

Binding Energy

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

B = 931 (1.00783Z + 1.00867N - M)

Nuclear Radius

R(cm) = 1.4 x 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'}{(A^{1/3} + A'^{1/3})}

Specific Activity

A is mass number, T is half-life in days
\frac{mCi}{mg} = \frac{1.3 \times 10^8}{AT}
\frac{MBq}{mg} = \frac{4.8 \times 10^6}{AT}

Equilibrium

Secular

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

Beta Recoil

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

Alpha Range

R_{air} = 0.31 E_{\alpha}^{1.5}
R_{\gamma} = R_{air} * \rho_{Air} / \rho_{\gamma}
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} 543 E_m - 133 & E_m \geq 0.8 \text{ MeV} \\ 407 E_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} (1 - \cos \theta_{\gamma})}

counting

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

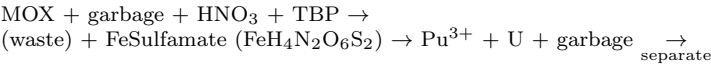
Quality Factors

Particle	Energy	Q
\gamma, X-ray		1
\beta^{\pm}		1
neutron	0.025 eV	5
	0.01 MeV	5
	0.05 MeV	10
	10 MeV	10
	1 MeV	20
\alpha	>20 MeV	5
		20
	proton	5

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 (mSv 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)

PUREX



Detectors

Detector	PC	GM	SC(s)	SC(l)	SS
Energy discrimination	y	n	y	y	y
Detection Medium	gas	gas	sol	liq	sol
Amplification	10^3	10^8	10^6	10^6	10^0
ext amp needed	hi	lo	med	med	hi
resolving time (\mu s)	5	150	1	1	0.1
background	med	med	hi	hi	lo/med
external \alpha efficiency	lo	lo	lo		hi
internal \alpha efficiency	hi			hi	
external low-E \beta	lo	lo	lo		hi
internal low-E \beta	hi			hi	
external hi-E \beta	hi	med	med		hi
internal hi-E \beta	hi			hi	
external low-E \gamma	med	med	med		hi
internal low-E \gamma	med			med	
external hi-E \gamma	lo	lo	hi		hi
internal hi-E \gamma	lo			lo	
commonly-used sample form	sol	sol	liq	liq	sol