Stationary states of the harmonic oscillator

wave functions

probability distributions

Ψ_3

Ψ_3^2

$n=3$ ---- $\frac{7}{2}\hbar\omega$

Ψ_2

$n=2$ ---- $\frac{5}{2}\hbar\omega$

Ψ_2^2

$n=1$ ---- $\frac{3}{2}\hbar\omega$

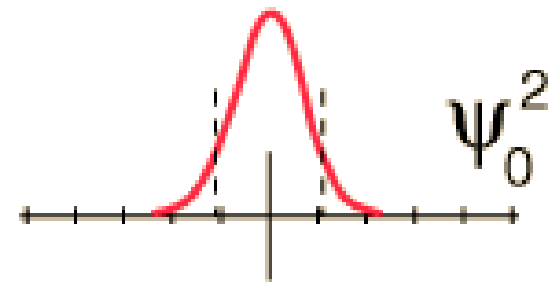Ψ_1

$n=0$ ---- $\frac{1}{2}\hbar\omega$

Ψ_1^2

$\sqrt{\alpha}\,x$
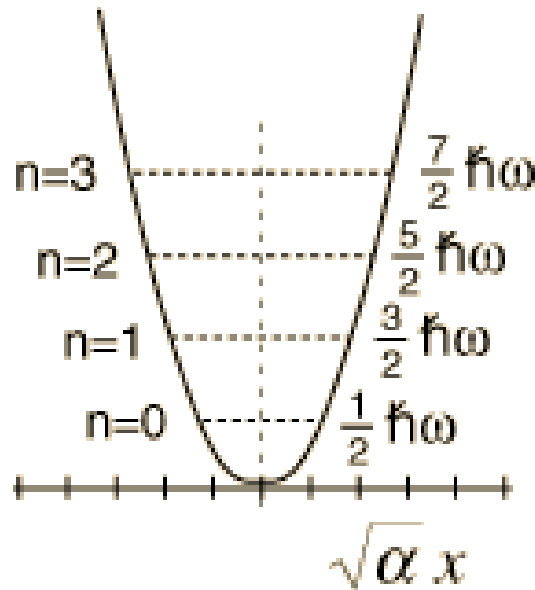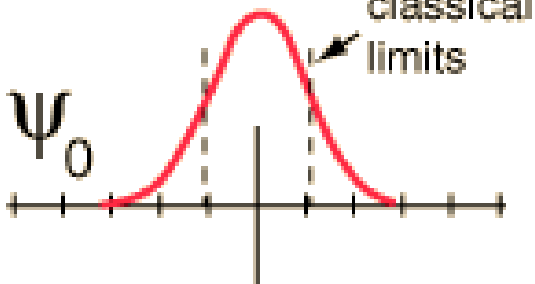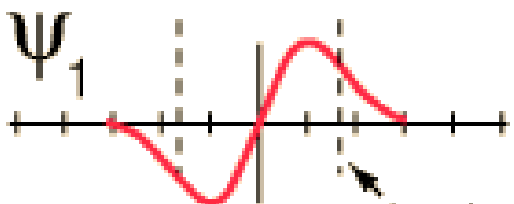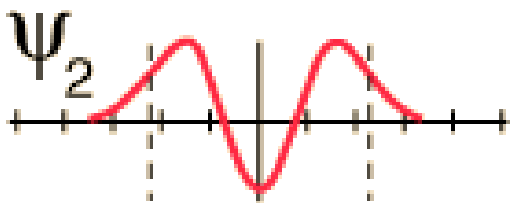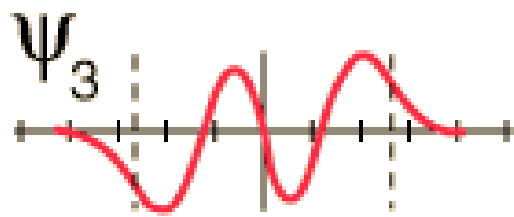
classical
limits

Harmonic oscillator
potential and
wavefunctions

Ψ_0

Ψ_0^2
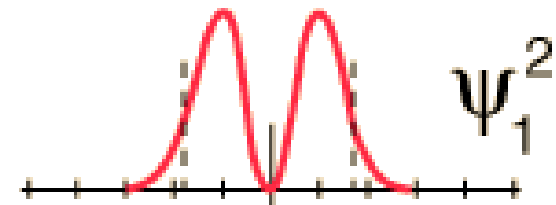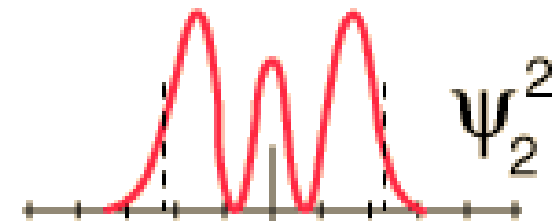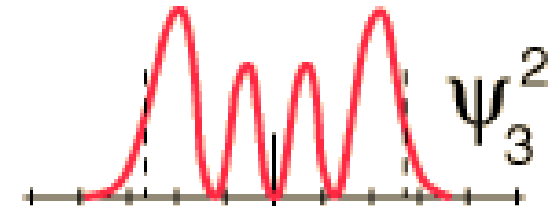
Stationary states of the harmonic oscillator

peculiar features

Classical probability

Classical limit

ψ_0^2

$\frac{\hbar\omega}{2}$ ..... $V(x)$

• the probability of finding the particle outside the classically allowed range is non-zero

• the quantum position distribution is unlike the classical distribution
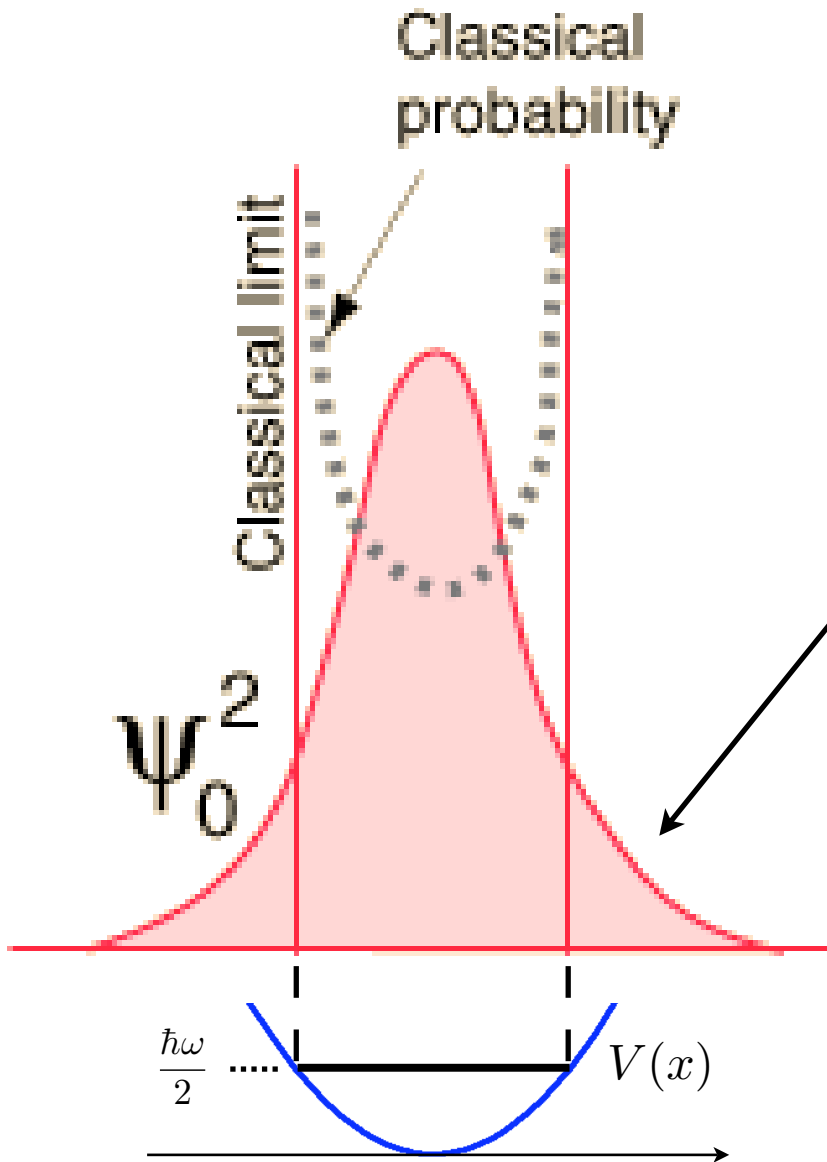
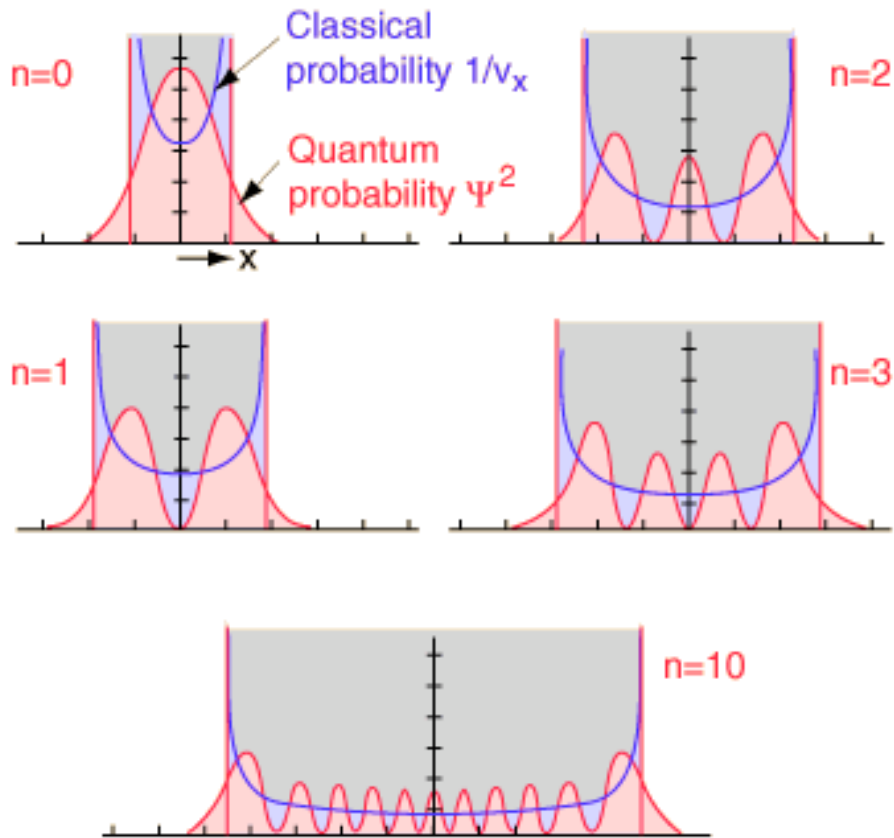**quantum oscillator in the ground state most likely found at center** **whereas** **classical oscillator with same energy spends least time at center where its velocity is largest**

Stationary states of the harmonic oscillator

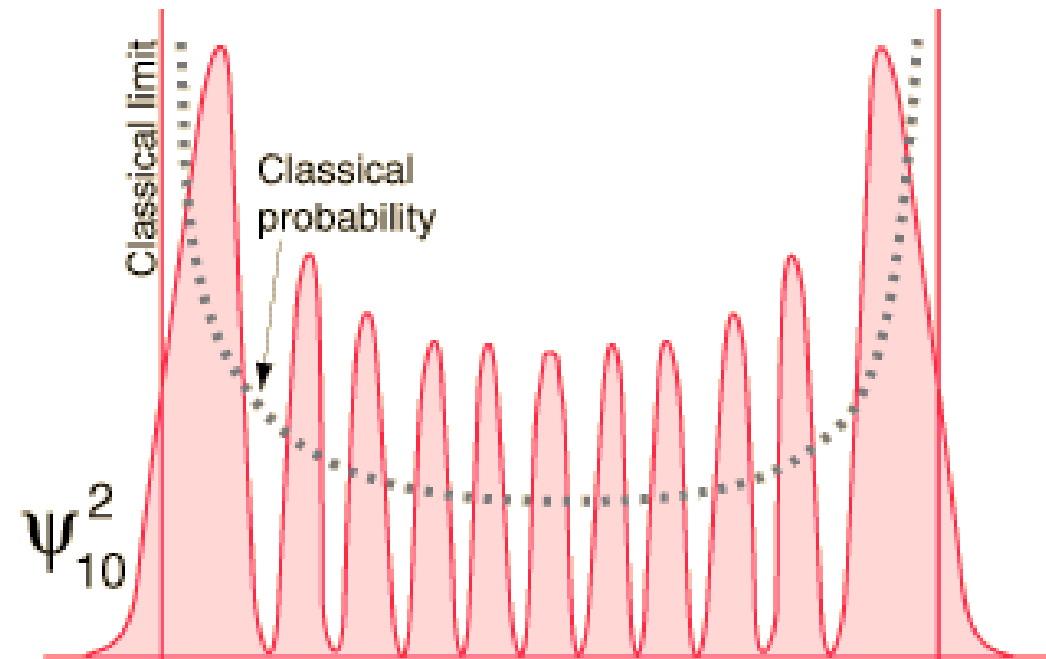*successively higher excited states*
"approach" the classical probability distribution