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1. [5 Marks] Calculate the coefficients of transmission and reflection at $x = 0$ for the step potential given by

$$V(x) = \begin{cases} 0 & x < 0 \\ V_0 & x > 0 \end{cases}$$

assuming $0 < E < V_0$, where E is the energy of the incoming beam of particle (mass m) travelling in positive x direction.

2. [5 Marks] The **normalized** wave function of a particle (mass m), moving in the harmonic potential of natural angular frequency ω, at an instant is given by

$$\psi(x) = \left(\frac{\alpha}{\sqrt{\pi}}\right)^{\frac{1}{2}} \exp\left(i\frac{p_0 x}{\hbar} - \frac{\alpha^2 x^2}{2}\right)$$

where $\alpha = \sqrt{m\omega/\hbar}$ and p_0 is a positive constant. Find the average energy of the particle.

Useful Information:

$$\int_{-\infty}^{\infty} x^2 \exp\left(-a^2 x^2\right) dx = \frac{\sqrt{\pi}}{2a^3}$$