EXERCISE QUESTIONS

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 no phase difference or have a constant phase difference. Two independent light sources are never coherent as each source emits waves with random phases.

A common method for producing two coherent light sources is to use monochromatic light source to illuminate a screen containing two slits. The light emerging from both the slits in this way is coherent.

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

Answer :- As we have

$$\Delta y = \frac{L\lambda}{d}$$

$$\Rightarrow \Delta y \propto \frac{1}{d}$$

This shows that fringe spacing varies inversly with separation between the slits. If separation is increased, the distance between the fringes decreases. They come closer and may eventually disappear producing a general illumination.

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

Answer :- Yes, visible light or white light can produce interference fringes but each wavelength will produce its own interference fringe and hence the fringe pattern will then be coloured at each point depends on which wavelength is reinforced by interference.

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

Answer:- Since blue and red lights have different wave lengths, so these are not in coherence, hence no interference pattern will be observed.

9.5:- Explain whether the Young's experiment is an experiment for studing interference or diffraction effects of light.

Answer:- Young's experiment was performed to study the interference of light, although the diffraction can also be studied by this experiment because when light passes through the slit it bends towards the corner.

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 light through thin film (oil film). When a light beam is incident, a part of it is reflected from the upper surface of thin oil film and other is reflected from the lower surface of thin film. The two reflected beams are coherent being part of same beam. As the sun light (white light) consists of seven colours and each colours refracts differently hence after reflection different colours interfere at different points as compared to others and a wet footpath shows colours.

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 observed with transmitted light. The only difference will be that central point will not be dark but bright by transmitted light.

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 the two wavelengths:

Answer:- For a diffraction grating

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

where $d\sin\theta$ = Path Difference
n = Order of the Image.
λ = wave length

For 3rd order image and first wavelength

$$d \sin\theta = 3\lambda_1 \quad \text{---} (1)$$

For 4th order image and second wavelength

$$d \sin\theta = 4\lambda_2 \quad \text{---} (2)$$

As the two wavelengths coincides, so the path diff. will be equal.

Dividing eq (1) by (2)

$$\frac{3\lambda_1}{4\lambda_2} = \frac{d\sin\theta}{d\sin\theta}$$

$$3\lambda_1 = 4\lambda_2$$

$$\boxed{\frac{\lambda_1}{\lambda_2} = \frac{4}{3}}$$

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

Answer:- For a diffraction grating

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

So for a given wavelength λ, the order 'n' of spectra depends on 'd' the grating element. For maximum value of $\sin\theta$ i-e 1 the angle is 90°. Hence order of spectra depends on grating element (i-e $d \propto n$). The only way to increase the value of grating element or spacing between the lines, we can increase order.

As $d = \frac{1}{N}$

Hence a grating with lesser number of lines per centimeter ruled over it can produce more orders of spectra.

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

Answer:- The sunlight reflected from smooth surfaces such as wet road, lakes window panels and table tops etc, is horizontally polaroids and produces glare. The glare to the reflected light can be reduced or eliminated by using sunglasses made out polaroid sheet of glass with its select transmission axis vertical. Thus the horizontally polarized light cannot go through.

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

Answer:- The un-polarized and plane-polarized light canbe distinguished by using a polarizer. If a polarizer is rotated infront of incident un-polarized light, a component of light will pass through polarizer in each orientation. In case of polarized light except at a particular orientation no light will pass through at all.

9.12 Fill in the blanks

Answer :-

(i)- According to Huygen's principle, each point on a wavefront act as a source of secondary wavefront

(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 wave.

(vi)- A Polaroid is a commercial polarizer

(vii)- A Polaroid glass eliminates glare of light produced at a road surface

NUMERICAL PROBLEMS

9.1:- Light of wavelength 546nm is allowed to illuminate the slits of Young's experiment. The separation between the slits is 0.10 mm and the distance of the screen from the slits where interference effects are observed is 20cm. At what angle the first minimum will fall? What will be the linear distance on the screen between adjacent maxima?

SOLUTION :-

Given Data :- $\lambda = 546\,nm = 546 \times 10^{-9}\,m$