Example- Let's examine various quantities when an electron with a kinetic energy of 1 eV in a region of zero potential is incident on a finite potential barrier at $x = 0$ of 12 eV that is 4 Angstroms wide followed by another zero potential region.

Define some constants

$h := 6.62607015 \cdot 10^{-34}$ J-s $hmod := \frac{h}{2 \cdot \pi}$ $hmod = 1.05457 \times 10^{-34}$ J-s

$m := 9.1093837015 \cdot 10^{-31}$ kg $a := 4 \cdot 10^{-10}$ m

Calculate some quantities and/or define equations

$EeV := 1$ eV $E := EeV \cdot 1.602176634 \cdot 10^{-19}$ $\boxed{E = 1.60218 \times 10^{-19}}$ J

$V0\_eV := 12$ eV $V0 := V0\_eV \cdot 1.602176634 \cdot 10^{-19}$ $\boxed{V0 = 1.92261 \times 10^{-18}}$ J

Per (2.61a), the wave number k_1 (rad/m) for regions I & III is

$$k1 := \sqrt{\frac{2 \cdot m \cdot E}{hmod^2}} \qquad \boxed{k1 = 5.12317 \times 10^{9}} \text{ rad/m}$$

Per (2.61b), the wave number k_2 (Np/m) in region II is

$$k2 := \sqrt{\frac{2 \cdot m \cdot (V0 - E)}{hmod^2}} \qquad \boxed{k2 = 1.69916 \times 10^{10}} \text{ Np/m}$$

From notes, the exact transmission coefficient T is

$$Texact := \frac{1}{1 + \frac{V0^2 \cdot \sinh(k2 \cdot a) \cdot \sinh(k2 \cdot a)}{4 \cdot E \cdot (V0 - E)}} \qquad \boxed{Texact = 1.52636 \times 10^{-6}}$$

Pretty small!

For $k2 \cdot a = 6.7966$ $\sinh(k2 \cdot a) \cdot \sinh(k2 \cdot a) = 2.001859 \times 10^{5}$

which can be approximated as $0.25 \cdot e^{2 \cdot k2 \cdot a} = 2.001864 \times 10^{5}$

Per (2.63), the approximate transmission coefficient T is

$$Tapprox := 16 \cdot \frac{E}{V0} \cdot \left(1 - \frac{E}{V0}\right) \cdot e^{-2 \cdot k2 \cdot a} \qquad \boxed{Tapprox = 1.52635 \times 10^{-6}}$$

Very good approximation!