CHAPTER NO. 9 (PHYSICAL OPTICS)

Question 9.1:- Under what conditions two or more sources of light behave as coherent sources?

Answer:- Two or more sources of light can only behave as coherent sources if they have constant phase difference between them with respect to space and time.

Two independent light sources can never be coherent. A common way to produce coherent sources is to illuminate a screen having two or more slits.

Question 9.2:- How is the distance between interference fringes affected by the separation between the slits of Young's experiment? Can fringes disappear?

Answer:- We know that fringe spacing in Young's experiment is given as $\Delta Y = \frac{\lambda L}{d}$.

This shows that fringe spacing varies inversely with the slit spacing d.

Yes, fringes can disappear. If slit spacing d is increased, fringe spacing ΔY decreases. If we keep on increasing slit spacing, fringes will come closer and eventually disappear.

Question 9.3:- Can visible light produce interference fringes? Explain.

Answer:- Yes, visible light or white light can produce interference but each colour (wavelength) will produce its own interference pattern. The fringe pattern will be coloured having spectrum of all seven colours.

Question 9.4:- In the Young's experiment, one of the slit is covered with blue filter and other with red filter. What would be the pattern of light intensity on the screen?

Answer:- On covering the slits with blue and red filters respectively, one slit emits red light and other emits blue light. In order to produce interference, interfering beams must be monochromatic, unidirectional and coherent. The emerging light beams from both slits are not monochromatic and coherent so no interference pattern will be observed on the screen. Only two bright spots of corresponding light will be observed on the screen.

Question 9.5:- Explain whether the Young's experiment is an experiment for studying interference or diffraction effects of light?

Answer:- Young's experiment is primarily designed to study the interference of light waves.

However, diffraction of light is also interference of light rays coming from different parts of a source of light.

Question 9.6:- An oil film spreading over a wet footpath shows colours. Explain how does it happen?

Answer:- An oil film spreading over a wet footpath shows colours due to interference of visible light through thin film. When light beam is incident on oil film, some part of it is reflected from upper surface. The remaining portion of light refracts through the film and is reflected from lower part of the film. These two beams interfere. Some colours show constructive interference while others show destructive according to angle of incidence, nature and thickness of oil film.

Question 9.7:- Could you obtain Newton's rings with transmitted light? If yes, would the pattern be different from that obtained with reflected light?

Answer:- Yes, Newton's rings can be obtained with transmitted light.

Yes, the pattern would be exactly opposite to that obtained with reflected light i.e. the central spot will be bright in case of transmitted light.

Question 9.8:- In the white light spectrum obtained with a diffraction grating, the third order image of a wavelength coincides with the fourth order image of a second wavelength. Calculate the ratio of two wavelengths.

Answer:- For a diffraction grating, condition for n^{th} order maxima is $d \sin \theta = n \lambda$.

For 3^{rd} order spectrum of first wavelength, $d \sin \theta = 3 \lambda_1$

For 4^{th} order spectrum of second wavelength, $d \sin \theta = 4 \lambda_2$

We can equate right hand sides of both equations as $3 \lambda_1 = 4 \lambda_2$

Rearranging gives $\frac{\lambda_1}{\lambda_2} = \frac{4}{3}$

Question 9.9:- How would you manage to get more orders of spectra using a diffraction grating?

Answer:- We know that for a diffraction grating $d \sin \theta = n \lambda$.

$n = \frac{d \sin \theta}{\lambda} = = \frac{\sin \theta}{N \lambda}$ as $d = \frac{1}{N}$ = Grating element = Distance between two consecutive lines on grating

In order to get more orders of spectrum, $\sin \theta$ should be maximum i.e. $\sin \theta = 1$ so $n_{max} = \frac{1}{N \lambda}$

We should use a grating having less number of lines per centimeter and use light of short wavelength.

Question 9.10:- Why the polaroid sunglasses are better than ordinary sunglasses?

Answer:- The sunlight reflected from roads, pond surfaces, table tops and window panels is horizontally polarized and produce glare. This glare of reflected light can be reduced or eliminated by using sunglasses made up of polaroid sheets or glasses whose transmission axis is vertical. Thus, polaroid sunglasses reduce the glare of reflected light from horizontal surfaces and are better than ordinary sunglasses.

Question 9.11:- How would you distinguish between un-polarized and plane-polarized lights?

Answer:- We can distinguish between un-polarized and plane-polarized light by using a polarizer. If a polarizer is rotated in front of incident un-polarized light, a component of light will pass through it for each orientation / angle. For polarized light, no light will pass through the polarizer except for a certain angle / orientation.

Question 9.12:- Fill in the blanks.

Answer:- (i) According to **Huygen's** principle, each point on a wavefront acts as a source of secondary **wavelet.**

(ii) In Young's experiment, the distance between two adjacent bright fringes for violet light is **less** than that for green light.

(iii) The distance between bright fringes in the interference pattern **increases** as the wavelength of light used increases.

(iv) A diffraction grating is used to make a diffraction pattern for yellow light and then for red light. The distance between the red spots will be **more** than that for yellow light.

(v) The phenomenon of polarization of light reveals that light waves are **transverse** waves.

(vi) A polaroid is a commercial **polarizing material.**

(vii) A polaroid glass **reduces** glare of light produced at a road surface.