Course Code: PHS 231

Course Title: Optics and Wave

Number of Unit: 3 Units

Course Duration Per Week: 3 Hours

COURSE DETAILS:

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Office Location Room A307 COLNAS Main Building

COURSE REQUIREMENTS:

This is a compulsory course for all students in the Department of Physics. In view of this, students are expected to participate in all the course lectures and have minimum of 75% attendance to be able to write the final examination.

READING LIST:

Eugen Huccht, Adelphi University: Optics, fourth Edition Pearson Education Inc. Publishing as Addison Wesley 1301.

Robert Guenither – Mordern Optis John Wiley and Sons, Inc.

John Beynon, Introductory University Optics: First Published 1996 by Prentice Hall Europe.

COURSE CONTENT:

WAVES AND OPTICS (3 UNITS)

The harmonic oscillator, Aquatic waves, waves on a string. Superposition, energy in wave motion; progressive and standing waves; longitudinal and transverse waves; group and phase velocity. Doppler effect. Physical Optics; interference, diffraction, thin films, crystal diffraction, holography, dispersion and scattering. Geometrical optics; waves and rays; reflection and refraction at a spherical surface; thin lenses, optical lenses, mirror and prisms. Ultrasound.

LECTURE NOTES

OPTICS AND WAVES

OPTICS

Newton corpuscular theory- consider light as a stream of particles from the sun or candle

Newton considered that light can be transmitted via transparent material

This corpuscular theory explains why angle of incidence and reflection are sharp

HUYGEN'S WAVE THEORY

Huygen a contemporary of Isaac Newton took a different look of light and thought light as a wave and as a wave motion. Therefore behave like winkles of water. Therefore has ability to pass through one another. This wave motion of light explains reflection and refraction of light.

He also assumed that the path taken by wave causes sensation of vision

$$\Theta = \frac{2\pi x}{\lambda}$$

$$\gamma = A \sin \frac{2\pi x}{\lambda} \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (2)$$

$$\frac{2\pi x}{\Lambda} = k$$

$$\gamma = A \sin kx \quad \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots (3)$$

from equation (2) we can have

$\gamma = A \sin wt$

$\gamma = A \sin 2\pi t/T$

WAVE LENGTH OF LIGHT

Light waves - look at a ray

Reflection on at a plane mirror

1ST law of reflection

2nd law - The angle of incidence I, the angle of reflection r and the normal all lie on the same plane

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SPECULAR AND DIFFUSE REFLECTION

This type of reflection occurs on spherical or plane mirror. The energy of the incident ray is confined to one direction on reflection or after reflection. On the other hand, energy of incident ray which is confined to one direction may be reflected in an irregular or different direction after leaving the spherical surface of the mirror.

Deflection of incident ray from a spherical surface or a mirror depends on the particulate nature of the material. Again it should be noted in most cases, the incident ray penetrates into the material before being reflected or refracted and then emerges from that material if it is a transparent material.

Placing two mirrors perpendicular to each other

REFLECTION AT A SPHERICAL MIRROR

A spherical mirror is a section of imaginary square sphere of radius, R centre of curvature C. They are classified as either concave or convex depending on the surface that is metalized. The principal axis on the concave or convex mirror is the line that passes through the centre of curvature ‘c’.

PARADOXIAL OR GUASSIAN OPTICS

Paradoxial or Guassian optic is that that consider only rays that are inclined to less than 10^0 to the principal axis. The presence of wide angle rays generate caustic curve (like the surface of the coffea)

Rules for image formation

1. In a concave mirror all parallel ray passes through principal focus F (where F is the principal focus) distance of the focal length is equal to half of the centre of curvature. A convex mirror all reflected rays appears to emerge from the principal focus.
2. All rays move along the normal from the centre of curvature moves along the normal at the point of incidence
3. It is sometimes applied (IR law) i.e incident-reflection laws applied to the vertex

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ACTERING OBJECT DISTANCE-CONVEX MIRROR

LATERAL MAGNIFICATION

Image height vary with object position in other words mirror magnifies

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Lateral magnification (m) = image height
Object height where m> 1

An alternative to drawing of ray diagram for determination of image position is to use mathematical approach $1/s + 1/s^{-1} = 1/f$

S= object distance S^1 = Image distance f= focal length

SS^1 and f must be measured from the vertex position of mirror

N/B = (i) Distance measured to the left of the vertex is positive

(ii) Focal length is positive in concave mirror because it is measured to the right of the mirror

$DQMC = \frac{QM}{MC} = \frac{h}{(S-R)}$ ………………………….. (1)

$\Delta Q^I M^I C = \frac{Q^I M^I}{CM^I} = -h/R^- S$ (Radian) ……………… (2)

Using similar triangle

$-h^I/R^- S^I = -h/S - R$

$-h^I/h = R-S^I/S- R$ ………………………………… (3)

Considering VPF $= h/f$………………………………. (4)

$Q^1M^1F = -h/S^1.f$ ………………………………………….. (5)

$h/f = -h^1/s^1.f$

$-h/h = s^1-f/f$ ………………………………………… (6)

Equating equation (3) and (6)

$S^1-f/f = R-S^1/S-K$

$I/f = R- S1\ (s-k)\ (S1 - f)$

Straight line property of light

Reflection on a plane surface

Set of lines are drawn to coincide at 0 on a sheet of paper and with a flat surface of a semi circular block place on a sheet of paper (with the mid point coincide with 0). Light from a ray box of a low power laser is now directed along the line drawn in turns while noting the angle of incidence.

As you continue to increase the angle of incidence, you get to a stage where the emergent beam along the radius which is normal to the surface at the point of emergent. Except experimental error, it will show that

$\frac{\text{Sin A}}{\text{Sin B}}$ = Constant for all angles between 0 and 90^0

It can also be shown that refractive index lies only in the plane of incident i.e the plane containing the incident ray and normal at the point of incident.

Refractive index

Refractive index of a medium e.g glass is 1.00 which is slightly different from the speed of light in vacuum.

	Refractive index
Pure water	1.330
Tap water	1.338
Crown glass	1.500- 1.600
Flint glass	1.600- 1.640
Diamond	2.300

The refractive index of air 1.003 which is slightly different from vacuum.

Snell's law of refraction

Na sina =nb sin b

Where a and b is the angle that the ray make with the normal to the plane boundary separating the two medium A and B

Sin a = Real depth

Sin b = Apparent depth

(2) The incident ray, refracted ray and the normal at point of incident all lie on the same plane

Sin a = nb …………….…………… (1)

Sinb

Sin a = nb sin b …………..……..…. (2)

nb sin b= nc……………………….. (3)

sin c

nb sin b = ncsinc ………………… (4)

nd sin d= n e sine = nd sin d= esine

sin e

Put equation 4 in 2

Sin C = nc sin c ………………..….. (5)

Sin a = ne sin e put 7 in

Sin a = nd sin d……………..…… (6)

Sin a ne sin e

Sin a = Nm= na

M_1………………………. (1)

Sin b = Nm = nb

M_0……………….…….. (2)

Tan a= Nm ……………………. (1)

N_1

Tan b= Nm ……………………. (2)

N_0

Nm x N_0 = N_0 = Real depth = n

M_0 N_1N_1 Apparent depth

$$\frac{\sin a}{\sin b} = \frac{Nm}{m_1}$$

$$1/_s + 1/_s = 1/_f \frac{\sin a}{\sin b} = n^1$$

$$\sin a = n^1 \sin$$

Consider a wave particle S from a distance O

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Where θ is the phase difference

For a phase difference of 2π the path difference = x

$$\lambda/_x = 2\pi/_\lambda \cdots\cdots\cdots (3)$$

$\propto = {}^{2\pi x}/_{\lambda} \cdots\cdots\cdots (4)$

$w = {}^{2\pi}/_{t} \cdots\cdots\cdots (5)$

$T = {}^{\lambda}/_{v} \cdots\cdots\cdots (6)$

Put eqn in (5)

$w = 2\pi/\lambda N = 2\pi v/\lambda \cdots\cdots\cdots (7)$

Put eqn (7) and (4) into (2)

$y = A \cdots \sin\left(\frac{2\pi vt}{\lambda} - \frac{2\pi x}{\lambda}\right)$

$\therefore A \ \sin {}^{2\pi}/_{\lambda} (vt - x) \cdots\cdots\cdots (8)$

Velocity $= dy/dt = \frac{2\pi v}{\lambda} - A\cos\frac{2\pi}{\lambda}(2vt - x) \cdots\cdots\cdots 9$

$Acceleration = \frac{d^2y}{dt^2} = \frac{-4\pi^2v^2}{\lambda^2} A\sin\frac{2\pi}{\lambda}(vt - 2) \cdots\cdots\cdots 10 =$

$$Acceleration = \frac{d^2y}{dt^2} = \frac{4\pi^2v^2}{\lambda^2} A\sin\frac{2\pi}{\lambda}(vt - x) \cdots\cdots\cdots 10$$

$$from\ eqn\ 9 = \frac{d^2y}{dt^2} = \frac{-2\pi}{\lambda} A\cos\frac{2\pi}{\lambda}(vt - x) \cdots\cdots\cdots\cdots 11$$

$$\frac{d^2y}{dt^2} = \frac{-4\pi^2}{\lambda} A\sin\frac{2\pi}{\lambda}(vt - x) \cdots\cdots\cdots 12$$

$$dy/dt = V\ dy/dx \left(\frac{d^2y}{dt^2} - \frac{v^2d^2y}{dx^2}\right)\ Wave\ equation$$

PARTICLE VELOCITY

The eqn of S.H.M. is $Y = A\sin {}^{2\pi}/_{\lambda} (vt - 2)$

V= Velocity of the wave and y is the displacement of the wave

$U = {}^{dv}/_{dt} = {}^{2\pi v}/_{\lambda} \cos\ ^{2\cos 2\pi A}/_{\lambda}\, (vt - 2)$

Hence Max. Velocity U max=$\frac{2\pi VA}{\lambda}$

To find the particle acceleration, different w.s.t

$t \qquad \therefore F = \frac{d^2y}{dt^2} = \frac{-4\pi^2 v^2 A}{\lambda^2} A \sin\frac{2\pi}{\lambda}(vt - 2)$

$F = \frac{d^2y}{dt^2} = \frac{4\pi^2 A}{\lambda^2}$

When acceleration is max y = A

$F = \frac{d^2y}{dt^2} = \frac{4\pi^2 A}{\lambda}$

-ve sign indicates that acceleration is towards the centre

Particle velocity at any instance

$$= \ Wave\ Velocity \times Slope\ of\ displacement$$

Distribution of straight and pressure in a wave progressive for a plane progressive

$y = A \sin\ ^{2\pi}/_{\lambda}{}^{(vt-2)}$

$Particle\ Vel\ U = {}^{2\pi v}/_{\lambda}\ A \cos {}^{2\pi}/_{\lambda}\ (Vt - 2)$

$The \max strain = {}^{dy}/_{dx}\ when\ {}^{dy}/_{dx}\ = refraction$

$when\ {}^{-dy}/_{dx}\ = Compression$

The bulk module of elasticity of medium

$K = \frac{\Delta Pressure}{Volume} = \frac{-dp}{dy/dx}$

$\therefore dp = k - (dy/dx)$

$dp = k + [2\pi a/\lambda \cos(vt - 2)]$

TRANSVERSE STATIONARY WAVE

Two waves travelling in opposite direction when 2 waves A and B with the same amplitude, frequency and period travelling in opposite direction in a straight line, the resultant obtained is called a stationary wave

ENERGY OF A PLANE PROGRESSIVE

Total Energy E = K.E + P.E

$$^{1}/_{2}\, mv^2 + mgh$$

$$m = \varphi \times volume \rightarrow m = \varphi \times = \varphi$$

$$\therefore m = \varphi$$

h = dy g = f

$$P.E = \varphi f\ dy$$

$$P.E = \varphi f \int_o^y ydy$$

$$\varphi f(y^2)$$

$$P.E = \frac{\varphi 4\pi^2 V^2 ydy}{\lambda^2}$$

$$\frac{\varphi 4\pi^2 V^2 ydy}{\lambda^2} \int_o^y ydy/2$$

$$\frac{\gamma 4\pi^2 V^2}{\lambda^2}\left[\frac{y^2}{2}\right] = \frac{\gamma 2\pi^2 V^2 y^2}{\lambda^2}$$

$$K.E. = {}^{1}/_{2}\, mv^2$$

$$^{1}/_{2}\, \varphi v^2$$

$$^{1}/_{2}\, \varphi\left(A \cos {}^{2\pi}/_{\lambda}\,(vt - 2\right)$$

Total energy E = K.E + P.E

$$\frac{\varphi 4\pi^2 V^2}{\lambda^2} A^2 \sin^2(\mathrm{vt}-\mathrm{x}) + \frac{4\mathrm{x}^2\mathrm{v}^2}{\lambda^2} \cos\ ^2(vt-x)$$

$$\frac{2\pi^2 V^2 A^2}{\lambda^2} \sin^2(\mathrm{vt}-\mathrm{x}) + \cos\ ^2(vt-x)$$

Hence the P.E. and K.E. per unit volume are equal and each is equal to ½ total energy i.e.

$$1/_2\, E = \frac{\varphi\pi^2 V^2 \lambda^2}{\lambda^2}$$

DOPPLER EFFECT

SOURCE MOVES TOWARDS A STATIONARY OBSERVER

$V = n\lambda \qquad \lambda = {}^{v}/_{n}$

Apparent $\lambda^1 = \frac{v-a}{n}$

Apparent $n^1 = {}^{v}/_{\lambda^1}$

Apparent pitch $n^1 = \frac{V}{\frac{v-a}{n}} = \left(\frac{V}{v-a}\right) n$

If the source mores towards the observer with a velocity a in 1 sec, n waves then apparent $\lambda^1 = \frac{v-a}{n}$ and when the source moves towards the observer.

In one sec, the n wave will have a length of (v + a) apparent wavelength $\lambda^1 = \frac{v-a}{n}$

Apparent $n^1 = {}^{v}/_{\lambda^1} = \left(\frac{V}{v-a}\right) n$

In the above apparent pitch n^1decreases when the source mores away from the stationary observer

SOURCE AT REST, OBSERVER IN MOTION

Suppose a source S is producing a sound of pitch n and wavelengthλ. The vel of the sound is V, let the observer more with a vel towards a stationary wave, in this case the observer recovers more no of wave in a second, the apparent frequency n^1 remains the same.

$n^1 = \frac{v+b}{\lambda} \cdots\cdots\cdots (1)$ $\quad\quad V = n\lambda\lambda = {}^{v}/_{n}$

$\frac{v}{\lambda} + \frac{b}{\lambda}$

Put 2 into (1) we have

$$n^1 = \frac{v+b}{{}^{v}/_{n}} = \left(\frac{v+b}{v}\right)n$$

Therefore the interpretation means that the apparent pitch of a note increases when the observer moves forwards a stationary source.

When the observer moves away from the stationary source

Suppose a source is producing a sound of pitch n and wavelengthλ, and the velocity of sound is b. Let the observer moves with a vel b from a stationary source. In this case, the observer receives length wave in one see.

Therefore n apparent pitch

$n^1 = \frac{n+b}{\lambda}$ $\quad\quad \frac{v}{\lambda} - \frac{b}{\lambda}$

1/s + 1/s = 1/f $\frac{\sin a}{sinb} = n^1$

$$\sin a = n^1 \sin b$$

When $\theta = very\ small$

$$a = n^1 b \ldots (1)$$

$$a = \alpha + \gamma \ldots (2)$$

$$b = \beta + \gamma \ldots (3)$$

$$\alpha = \frac{h}{s}, B = \frac{h}{s^1}, = \frac{h}{r}$$

$$a = \frac{h}{s} + \frac{h}{r} \ldots (4)$$

$$b = \frac{h}{s} - \frac{h}{r} \ldots (5)$$

Put eqn 4 in 5

$$\frac{h}{s} + \frac{h}{r} = \left(\frac{h}{s} - \frac{h}{r}\right)^{n^1}$$

$$\frac{1}{S} + \frac{1}{R} = \left(\frac{1}{S} - \frac{1}{R}\right)^{n^1}$$

$$\frac{1}{s} + \frac{n^1}{s^1} = \left(\frac{n^1 - 1}{R}\right)$$

$$S \to \infty$$

$$\frac{n^1}{f^1} = \left(\frac{n^1 - 1}{R}\right)$$

$$\frac{1}{f} = \left(\frac{n^1 - 1}{R}\right)$$

f and f^1 are unqual

$$\frac{1}{s} + \frac{1}{s^1} = \frac{1}{f}$$

$$1/_S + 1/_S = 1/f$$

$$\frac{\sin a}{\sin b} = n^1$$

$$\sin a = n^1 \sin b$$

$When\ \theta = Very\ small$

$a = n^1 b \cdots\cdots\cdots (1)$

$a = \propto + \forall \cdots\cdots\cdots (2)$

$b = \beta + \forall \cdots\cdots\cdots (3)$

$\propto = h/s\, , \beta = h/s^1\, , \forall = h/R$

$a = h/s + h/R \cdots\cdots\cdots (4)$

$b = h/s - h/R \cdots\cdots\cdots (5)$

Put eqn 4 and 5

$$\frac{h}{s} + \frac{h}{R} = \left(\frac{h}{s} - \frac{h}{R}\right)^{n^1}$$

$1/s + 1/R = (1/s - 1/R)n^1$

$1/s + n^1/s^1 = (1/s - n^{1-1}/R)$

$S \to \infty$

$n^1/_{f^1} = (n^{1-1}/R)$

$1/_f \ = (n^{1-1}/R)$

$f\ and\ f^1 are\ inequal$

$1/_s + 1/_s = 1/f$

INTERFERENCE

Two beam Interference

Two rods attached to a bar Is allowed to vibrate in and out of water at constant frequency each rod will generate a soot of its own set of ripples.

The principle of superposition states that when the crest and the through of one ripple system. The resultant amplitude of the system (in dis case water) will be equal to sum of individual amplitude.

The sum of the individual amplitude can create either constructive or a destructive interference. Constructive or a destructive interference. Constructive interference occurs because the ripples of one system is in phase with the other system. Also when the ripples of two systems are in phase, it is constructive conversely a destructive occurs when two ripples of a system are not in phase. It also means when the crest of one phase meets with the through of the other.

When one or two system produces waves, it is the ripples that travel outward the nodes at end the antinodes stays in their fixed point just as stationary waves.

Condition for obtaining stationery and interference pattern

- The frequency of the wave must be constant
- These must be constant phase difference between the waves leaving the source.

Coherence sources: - An example is a sodium lamp Light waves from Sodium lamp is due to energy changes in sodium atom. The emitted wave occurs in burst lasting for about losses, light waves emitted by different atoms are out of phase and are said to be incoherent. When we place two Na waves i.e. Waves from two different Na lamps. If the two waves are out of phase there would be incoherent (A destructive one)

CONDITION FOR INTERFERENCE

Let us examine the fig above with the same amplitude of vibration and are in phase with each other. The combined effect i.e the resultant is due to the amplitude.

The resultant of the effect is being defined by the principle of superposition.

N/B

(1) The x is equidistant from A and B(the vibration x due to A and B are always in phase)

(2) The resultant at x is due to the algebraic addition of vibrations of A and B

(3) A and B are assumed to have the same wavelength.

Resultant at x is said to be constructive.

The conditions above are satisfied, means the two sources of light A and B

Which means we can now observe bright band point of light at x due to constructive interference? Consequently if Q is a point such that BQ is grater than AQ by the wavelength then the vibration at Q due to A is in phase due to vibration at B and permanent bright band is observed at Q.

Generally a permanent bright band is obtained at any point Y if BY- AY= $n\lambda$

Where n can be 0,1,2,3, e.t.c

Where λ is the wavelength of point source of light A and B at n = 0,1,2,3 e.t.c

Destruction Interference ---- Let us consider a new distance P from B whose path distance from i.e. The vibration at B due to A is 180 out of phase

Permanent dark light is obtained at P due to destructive interference

AB - BP= $n\lambda$

$$n = \frac{1}{2\lambda}, \frac{3\lambda}{2}$$

Permanent dark light would be seen at P

Summary:- If the path length difference of the two waves is zero or a whole number of the path length, a permanent dark light would be seen and conversely if the path length or difference in path length is odd number, a permanent dark light would be seen.

Young's two Slit Experiment

Young's Two Slit Experiment

Young in 1801 demonstrated an experiment on interference between two monochromatic light.

Conditions for interference

- Two coherent sources of light must be produced
- A
- The two sources of light must be close to each other.

Young placed a monochromatic light in front of a narrow slit S and arranged two additional very narrow A and B close to each other. Young then observed

He explained this by considering A and B , since the light diverging from A have the some frequently and always in phase with the one diverging from B. A and B are said to be two closed coherent source of light. Interference the takes place when the beam over lap with each other. Then OA =OB, therefore a bright bond of light.

On the other hand if OB – OA =$\frac{\lambda}{2}$ we have dark band of light.

DIFFRACTION OF LIGHT

In 1665, Grimaldi observed that the shadow cast by thin wire is much smaller than expected. Consider 2 points A and B on the same wave font A &B is also said to be 2 coherent secondary sources of light wave. You will expect the two to have an interference pattern on the screen, provided the slot is small compared to the wavelength of light. The geometrical pattern is long on the screen. Shows that they exist from a geometrical pattern of attractive dark and bright band after M&N.

Diffraction of single slit

Let us consider the distance image of object t produced on the screen by objective lenses of telescope which is due to diffraction. Suppose parallel phone wave front from distance object is diffracted from a rectangular slit AB (this is called Franhofer diffraction). Let light passing through AB arrive at the screen S: light source AB are said to have the same phase and are therefore coherent. Therefore the combined effect of light waves arriving at S is the algebraic sum of all the individual wave front arriving at S.

CENTRAL BRIGHT IMAGE

Let point O be centre of diffraction such that O will be zero (0^o) where O is normal to AB i.e all waves arriving at ACB has no path difference (ie they have all characteristics of coherent sources)

The light waves arriving at ACB has no path different is slightly shifted to the direction <θ, inclined to

Co, the waves shifted $\theta,$ reaches the screen at P. therefore the intensity of the waves is slightly decreased from that wave reaching O. it can be shownthat the path difference of tha wave from A to B in this case is $\frac{\lambda}{2}+\frac{\gamma}{2}$. In this case upper half $\frac{\gamma}{2}$ $(AC) and$ $\frac{\gamma}{2}$ (CB) the lower half.

$$\text{Tan}\,\theta = \frac{opp}{Adj} \qquad Sin\theta = \frac{\lambda}{d}$$

θ is very small therefore $\text{Tan}\,\theta = \text{Sin}\,\theta = \frac{\lambda}{d}$

WAVES OPTICS

Waves can be divided into 2 parts which are

(1) Mechanical wave

(2) Electromagnetic wave e.g. Radio wave, light waves, U.V waves. U.V travels through space at the speed at the speed of light.

Pulse of waves on x,y rays are transverse waves because they are perpendicular to the direction of travel

TRANSVERSE WAVES

Transverse waves: ripples of H_2O are example of travelling or progressive wave.

SUPERPOSITION PRINCIPLE

Superposition principle allows the displacement of distance between the overlap region to be determined. If the displacement has along the x axis , the displacement is +ve and –ve it is below the y axis .

The displacement of the pulse y= y1 + y2

The most common periodic motion is simple harmonic motion. An object that oscillate about the mean position in space, where x is constant can be represented by yt graph as shown above. The displacement y and time t are represented by the equation y = A Sin wt Such Oscillations are called sinusoidal because y and t are related through the same function from the figure point of O (min displacement) are called NODE while that of the maximum displacement are called ANTINODES.

The phase of the oscillation is called wt. We can analyze equation . Using the value of phase angle to determine the motion of object. The period between O and t,y and T2, 2T and 3T describes the repitation and characterized the oscillation generally by simple harmonic motion.

t	wt	point	Point on S.H.M
O	O	O	O
$\lambda/4$	$\lambda/2$	P	P
$\lambda/2$	π	O	O

3/4T	$3\pi/2$	R	R
T	2π	Q	Q

The coil jumping up and down in the SHM produces a surface wave. The vertical session produces a wave. The vertical session produces displacement Vs wave y.

The equation that actually describe the displacement of the ripple y= A Sin K_r Where k_r - wave nos)

If two waves y1 and y2 gravels the same speed in the same direction they will always be at the same distance. He phase difference between them will be constant. If the waves are generated at the same time, they will overlap and at the phase difference will be zero. If the wave is displaced from each other, overlapping will occur and the phase difference will be 2 π rad directly from P using this equation θ = Kb rad.

TRANSVERSE AND LONGITUDINAL WAVE

Transverse wave have their direction perpendicular to the direction of waves e.g ripples of H_2O, sound waves e.t.c. whole longitudinal waves are E.M waves and are used for propagation of energy.

Longitudinal wave occurs in air e.g. radio wave. The frequency of this wave depends on the oscillation they undergo per seconds.

Frequency in Hertz (H$\cancel{z}$) (1/T). In the case of ripples of H_2O is the number of crest crossing a particular point per minute.

WAVE FRONT

Ripples are usually wave front connect nos of crest together, Also any point connecting equal phase in a WAVE FRONT.

A point sources of light placed at the principal focus of a converging ions produces a parallel beam of light. Alternative explanation shows us that wave coming from point source are refracted by the lens parallel.

……………………………………..

$n^1 = V - b/\lambda$

Where $\lambda = \frac{v}{n}$ $we\ have$

$$n^1 = \frac{v-b}{v/n} = \frac{(v-b)n}{v}$$

Source and observer in motion

When the observer moves towards the source and the source move away from the observer.

Suppose the source is producing a pitch n of wavelength λ, and the vel of the source V. vel of d is @, velocity of the observer is b. let the source moves towards the observer with vel@ and the observer moves away from the source@

The apparent $\lambda^1 = \frac{v-a}{\lambda} \ldots (1)$

Apparent frequency $n^1 = \frac{v-b}{\lambda} \ldots. (2)$

Put 1 into 2

$$n^1 = \frac{v-b}{\frac{v-a}{n}} = \left(\frac{v-b}{v-a}\right) n \ldots (3)$$

Equation 3 is the general eqn of dipper effect some more towards the observer and observe mones away from the source

Special Cast

1 source mores toward observer and observer mores towards the source

$$n^1 = \left[\frac{v-(-b)}{v-a}\right] n$$

2 Source mores away from the observer and observer mores away from the sources

$$n^1 = \left[\frac{v-b}{v-(-a)}\right]n$$

NOTE

While serving numerical problems, the general relation, the case when source mores away from the observer and the observer mores away from the source. When any of the 2 rotating changes the sign of a and b must change

HOLOGRAPHY

Holography is lenseless photography in which an image is captured not as an image forever on film, but as interfere pattern at the film typically, coherent light from a later is reflected from an objects and combined at the film with light from a reference beam . This rewarded interference pattern actually contained much more information that a found image enables the near to new a time 3 dimensional image which exhibit parallel that is the image will change its appearance if you look at it from different angle first as if were looking at a real 3d object.