$$\Rightarrow \quad \frac{1}{T} \approx 1 + \frac{V_0^2}{16E(V_0 - E)}\, e^{2\gamma}.$$

Since γ is large, we must have $V_0 >> E$, so we can neglect the 1 and write

$$\frac{1}{T} \approx \frac{V_0^2}{16E(V_0 - E)}\, e^{2\gamma} \quad \Rightarrow \quad T \approx \frac{16E(V_0 - E)}{V_0^2}\, e^{-2\gamma}.$$

Note that this has exactly the same functional form as our WKB result in part b, and that the addition, the coefficient

$$\frac{16E(V_0 - E)}{V_0^2}$$

is of order 1. Note further that the dependence on $(V_0 - E)$ is dominated by the exponential factor, and that the WKB method provides a good approximation for the finite square barrier when $V_0 >> E$.

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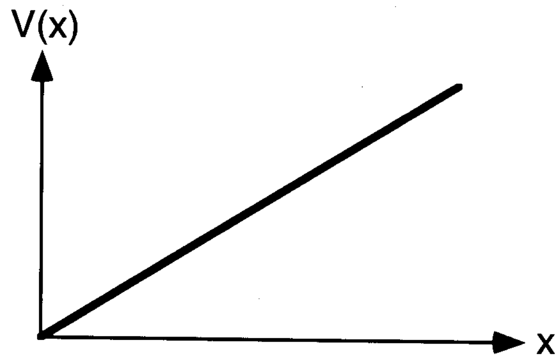
5. (a) The potential energy above the surface of the earth is given by

$$V(x) = mgx \quad \text{for} \quad x > 0.$$

Since the ball cannot pass through the surface, we also have

$$V(x) = \infty \quad \text{for} \quad x \leq 0.$$

So our idealized potential for the quantum mechanical bouncing ball looks like this



(b) The time-independent Schrodinger equation is given by,

$$-\frac{\hbar^2}{2m}\frac{d^2}{dx^2}\psi(x) + (mgx)\,\psi(x) = E\,\psi(x).$$

Change variables

$$y = x - \frac{E}{mg} \quad \Rightarrow \quad \frac{d}{dy} = \frac{d}{dx} \quad \Rightarrow \quad \frac{d^2}{dy^2} = \frac{d^2}{dx^2}\,.$$