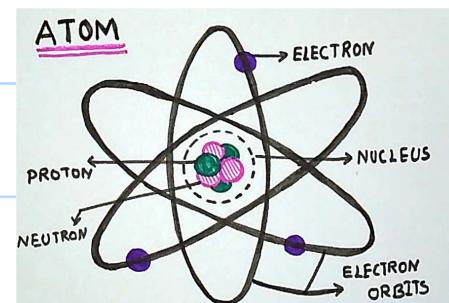


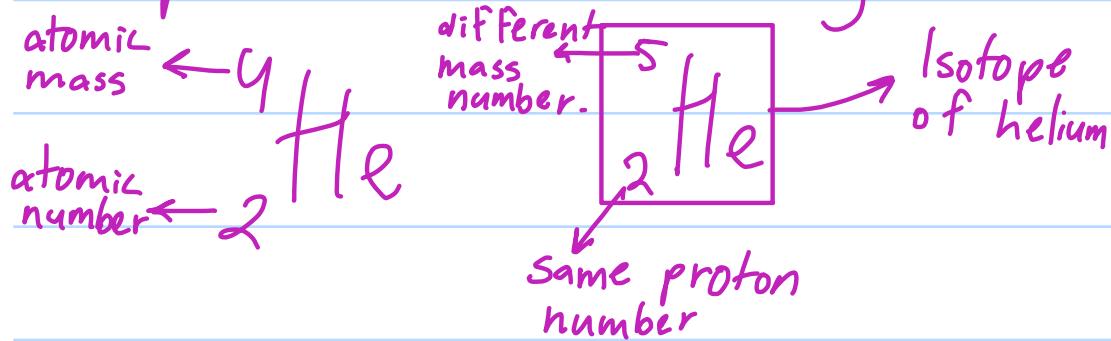
Nuclear Physics (Atomic Physics)

Structure of an Atom.

Particles	Relative Charge	Relative Mass
Proton	+1	1
Neutron $\begin{smallmatrix} p \\ e^- \end{smallmatrix}$	0	1
Electron.	-1	$\frac{1}{1890}$

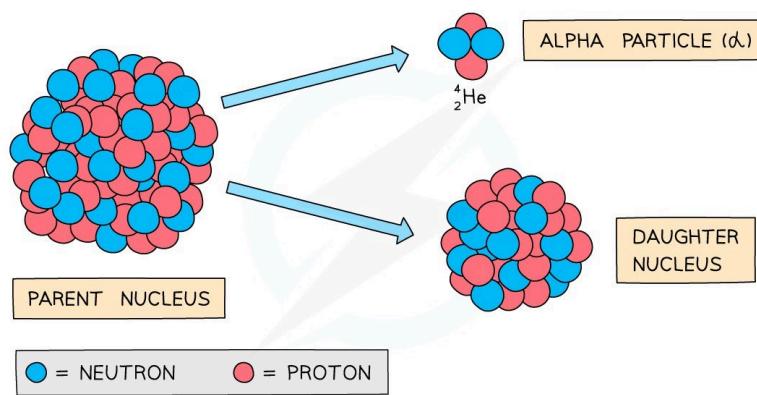


Isotopes & Radioactive Decay

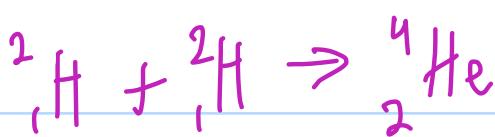


Isotopes: Same element with same proton number but different neutron number

Radio active Decay: When an unstable nucleus emits radiation to become stable.

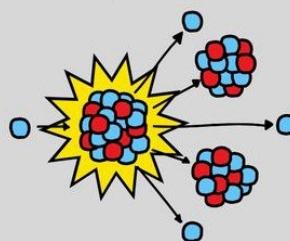


Nuclear Reactions



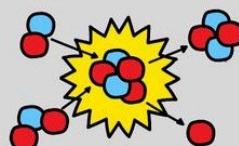
Fission

Fission is the splitting of a large atomic nucleus into smaller particles.

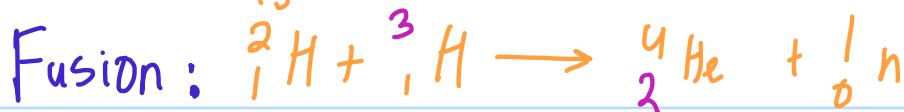


Fusion

Fusion is the combination of light atomic nuclei to form a heavier nucleus.



Examples of Fusion & Fission

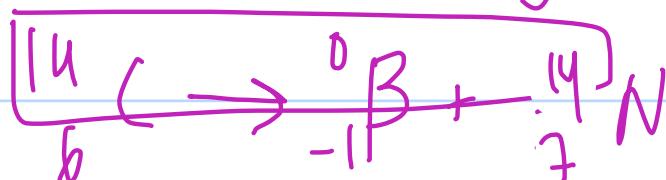


Radioactive Emissions

Type	Description	Equivalent	Symbol	Penetrating Power
Alpha	Dense (+) charged particle	Helium nucleus	$^{4}_{2}He$ (α)	Stopped by thick paper
Beta	(-) charged particle	High speed electron	$^{0}_{-1}e$ $^{0}_{-1}\beta$	Stopped by 6mm of Al
Gamma	Type of energy	High energy photons	$^{0}_{0}\gamma$	Stopped by several cm of Pb

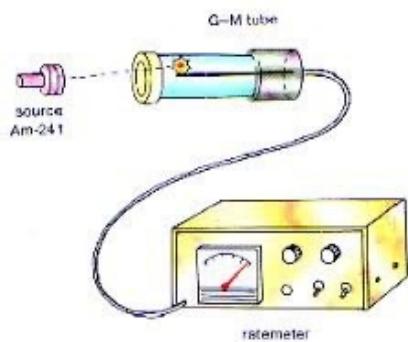
Property	α -particles		β -particles	γ -rays
	Nature	Particle consist of 2 protons & 2 neutrons	Fast-moving electrons	High frequency electromagnetic radiation
Range in air	A few cm		A few m	A few hundred m
Charge	Positive (+2)		Negative (-1)	No charge
Mass	High		Low	No mass
Speed	Up to 10% speed of light	90% speed of light	Speed of light	
Ionising effect (ions per mm in air)	Strong (10^5)	Weak (10^2)	Very weak (1)	
Relative penetrating power	Skin or thin sheet of paper - has a range of few centimetres in air	Thin aluminium - has a range of several metres in air	Thick lead or concrete - has a range of 120 metres in air	

How do Beta decay works?



$$\begin{aligned} l_4 &= 0 + y & g &= -1 + x \\ y &= l_4 & x &= ? \end{aligned}$$

How to detect background radiation?



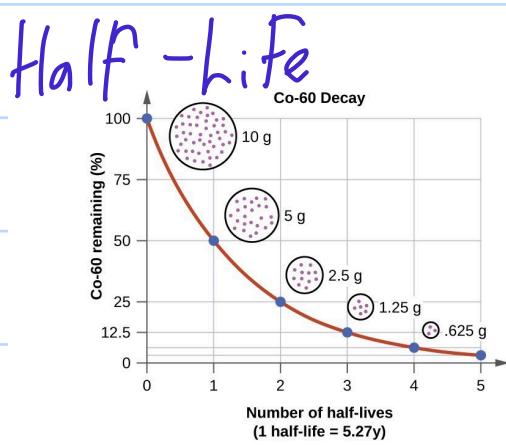
Sources of Background radiation.

- (i) Cosmic Rays (Sun)
- (ii) Radon gas in Air
- (iii) Underground Rocks & Buildings.

Geiger - Muller
(GM) tube.

Nature of Radioactive Decay.

- (i) It decreases over time
- (ii) It's Random
- (iii) It's spontaneous & random.



Definition: time taken for number of unstable nuclei to decrease by half.

$$\text{Equation: } N(t) = N_0 \left(\frac{1}{2}\right)^{\frac{t}{t_1}}$$

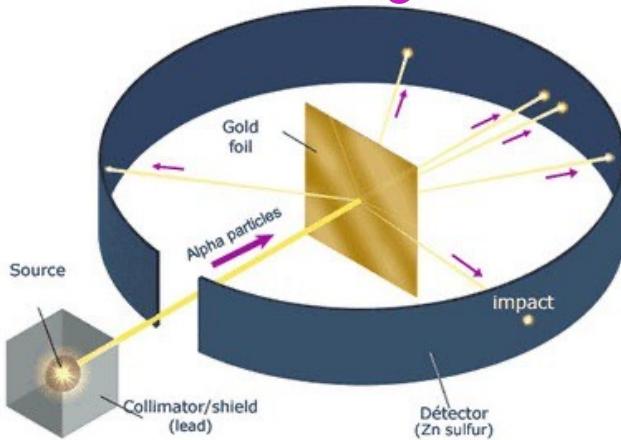
$N(t)$: quantity of the substance remaining

N_0 : initial quantity of the substance

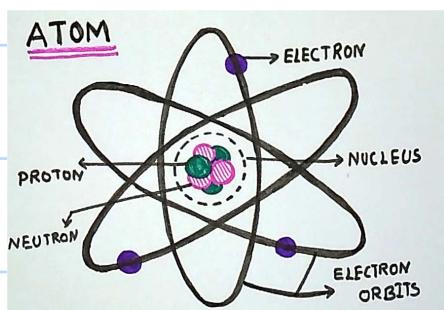
t : time elapsed

t_1 : half-life of the substance.

Alpha Scattering Experiment



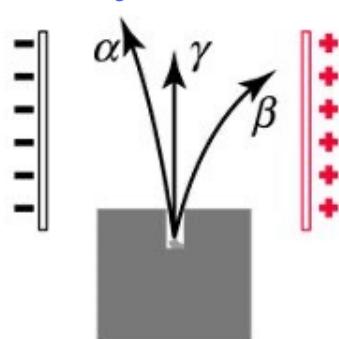
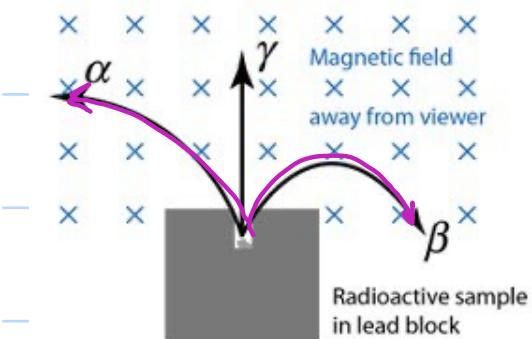
Observation	Description	Proof of atomic model
Most α -particles	Passed through the gold foil without deflection.	Atom is mostly empty space.
Some α -particles	Deflected at small angles.	Presence of a dense, positively charged nucleus which repels the α -particles
Approximately 1 in 8000 α -particles	Deflected back towards the source at large angles.	Nucleus is very small and dense compared to the rest of the atom.



Conclusions

- Positively charged nucleus of an atom.
- Atoms are mostly empty space.
- Negatively charged electrons orbiting at a great distance.

Interaction of radiation in magnetic fields and electric fields.



Use:

Fleming's left: Alpha particles (α)

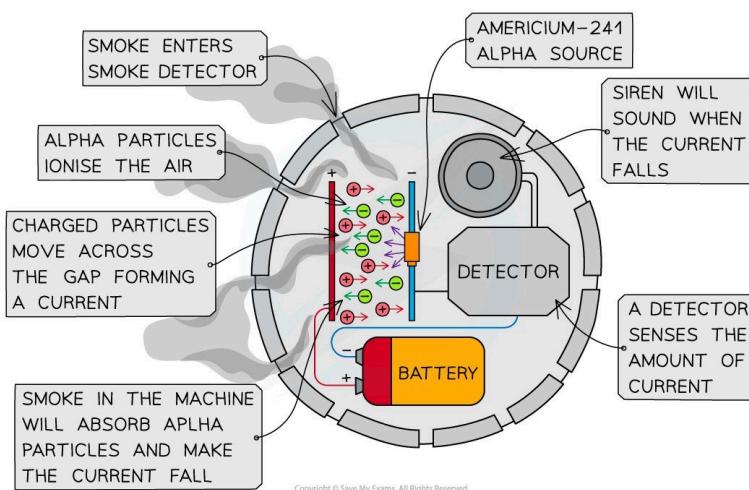
Fleming's right: Beta particles (β)

Gamma (γ) no interaction with magnetic & electric fields.

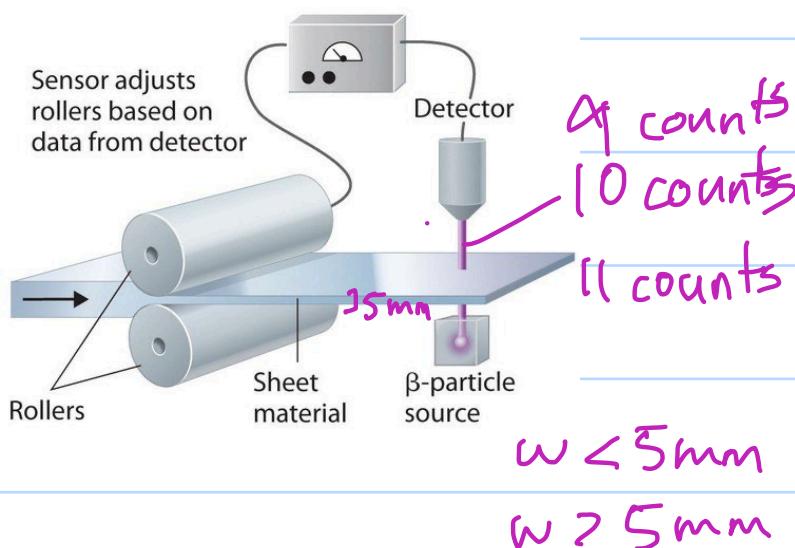
Application of Radioactivity.

- Smoke Detectors
- Sterilization of medical equipment
- Irradiating food
- Treatment of cancer using Gamma rays (radiotherapy)
- Thickness Measurement of Paper/Aluminum foil
- Checking for broken underground pipes

Application of Alpha particles (a) Smoke detectors



Application of Beta particles (B) Material Measurement



Safety Precautions

- Safe storage of radioactive material (lead boxes)
- Reducing exposure time
- Increasing distance between source & living tissue (use tongs)
- Using shields to absorb radiation.



Tongs

WEEKLY TEST - 6
IMAS

2. (a) A radiation detector used in a laboratory detects a background count rate of 30 counts / min. A radioactive source is placed in front of the radiation detector. The initial reading on the detector is 550 counts / min. The half-life of the source is 25 minutes. Calculate the expected reading on the detector after 75 minutes.

550 - $\frac{1}{2} = 2$ 520 Count rate
 $520 - \frac{1}{2} = 2$ 500
 $500 - \frac{1}{2} = 2$ 480
 $480 - \frac{1}{2} = 2$ 460
 $460 - \frac{1}{2} = 2$ 440
 $440 - \frac{1}{2} = 2$ 420
 $420 - \frac{1}{2} = 2$ 400
 $400 - \frac{1}{2} = 2$ 380
 $380 - \frac{1}{2} = 2$ 360
 $360 - \frac{1}{2} = 2$ 340
 $340 - \frac{1}{2} = 2$ 320
 $320 - \frac{1}{2} = 2$ 300
 $300 - \frac{1}{2} = 2$ 280
 $280 - \frac{1}{2} = 2$ 260
 $260 - \frac{1}{2} = 2$ 240
 $240 - \frac{1}{2} = 2$ 220
 $220 - \frac{1}{2} = 2$ 200
 $200 - \frac{1}{2} = 2$ 180
 $180 - \frac{1}{2} = 2$ 160
 $160 - \frac{1}{2} = 2$ 140
 $140 - \frac{1}{2} = 2$ 120
 $120 - \frac{1}{2} = 2$ 100
 $100 - \frac{1}{2} = 2$ 80
 $80 - \frac{1}{2} = 2$ 60
 $60 - \frac{1}{2} = 2$ 40
 $40 - \frac{1}{2} = 2$ 20
 $20 - \frac{1}{2} = 2$ 10
 $10 - \frac{1}{2} = 2$ 5
 $5 - \frac{1}{2} = 2$ 2.5
 $2.5 - \frac{1}{2} = 2$ 1.25
 $1.25 - \frac{1}{2} = 2$ 0.625
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