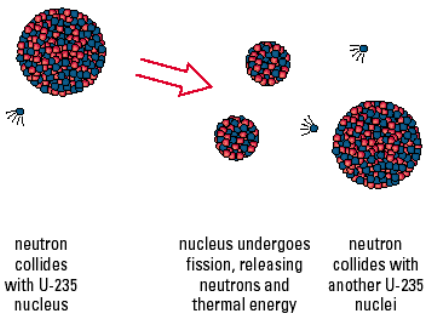
- Small particles bend more in an electric/magnetic field because they are lighter. Also, the brightness on the reciever will indicate the quanitity of the partical is present.
- Eg. Cl-35 = 76% and Cl-37 = 24% therefore the mass of Cl is recorded as 35.45

Radioisotopes

- Radioisotopes are atoms that decay and give off radioactive particles.
- Alpha (α) → helium nucleus, slow with low penetration in air.
  - $^{238}_{92}U \rightarrow ^{234}_{90}Th + ^{4}_{2}He$
- Beta (β) → an electron, fast with moderate penetration in air (the neutron turns into a proton and electron)
  - $^{3}_{1}H \rightarrow ^{3}_{2}He + ^{0}_{-1}e$
- Gamma (γ) → radiation, speed of light and difficult to stop.
  - $^{60}_{27}Co \rightarrow ^{60}_{28}Ni + ^{0}_{-1}e + \gamma$
- Half-life is the amount of time it takes for ½ a radioactive sample to decay.
- Some math to make it easier:
  - $m_i \times \left(\frac{1}{2}\right)^n = m_f$ Where n is the number of half-lives, m_i is the initial mass and m_f is the final mass.
  - $n = \frac{\log\left(\frac{m_f}{m_i}\right)}{\log\left(\frac{1}{2}\right)}$

Nuclear Power and Nuclear Waste

- Fission in a CANDU reactor



- In the reactor, U-235 reacts with a neutron to release energy when the atom splits.
- During this reaction sometimes the neutron will fuse with the U atom. The material can become more radioactive as U-238 and Pu-239 are formed.
- The waste products need to be stored for long periods of time due to the long half-lives.
- Accidents have happened: 3 Mile Island and Chernobyl.
- Should be use nuclear power? What should we do with the waste?

Homework

- Practice Questions: 1,2,3,4,5,6,7,8,9,10,12,13,20,21,22
- Section Questions: 1,3,5