Wave Optics

Assertion & Reason Type Questions

Directions: In the following questions, a statement of Assertion (A) is followed by a statement of Reason (R). Mark the correct choice as:

a. Both Assertion (A) and Reason (R) are true and Reason (R) is the correct explanation of Assertion (A).

b. Both Assertion (A) and Reason (R) are true but Reason (R) is not the correct explanation of Assertion (A).

c. Assertion (A) is true but Reason (R) is false.

d. Both Assertion (A) and Reason (R) are false.

Q1. Assertion (A): In Young's experiment, the fringe width for dark fringes is different from that for white fringes.

Reason (R): In Young's double slit experiment, the fringes are performed with a source of white light, then only black and bright fringes are observed.

Answer : (d) In Young's experiments fringe width for dark and white fringes are same while in Young's double slit experiment when a white light as a source is used, the central fringe is white around which few coloured fringes are observed on either side.

Q2. Assertion (A): For best contrast between maxima and minima in the interference pattern of Young's double slit experiment, the intensity of light emerging out of the two slits should be equal.

Reason (R): The intensity of interference pattern is proportional to square of amplitude.

Answer :

(b) When intensity of light emerging from two slits is equal, the intensity at minima $I_{min} = (\sqrt{I_a} - \sqrt{I_b})^2 = 0$, or absolute dark.

It provides a better contrast.

Q3. Assertion (A): In Young's double slit experiment, the fringes become indistinct if one of the slit is covered with cellophane paper (a thin transparent sheet made of regenerated cellulose).

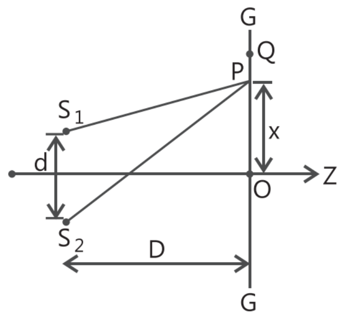
Reason (R): The cellophane paper decreases the wavelength of light.

Answer : (c) When one of slits is covered with cellophane paper, the intensity of light emerging from the slit is decreased (because this medium is translucent). Now the two interfering beam have different intensities or amplitudes. Hence intensity at minima will not be zero and fringes will become indistinct.

Q4. Assertion (A): The fringe closest on either side of the central white fringe in case of interference pattern due to white light is red and the farthest appears blue.

Reason (R): The interference patterns due to different component colours of white light overlap.

Answer : (b) The interference patterns due to different component colours of white light overlap incoherently.



The central bright fringes for different colours are at the same position. Therefore, the central fringe is white.

For a point P at which $S_2P - S_1P = \frac{\lambda_b}{2}$, where

λ_b = 4000 Å represents the wavelength for the blue colour, the blue component will be absent and the fringe will appear red in colour. Slightly farther

away where $S_2Q - S_1Q = \lambda_b = \frac{\lambda_r}{2}$ where $\lambda_r \approx 8000$ Å

is the wavelength for the red colour, the fringe will be predominantly blue. Thus, the fringe closest on either side of the central white fringe is red and the farthest will appear blue.

Q5. Assertion (A): The film which appears bright in reflected system will appear dark in the transmitted light and vice-versa.

Reason (R): The conditions for film to appear bright or dark in reflected light are just reverse to those in the transmitted light.

Answer :

(a) For reflected system of the film, the maxima or constructive interference is $\underline{2\mu t \cos r = \frac{(2n-1)\lambda}{2}}$ while the maxima for transmitted system of film is given by equation $\underline{2\mu t \cos r} = \underline{n}\lambda$, where t is thickness of the film and r is angle of reflection.

From these two equations, we can see that condition for maxima in reflected system and transmitted system are just opposite.

Q6. Assertion (A): Thin films such as soap bubble or a thin layer of oil on water show beautiful colours when illuminated by white light.

Reason (R): It happens due to the interference of light reflected from the upper surface of the thin film.

Answer : (c) The beautiful colours are seen on account of interference of light reflected from the upper and the lower surfaces of the thin films.

Q7. Assertion (A): When a tiny circular obstacle is placed in the path of light from some distance, a bright spot is seen at the centre of shadow of the obstacle.

Reason (R): Destructive interference occurs at the centre of the shadow.

Answer : (c) As the waves diffracted from the edges of circular obstacle, placed in the path of light interfere constructively at the centre of the shadow resulting in the formation of a bright spot.

Q8. Assertion (A): Coloured spectrum is seen when we look through a muslin cloth.

Reason (R): It is due to the diffraction of white light on passing through fine slits.

Answer : (a) It is quite clear that the coloured spectrum is seen due to diffraction of white light on passing through fine slits made by fine threads in the muslin cloth.

Q9. Assertion (A): If we look clearly at the shadow cast by an opaque object, close to the region of geometrical shadow, alternate dark and bright regions can be seen.

Reason (R): This happens due to the phenomenon of interference.

Answer : (c) This happens due to the phenomenon of diffraction. It is a general characteristics exhibited by all types of waves, sound waves, light waves, water waves or matter waves.

Q10. Assertion: According to Huygen's principle, no backward wave-front is possible.

Reason: Amplitude of secondary wavelet is proportional to $(1 + \cos\theta)$ where θ is the angle between the ray at the point of consideration and the direction of secondary wavelet.

Q11. Assertion: Thin film such as soap bubble or a thin layer of oil on water show beautiful colours when illuminated by white light.

Reason: It happens due to the interference of light reflected from upper and lower face of the thin film.

Q12. Assertion: No interference pattern is detected when two coherent sources are infinitely close to each other.

Reason: The fringe width is inversely proportional to the distance between the two sources.

Q13**. Assertion:** It is necessary to have two waves of equal intensity to study interference pattern.

Reason: There will be an effect on clarity if the waves are of unequal intensity.

Q14**. Assertion:** White light falls on a double slit with one slit is covered by a green filter. The bright fringes observed are of green colour.

Reason: The fringes observed are coloured.

Q15**. Assertion:** In YDSE, if a thin film is introduced in front of the upper slit, then the fringe pattern shifts in the downward direction.

Reason: In YDSE if the slit widths are unequal, the minima will be completely dark.

Q16**. Assertion:** In Young's double slit experiment if wavelength of incident monochromatic light is just doubled, number of bright fringe on the screen will increase.

Reason: Maximum number of bright fringe on the screen is inversely proportional to the wavelength of light used.

Q17. Assertion: In YDSE number of bright fringe or dark fringe can not be unlimited

Reason: In YDSE path difference between the superposing waves can not be more than the distance between the slits.

Q18. Assertion: Interference pattern is made by using yellow light instead of red light, the fringes becomes narrower.

Reason: In YDSE, fringe width is given by $\beta=\lambda D/d$

Q19. Assertion: Coloured spectrum is seen when we look through a muslin cloth.

Reason: It is due the diffraction of white light on passing through fine slits.

Q20. Assertion: Diffraction takes place for all types of waves mechanical or non-mechanical, transverse or longitudinal.

Reason: Diffraction's effect are perceptible only if wavelength of wave is comparable to dimensions of diffracting device.

ANSWER KEY 10 to 20

Q10 **:** (b) **Q**11 **:** (a) **Q**12 **:** (a)

Q13 **:** (d) For interference, the waves may be of unequal intensities.

Q14 **:** (c) Interference will take place in green light only

Q15 **:** (d) **Q**16 **:** (a) **Q**17 **:** (b) **Q**18 **:** (a)

Q19 **:** (a) **Q**20 **:** (b)