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## Background (Review)

14.2 **Simple Harmonic Motion**

$$\sum F_x = ma_x \qquad -kx = m\frac{d^2x}{dx^2} \qquad \frac{d^2x}{dt^2} + \overbrace{\left(\frac{k}{m}\right)}^{\omega^2} x = 0$$

solution: $x(t) = A\sin(\omega t + \phi)$

14.4 **Torsion Pendulum**

$$\sum \tau = I\alpha \qquad -K\theta = I\frac{d^2\theta}{dt^2} \qquad \frac{d^2\theta}{dt^2} + \frac{K}{I}\theta = 0$$

solution: $\theta(t) = \Theta_0 \cos(\omega t + \phi)$

15.3 **Mathematical Description of a Wave**

$$y(x,t) = A\cos\left[2\pi\left(\left(\frac{x}{\lambda}\right) - \frac{t}{T}\right)\right] = A\sin(kx - \omega t)$$

Left → Right.

Graphing of a wave function

Speed of a wave function $\Rightarrow$ $dx/dt = \frac{\omega}{k} = \underbrace{f\lambda}_{\text{Eq. 15.1}}$

**Wave Equation**

Eq. 15.12 $$\frac{\partial^2 y(x,t)}{\partial x^2} = \frac{1}{v^2}\frac{\partial^2 y(x,t)}{\partial t^2} \qquad v = \frac{\omega}{k}$$

Solution: $y(x,t) = A\cos(Kx - \omega t)$

15.6 **Wave Interference, Boundary Conditions, and Superposition**

15.7 **Standing Waves on a String**

15.8 **Normal Modes of a String**

"fixed" at both ends $\Rightarrow$ $\lambda_n = \frac{2L}{n}$

$y_n(x,t) = A_{sw}(\sin k_n x)(\sin \omega_n t)$ Eq. 15.34

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## Background

Maxwell velocity (energy) distribution

18.5 Molecular Speeds: $f(v) = 4\pi \left(\dfrac{m}{2\pi kT}\right)^{3/2} v^2 e^{-mv^2/kT2}$ (18.32)

pdf

$v_{mp}$ = most probable velocity $= \sqrt{\dfrac{2kT}{m}} \Rightarrow \dfrac{\partial f}{\partial v} = 0 \quad v_{max} = ?$

$v_{Av}$ = average velocity $= \sqrt{\dfrac{8kT}{\pi m}} \Rightarrow \bar{v} = \int_0^\infty v\, f(v)dv = ?$

$v_{rms}$ = root-mean-square $= \sqrt{\dfrac{3kT}{m}} \Rightarrow \overline{v^2} = \int_0^\infty v^2 f(v)dv =$

$= \sqrt{\overline{v^2}}$

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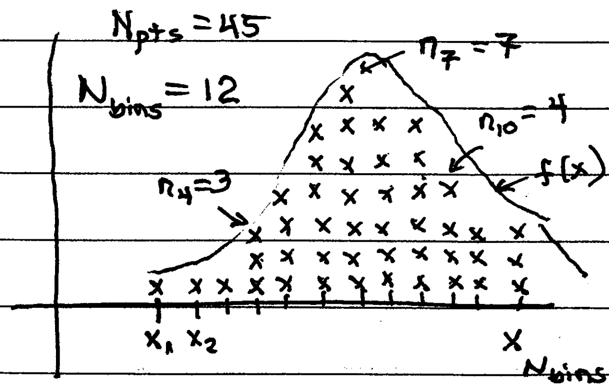
Probability Density Function




$$\bar{x} \equiv \frac{\sum x_i}{N} = \frac{\sum_{i=1}^{N_{pts}} x_i}{N_{pts}}$$

$$\bar{x} \equiv \frac{\sum_{i=1}^{N_{bins}} n_i x_i}{\sum_{i=1}^{N_{bins}} n_i} \quad \sum_{i=1}^{N_{bins}} n_i = N_{pts}$$

$$\bar{x} \equiv \frac{\int_0^\infty f(x)\, x\, dx}{\int_0^\infty f(x)\, dx}$$

where $f(x)dx$ = probability if $f(x)$ is normalized

$f(v) = \dfrac{\text{probabity}}{\text{velocity}}$ $f(v)\,dv$ = probability of finding a molecule with velocity between $v \rightarrow v + dv$

$$\int_{-\infty}^{\infty} \underbrace{\psi^* \psi}_{\text{normalized pdf}}\, dx = 1 \qquad \bar{x} = \int_{-\infty}^{\infty} x\, \psi^* \psi\, dx$$

$$\overline{x^2} = \int_{-\infty}^{\infty} x^2 \psi^* \psi\, dx$$