Wave Motion

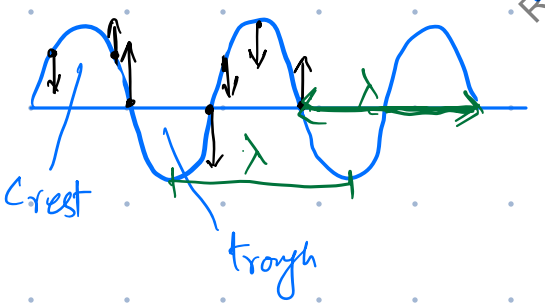
"A disturbance in a medium / space which transfers energy from one point to another"

* All waves transfer energy

Progressive Waves: Waves that transfer energy but do not transfer matter.

Transverse Waves: Oscillation of medium / particles is perpendicular to the direction of energy transfer

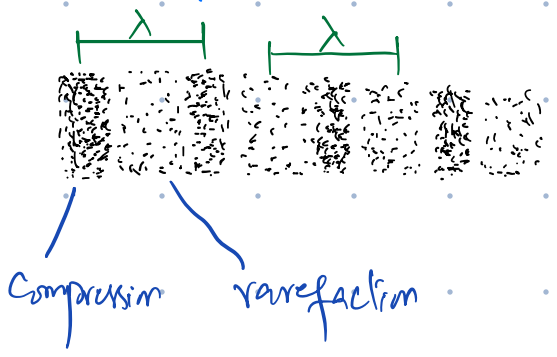
* Displacement varies



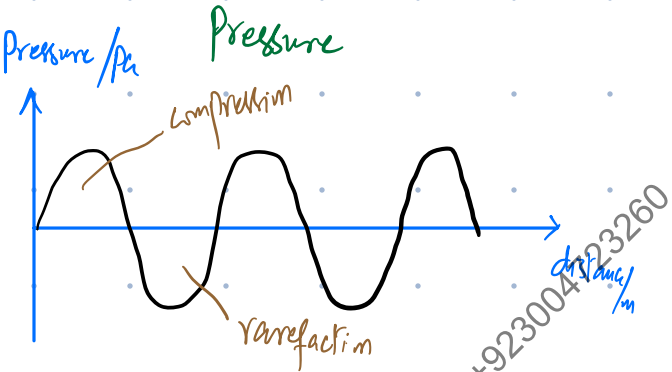
* black arrows indicate the direction in which particles move, it is important

Longitudinal Waves:

Oscillations of medium / particles is parallel to the direction of energy transfer



* Varying quantity is Pressure



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Amplitude: Maximum displacement of particles from rest position

Wavelength: Distance of one wave (one crest and one trough)

Frequency: Number of waves per second

- SI unit: Hertz (Hz)

Time Period: Time taken by one wave to pass through a point.

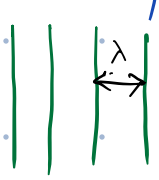
$$\text{frequency} = \frac{1}{\text{time period}}$$

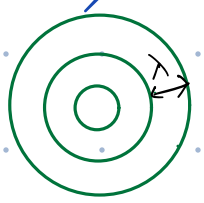
Phase Points

Points on a wave that are at same displacement from rest position and move in same direction.

* In phase points are one wavelength apart

Wave front: Line / curve formed by joining in-phase points (Top view of a wave)





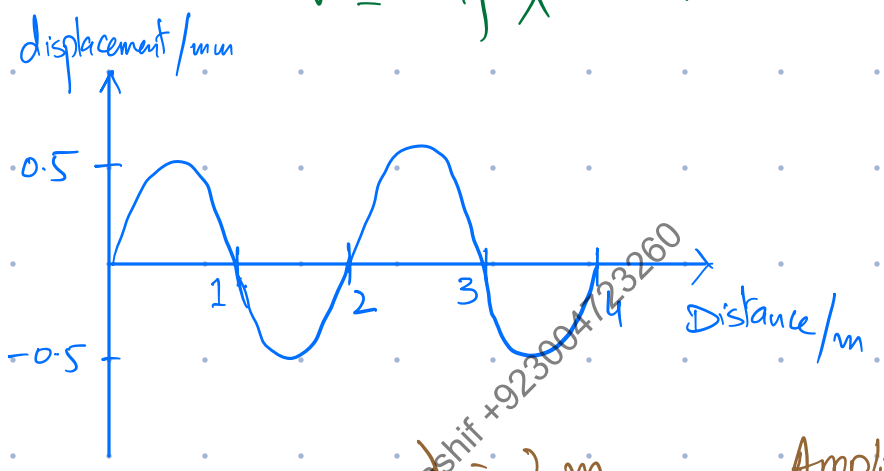
Circular wavefronts

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Wave Equation

Speed = frequency x wavelength

$$v = f\lambda \quad \text{or} \quad v = \frac{1}{T}\lambda$$



$\lambda = 2\ m$; Amplitude = 0.5 mm

Example: 5000 waves pass through a point in 10 sec, find wave speed. (Wavelength = 0.2 mm)

Sol:

$$\text{frequency} = \text{no. of waves per second} = \frac{5000}{10} = 500\ Hz$$

$$\lambda = 0.2 \times 10^{-3}\ m$$

$$v = f\lambda$$

$$= 5000 \times 0.2 \times 10^{-3}$$

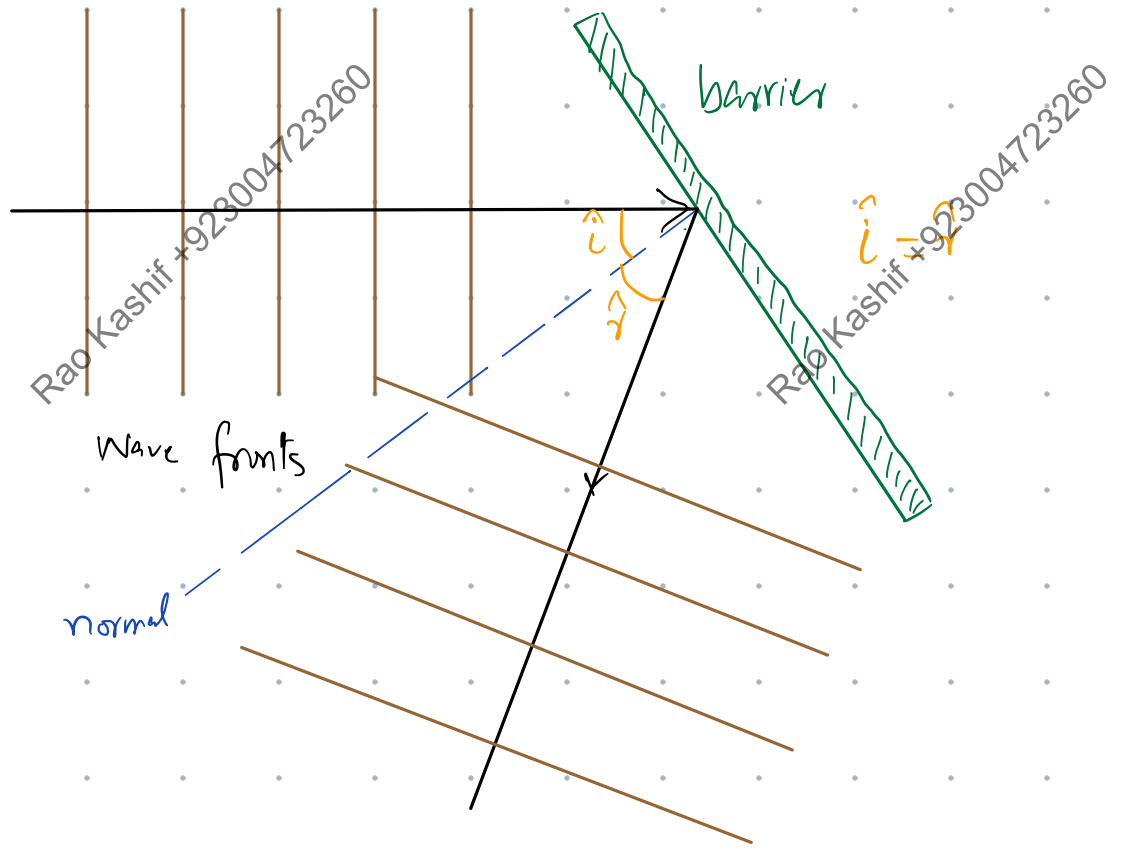
$$= 1\ ms^{-1}$$

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General Properties of Waves

Reflection: Wave fronts hitting a barrier bounce back: angle of incidence = angle of reflection

* Wavelength, frequency, speed remain same



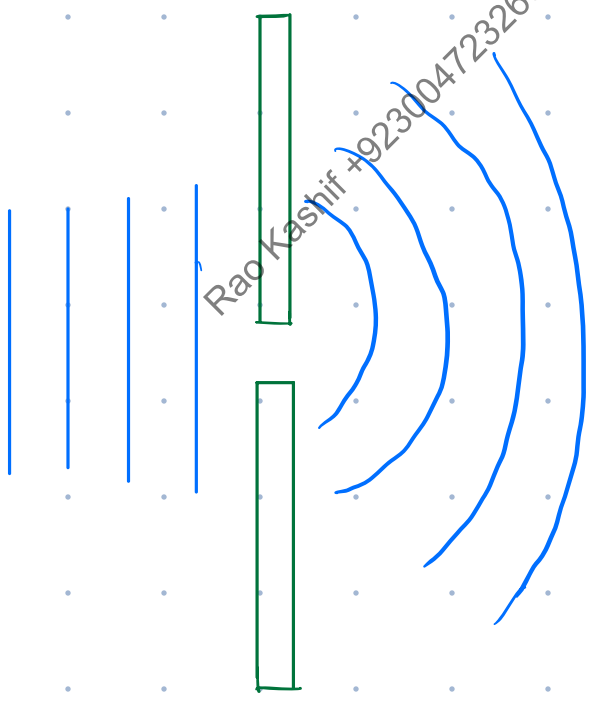
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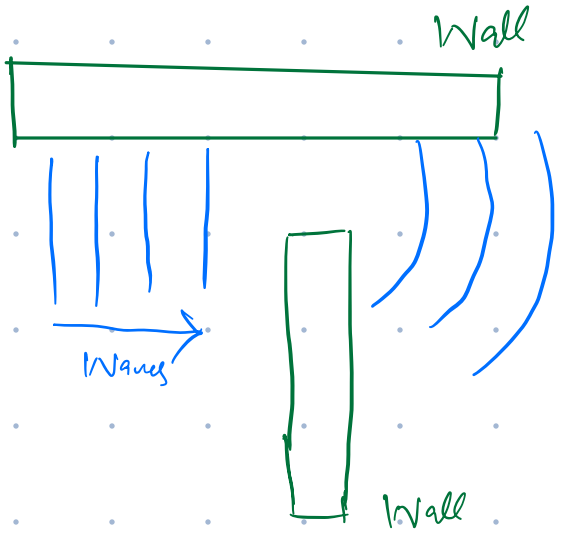
Diffraction

Waves passing through an edge / slit or opening Spread out

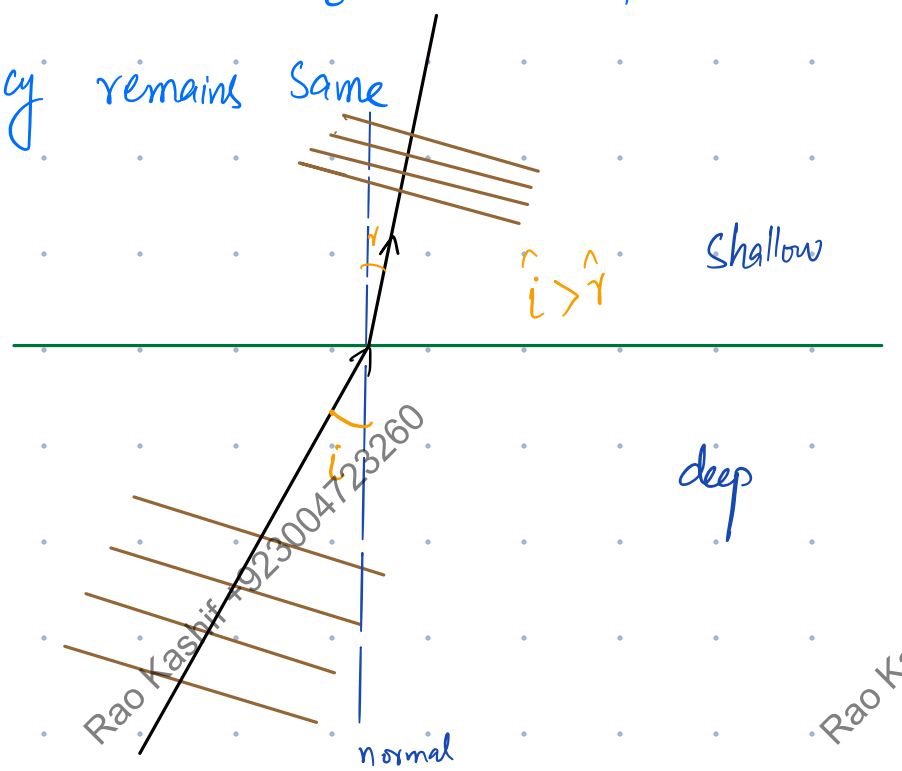
* Diffraction is maximum when slit gap is equal to wavelength.

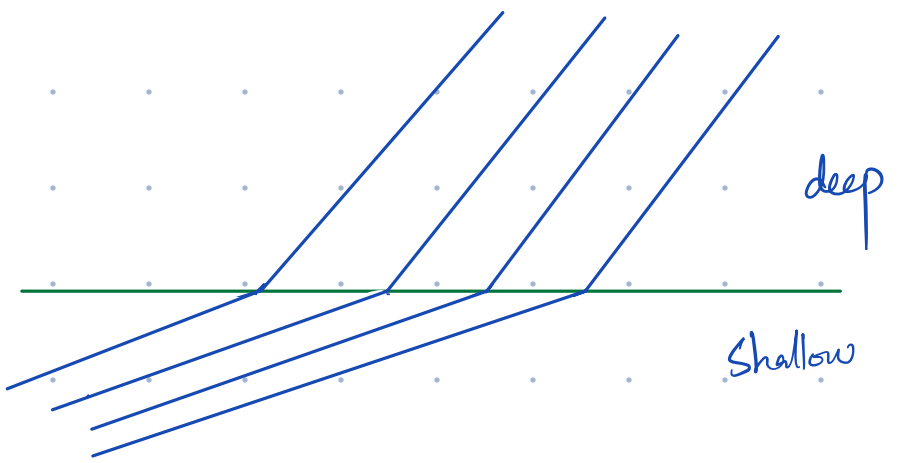


* Sound wave Spread out through doors / gaps but light waves don't, this is because Sound Waves have longer Wavelength.



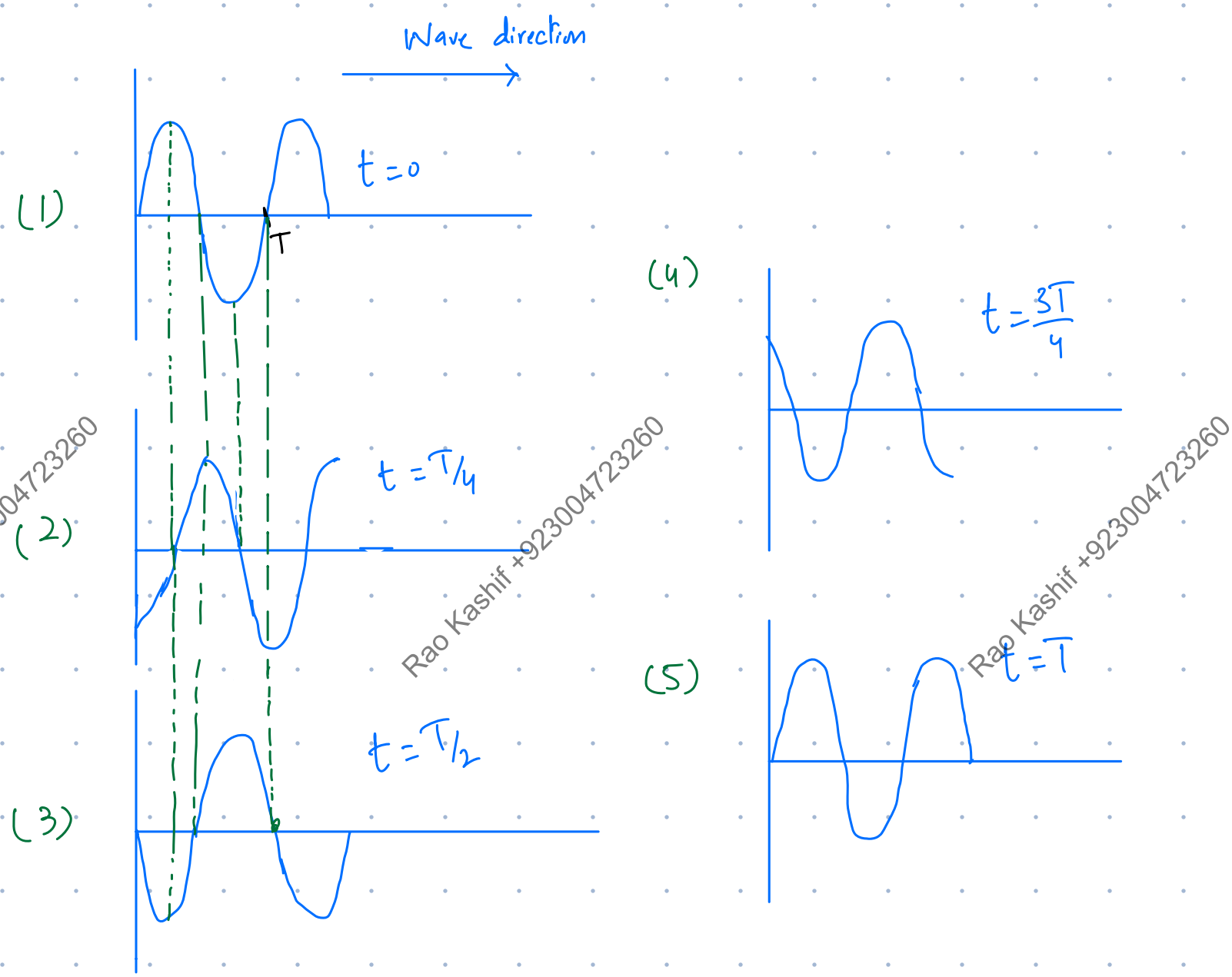
Refraction : Waves enter from deep to Shallow region, their wavelength and speed decreases, frequency remains Same





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(Wave Motion)



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Electromagnetic Spectrum

decreasing wavelength

G X U V I M R

gamma rays — X-rays — ultraviolet — visible light — infrared — micro waves — radiowaves

* Highest frequency rays are gamma rays (shortest wavelength)
* Lowest frequency rays are radiowaves (longest wavelength)

Properties of Electromagnetic Waves

- In vacuum, all EM waves travel at the speed of light ($3.0 \times 10^8 \, ms^{-1}$)
- Electromagnetic waves obey laws of reflection, refraction diffraction
- Electromagnetic Wave consists of fluctuations in electric and magnetic field in space, perpendicular to each other
- Electromagnetic Waves carry no charge

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Uses of Electromagnetic Waves

Infrared

- Our bodies detect infrared radiations
- it is emitted by hot object
- Used in thermal imaging cameras
- Used in finding victims of Earthquake
- remote control

Ultraviolet

- Cause Sun tan
- Produce Vitamins in Skin using Sunlight
- Too long exposure is harmful
- Used in fluorescent paints and detergents
- Used in security markings like invisible signatures
- Used in water treatment plants to kill bacteria

Long exposure can cause cancer and eye problems

Radio waves

- high wavelength waves used for aerial communication to spread signals over a vast area
- Astronomers use radio telescopes to pick radio signals from other stars and galaxies

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Micro Waves

- used for international communication via Satellite
- wireless applications such as bluetooth
- used for cooking as they cause water molecules in the food to vibrate vigorously

X-rays

- In medical, used to detect broken, dislocated bones
- High dose X-rays can be used to kill cancer cells
- Security machines at airports but they are very low dose X-rays
- In engineering, X-rays are used to inspect welded joints and detect cracks in metals

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Gamma rays

- These are more penetrating and dangerous than X-rays
- Used to diagnose and treat Cancer
- Used to detect cracks and flaws in metals

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