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2. Normalised wave fn $\psi = A\cos\left(\frac{\pi x}{2L}\right)$.

$$\langle \text{Kinetic energy} \rangle = -\frac{\hbar^2}{2m}\int_{-L}^{L} \psi^* \nabla^2 \psi \, dx$$

$$= \frac{\hbar^2}{2m} \cdot \frac{\pi^2}{4L^2}.$$

$$= \frac{\hbar^2\pi^2}{8mL^2}$$ [1 D finite well problem].

3. $\psi(r,t) = \psi(r)\, e^{-iEt/\hbar}$

$$P = \int \psi^* \psi \, d^3r$$

$$= \int \psi^*(r)\psi(r).\, e^{-i(E-E^*)t/\hbar} \, d^3r.$$

$$\frac{\partial}{\partial t} P = -\frac{i}{\hbar}(E-E^*) \underbrace{\int \psi^* \psi \, e^{-\frac{i}{\hbar}(E-E^*)t} \, d^3r}_{1}.$$

$$= 0 \implies E = E^*.$$