Topic: 4. Oscillations and Waves

Formulae

- $T = \frac{1}{f}$
- $E_K + E_p = CONST$ (N.D.B.)
- $c = f\lambda$, wave speed
- $I = \frac{P}{A}$, intensity (N.D.B), A = area P = power
- $I \propto \frac{1}{x^2}$, x = distance from source
- For spherical waves, $I = \frac{Power}{4\pi r^2} = I = \left(\frac{P}{4\pi}\right)\frac{1}{r^2}$ (N.D.B.)
- $I \propto A^2$ A = amplitude
- $\theta_{incident} = \theta_{reflection}$ (N.D.B.)
- $I = I_0 \cos^2\theta$ (Polarization, Malus' Law) (For Analyzer usually)
- $I \propto E^2$, E = electric field (Polarization)
- $I \propto E_0^2 \cos\theta^2$ N.D.B.

θ = Angle between transmission axis of polarizer or analyzer, and direction of electric field. Can be angle between polarizer and analyzer.

$\frac{n_1}{n_2} = \frac{\sin\theta_2}{\sin\theta_1} = \frac{v_2}{v_1}$

$S = \frac{\lambda D}{d}$ (Fringe spacing) in 2 slit diff. — D = distance maxima; d = dis. between slits

S = Length between max & center max. d = distance between slits

$\theta = \frac{\lambda}{b}$ (rad) First minima in single slit diffraction — b = slit width

$\theta_i = \theta_{reflection}$

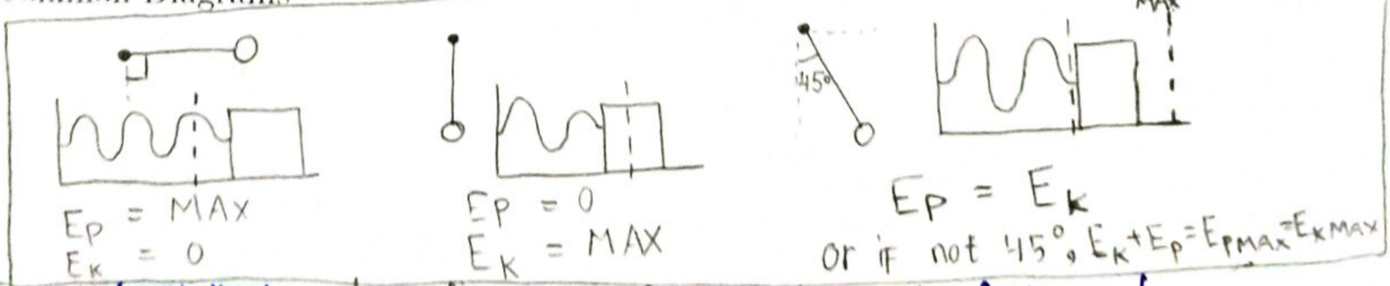
$\frac{n_1}{n_2} = \frac{1}{\sin c}$ (NDB All)

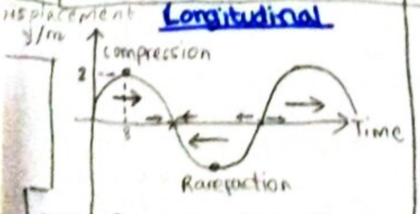
Path difference $= n\lambda$, $= (n + \frac{1}{2})\lambda$ — Explained in common Diagrams Ch 4. Check

Required Definitions

1) Isochronous oscillations - oscillations that repeat in the same time period, regardless of amplitude changes.
2) Period (T) - time duration of one oscillation. (sec)
3) Frequency (f) - number of oscillations per unit time. (Hz)
4) Amplitude - refers to maximum displacement. (m)
5) Phase difference - the fraction of the wave cycle that has elapsed relative to the origin. (rad)
6) Restoring Force - any force oppositely proportional to a displacement.
7) Transverse Wave - waves with direction of oscillation perpendicular to direction of energy propagation.
8) Longitudinal Wave - waves with direction of oscillation parallel to direction of energy propogation.
9) Wavefront - wavefront is a surface that travels with a wave, and is perpendicular to its direction of travel, or energy propagation.
10) Ray - Rays are lines showing the direction of energy propagation, and are perpendicular to wavefronts.
11) Superposition - ~~refers to~~ means that when 2 or more waves superimpose, the sum of their individual amplitudes becomes the amplitude of the resultant wave. They is constructive & destructive interference.
12) Polarization - polarization restricts the direction of oscillation of electric field of a wave to a plane perpendicular to the direction of propagation.
13) Refractive index - ratio of speed of light in vacuum c to speed in medium v_m.
14) Coherent waves - in-phase & same frequency.
15) Standing waves - when coherent travelling waves superimpose, they form standing waves in which energy may not be transferred.

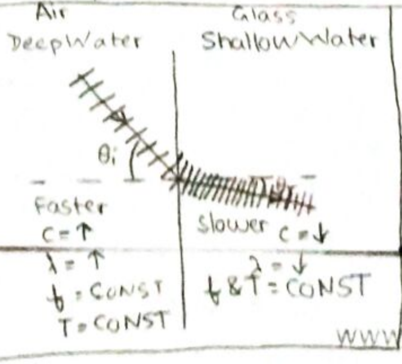
Common Diagrams

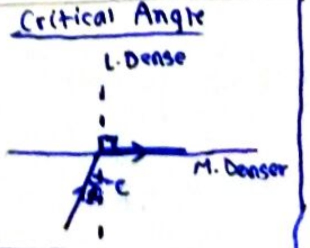


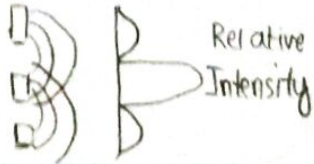


Just Remember this! Maybe, a MCQ.

So, the particle at compression moved 2 m to right →, from 8m to 10 m from origin. It is always to the →.







Topic 4 Oscillation and Waves

Common Graphs

Similar to F = -kx and kinematics graphs in Mechanics Notes.

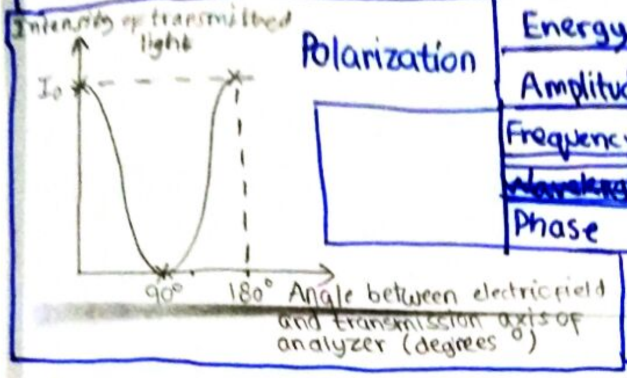
Hooke's Law

Gradient = k

Area under graph = Work done = $E_{p\,max} = E_{K\,max}$

$\frac{1}{2} F x_{max} = \frac{1}{2} k x_{max}^2 = \frac{1}{2} m v_{max}^2$

More other notes



Polarization

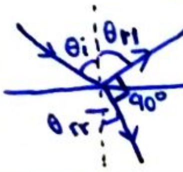
	Standing	Travelling
Energy	Not transferred	Transferred
Amplitude	Different for all points	Same all points
Frequency	SHM & same f	SHM & same f
~~Wavelength~~ Phase	Same for each point in a lobe. Adjacent ~~points~~ lobes shifted 180°.	Different, all points along 1 wavelength
Wave Pattern	Does not move	Moves

Experiment Summaries

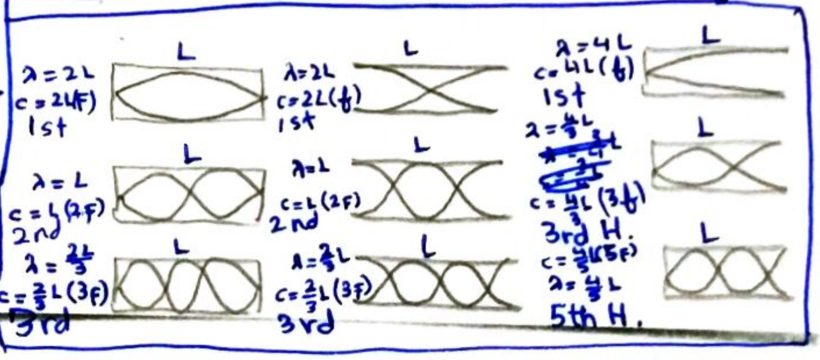
~~Similar to F~~

Brewster's Law (polarization) - If reflected & refracted ray are at 90°, the reflected ray will be totally plane polarized.

$\theta_{reflection} + \theta_{refraction} = 90°$, Brewster's angle



Check practical booklet



Antinode at fork
Node at air-water

Node = Loudest sounds

$y - x = \frac{1}{2}\lambda$

$\frac{4}{3}y - 4x = \frac{1}{2}\lambda$

Resonance (Loud) occurs at adjacent lengths of $\frac{\lambda}{2}$

Other Notes Learned From Past Papers

- Period and Amplitude are independent. (Spring or Pendulum) in terms of magnitude
- Conditions for SHM (2): Acceleration is proportional to displacement. The direction of acceleration is opposite the direction of displacement. (Restoring) and thus force.
- Electromagnetic spectrum: All transverse waves
- $c = 3.0 \times 10^8\ ms^{-1}$. Constant for entire electromagnetic spectrum.
- Sound waves cannot travel through vacuum. Light can. Electromagnetic spectrum can.
- In longitudinal waves, compressions are wavefronts. In transverse, crests are wavefronts.
- Refraction, Speed and λ change, f and period T no change.
- Polarization is only for transverse waves.
- Remember that ~~after~~ if I_0 is incident intensity of unpolarized light on a polarizer, then only $\frac{I_0}{2}$ is transmitted to analyzer. So, $I = \frac{I_0}{2}\cos^2\theta$, I = intensity after analyzer.
- θ in reflection or refraction diagrams is always against the normal, not plane.
- Understand path difference online.
- A HARMONIC is named by ratio of its frequency to that of first HARMONIC.
- Revise tuning fork. Pg 49 Revision Guide
- In $s = \frac{\lambda D}{d}$, remember $\frac{n\lambda D}{d}$ & $\frac{(n+\frac{1}{2})\lambda D}{d}$, where n shows which maxima order & minima order.