## Binding Energy

$$B = 15.56A - 17.23A^{2/3} - 0.72Z^2A^{-1/3} - 23.285\left(A-2Z\right)^2A^{-1} + 11A^{-1/2}$$

$$B = 931\left(1.00783Z + 1.00867N - M\right)$$

## Nuclear Radius

$$R(\text{cm}) = 1.4 \times 10^{-13}A^{1/3}$$

## Magic Numbers

2, 8, 20, 28, 50, 82, 126 (also 118 for $p^+$)

## AMU

1 u=931 MeV

## Coulomb Barrier

$$E_C = 1.11\frac{(A+A')}{A}\frac{ZZ'}{\left(A^{1/3}+A'^{1/3}\right)}$$

## Specific Activity

A is mass number, T is half-life in days

$$\begin{array}{ll} \frac{\text{mCi}}{\text{mg}} & \frac{1.3\times10^8}{AT} \\ \frac{\text{MBq}}{\text{mg}} & \frac{4.8\times10^6}{AT} \end{array}$$

## Equilibrium

### Secular

$$\lambda_d N_d = \lambda_p N_p\left(1-\mathrm{e}^{-\lambda dt}\right)$$

## Beta Recoil

$$E_{Max} = E_m\frac{m_e}{m_e+M_D}$$

## Alpha Range

$$R_{air} = 0.31E_\alpha^{1.5}$$

$$R_? = R_{air} * \rho_{Air}/\rho_?$$

$$E_\alpha = E_{decay}\frac{m_{Daughter}}{m_\alpha + m_{Daughter}}$$

$\alpha$ produces 30 000 ion pairs per cm in air

## Beta Ranges

$$E_{avg} \approx E_{max}/3$$

$$E_{max}^{daughter} = E_\beta\frac{m_\beta}{m_\beta + M_{daughter}}$$

$$R(mg/cm^2) = \begin{cases} 543E_m - 133 & E_m \geq 0.8\,\text{MeV} \\ 407E_m^{1.38} & E_m < 0.8\,\text{MeV} \end{cases}$$

Scattering increases with Z and surface density up to about 1/5 of the range

## Compton

$$E_s = \frac{E_{tot}}{1+\frac{E_{tot}}{m_e}\left(1-\cos\theta_\gamma\right)}$$

## counting

$$t_s/t_b = \sqrt{\frac{S/t_s}{B/t_b}}$$

## Quality Factors

## Bio effects

Most to least sensitive: gonads, bone marrow, colon, lung, stomach, bladder, breast, liver, esophagus, thyroid, other (adrenals, brain, intestines, kidney muscle, pancreas, spleen, thymus, uterus, etc), bone surface, skin.

Natural sources ($\text{mSv}\,\text{yr}^{-1}$) cosmic rays (0.4), external (K,U,Th) (0.5), internal ($^{40}$K) (0.3), inhaled Rn (3), total (4.2)
Artificial (mSv per dose) local: external medical diagnosis (1-5), external therapy ( 50000), internal diagnosis (1-1000), internal therapy (10000)
whole body: external diagnosis (0.02-0.5), external therapy (up to 50), internal diagnosis (0.1-10), internal therapy (50)

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