EXERCISE

Select the correct answer of the following questions:

1) Which one of the following properties of light does not change when it enters from one medium to another medium?

a. Frequency b. Wavelength c. Velocity d. Amplitude

2) The principle of Young's double slits experiment is based on the division of:

a. Amplitude b. Frequency c. Velocity d. Wavelength

3) Which one of the following properties proves the transverse wave nature of light?

a. Interference b. Refraction c. Polarization d. Diffraction

4). Colored fringes observed in soap bubbles are the examples of

a. Diffraction b. Interference c. Polarization d. Reflection

5) During a sunny day we see the objects in a class room even when all the electric lights are off, due to

a. Reflection of light b. Refraction of light

c. Diffraction of light d. Interference of light

6) The principle of Michelson interferometer is based on the division of

a. Wave front b. Amplitude c. Frequency d. Speed of light

7) In the Young's double slit experiment the separation between the slits is halved and the distance between the slits and the screen is double. The fringe width is

a. Halved b. Unchanged c. Doubled d. Quadrupled

8) Signal from a remote control to the device operated by it travels with the speed of:

a. Sound b. Light c. Ultrasonic d. Supersonics

9) Light of wavelength λ is incident normally on a diffraction grating for the slit spacing is equal to 3λ. What is the sin θ of the angle between the second order maximum and the normal?

a. $\frac{1}{6}$ b. $\frac{1}{3}$ c. $\frac{2}{3}$ d. 1

10) Which of the following three regions of the electromagnetic spectrum in order of increasing wavelength, visible radiation.

a. Gamma rays, microwaves, visible radiation.

b. Radio waves, ultraviolet, X-rays.

c. Ultraviolet, infra-red microwaves.

d. Visible radiation, gamma rays, radio waves.

11) Two monochromatic radiating X and Y are incident normally on a diffraction grating. The second order intensity maximum for X coincides with the third order intensity maximum for Y.

What is the ratio $\frac{\text{wavelength X}}{\text{wavelength Y}}$?

a. $\frac{1}{2}$ b. $\frac{2}{3}$ c. $\frac{3}{2}$ d. $\frac{2}{1}$

12) The tip of a needle does not give a sharp image. It is due to

a. Polarization b. Interference c. Diffraction d. Refraction

Answers:

1.	(a)	**2.**	(a)	**3.**	(c)	**4.**	(b)	**5.**	(c)
6.	(b)	**7.**	(d)	**8.**	(b)	**9.**	(c)	**10.**	(a)
11.	(c)	**12.**	(c)	-	-	-	-	-	-

Write the short answers of the following questions:

1) A soap bubble looks black when it bursts. Why?

Answer

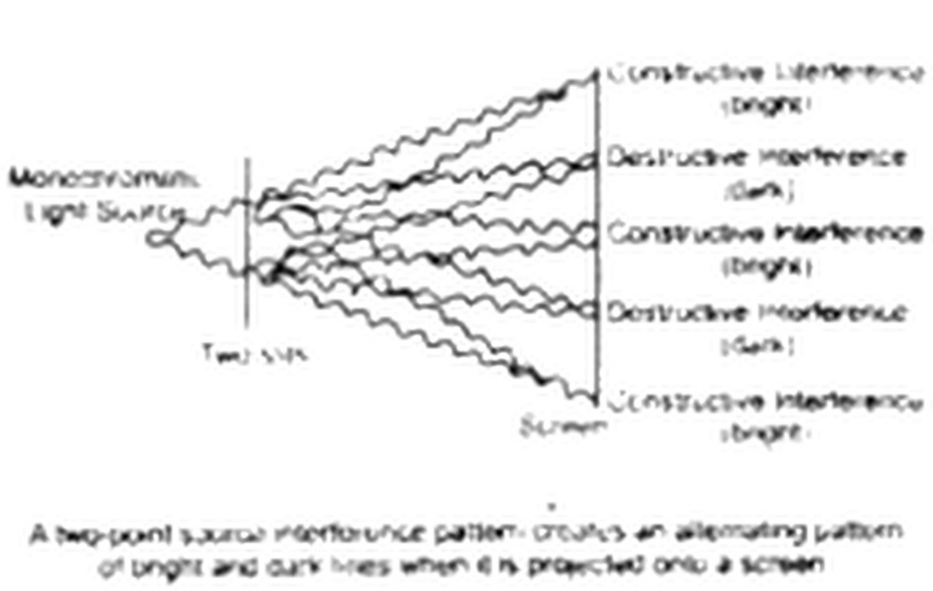
As brilliant and beautiful colour on soap bubble are produced due to interference of light reflected from two surfaces (upper and lower) does not occur in regular manner to satisfy the condition for interference. Hence a soap bubble looks black when it bursts.

2) What is the difference between interference and diffraction?

Answer:

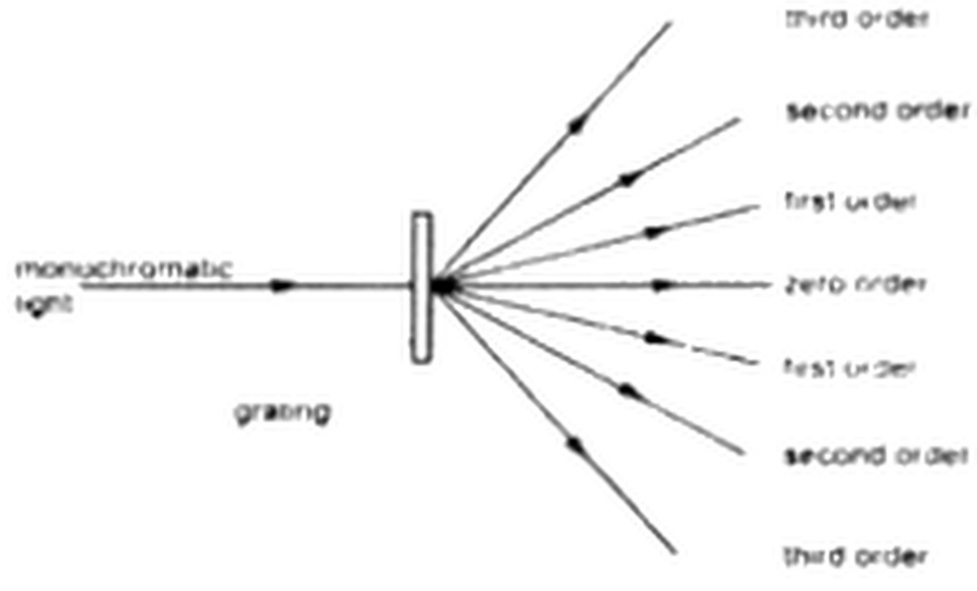
There is no fundamental distinction between interference and diffraction. However, interference phenomena involving waves from small number of waves usually two while diffraction phenomena involve a continuous distribution of Huygens's Wave lets across the area of an aperture or very large number of sources or slits (e.g. diffraction grating). The phenomena of interference and diffraction can also be distinguished as follows.

- When the waves to be superposed come from two openings, the resulting pattern which have alternate dark and bright fringes equally spaced on the screen.
- But when various portions of a single wave interfere the result is a diffraction pattern. In diffraction pattern the central bright fringes has maximum intensity and gradually decreases on either side from the central point as shown in fig.



A two-point source interference pattern creates an alternating pattern of bright and dark lines when it is projected onto a screen

Interference



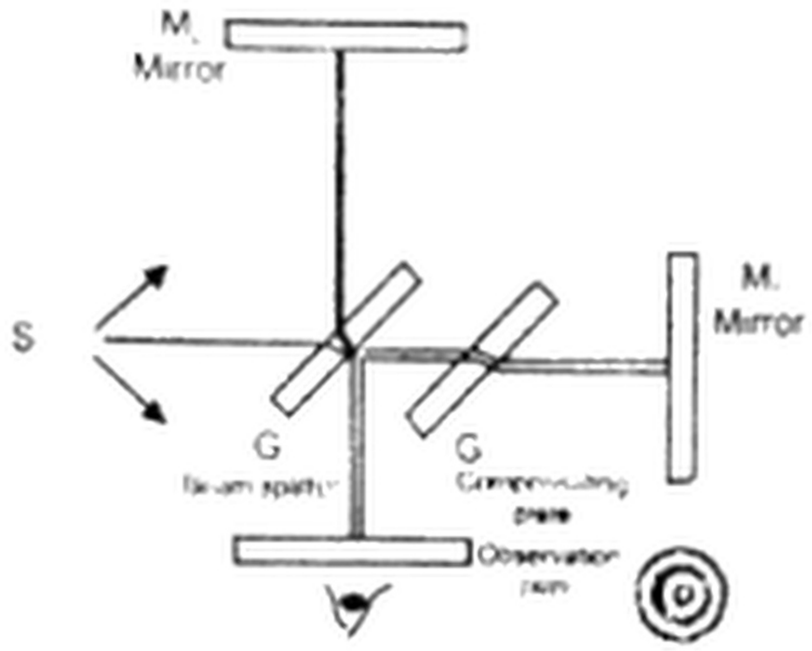
Diffraction

3) In a Michelson interferometer a second glass plate is also used. Why?

Answer

The second glass plate in Michelson interferometer is cut from the same piece of glass as first. Both glasses have equal thickness. The second glass which is introduced in the path of beam II acts as compensator plate. Therefore, it

equalizes the path length of beams I & II. The two beams having their different paths are coherent. That is why they produce interference effect when they arrive at the observer's eyes. The observer then seeds a series of parallel interference fringes.



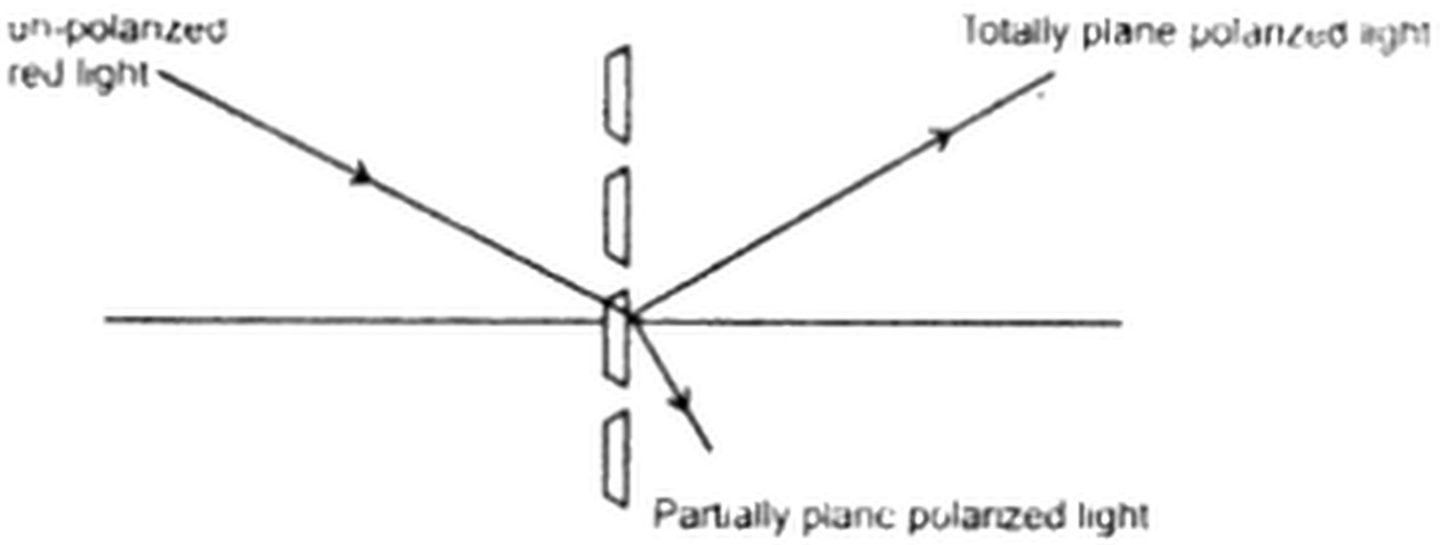
4) How can you explain Brewster's Law of polarization?

Answer

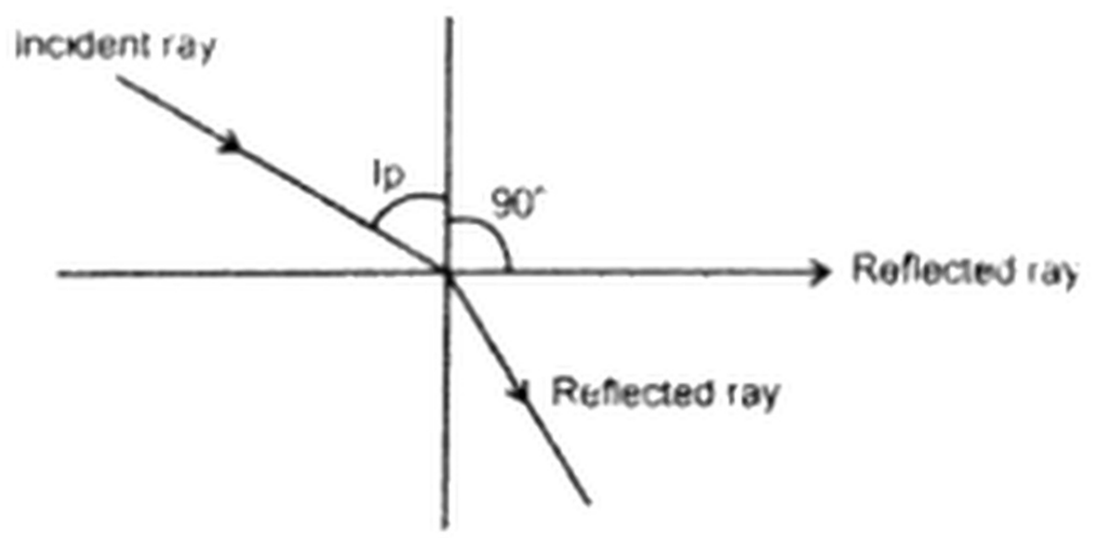
This law states that when un-polarized light falls on glass, water etc. at certain angle of incidence called polarizing angle. The polarization is complete.

Explanation

Suppose an un-polarized beam of light is incident on a glass surface as shown in fig. i.



The beam can be described by two electric field components, one parallel to surface and other perpendicular to the first component and to the direction of propagation. It is found that parallel component reflects more strongly than the other which results partial polarized reflected beam.



Let the angle of incidence Ip is varied until the angle between reflected and refracted beams becomes 90°. At this angle of incidence, the reflected beam is completely polarized.

An expression can be obtained for polarizing angle by Snell's Law.

$$n_1 \sin i_p = n_2 \sin r \qquad \text{.....(1)}$$

From the fig (ii)

$$I_p + 90^\circ + r = 180$$

$$r = 90^\circ - I_p \qquad \text{.....(2)}$$

Equation (1)becomes

$$n_1 \sin I_p = n_2 \sin(90^\circ - I_p)$$

$$n_1 \sin i_p = n_2 \cos I_p$$

$$\tan I_p = \frac{n_2}{n_1} \qquad \text{.....(3)}$$

This is known as Brester's Law

5) What is meant by the path difference with reference to the interference of two wave motion?

Answer

The path difference in interference of waves is the distance from two sources to that point in terms of wave length where waves superpose each other to result interference phenomenon. For example, path difference for constructive and destructive interference of waves are given as respectively.

$$\Delta S = n\lambda \qquad \ldots\ldots (1) \qquad \text{where } n = 0, 1, 2,$$

&

$$\Delta s = \left(n + \frac{1}{2}\right)\lambda \qquad \ldots\ldots (2)$$

6) Why it is not possible to see interference where the light beams from head lamps of a car overlap?

Answer:

For detectable interference of light, the following conditions must be satisfied.

i) The sources must be coherent

ii) The source must be monochromatic.

iii) Superposition principle must be applied.

Since light beams from head lamps of a car do not satisfy the above conditions because such light sources i.e. (from head lamps) undergo random changes about once every 10^{-8} sec. Therefore, conditions for constructive, destructive or intermediate state last for time of the order of 10^{-8} sec.

The result is that no interference effects are observed since the eyes cannot follow such short-term changes.

7) Why it is not possible to obtain the diffraction of x-rays by Young's double slits experiment.

Answer

As condition for diffraction of waves to occur is that the wave length of waves should be comparable to the width of lit through which they pass. Since x-rays are electromagnetic waves whose wavelength λ is of the order of 10^{10} m, which is far less than the width of slits in Young's experiment. That is why x-rays cannot diffract through slits. But x-rays can be diffracted through crystal because atomic spacing is comparable to the wavelength of x-rays.

8) Can we apply Huygens' principle to radar waves?

Answer

According to Huygens' principle every point of wave may be considered as a source of secondary wavelets i.e. Huygens' principle explains the propagation of all types of waves. Since radar is operated on radio waves which are electromagnetic in nature. Certainly, Huygens' principle can be applied to radar waves.

9) How would you justify that light waves are transverse in nature?

Answer

Light waves are electromagnetic in which electric field vector, magnetic field vector and direction of propagation are mutually orthogonal.

Interference and diffraction phenomenon are the best evidence to prove the wave nature of light, but cannot tell us whether the light waves are longitudinal or transverse.

However, polarization of light strongly suggest that the light waves are transverse in nature