PHY132S - Class 2 - January 7, 2009

Sinusoidal Waves

$$f_{source} = f_{wave}$$

Snapshot:

$$D(x, \text{fixed } t)$$

In general

$$= A \sin\left(2\pi \frac{x}{\lambda} + \phi_0\right)$$

$\phi_0 \equiv$ "phase angle"

Fig 20.11 (b)

$$D(x,t) = A \cos\left(2\pi \frac{x}{\lambda}\right)$$

$$= A \sin\left(2\pi \frac{x}{\lambda} + \frac{\pi}{2}\right)$$

History In general

$$D(\text{fixed } x, t) = A \sin\left(2\pi \frac{t}{T} + \phi_0\right)$$

$$= A \sin(\omega t + \phi_0)$$

$$\omega = 2\pi f = 2\pi / T$$

$$[(\text{rads})/s = s^{-1}]$$

$$D(x, \text{fixed } t) = A \sin(2\pi \frac{x}{\lambda} + \phi_0)$$

$$= A \sin(kx + \phi_0)$$

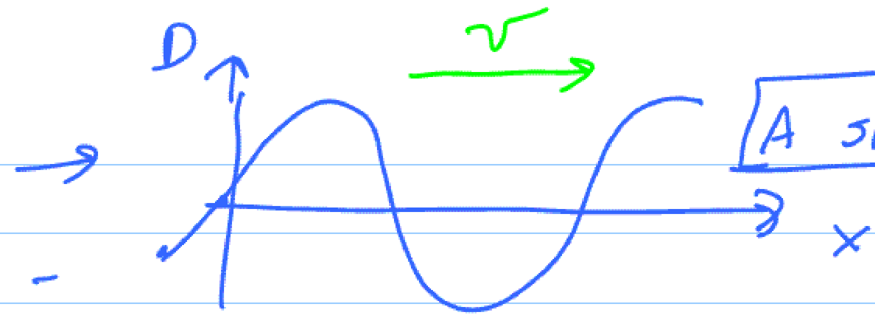
$k = \frac{2\pi}{\lambda}$ wave number

$$[(\text{rads})/m = m^{-1}]$$

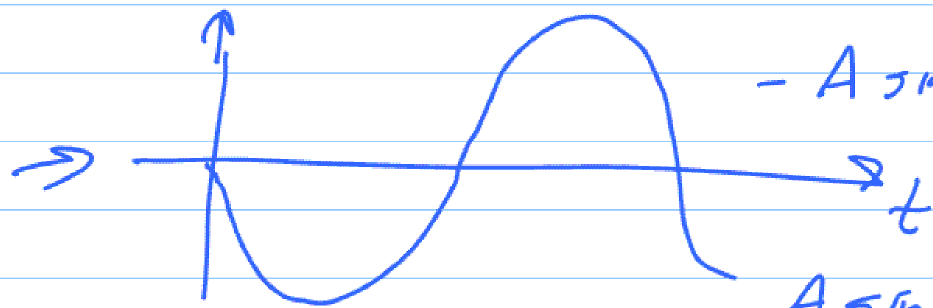
Combine History & Snapshot Descriptions

Text pg 610. nice way

Another way:



$A \sin(kx)$



$-A \sin(\omega t)$

$A \sin(-\omega t)$

$D(x,t) = A \sin(kx - \omega t)$ this case

In general: $A \sin(kx - \omega t + \phi_0)$

Wave travels to left:

$$A \sin(kx + \omega t + \phi_0)$$

Watch wave go by

Travels distance λ in a time T

$$d = v t$$

$$\rightarrow \boxed{\lambda = v T}$$

write in terms of k, f, ω

$$\boxed{v = \lambda f}$$

WAVE ON A STRING

Each particle SHM

$$y = A \sin(\omega t + \phi_0)$$

$$v_y = A\omega \cos(\omega t + \phi_0)$$

$$a_y = -A\omega^2 \sin(\omega t + \phi_0)$$

$$= \frac{1}{m} F_y$$

F_y: from tension of string T_s

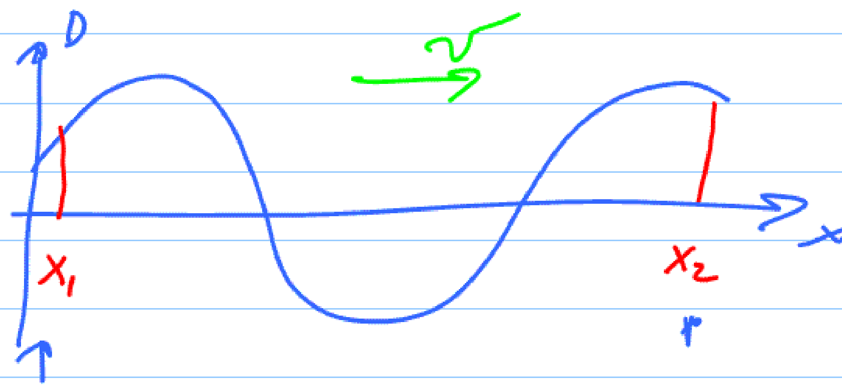
m: from mass/length = μ

Dynamics (pg 613) ⇒

wave speed $v = \sqrt{\frac{T_s}{\mu}}$

§20.4 - 2D & 3D WAVES

Phase difference for a wave



$\phi_1 = kx_1 - \omega t + \phi_0$ $\phi_2 = kx_2 - \omega t + \phi_0$

$$\Delta\phi = \phi_2 - \phi_1 = k(x_2 - x_1)$$
$$= 2\pi \frac{(x_2 - x_1)}{\lambda}$$

§20.5 - Sound & Light

$$\lambda = \frac{v}{f} = \frac{\text{property of medium}}{\text{property of source}}$$

λ can change

Light:

$c \equiv$ speed in vacuum
$= 3 \times 10^8$ m/s

$v =$ speed in some medium
$< c$

Index of refraction: $n \equiv \frac{c}{v} > 1$

§ 20.6 – Intensity, Power, ~~Decibels~~

dropped

Waves carry energy

Recall Power $P = \frac{E}{t}$

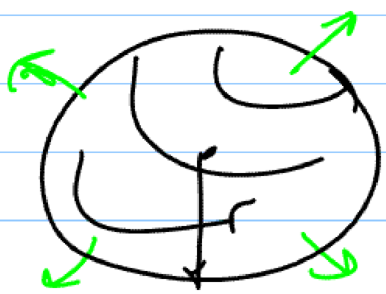
Wave energy spread out

Intensity $I = \frac{P}{a}$

$a \equiv$ area

No dissipative forces total energy conserved.

3D WAVE



Energy spread out over wave front

Total energy $I a$

$= I \, 4\pi r^2 = \text{const.}$

$I \propto \frac{1}{r^2}$

Recall: SHM: $E \propto A^2$

Sine wave: looks like SHM

$I \propto A^2$

§20.7 - Doppler Effect

$f_{wave} = f_{source}$:

only true for source stationary relative to the medium