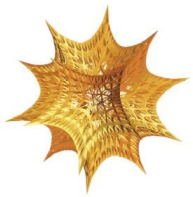

Mathematica Exercise: Tunneling Through a Barrier of Finite Width

Physical Chemistry I
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The expression for the tunneling probability for a particle of mass m having energy E through a square barrier of width a and height V is given by

$$P = \frac{1}{1 + \frac{V^2 \sinh^2\left(\frac{\sqrt{2m(V-E)a^2}}{\hbar}\right)}{4E(V-E)}}$$

where

$$\kappa = \sqrt{\frac{2m(V-E)a^2}{\hbar^2}}$$

P is sometimes written as

$$P = \frac{1}{1+G}$$

where

$$G = \frac{V^2 \sinh^2 \kappa}{4E(V-E)}$$

Sketch the potential function.

What parameters does the tunneling transmission probability depend on?

What is *sinh*? (Hint: Check Mathworld site at http://mathworld.wolfram.com/) What are the units on G?

Consider an electron impinging on a barrier of 5.0 eV. The barrier has a width of 1 Angstrom (0.1 nm). What is the probability of the electron moving through the barrier when the energy of the electron is 10% of the barrier, 50% of the barrier and 90% of the barrier?

Consider the same question for a proton, deuteron, H_2 and CO. What effect does increasing the mass have on the tunnelling probablity?

It has been proposed that precursors to amino acids have formed in comets by the tunnelling of H_2 and CO. Do you think this is reasonable?

What happens when you increase the length of the box? Decrease it? Does this make sense to you?

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