Definition

Wave

- > *Pattern of disturbances [1] which transport energy but does not transport matter[1]*
- a wave have pattern of disturbances as the particles are ocillating
- how to draw a wave moving in the right direction
    - parallel move the wave
    - draw parallel for the coincidence point
    - notice for crust they are at the point about to move
- For electromagnetic waves not particles but electric and magnetic fields vibrate

Amplitude, Wavelength, Frequency, Period

- > *Amplitude(A) is the maximum displacement from **equillibrium position** of the wave*
- > *Wavelength(λ) is the distance between two consecutive disturbances*
- > *Frequency(f) is the number of waves made in second[Hz] = [s^{-1}]*
- > *Period(T) is the time for a wave to made a complete ocillation*
- $T = \frac{1}{f} \iff f = \frac{1}{T}$

Doppler effect

- > *the **apparent** change[1] in frequency for the **observer**[1] if there is **relative motion** between observer and source[1]*
- $f_o = \frac{f_S v}{v \pm v_S}$
- the wavelength get smaller && frequency get bigger for source moving toward observer
- the wavelength get bigger && frequency get smaller for source moving away from observer

Longitudinal/Transverse wave

- Longitudinal

    - > *Longitudinal wave are the wave that the particles of the wave vibrate along the direction of propagation of the wave*
    - compression(the closest part of particles)/rerafraction(between compression)
    - $\lambda =$ distance between two consecutive compression
    - $A =$ half distance ocillate by the point at compression
    - $T =$ time taken for the particles to vibrate one ocillation
    - example: P wave, slinky spring, sound wave
- Transverse
    - > *Transverse wave are the wave that the particles of the wave vibrate perpendicular to the direction of propagation of the wave*
    - direction of propgation of wave is the direction where the energy is transfer
    - wave front(birds eye view of wave) and the direction of propagation are always perpendicular
    - Example: electromagenetic wave, S wave, ocean wave

Intensity

- > *Intensity is the energy per time per area*
- $I = \frac{\frac{E}{t}}{A} = \frac{E}{At} = \frac{P}{A}$
- Factor affecting Intensity
    - For 3D situation, $I = \frac{P}{4\pi R^2} \Rightarrow I \propto \frac{1}{r^2}$
    - $I \propto A^2 \Rightarrow I = kA^2$

Standing Wave

- > *Standing Wave is the result of superposition of a progressive wave and its relection travelling in opposite direction at certain frequency*
- nodes: the place where the particle of standing wave doesn't vibrate
- antinodes: the place where the particle of standing wave are vibrate at maximum distance
- frequency at which the standing waves are form is called harmonics
    - f_0 Fundamental harmonic/first harmonic
    - $2f_0$ second harmonic
    - etc.
- $\lambda = \frac{2L}{n}$(for fundamental frequency, the Length is half the wavelength)
- change in position for the wave is calculate by T and then deduce to shift up or down
- open end tube && closed end tube
    - open end: $L = \frac{1}{2}L$
    - close end: $L = \frac{1}{4}L$, end correction(c) may be found by changing the length of the tube

Concept

Wave Equation

- $v = \lambda f$
- Derivation:
    - $v = \frac{s}{t} = \frac{\lambda}{T} = \lambda\frac{1}{T} = \lambda f$

Phase difference

- Phase differnce is an angle/relationship
    - simple harmonic motion can be related to a wave if extended in time, and then the phase difference can be related from points between waves
    - thus we would obtain $\phi = \frac{\pi}{2} rad = 90^o = \frac{\lambda}{n} m$
- Progressive Wave
    - In phase: $\phi = 2k\pi = k\lambda (k \in N)$
    - Anti phase: $\phi = (2k+1)pi = \frac{2k+1}{2}\lambda (k \in N)$
    - $\phi = \frac{2\pi}{T} t$ where t = difference between two points
- Standing wave
    - two consecutive point:0
    - between opposite point:π
    - between diagnoal point:π

Principal of Superposition

- > *when two or more wave comes together, the displacement of corespond wave is the **Algebraic Sum** for the displacement of the waves*
- > *Interference is the superposistiuon of two coherent sources(pitcture doesn't change)*
- > *Coherent source are the source that the phase difference between waves in time are constant*
    - Constructive Superposisiton: $\Delta d = n\lambda (n \in N)$ (maxima)
    - Destructive Superposistion: $\Delta d = \frac{n+1}{2}\lambda (n \in N)$ (minima - they are between two maxima)
- Δd are the path difference, which is the difference in wavelength between two waves

Double slit experiment

- one light source to a monochromatic filter with single slit follow by a double slit and a screen

- $\lambda = \frac{ax}{D}$ where a is the slit seperation, x is the fringe seperation, D is the distance between double slit and light screen
- Derivation:
    - Path difference between the waves from two slit to 1^o maxima is λ
    - It would then obtain$sin\theta_1 = \frac{\lambda}{a}$
    - Obtain another triangle between distance from cetnre between slits to 0^o maxima and to 1^o maxima (isolecese if $D \ggg big$)
    - $\theta_1 \simeq \theta_2$ as both are small
    - therefore $\sin\theta_1 \simeq \tan\theta_2 \Rightarrow \frac{\lambda}{a} = \frac{x}{D} \Rightarrow \lambda = \frac{ax}{D}$
- This is the only ways to calculate the wavelength of light
- Diffracting grating:
    - $d\sin\theta = n\lambda (n \in N)$, derivation comes from the double slit experiment if change the λ to different maxima and a to d(grating spacing)
- Changes to the effect with different effect:
    - close one slit - no pattern of diffraction and dimmer
    - narrw the slit - dimmer but pattern still there
    - different light source is used - fringe sepreation change because λ change

Experiment Demonstratge

- Diffraction of a wave
    - light, water tank with screen and ocillator
- Standing wave
    - ocillrater, string, generator
- Wave length of Light wave:
    - Young's double slit
- Wavelength of sound wave:
    - Kant's dust tube