Topic: ____________ Date: ____________

Waves.

Progressive Wave.

* Waves which travel or move and as they move they travel from one point to Another point

Stationary Wave.

Part of As level.

Transverse

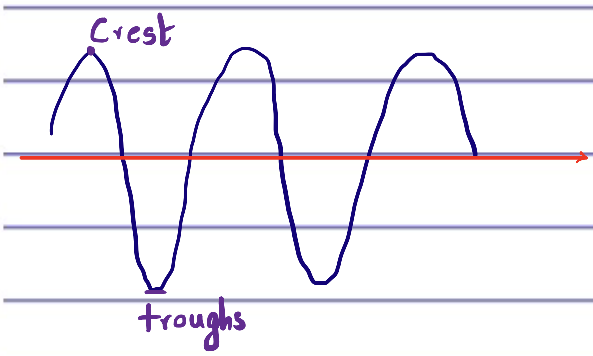
Direction of vibration is perpendicular to the direction in which waves travels

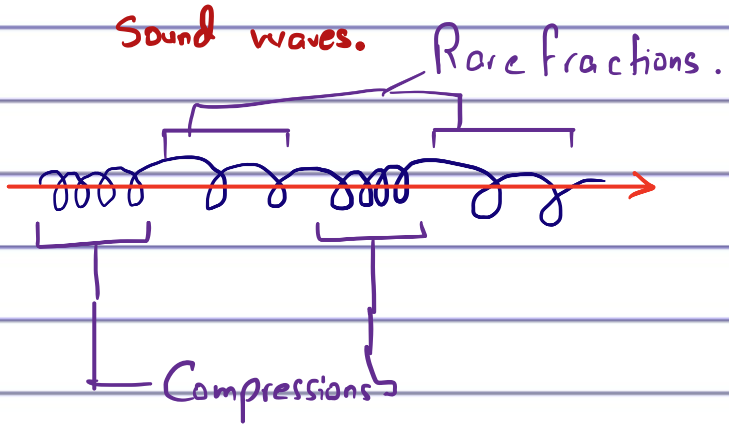
eg: Water waves, waves in ropes, Electromagnetic Waves.

Longitudinal.

Direction of vibration is parallel to the direction in which waves travel.

Eg Waves in spring, Sound waves.





Topic: ______ Date: ______

Properties of Waves.

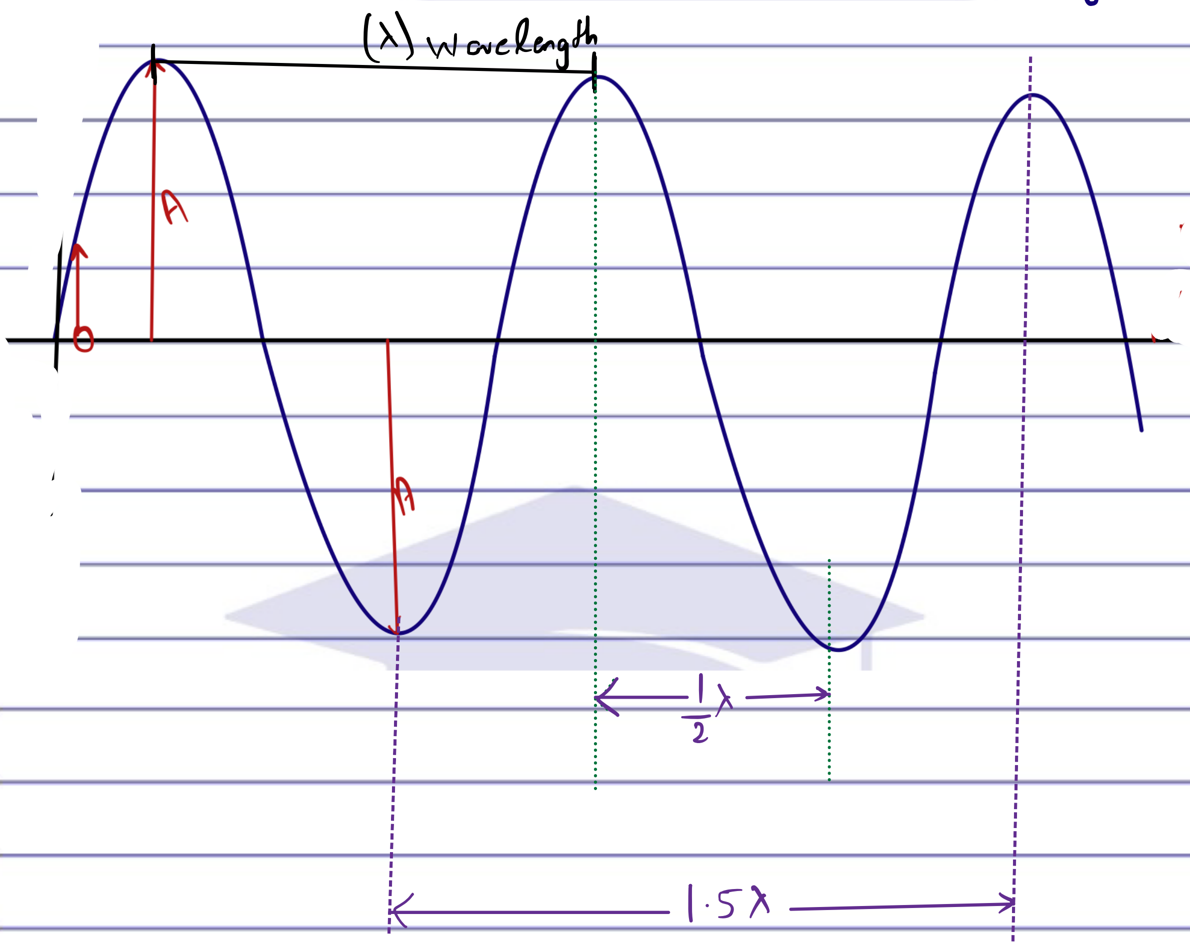
1. Reflection
2. Refraction
3. Diffraction

} O levels

4. Superposition
5. Interference.

} As level.

⇒ Path Difference : Refers to Distance b/w any two points on a wave measured in terms of wave length (λ)



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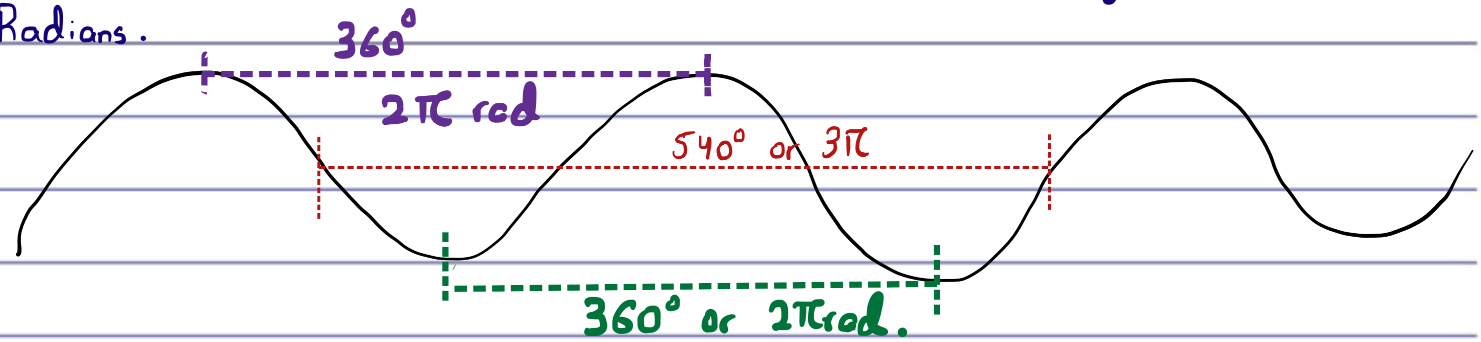
Topic: ____________ Date: ____________

* Phase means angle.

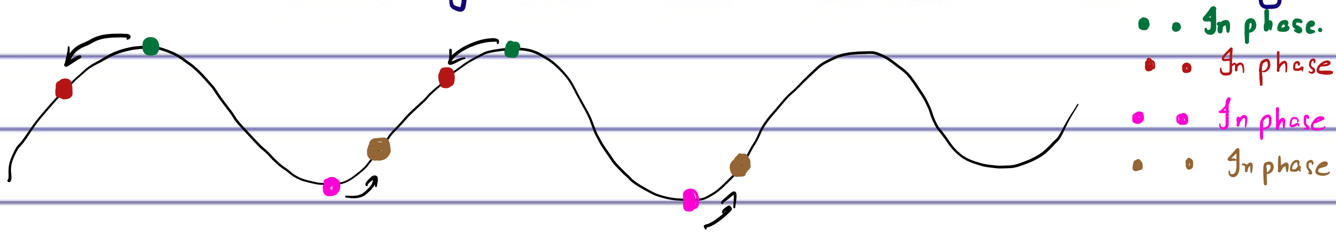
Phase Difference :: refers to distance b/w any two points on a wave measured either in terms of degrees or Radians.



* A path difference of 1 λ corresponds to a phase difference of 360° / 2π rad.

* **What are In Phase points:**— Two points if upon comparission exhibit identical / similar behavior then they are said to be in phase with each other.

→ Examples could be a crest if compared with another crest or a trough if compared with another trough.

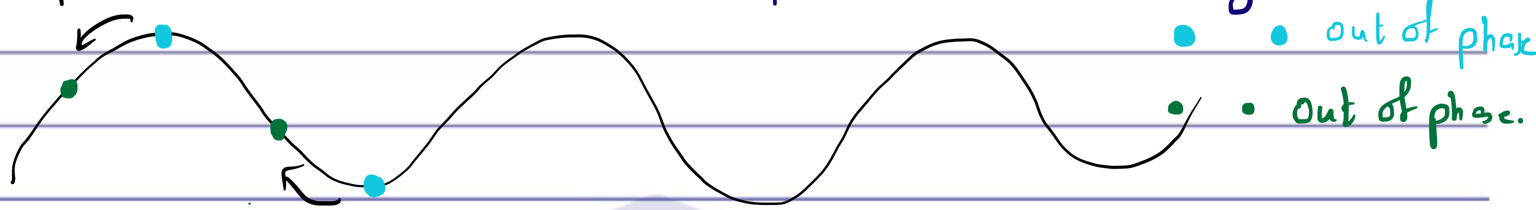


① For In phase points they must have a path difference of 1λ, 2λ, 3λ, 4λ, 5λ, ... and likewise they must have a corresponding phase difference of 2π, 4π, 6π, 8π, 10π.......

Topic: ______________ Date: ______________

What are out of phase points: Two points if upon comparision exhibits exactly opposite behaviour then they are said to be out of phase with each other.

Example: If a crest is compared with a trough.



* For out of phase point they must have a path difference of $\frac{1}{2}\lambda$, $\frac{3}{2}\lambda$, $5/2\,\lambda$, $7/2\,\lambda$, $\frac{9}{2}\lambda$ and they should have corresponding phase difference of $\pi, 3\pi, 5\pi, 7\pi, 9\pi$

Example Question

$v = 640\ m/s$

$f = 800\ Hz$

Q) Calculate the phase difference b/w 2 points on this wave which is separated by a distance of 0.4 m

Step 1

$v = f\lambda$

$\frac{640}{800} = \lambda$

$\lambda = 0.8\ m$

1 wavelength (0.8m) $\longrightarrow$ 2π or $360°$

0.4 $\longrightarrow$ x

$x = \pi$

* Out of phase.

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Topic: ____________________ Date: ____________________

① Super position:

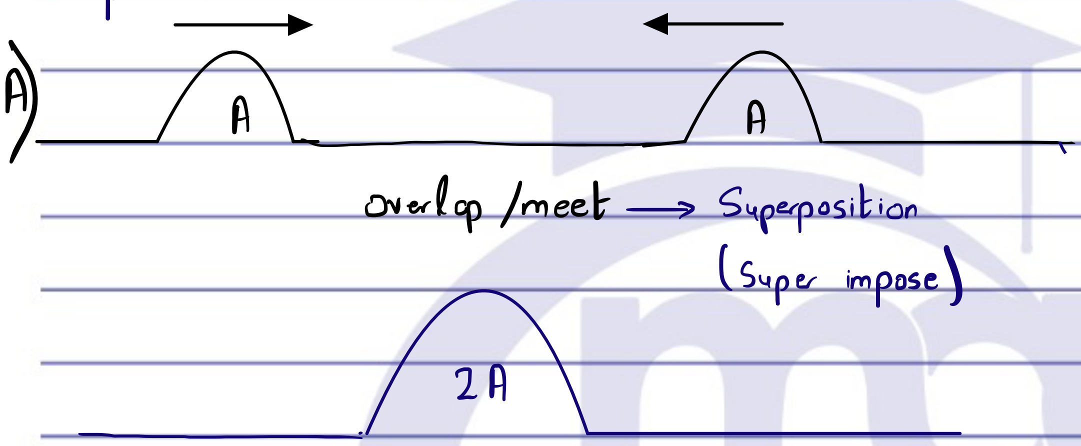
→ Super imposed

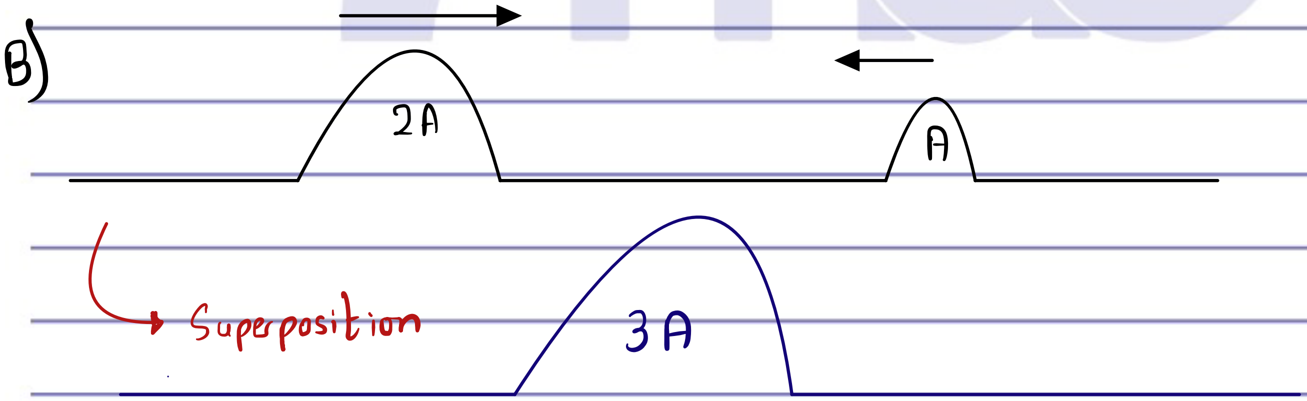
Do waves ka apas mayn meet karna. yan over lap karna.

Principle of Superposition:

According to the principle of superposition if two or more waves overlap/meet at a common point, then the total displacement due to these waves will be the sum of their individual displacements.

Two waves
- → meet
- → mapping on top of each other.
- → Over lap





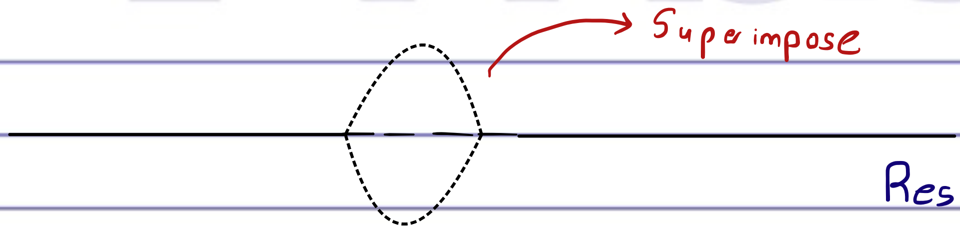
Topic: ______ Date: ______

* The phenomena of superposition gives rise to **Interference**
The above case can be classfied using a term
Constructive interference

* Constructive Interference occurs when Inphase points superimpose each other

For Constructive Interference to occur we can say that path difference $1\lambda, 2\lambda, 3\lambda, 4\lambda, 5\lambda, 6\lambda$ and phase difference will be $2\pi, 4\pi, 6\pi, 8\pi \cdots$

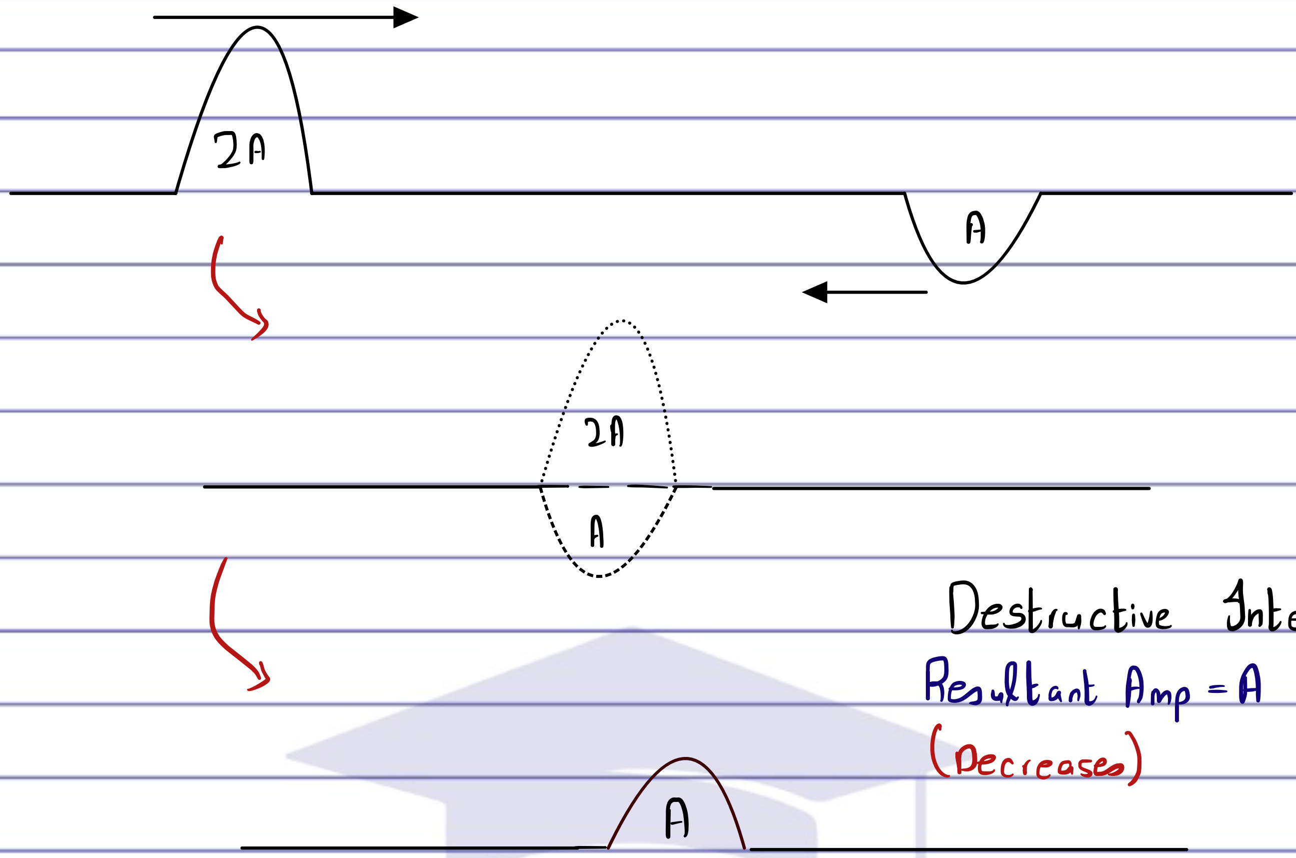
Destructive Interference : when out of phase points super-impose with each other.



Resultant Amplitude = 0

hence : Destructive Interference

Topic: ________ Date: ________



Destructive Interference

Resultant Amp = A

(Decreases)

Amplitude: Maximum displacement from mean position.

$2A + (-A)$

$= A$

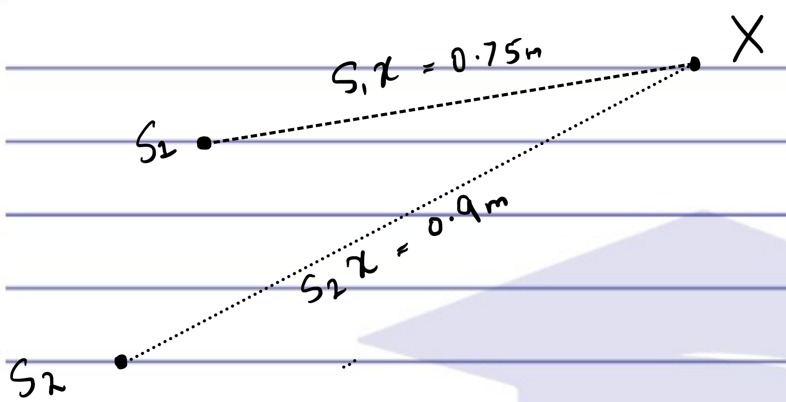
* For Destructive Interference to occur, out of phase points must superimpose each other.
* For destructive interference, the path difference corresponds to $\frac{1}{2}\lambda, \frac{3}{2}\lambda, \frac{5}{2}\lambda, \frac{7}{2}\lambda, \frac{9}{2}\lambda$ .... and phase difference corresponds to $\pi, 3\pi, 5\pi, 7\pi, 9\pi,$ ....

Topic: ______________ Date: ______________

Question 1:

Sources S_1 and S_2 microwaves (EMW) $v = 3\times10^8\ m/s$, $f = 12\ GHz$

Determine what type of Interference will occur when waves from S_1 and S_2 meet at a point x?



$S_1 - x = 0.75m$

$S_2 - x = 0.9m$.

Method no 1:

$v = f\lambda$

$\frac{3\times10^8}{12\times10^9} = \lambda$

$\lambda = 0.025m$

How many waves will be formed along the path S_1x

$\frac{0.75}{0.025} = 30$ waves. / 30λ ✓

How many waves will be formed along the path S_2x

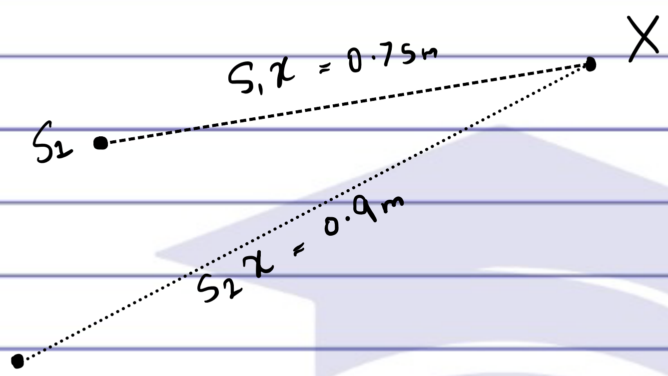
$\frac{0.9}{0.025} = 36$ waves / 36λ

Topic: ______ Date: ______

Path difference : $36\lambda - 30\lambda = 6\lambda$

They meet In phase at point x hence Constructive Interference.

2nd Method:



$v = f\lambda$

$v = 3\times10^8$

$f = 12\times10^9$

$\lambda = 0.025m$

Firstly you calculate the path difference b/w S_2x and S_1x

$0.9 - 0.75 \Rightarrow 0.15m.$

Then you find out how many waves can be formed in this path difference of 0.15m.

$$\frac{0.15}{0.025} \Rightarrow 6\lambda$$

They meet In phase at point x hence Constructive Interference.

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Topic: ______ Date: ______

Conditions Required for inteference to take place.

1. Waves must meet at a common point.
2. Waves must be of same type.
3. Waves must travel in same plane.
4. Waves must be Coherent. (The term coherent means that the path diff or phase diff. b/w the two waves must remain constant)

Q) What additional condition must be satisfied in waves were to interfere

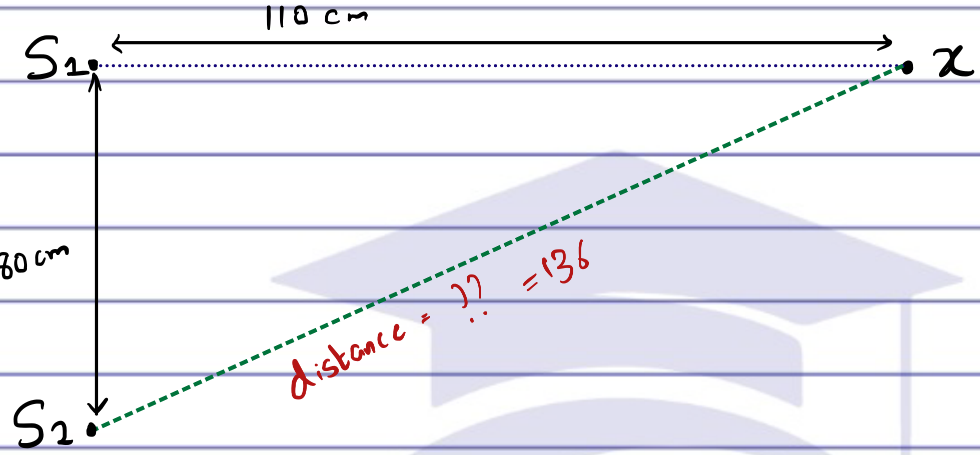
(a) Constructively (b) Destructively.

→ Constructive Interference: They must meet in phase with each other.

→ Destructive Interference: They must meet out of phase with each other.

Topic: ________ Date: ________

Example: Diagram shows sources S1 and S2. The waves produced meets at x. It is given that the frequency of Both sources. Simultaneously varied from 1000Hz until it reaches 4000 Hz. The speed of the wave is 340 m/s. Calculate on how many occasions you would expect the phenomenon of Destructive Interference to occur at point x



$v = f\lambda$

$340 = 1000\lambda$

$0.340 = \lambda$ or **34 cm**

$H^2 = P^2 + B^2$

$H = \sqrt{110^2 + 80^2}$

$H = 136$ cm

* For Distructive Interference to occur path difference must be

$\frac{1}{2}\lambda, \frac{3}{2}\lambda, \frac{5}{2}\lambda, \frac{7}{2} \ldots$

$v = f\lambda$

$\frac{340}{4000} = \lambda$

$\lambda = $ **8.5 cm**

Path difference =

$136 - 110 = 26$ cm

$26 = \frac{1}{2}\lambda, \frac{3}{2}\lambda, \frac{5}{2}\lambda, \frac{7}{2}\lambda \ldots$

8.5 cm $\leq \lambda \leq 34$ cm

→ Range of wavelength from source.

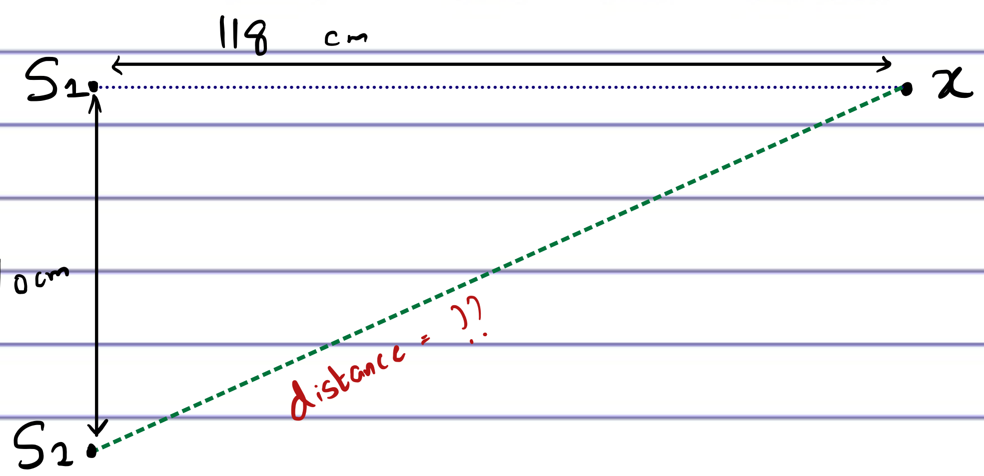
Topic: ______ Date: ______

$\frac{1}{2}\lambda = 26$	$\frac{3}{2}\lambda = 26$	$\frac{5}{2}\lambda = 26$	$\frac{7}{2}\lambda = 26$	$\frac{9}{2}\lambda = 26$
$\lambda = 52cm$	$\lambda = 17.3$	$\lambda = 10.4$	$7.4 cm$	$6.5 cm$

→ Wavelengths at which Destructive Interference takes place.

* 2 occasions.

Example: Diagram shows sources S1 and S2. The waves produced meets at x. It is given that the frequency of both sources simultaneously varied from 200 Hz until it reaches 4500 Hz. The speed of the wave is 340 m/s. Calculate on how many occasions you would expect the phenomenon of Constructive Interference to occur at point x.



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f = 200 v = 250 f = 4500 v = 250

λ = 80 cm λ = 5.55

$5.55 \leq \lambda \leq 80$

$H = \sqrt{118^2 + 90^2}$

H = 148 cm.

For constructive Interference to occur $1\lambda, 2\lambda, 3\lambda, 4\lambda, 5\lambda$

148 − 118 = 30

30, 15, 10, , 7.5 6

→ 5 occasions.

Topic: ______ Date: ______

⇒ Intensity of a Wave:

How do we define and calculate Intensity of a wave and factors which govern the intensity.

* Symbol I
* units Wm^{-2}

Defination: Intensity is defined as power of a wave falling on a unit Area.

Formula ⇒ $I = \frac{P}{A}$ Since $P = \frac{E}{t}$

$I = \frac{E/t}{A}$ $I = \frac{E}{t \cdot A}$

Factors which affect the intensity of a wave.

1) Amplitude (A)
2) Distance from the source.

Topic: ______ Date: ______

Intensity is known to be directly propotional to the square of the Amplitude

$$I \propto A^2$$

$$I = k A^2$$

$(\text{double})^2$

If Amplitude is doubled Intensity will increase by a Factor of 4 times.

If Amplitude is trippled Intensity will increase by a Factor of 9 times.

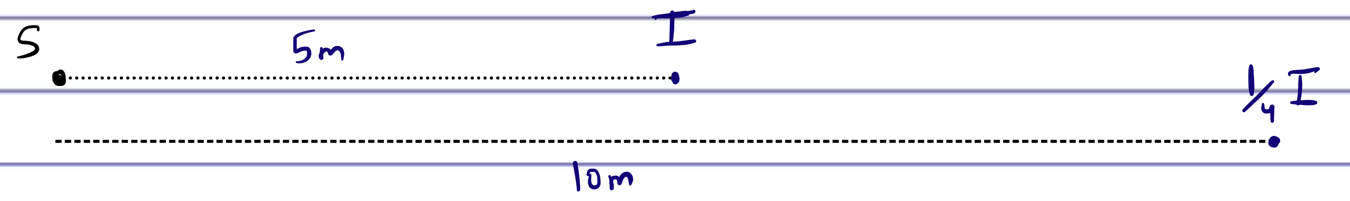
Intensity is known to be inversly propotional to the square of the distance from the source.

$$I \propto \frac{1}{d^2} \Rightarrow I = \frac{k}{d^2}$$

$1/4^{th}$

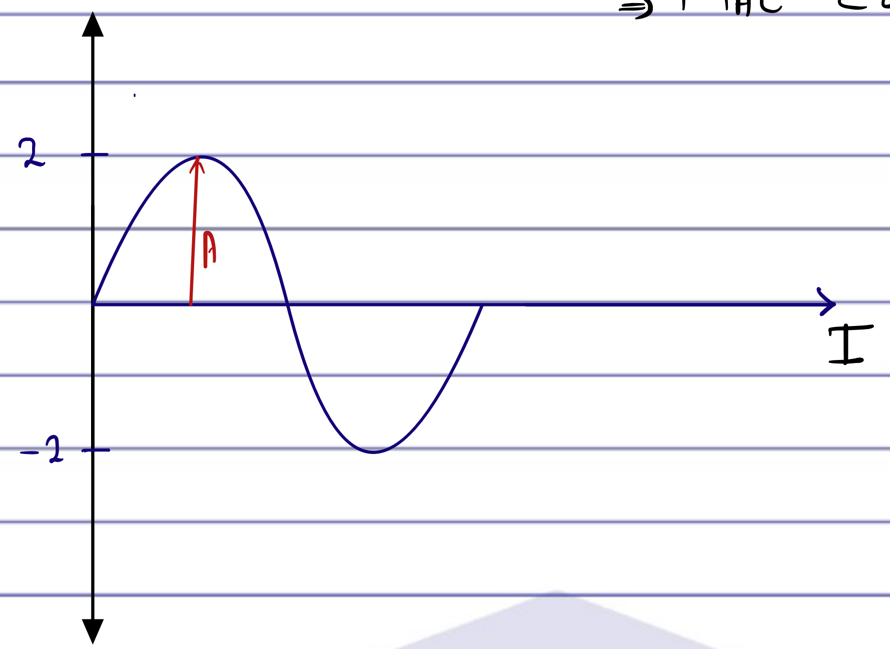
$(\text{doubled})^2$

If distance is doubled I will be $1/4^{th}$.



Topic: ____________ Date: ____________

⇒ MAC Case 1.



→ Construct a second wave on the same diagram which has thrice the intensity and is in phase with the first wave.

① $I = k(2)^2$

$I = 4k$

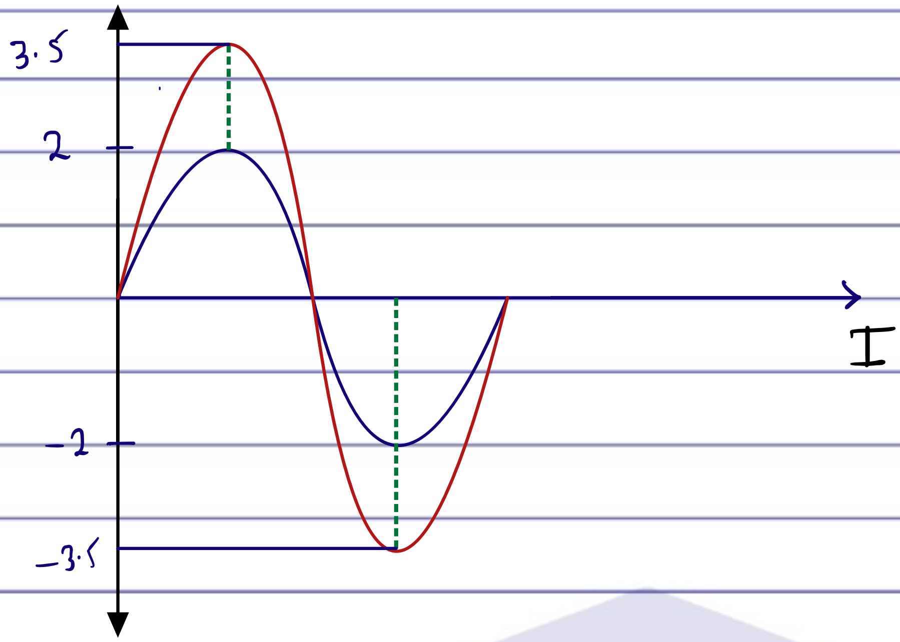
$\frac{I}{4} = k$

② $3I = k(A)^2$

$3I = \frac{I}{4}(A^2)$

$\frac{12I}{I}$ $\sqrt{12} = A$

$A = 3.5$ units



Hence Calculate the Resultant Intensity (y) if these waves were to interfere constructively? (give your answer in terms of I)

Resultant Amplitude = 2 + 3.5
= 5.5

$I = kA^2$

$y = \frac{I}{4}(5.5)^2$

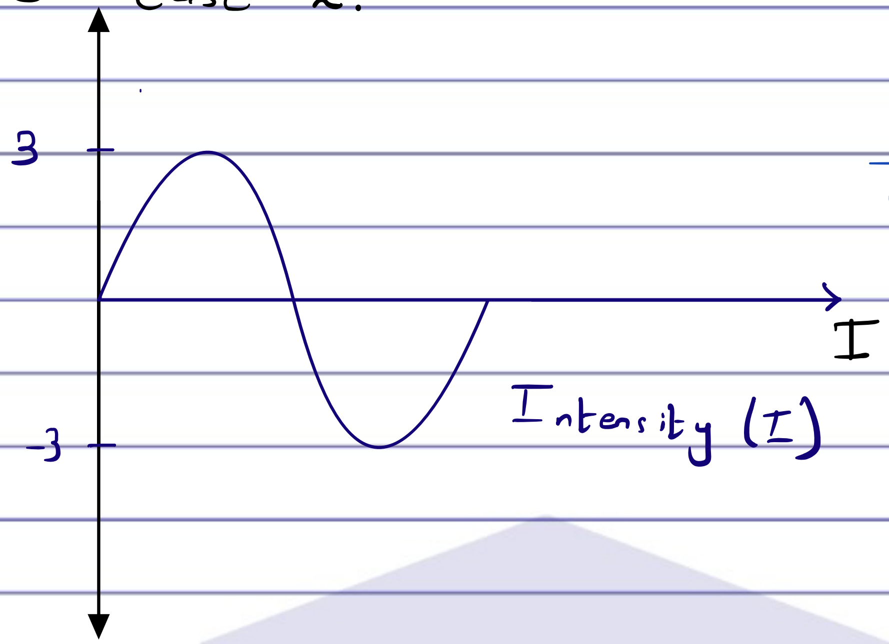
$y = \frac{I}{4}(5.5)^2$

$y = 7.6I$

$y = 7.6I$

Topic: ______________ Date: ______________

MAC Case 2.



$y = kA^2$

$y = k(3)^2$

$\frac{y}{9} = k.$

* Construct a second wave which has thrice the intensity and is out of phase with the first wave.

$I = k(3)^2$

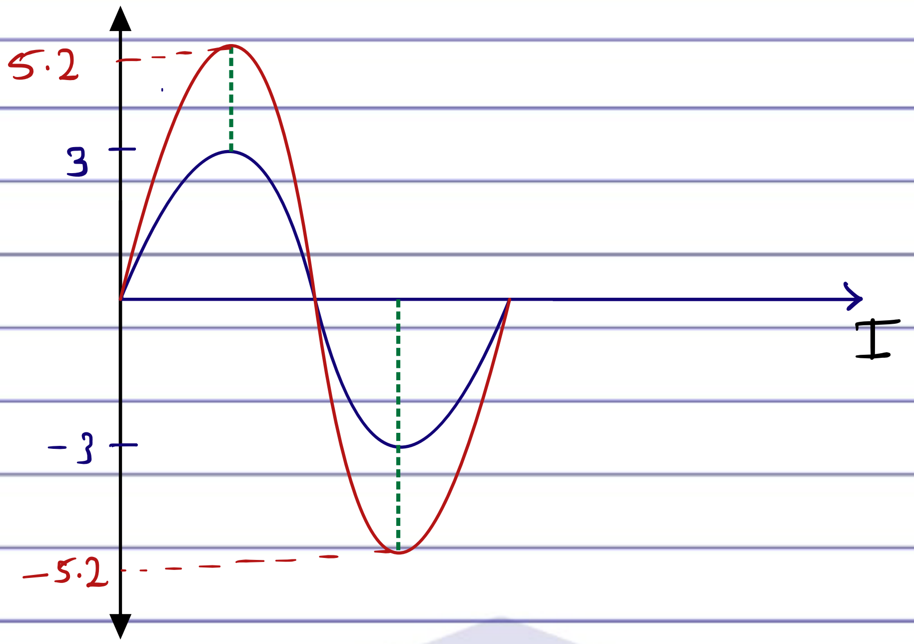
$k = \frac{I}{9}$ ——— (1)

$3I = \frac{I}{9}(A)^2$

$\frac{27I}{I} = A^2$

$A = 5.2$

Topic: ____________ Date: ____________



Hence calculate the Resultant Intensity (z) if the two waves interfere destructively give your Answe in terms of I

Resultant Amplitude $5.2 - 3 = 2.2$

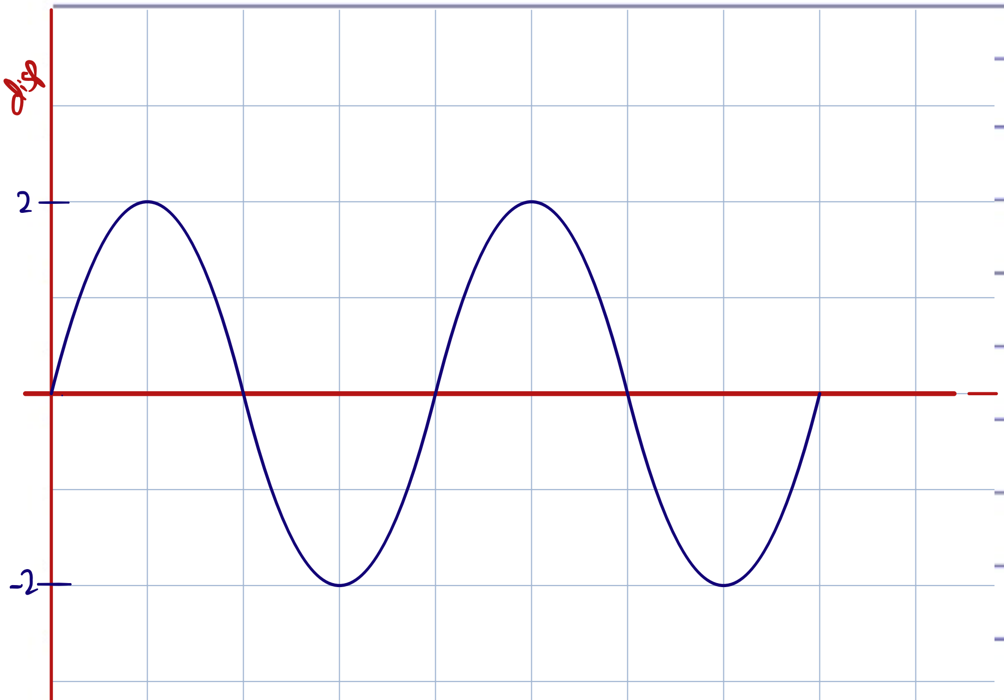
Resultant Intensity $= z$ (unknown)

$I = \frac{I}{9}(2.2)^2$ $\quad I = kA^2$

$z = \frac{I}{9}(2.2)^2$

$z = 0.5\,I$

Topic: ______ Date: ______



Construct a second wave whose intensity is twice and is in phase with the first one

$I = k(2)^2$

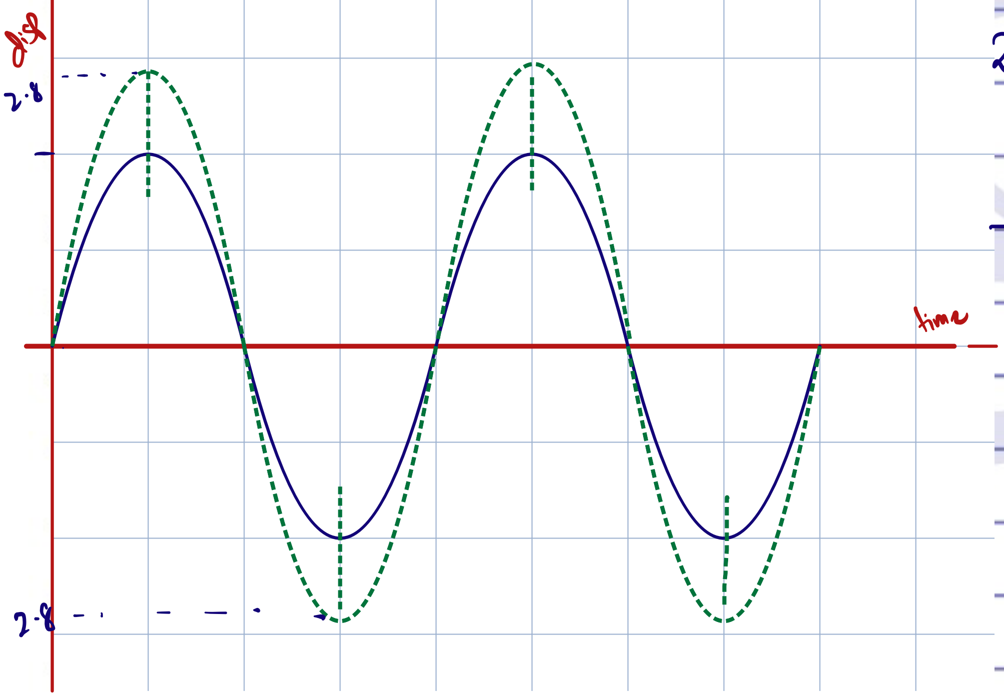
$k = \frac{I}{4}$ —— (1)

$2I = \frac{I}{4}(A)^2$

$\frac{8I}{I} = A^2$

$\sqrt{8} = A$

$A = 2.8$



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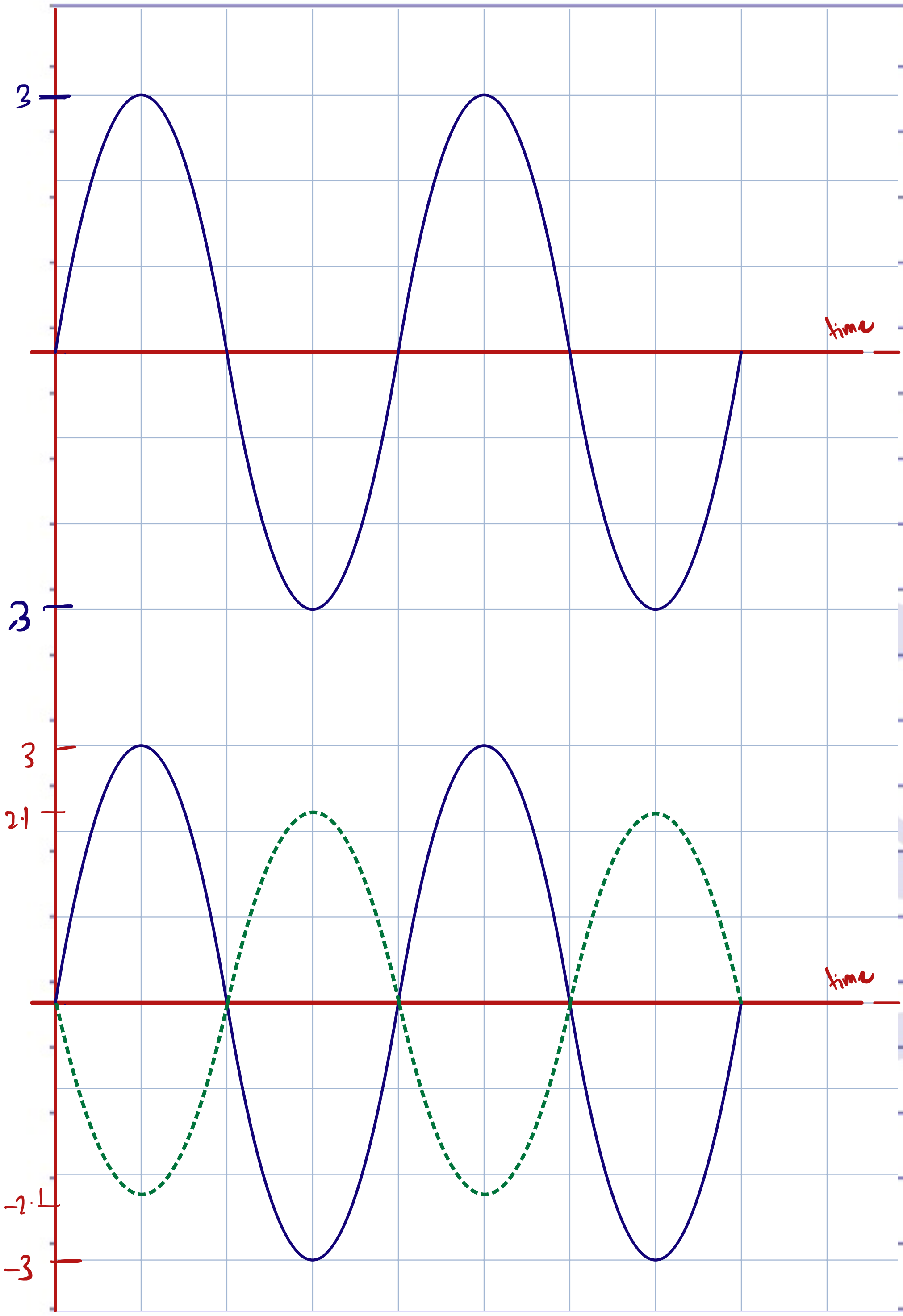
Topic: ____________________ Date: ____________________



Second wave half the intensity and out of phase with first one!

$I = k(3)^2 \Rightarrow k = \frac{I}{9}$

$\frac{1}{2} I = k(A^2)$

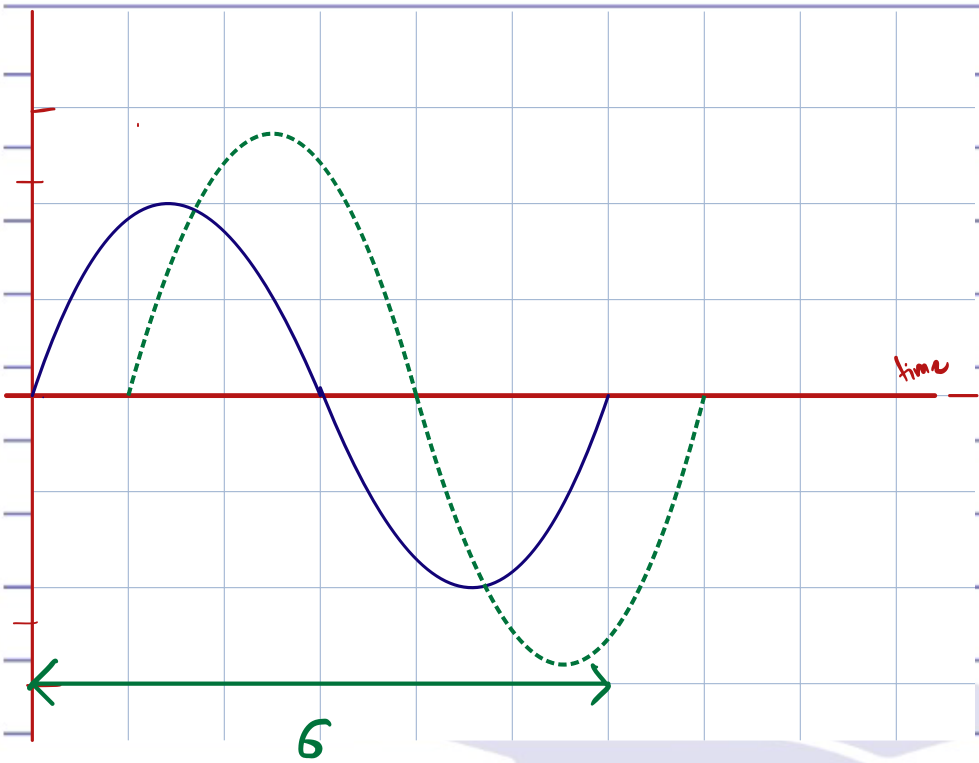
$\frac{1}{2} I = \frac{I}{9}(A^2)$

$\frac{9}{2} = A^2$

$\frac{3}{\sqrt{2}} = A$

$A = 2.1$

Topic: ______ Date: ______



Second wave has phase difference of 60° with the first wave.

$J = 3I$

$I = k(2)^2$

$\frac{I}{4} = k$

$2I = k(A)^2$

$2I = \frac{I}{4}(A)^2$

$8 = A^2$

$\sqrt{8} = A$

$A = 2.8$

6 boxes ⟶ 360°

x ⟶ 60°

x = 1 bos

When to shift on Right or left.

If question has no tern like leading / Lagging its ur choice to shift on Right or left.

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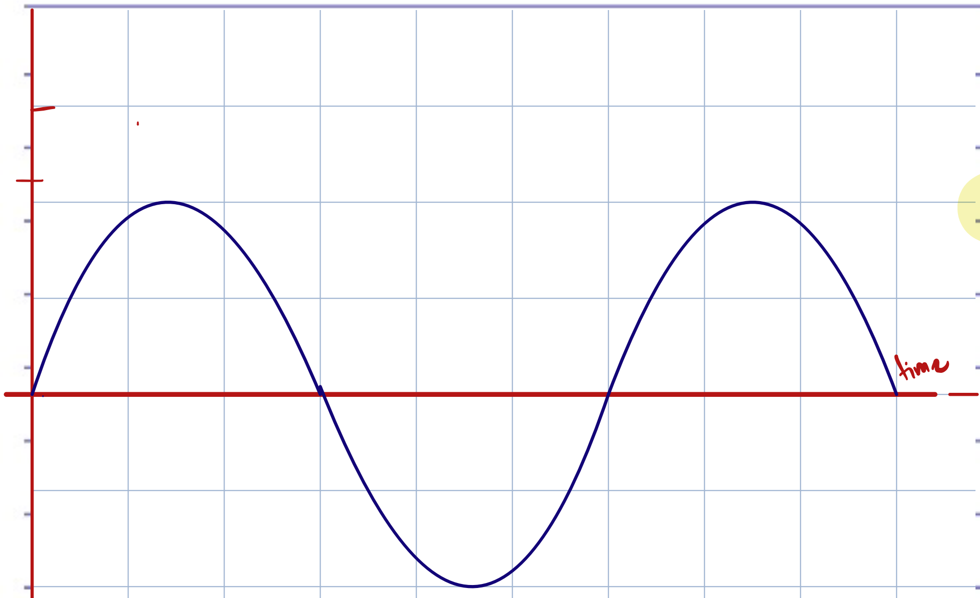
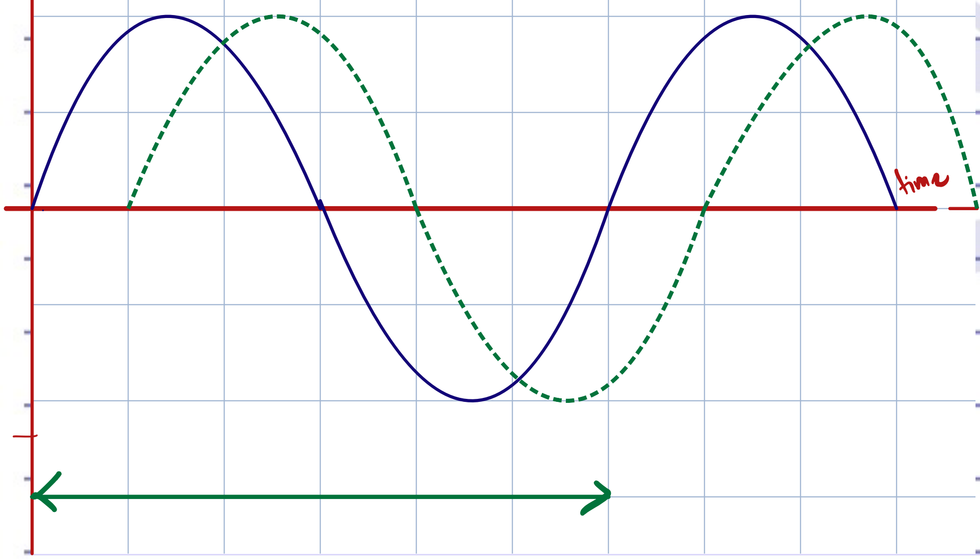
Topic: ____________ Date: ____________



Second wave with same intensity lags behind the first wave by 60^0 construct the second wave.



On a time scale something lags behind it must start at a later time

Right Shift

6 boxes ⟶ 360°

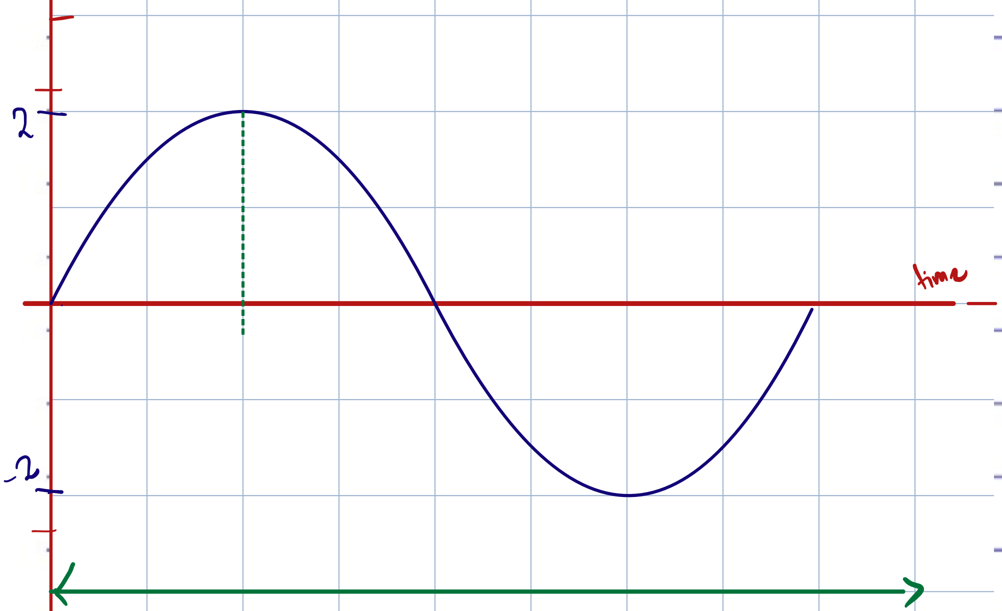
1 box ⟶ 60°

Lead means starting earlier

Topic: Date:

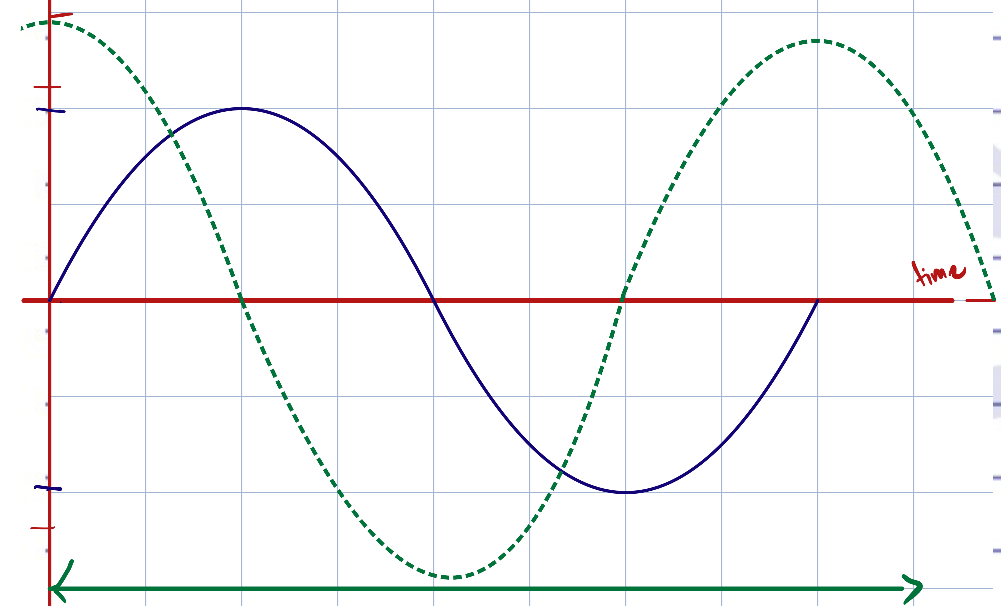
Left shift

Second wave twice Intensity but it leads the first wave by 90° Construct the Second wave?



8 boxes → 360

2 boxes → 90°



$I = k(2)^2$

$K = \frac{I}{4}$

$2I = k(A)^2$

$\frac{2I \times 4}{I} = A^2$

$8 = A^2$

$A = 2.8$

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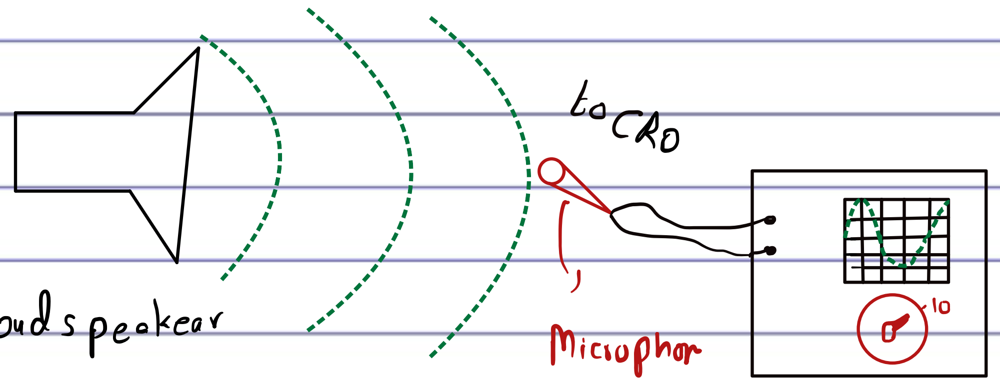
Topic: Sound :

Date:

Exp to calculate freq of sound waves.



$f = \frac{1}{T}$

1cm corresponds to 10ms

4cm ⟶ 40ms

Time Base (ms/cm)

$f = \frac{1}{T}$ $f = \frac{1}{40 \times 10^{-3}}$. $f = 25\ Hz$

List of Apparatus.

loud speakers
microphone
CRO & connecting wire

Precautions

Freq of sound to remain constant
Exp to be conducted in sound proof room
There must be no echo

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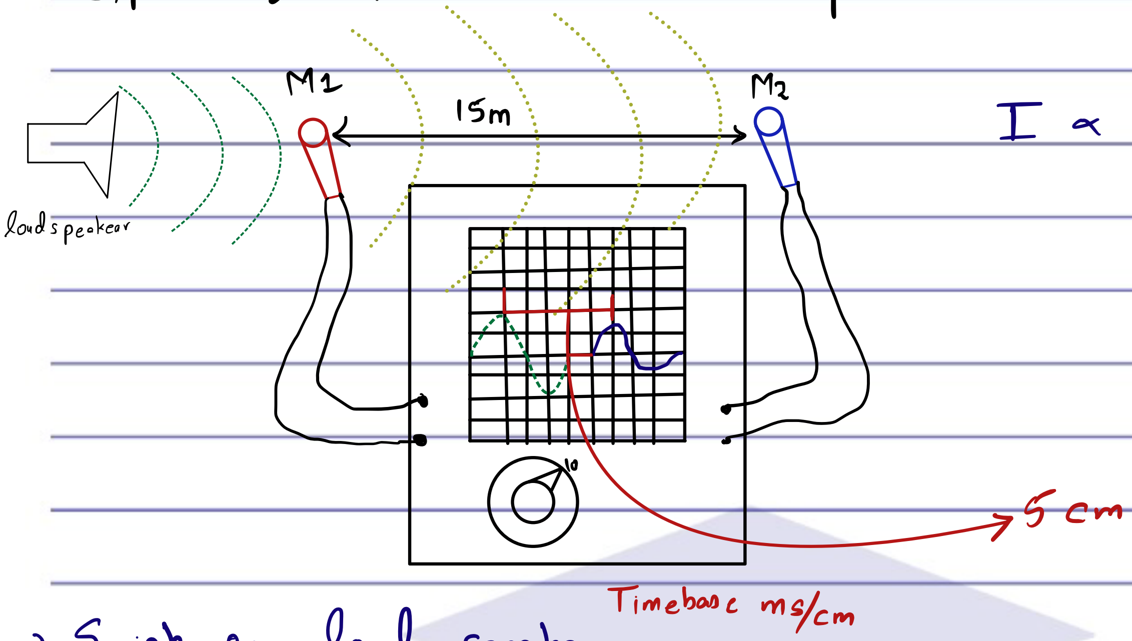
Topic: ______ Date: ______

Experiment to calculate the speed of sound.



$$I \propto \frac{1}{d^2}$$

→ Swich on loud specker
→ As soon as sound recches first microphone M1
→ First microphe will send signal to CRO
→ A pulse will be formed on the CRO

1 cm → 10 ms

5 cm → 50 ms { time taken for sound to travel b/w M1 and M2 }

$$V = \frac{d}{t}$$

$$V = \frac{15}{50 \times 10^{-3}} \therefore \Rightarrow \text{Speed} = 300 \text{ m/s}$$

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Topic: Date:

→ Concept of Diffraction

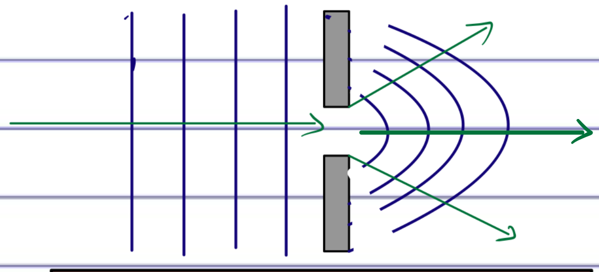
defination: The term diffraction refers to spreading of waves. when they travel through a narrow gap, small opening, slit or an aperture.

- Experiments have shown that for significant diffraction to occur, the size of the gap/aperture/slit opening must be comparable to the wavelength of the waves.

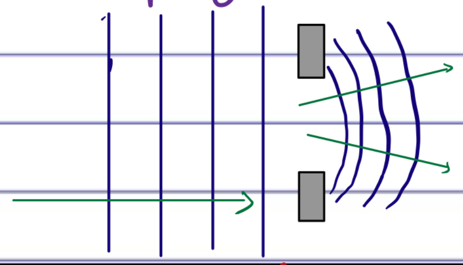
→ Less diffraction occur when size of the gap is significantly larger as compared to the wavelength.

Topic: ______ Date: ______

Diffraction: Diffraction is spreading out of wave when they pass an obstruction
narrow ap. g



less gap more spreading

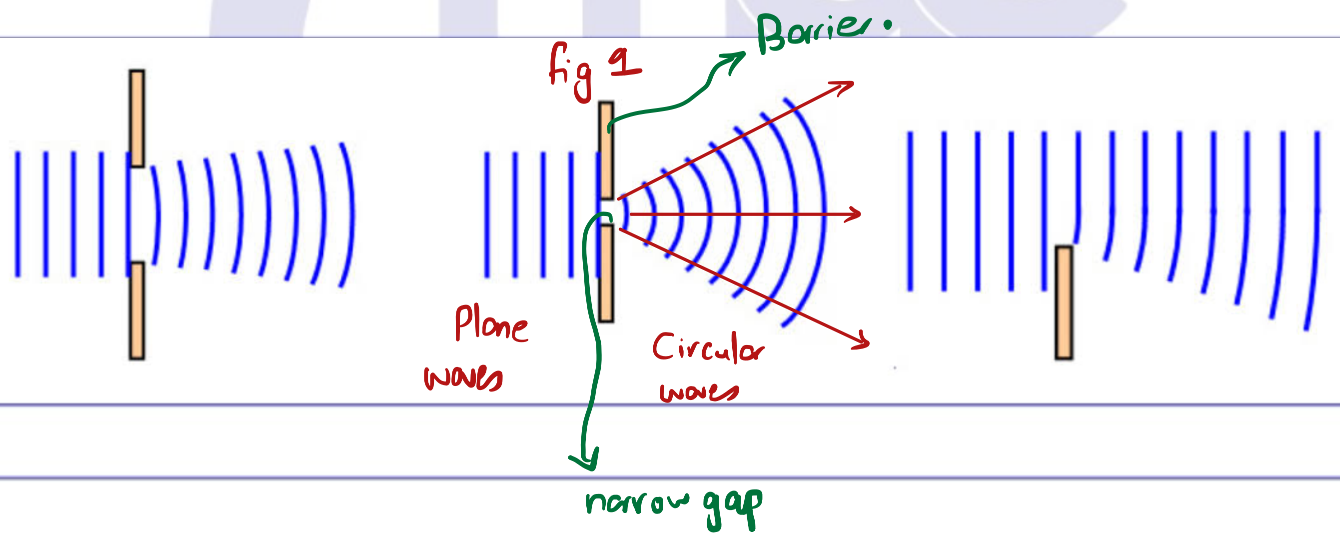


more gap less spreading

Olevels

This diagram can be of 3 marks.

* Diffraction is observed in fig 1
* During diffraction, the wavelength (λ), speed (v) and Frequency (f) remains unchanged.



Topic: ______ Date: ______

- A simplied diagram for 1 marks.

Fig 2

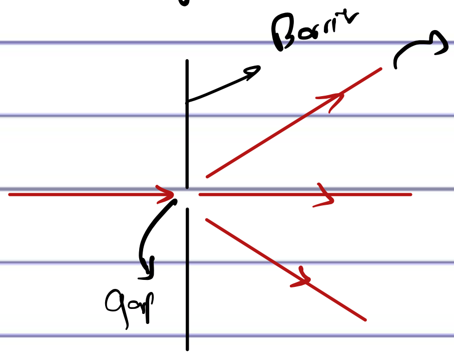
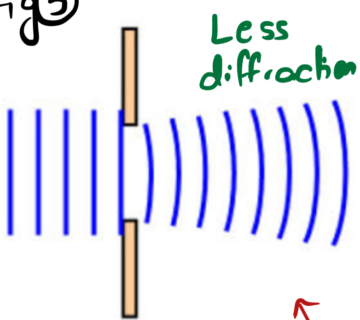
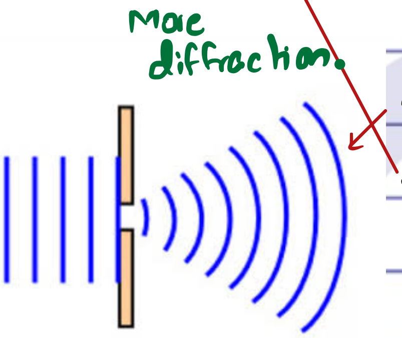


Fig ③



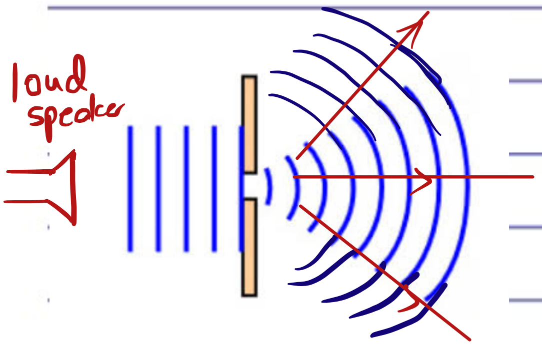
In fig 3 and fig 4 we can observe that the amount of diffraction/amout of spreading depends on the size of the gap in comparision with same wave length.

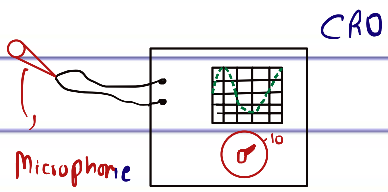
Fig ④

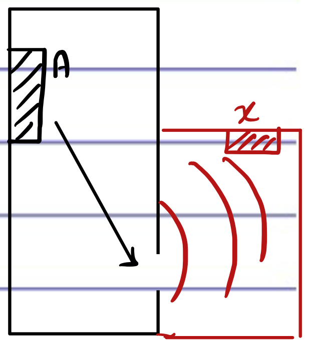


- Size of gap ≈ λ Significant diffraction fig 4
- Size of gap >> λ less diffraction. fig 3

Exp to show diffraction of sound waves.







Topic: ____________ Date: ____________

Appratus.

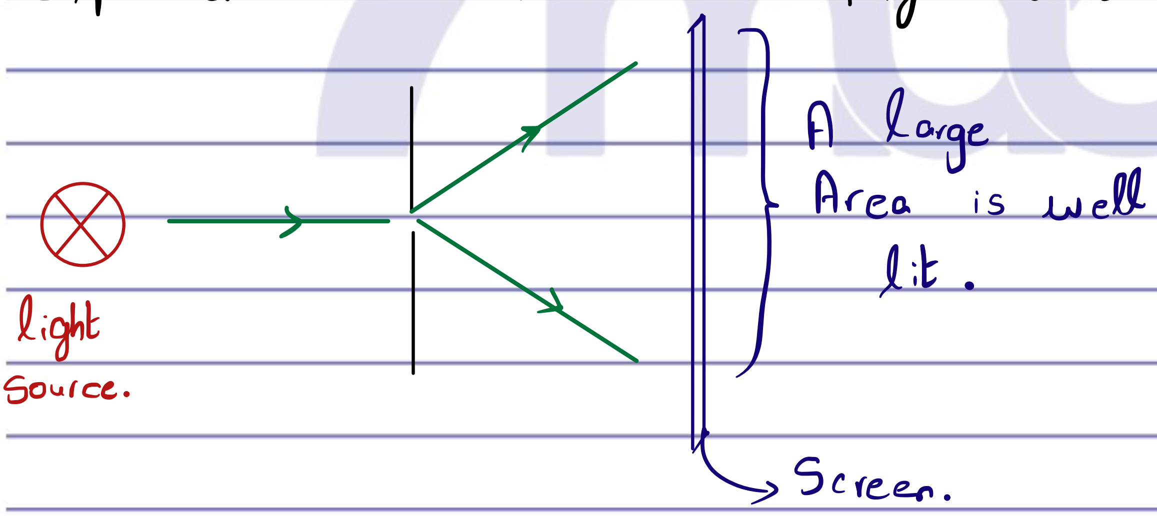
* loud speake
* Reciver (CRO + microPhone)

Barrier with an opening
(Size of the opening must be approx equal to the wavelength)
wavelength of sound is 0.5 m

Precaution: Sound proof Room.

Observation: A waveform is displayed on CRO Indicating that sound undergoes diffraction.

Experiment for diffraction of light waves.



Apparatus: light source.
Screen
Barrier with a much smaller gap (λ = few cm or mm)

Topic: ______ Date: ______

Observation: A large area on the screen is lit up indication of light waves.

Young's Double Slit Interference pattern. Thomas young

Purpose: To observe Interference from two light sources.

Procedure. light waves were allowed to fall onto slits labelled as S_1 and S_2 on the diagram below. Diffraction occurs causing the light waves to spread out as they pass through the slits, this allows light waves to interfere with each other. hence an Interference pattern is observed. on screen.

Observation: Bright and dark spots (also called bright fringes and dark fringes are observed on screen)

Reason: Bright fringes arrise due to constructive Interference b/w in phase pts and dark fringes arrises due to Destructive interferences b/w out of phase pts i.e (crest + Troughs)

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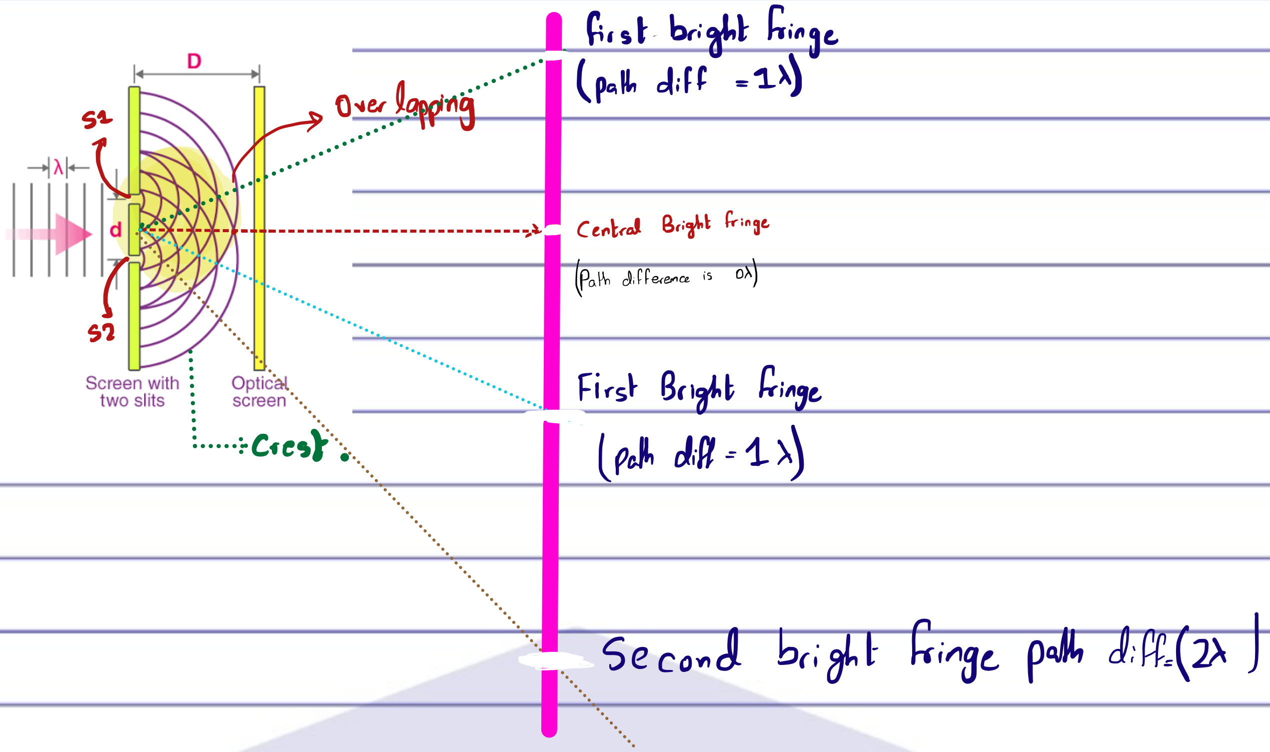
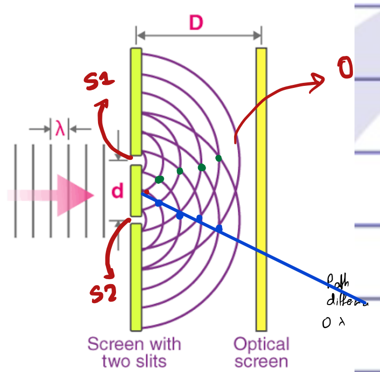
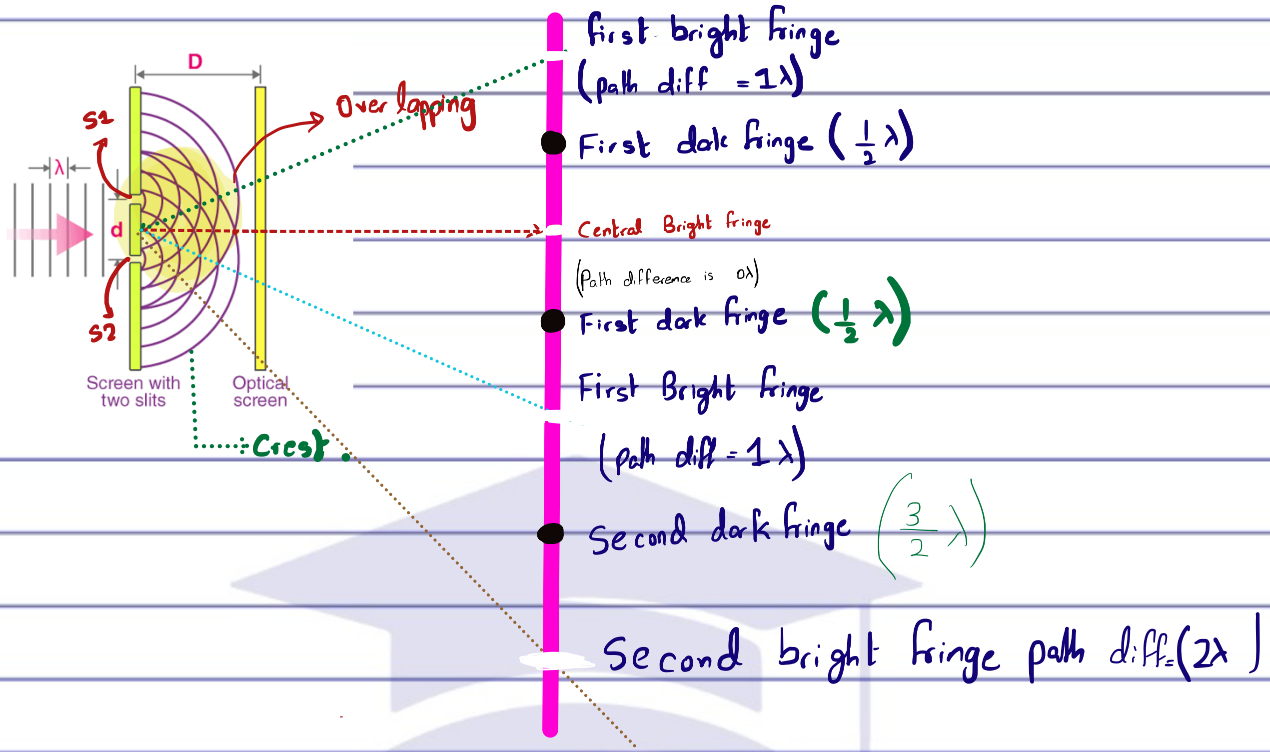

D
S1
λ
d
S2
Over lapping
Screen with two slits
Optical screen
Crest
first bright fringe
(path diff =1λ)
Central Bright fringe
(Path difference is 0λ)
First Bright fringe
(path diff = 1 λ)
Second bright fringe path diff=(2λ)

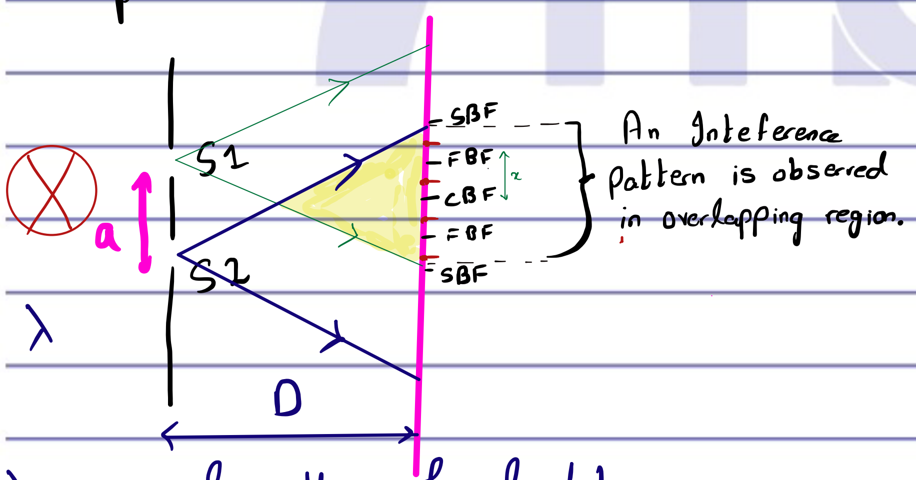

D
S1
λ
d
S2
O
Path difference
0 λ
Screen with two slits
Optical screen

Topic: ____________ Date: ____________



Drawing in Exam

Simplified version



λ = wavelength of light

D = distance b/w doubleslit & screen.

a = Slit seperation (Dis b/w 2 slits S1 and S2)

x = Fringe seperation. (Distance b/w 2 bright or dark fringes succesive)

Formula which relates x, a, λ, D

$$x = \frac{\lambda \cdot D}{a}$$

Q Suggest typical values for λ, D, & a, so that an Interference pattern can be easily observed on the screen. ?

learn.

$\lambda = 400\,nm$ (violet) to $700\,nm$ (Red) VIBGYOR

400 —— 700 nm

$D = 1\,m$ to $3\,m$

$a = 0.5\,mm$ to $1.5\,mm$.

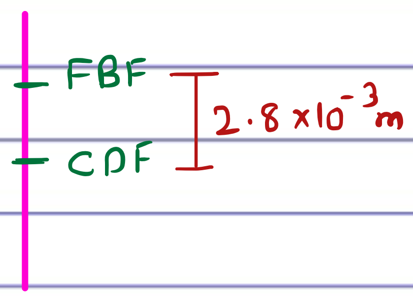
Q:- $\lambda = 550\,nm$ $D = 2.8\,m$ $a = 0.55\,mm$

1) Calculate distance b/w 2 successive bright fringes? (x) ??

$$x = \frac{\lambda \cdot D}{a} \Rightarrow \frac{(550 \times 10^{-9}) \cdot (2.8)}{0.55 \times 10^{-3}}$$

$x = 2.8\,mm$

$(2.8 \times 10^{-3}\,m)$



Topic: Date:

ii) Calculate distance b/w two Succesive Dark fringes.

$x =$ Same as (i)

$2.8mm \ (2.8 \times 10^{-3} m)$

iii) Calculate distance b/w a bright and dark fringe

$\frac{1}{2} x \Rightarrow 1.4mm.$

iv) Calculate distance b/w Central Bright fringe and 3rd bright fringe.

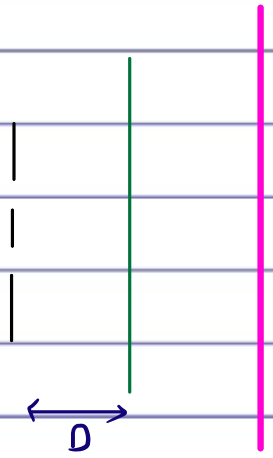
$3x =$

$8.4 \times 10^{-3} m$

Topic: Date:

Factors:

Factors affecting the fringe seperation (x) and brightness of fringes.



① The distance (D) b/w the double slit and the screen is increased, while all other factors stay unchanged.

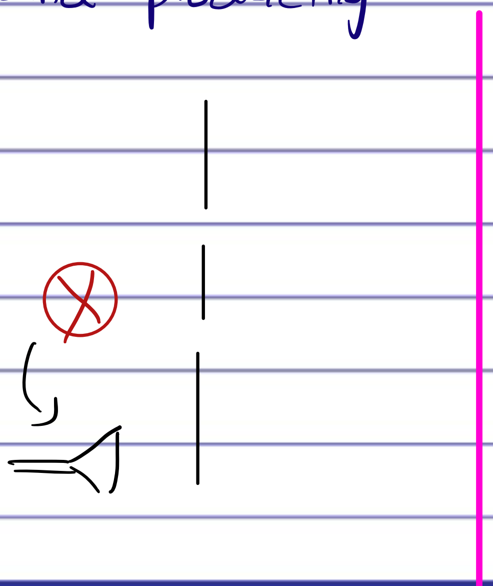
$$\uparrow x = \frac{\lambda D \uparrow}{a}$$

$\therefore$ x increases i.e fringe seperation increase.

$$I \propto \frac{1}{d^2}$$

$\therefore$ as distance increases light falling on screen will decrease hence fringes will be less bright.

② light source is replaced with sound producing source



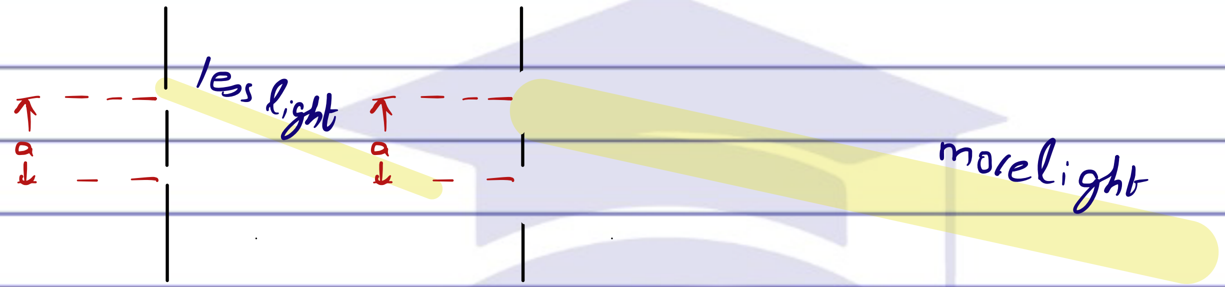
Since λ sound $\uparrow$ > λ light

$$\uparrow x = \frac{\uparrow \lambda D}{a}$$

Topic: ______________ Date: ______________

* Interferce patten will disappear Bright and dark will be replaced with loud sound and soft/zero sound.

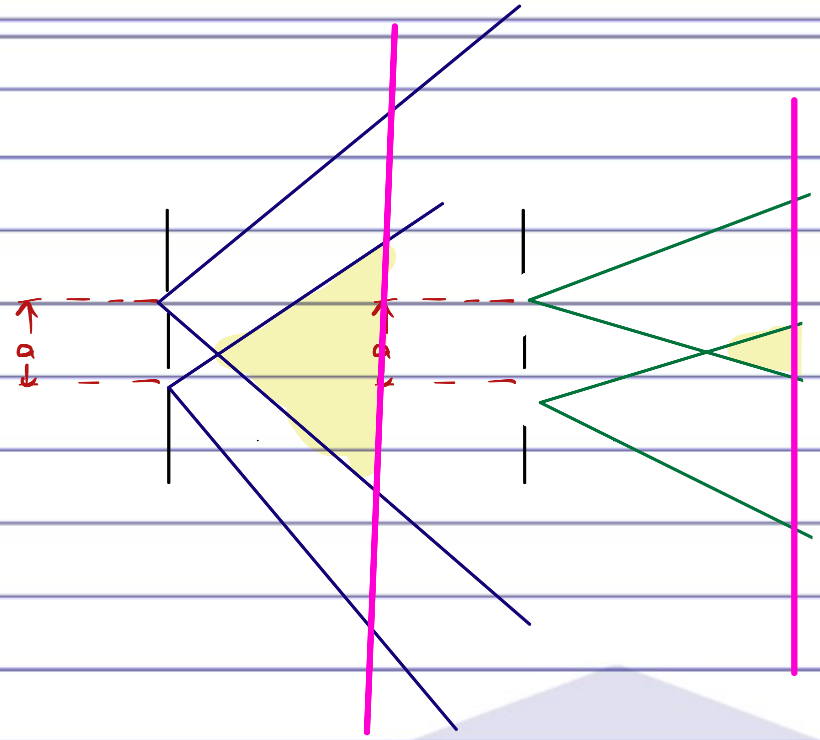
③ Size of each Slit is increased while keeping other things constant.



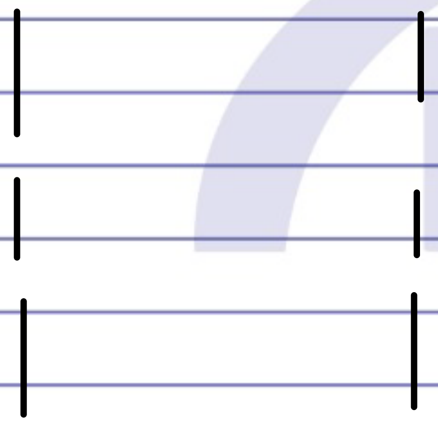
⇒ Since λ, D & a are all unchanged fringe seperation also remains unchanged.

Since size of Slit increases ∴ Brightness of fringe will also increase.

As slit size is increased, less diffraction occurs ∴ Interference pattern will now be observed over a limited area ∴ less no of fringes detected



(4) Size of only one slit is increased, S_2 is kept unchanged. other factors are constant

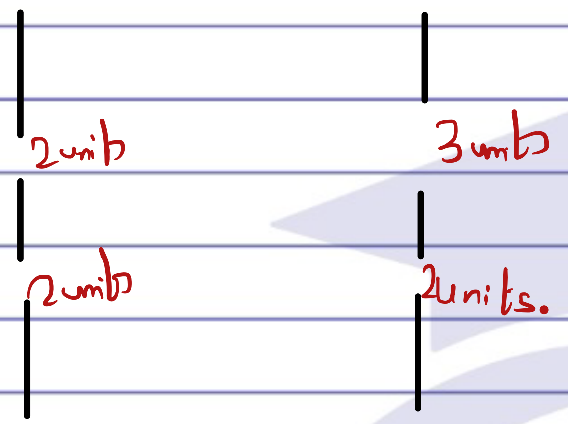


a = Same

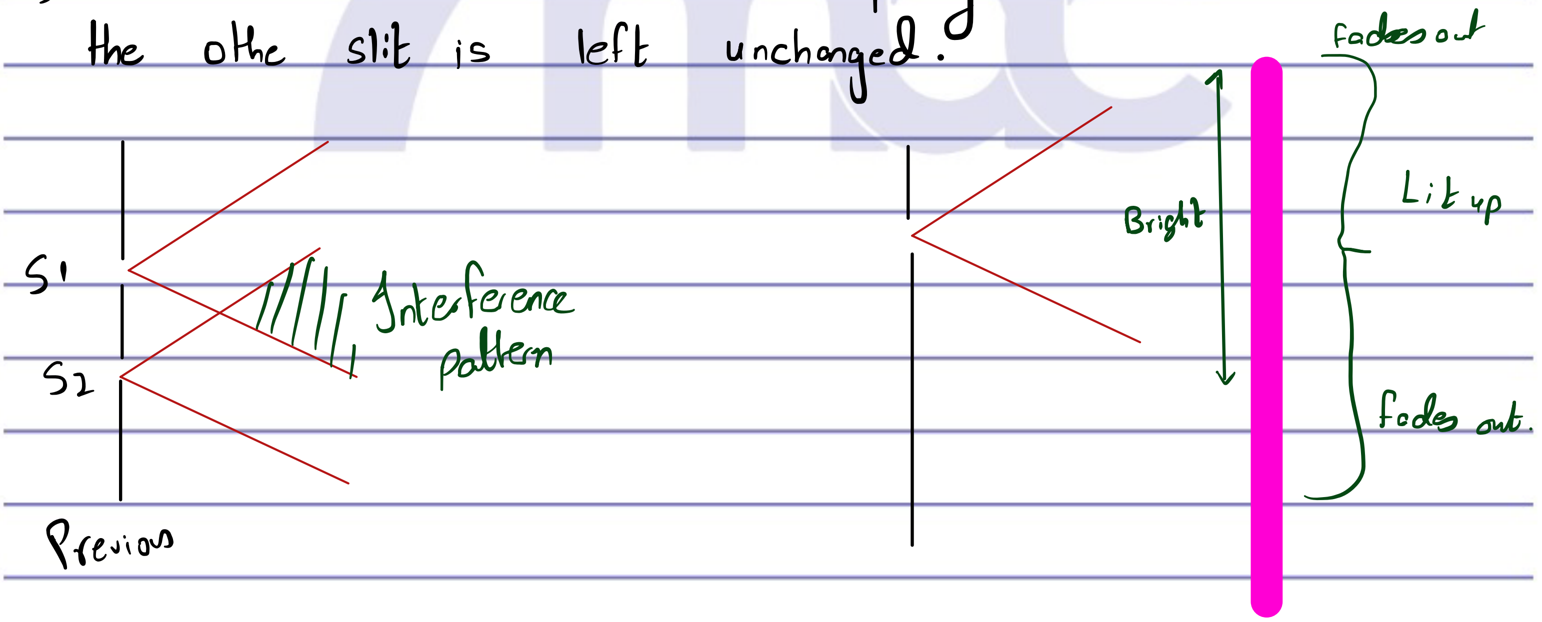
$x = \frac{\lambda D}{a}$ x = unchanged.

Topic: ______________ Date: ______________

The term bright and dark fringes will be replaced by more bright and less bright fringes.



5) One of the slit is completly closed while the othe slit is left unchanged.

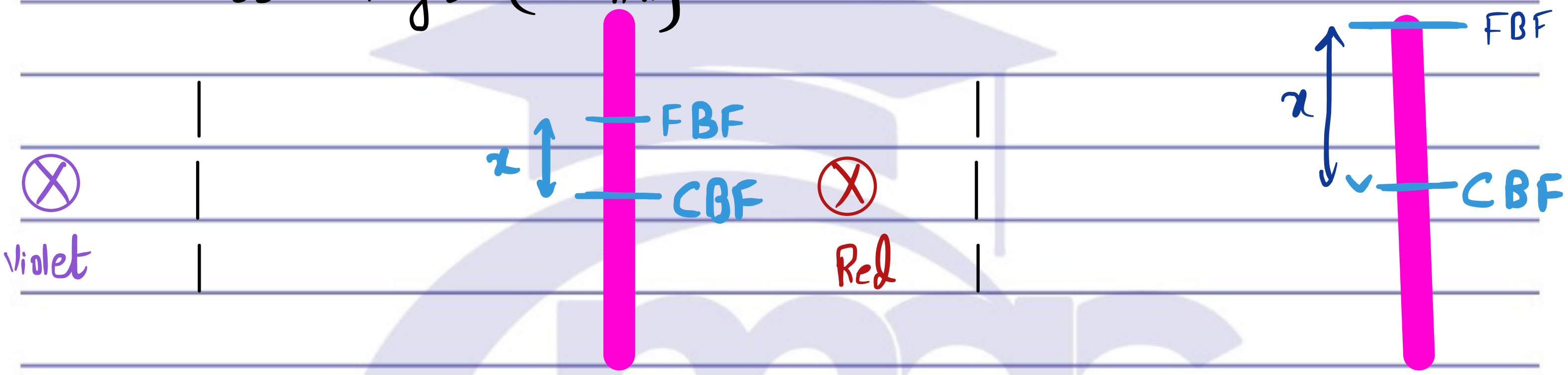


Topic: Date:

* No Interference pattern is formed hence no appearance of Bright and dark fringes.

* A large Area will be lit Intensity will decrese as we approach to the end of the screen on either side $I \propto \frac{1}{d^2}$

6) The violet (400 nm) is now replaced with a red light (700 nm)



ORignal   New

$\uparrow x = \frac{\uparrow \lambda D}{a}$ Frige sep (x) will increase.

* CBF appearance unchanged.

* FBF (Since FBF for longer wavelength Red is further away from CBF) its Brightness will marginally reduce)

Note Almost unchanged.

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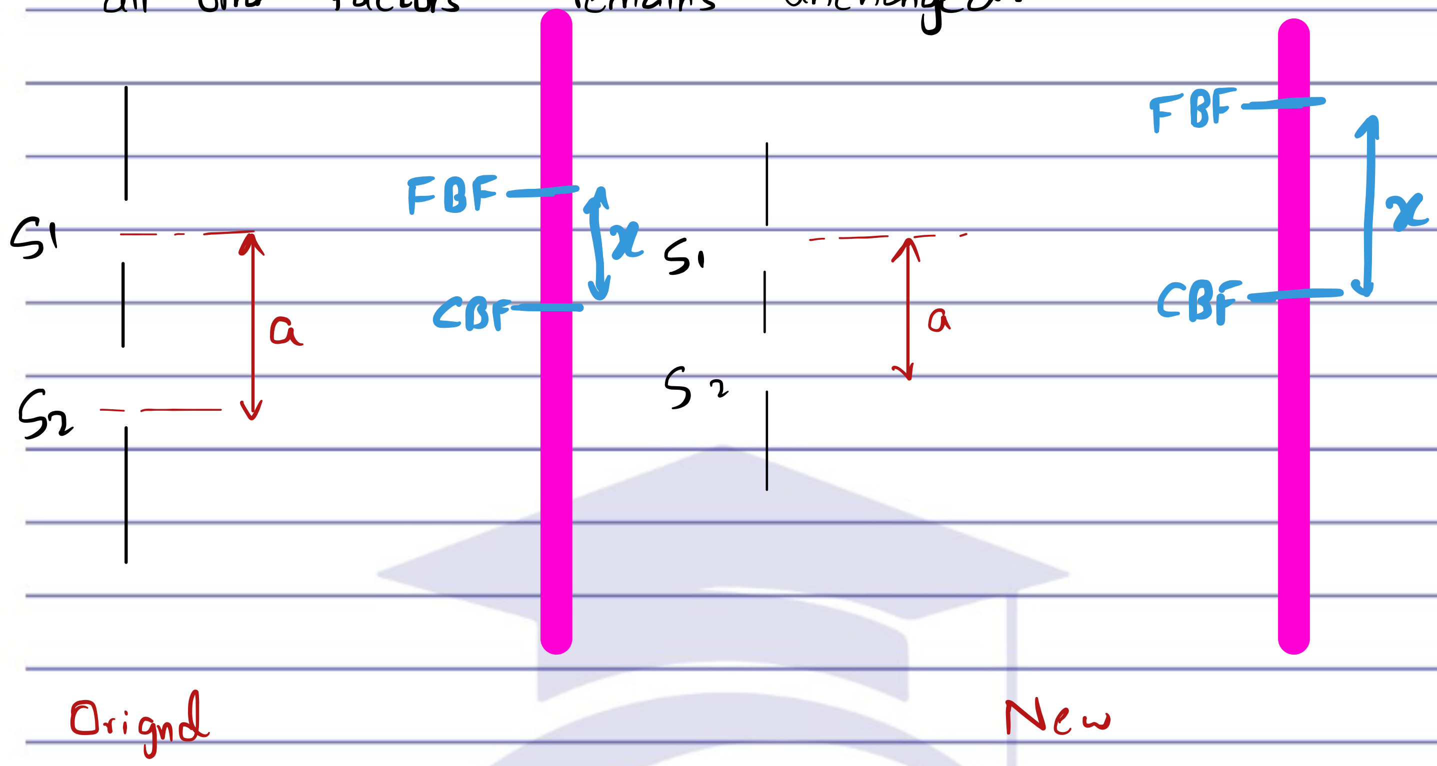
Topic: ____________ Date: ____________

7) The Slit seperation (a) is now reduced, while all other factors remains unchanged.



(fringe Seperation x) will increase.

$$\uparrow x = \frac{\lambda D}{a \downarrow}$$

* CBF remains unchanged
* FBF (Brightness marginally decreases) or (Almost unchanged)

* Interference pattern will be observed in larger Area.

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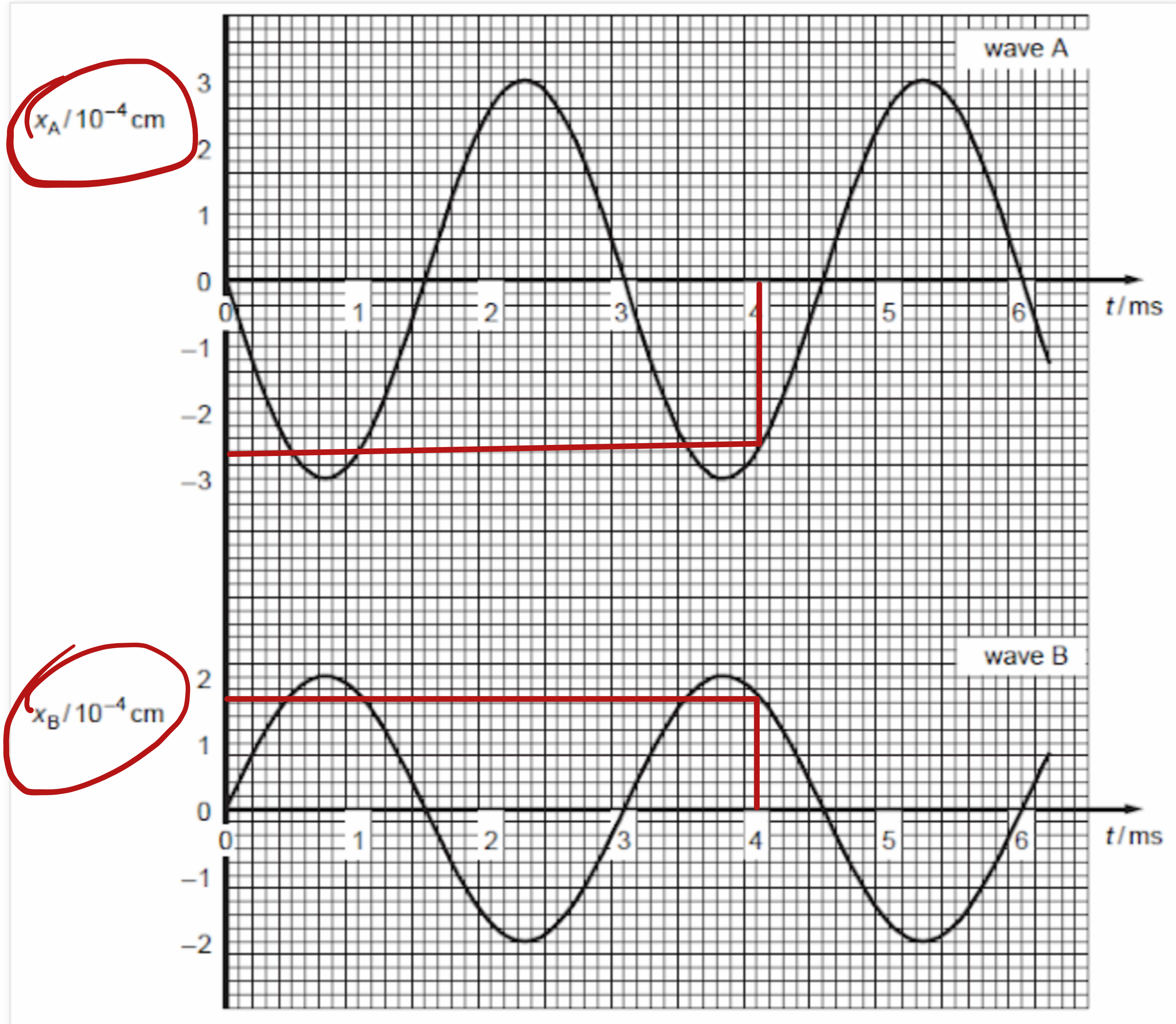
Topic: ______________________ Date: ______________________

Question 975: [Waves > Intensity]

Fig. 5.1 shows the variation with time t of the displacements x_A and x_B at a point P of two sound waves A and B.



(a) By reference to Fig. 5.1, state one similarity and one difference between these two waves.

(b) State, with a reason, whether the two waves are coherent.

(c) The intensity of wave A alone at point P is I.
(i) Show that the intensity of wave B alone at point P is (4/9) I.
(ii) Calculate the resultant intensity, in terms of I, of the two waves at point P.

(d) Determine the resultant displacement for the two waves at point P
(i) at time t = 3.0 ms,
(ii) at time t = 4.0ms.

Reference: *Past Exam Paper – November 2005 Paper 2 Q5*

Solution 975:

(a)

Similarity: example: same wavelength / frequency / period, constant phase difference
Difference: example: different amplitudes / phase

(b) They are coherent since the phase difference is constant.

(c)

(i)

{The intensity of a wave is proportional to the square of its amplitude. The amplitude is the maximum displacement, and can be obtained from the graph.}

Intensity ∝ (amplitude)^2

So, $I_A = I \propto 3^2 = 9$ and $I_B \propto 2^2 = 4$ leading to

{For wave A, the amplitude is 3. Its intensity I is $3^2 = 9$ units. So, 9 units [the square of the amplitude (3^2)] represents I. So, 1 unit would represent I/9. The amplitude of wave B is 2. So, its intensity is $2^2 = 4$ units. In terms of I, this is 4 (I/9) = (4/9)I.}

$I_B = (4/9)\ I$

(ii)

{Amplitude of wave A = (+)3×10^{-4} cm and the amplitude of wave B is (-)2×10^{-4} cm. The signs account for the waves being out of phase with each other.}

Resultant amplitude = $(3 - 2)\times10^{-4} = 1.0\times10^{-4}$cm

{The resultant amplitude is 1 (let forget the $\times10^{-4}$ cm for now). For the intensity of the resultant wave, we consider the square of the resultant amplitude = $1^2 = 1$ unit.
As stated before, 9 units (amplitude squared) corresponds to I. The intensity of the resultant wave would correspond to [by proportion] (1/9) I}

So, resultant intensity = (1/9) I

(d)

(i) Resultant displacement = 0

(ii)

$x_A = -2.6\times10^{-4}$cm and $x_B = +1.7\times10^{-4}$cm

So, resultant displacement = (-) 0.9×10^{-4}cm

Topic: ______ Date: ______

a) Similarity : Same time period. ✓
Difference : Amplitude. ✓

b) Since they maintain a constant phase difference hence coherent.

c) $I = kA^2$

$I = k(3)^2$

$k = \frac{I}{9}$

$y = k(2)^2$

$y = \frac{I}{9}(2)^2$

$y = \frac{4}{9}I$

ii) $3 - 2 = 1$

$z = k(A)^2$

$z = \frac{I}{9}(A)^2$

$z = \frac{I}{9}$

Topic: ______ Date: ______

d) Resultant disp = 0

-2.6×10^{-4} 1.7×10^{-4}

$(-) 0.9 \times 10^{-4}$

Topic: Date:

Diffraction Grating.

What is Diffraction grating

* A diffraction grating is an optical instrument which can be constructed that is constructed with glass or plastic.

* This has many microspocic slits on it, so when light hits on it light diffract.

* A screen is positioned on the background hence spreading of light can be displayed on the screen.

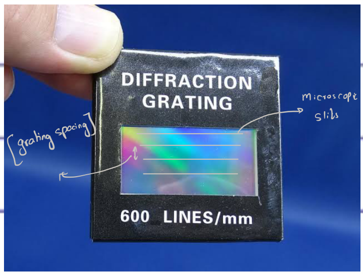
* The angle through which the light spread is denoted by θ. (It is meaured by central line. The angle θ can be calculated using

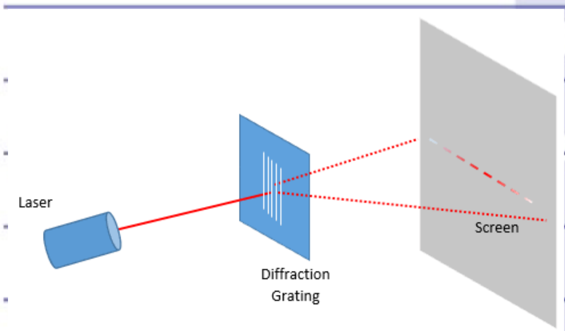
$$d \sin\theta = n\lambda$$

λ = wavelength.

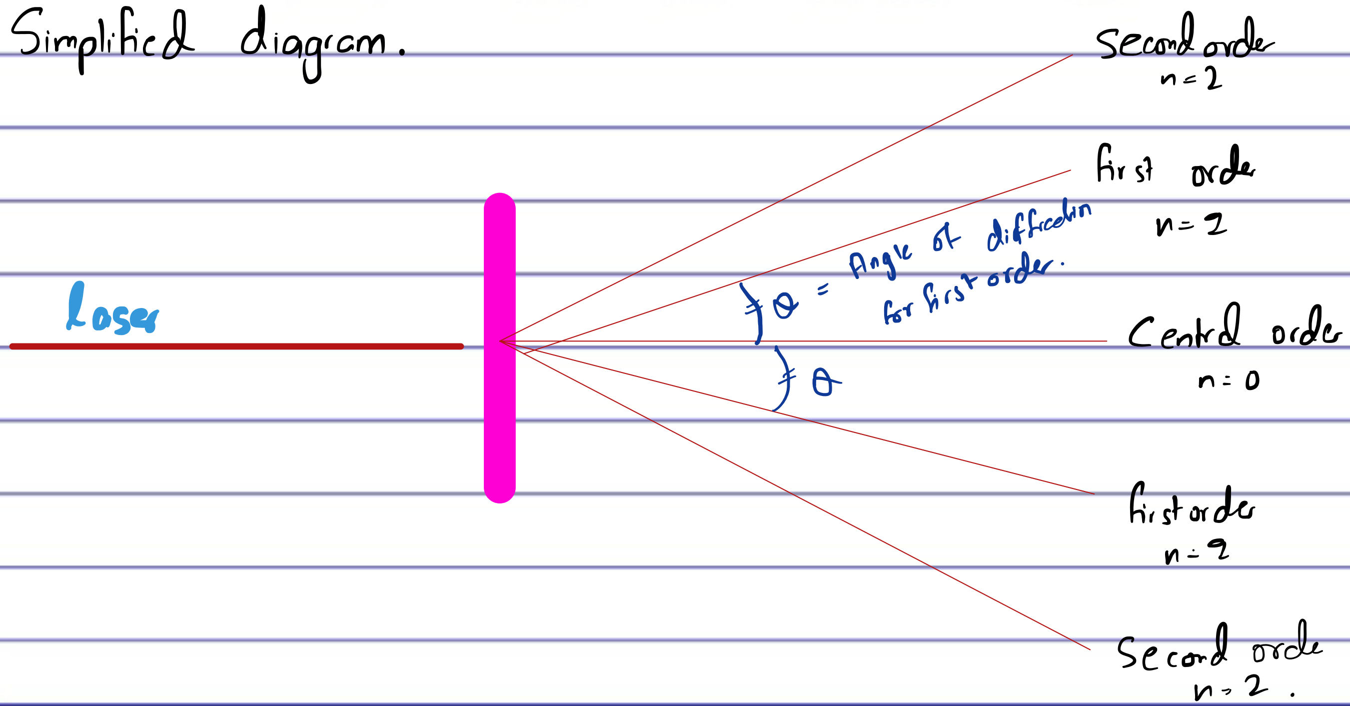
θ = angle through which light diffracts.

n = denotes number of order 1, 2, 3, 4, 5 etc & d is a constant known as grating spacing. (provided by manufacturer)





Simplified diagram.



2. **O/N 18/P22/Q5**

Red light of wavelength 640 nm is incident normally on a diffraction grating having a line spacing of 1.7×10^{-6} m, as shown in Fig. 5.1.

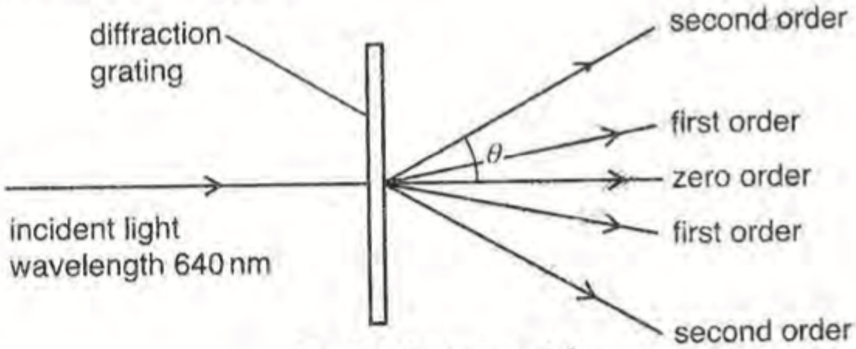


Fig. 5.1 (not to scale)

The second order diffraction maximum of the light is at an angle θ to the direction of the incident light.

(a) Show that angle θ is 49°.

$d \sin\theta = n\lambda$

[3]

(b) Determine a different wavelength of **visible** light that will also produce a diffraction maximum at an angle of 49°.

wavelength = ... m [2]

13. M/J 16/P22/Q5

(a) Light of a single wavelength is incident on a diffraction grating. Explain the part played by *diffraction* and *interference* in the production of the first order maximum by the diffraction grating.

diffraction: ....

....

interference: ....

....

....

....

[3]

(b) The diffraction grating illustrated in Fig. 5.1 is used with light of wavelength 486 nm.

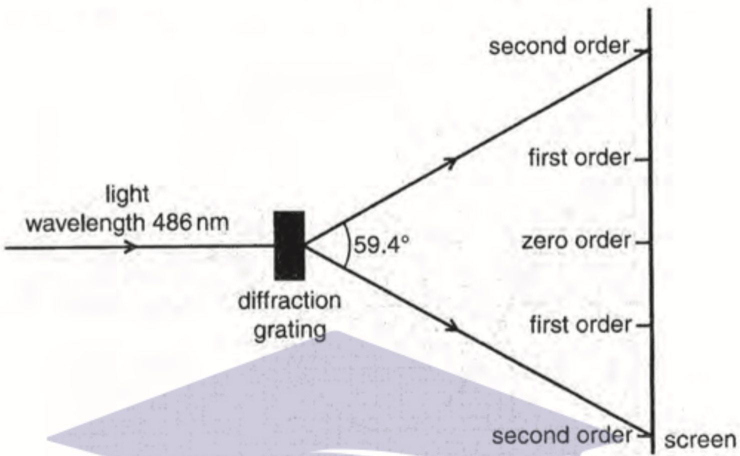


Fig. 5.1 (not to scale)

The orders of the maxima produced are shown on the screen in Fig. 5.1. The angle between the two second order maxima is 59.4°.

Calculate the number of lines per millimetre of the grating.

number of lines per millimetre = ... mm^{-1} [3]