PHYS 107 - Week 14 - Monday

* Waves: similar to simple harmonic motion but now moving in space, not just at one point

examples: water waves (vs. "single point going up/down")
waves on a string (vs. single point)
seismic waves
sound waves
nerve pulses
electromagnetic waves: light, X-rays, UV, IR
(no medium needed!)

Features: - energy is transported, but {medium} matter is not
- propagation of a disturbance

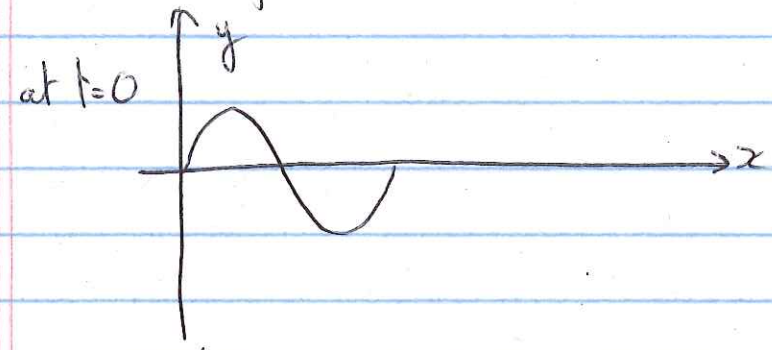
Types of waves: - transverse → string, electromagnetic
- longitudinal: motion is parallel to the direction of propagation
↳ sound waves, slinky

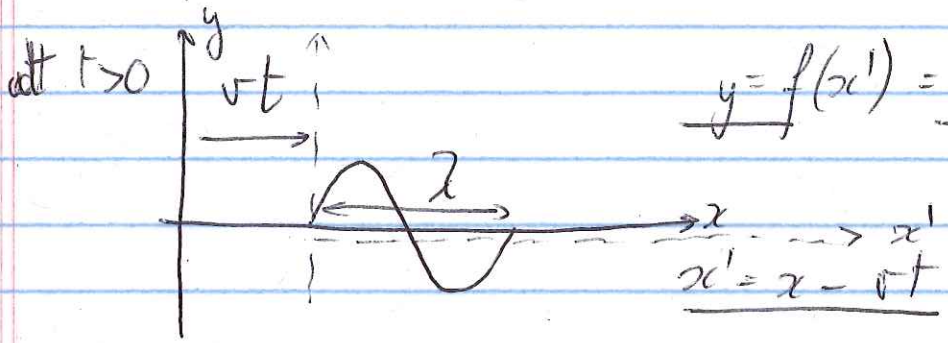
mixed waves too

Slinky

Phenomena of waves: interference, reflection

* Wave function



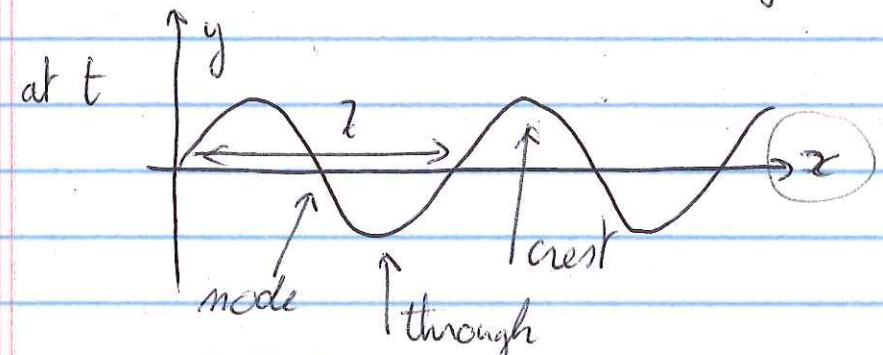


$y = f(x') = f(x - vt)$

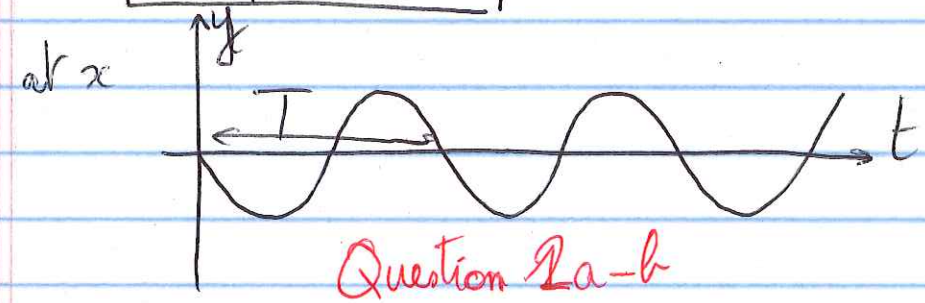
Waves have form $y = f(x - vt)$

Question 1a

* Periodic waves → wave length = λ



$$v = \frac{\lambda}{T} = \lambda f$$



Question 2a-b

If v = constant (depends on medium)

↳ large λ, small f
small λ, large f

WCWM: $f = 90.9\ MHz$, $v = c = 3\times10^{8}\ m/s$

↳ $\lambda = \frac{3\times10^{8}\ m/s}{90.9\times10^{6}\ Hz} = \underline{3.3\ m}$

microwave oven: $f = 2.45\ GHz$, $v = c$

↳ $\lambda = 12.5\ cm$ → rotation

v is determined by the medium properties

waves on a string → could depend on tension ($N = kg\ m/s^2$), mass of string, length ℓ

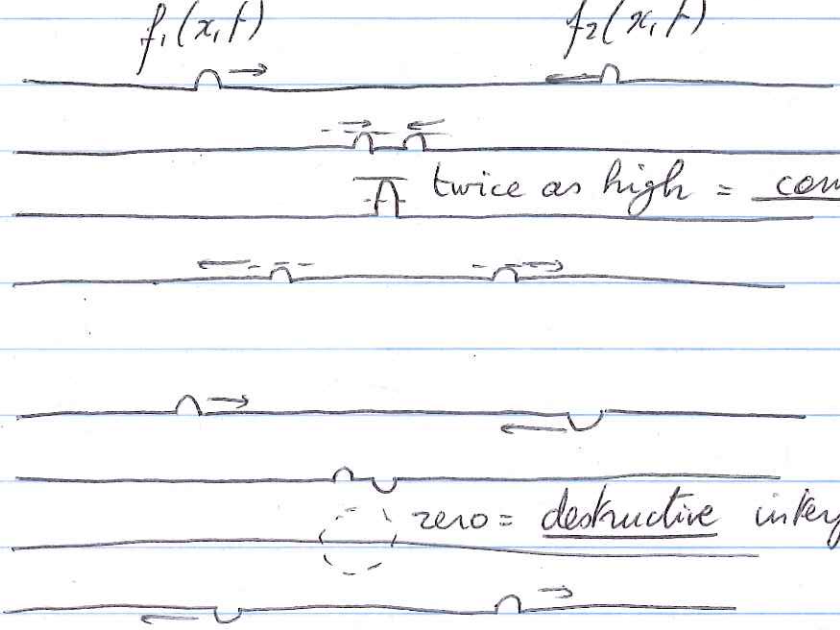
ℓ: kg, m: m

$v^2 = \frac{m^2}{s^2}$ → $v \propto \sqrt{\frac{\ell T}{m}}$ has correct units

↳ introduce $m/\ell = \mu$ as mass per unit length

$$v = \sqrt{\frac{T}{\mu}}$$

* Superposition of waves: $f(x,t) = f_1(x,t) + f_2(x,t)$



* Beats = interference of waves with slightly different frequencies

$y_1 = A\cos(2\pi f_1 t) \qquad y_2 = A\cos(2\pi f_2 t)$

$\hookrightarrow y = y_1 + y_2 = A\left(\cos(2\pi f_1 t) + \cos(2\pi f_2 t)\right)$

$= A\left(2\cos\frac{2\pi f_1 t - 2\pi f_2 t}{2}\cos\frac{2\pi f_1 t + 2\pi f_2 t}{2}\right)$

$= 2A\cos\pi\underbrace{(f_1 - f_2)}t\cos 2\pi\underbrace{\frac{f_1+f_2}{2}}t$

$f_B = |f_1 - f_2| \qquad f_{avg} = \frac{f_1+f_2}{2}$

$y = \underbrace{2A\cos(\pi f_B t)}\cos 2\pi f_{avg} t$

$\hookrightarrow$ amplitude is modulated with frequency f_B