Tunnelling in Nuclear Potentials

$Z1 := 90$ $A1 := 234$ $Z2 := 2$ $A2 := 4$ $Q := 4.27$ $Vo := -50.0$ $a := 0.45$

$R := 1.10 \cdot \left(A1^{0.3333} + A2^{0.3333}\right) = 8.523$

$m := \frac{A1 \cdot A2}{A1 + A2} = 3.933$

$Vn(r) := \frac{Vo}{1 + e^{\frac{r-R}{a}}}$

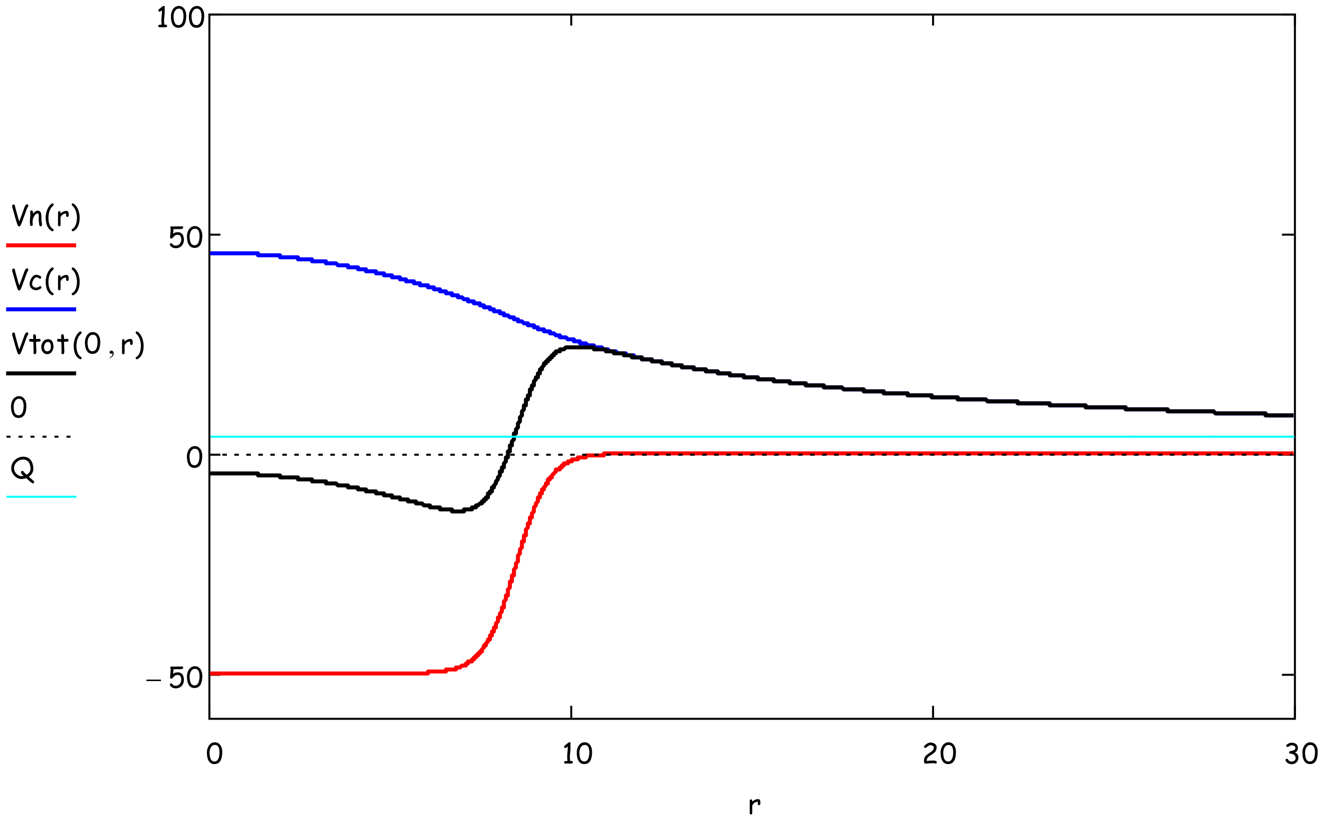
$Vl(l, r) := 20.9 \cdot \frac{l \cdot (l+1)}{m r^2}$

$Rs := 1.10 \cdot \left(A1^{0.3333} - A2^{0.3333}\right) = 5.031$

$r := 0.05, 0.06 .. 30$

$$Vc(r) := \begin{array}{|l} t \leftarrow \frac{1}{r} \quad \text{if } r > R \\ t \leftarrow \frac{1}{R}\left(\frac{3}{2} - \frac{r^2}{2 \cdot R^2}\right) \quad \text{if } r \le R \\ Vc \leftarrow 1.44 \cdot Z1 \cdot Z2 \cdot t \\ \text{return } Vc \end{array}$$

$Vtot(l, r) := Vn(r) + Vc(r) + Vl(l, r)$



Calculation of tunnelling probability

$R1 := R$ | $R1 = 8.523$ | Low Limit

$R2 := 1.44 \cdot \frac{Z1 \cdot Z2}{Q}$ | $R2 = 60.703$ | Upper Limit

$F(x) := \frac{2}{\pi} \cdot \left[acos\left(\sqrt{x}\right) - \sqrt{x \cdot (1 - x)} \right]$ | $F\left(\frac{R1}{R2}\right) = 0.534$ | (analytical solution)

$kc := F\left(\frac{R1}{R2}\right) \cdot \frac{1.44 \cdot Z1 \cdot Z2}{\sqrt{Q}} \cdot \pi$ | $kc = 210.555$ | (only Coulomb)

$k := \int_{R1}^{R2} 2\sqrt{Vtot(0, r) - Q}\, dr$ | $k = 206.622$

$G := \frac{\sqrt{2 \cdot m \cdot 931.5}}{197} \cdot k$ | $G = 89.777$

$\tau := 7 \cdot 10^{-23} \cdot e^{G}$ | $\tau = 6.838 \times 10^{16}$ | sec (mean lifetime)