29. Wave Optics & Electromagnetic Theory – Multiple Choice Questions

1. Wave Nature and Interference of Light

1. By Huygens' wave theory of light, we cannot explain the phenomenon of
   (a) Interference (b) Diffraction
   (c) Photoelectric effect (d) Polarisation

2. By a monochromatic wave, we mean
   (a) A single ray
   (b) A single ray of a single colour
   (c) Wave having a single wavelength
   (d) Many rays of a single colour

3. Spherical wave fronts, emanating from a point source, strike a plane reflecting surface. What will happen to these wave fronts, immediately after reflection
   (a) They will remain spherical with the same curvature, both in magnitude and sign
   (b) They will become plane wave fronts
   (c) They will remain spherical, with the same curvature, but sign of curvature reversed
   (d) They will remain spherical, but with different curvature, both in magnitude and sign

4. Newton postulated his corpuscular theory on the basis of
   (a) Newton's rings
   (b) Colours of thin films
   (c) Rectilinear propagation of light
   (d) Dispersion of white light

5. Select the right option in the following
   (a) Christian Huygens a contemporary of Newton established the wave theory of light by assuming that light waves were transverse
   (b) Maxwell provided the compelling theoretical evidence that light is transverse wave
   (c) Thomas Young experimentally proved the wave behaviour of light and Huygens assumption
   (d) All the statements give above, correctly answers the question "what is light"

6. Huygen's principle of secondary wavelets may be used to
   (a) Find the velocity of light in vacuum
   (b) Explain the particle behaviour of light
   (c) Find the new position of the wavefront
   (d) Explain photoelectric effect

7. Huygens wave theory allows us to know
   (a) The wavelength of the wave
   (b) The velocity of the wave
   (c) The amplitude of the wave
   (d) The propagation of wave fronts

8. Which of the following is not a property of light
   (a) It requires a material medium for propagation
   (b) It can travel through vacuum
   (c) It involves transportation of energy
   (d) It has finite speed

9. The rectilinear propagation of light in a medium is due to its
   (a) High Velocity (b) Large wavelength
   (c) High frequency (d) Source

10. Two beams of light will not give rise to an interference pattern, if
    (a) They are coherent
    (b) They have the same wavelength
    (c) They are linearly polarized perpendicular to each other
    (d) They are not monochromatic

11. Two coherent sources of light can be obtained by
    (a) Two different lamps
    (b) Two different lamps but of the same power
    (c) Two different lamps of same power and having the same colour
    (d) None of the above

12. Two sources of waves are called coherent if
    (a) Both have the same amplitude of vibrations
    (b) Both produce waves of the same wavelength
    (c) Both produce waves of the same wavelength having constant phase difference
    (d) Both produce waves having the same velocity

13. Two light sources are said to be coherent if they are obtained from
    (a) Two independent point sources emitting light of the same wavelength
    (b) A single point source
    (c) A wide source
    (d) Two ordinary bulbs emitting light of different wavelengths

14. For constructive interference to take place between two monochromatic light waves of wavelength λ, the path difference should be

(a) $(2n-1)\frac{\lambda}{4}$ (b) $(2n-1)\frac{\lambda}{2}$

(c) $n\lambda$ (d) $(2n+1)\frac{\lambda}{2}$

15. Two waves of intensity I undergo Interference. The maximum intensity obtained is

(a) $I/2$ (b) I

(c) $2I$ (d) $4I$

16. If the amplitude ratio of two sources producing interference is 3 : 5, the ratio of intensities at maxima and minima is

(a) 25 : 16 (b) 5 : 3

(c) 16 : 1 (d) 25 : 9

17. A thin film of soap solution $(\mu_s = 1.4)$ lies on the top of a glass plate $(\mu_g = 1.5)$. When visible light is incident almost normal to the plate, two adjacent reflection maxima are observed at two wavelengths 420 and 630 *nm*. The minimum thickness of the soap solution are

(a) 420 *nm* (b) 450 *nm*

(c) 630 *nm* (d) 1260 *nm*

18. A light of wavelength 5890 Å falls normally on a thin air film. The minimum thickness of the film such that the film appears dark in reflected light is

(a) $2.945\times10^{-7}m$ (b) $3.945\times10^{-7}m$

(c) $4.95\times10^{-7}m$ (d) $1.945\times10^{-7}m$

2. Young's Double Slit Experiment and Biprism

1. In a Young's double-slit experiment, the source is white light. One of the holes is covered by a red filter and another by a blue filter. In this case,

(a) There shall be alternate interference patterns of red and blue

(b) There shall be an interference pattern for red distinct from that for blue

(c) There shall be no interference fringes

(d) There shall be an interference pattern for red mixing with one for blue

2. An interference pattern was made by using red light. If the red light changes with blue light, the fringes will become

(a) Wider (b) Narrower

(c) Fainter (d) Brighter

3. The two slits at a distance of 1 *mm* are illuminated by the light of wavelength $6.5\times10^{-7}m$. The interference fringes are observed on a screen placed at a distance of 1*m*. The distance between third dark fringe and fifth bright fringe will be

(a) 0.65 *mm* (b) 1.63 *mm*

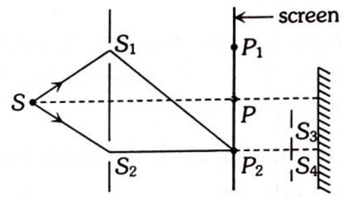
(c) 3.25 *mm* (d) 4.88 *mm*

4. In a two slit experiment with monochromatic light fringes are obtained on a screen placed at some distance from the sits. If the screen is moved by $5\times10^{-2}m$ towards the slits, the change in fringe width is $3\times10^{-5}m$. If separation between the slits is $10^{-3}m$, the wavelength of light used is

(a) 6000 Å (b) 5000 Å

(c) 3000 Å (d) 4500 Å

5. Figure shows a standard two slit arrangement with slits S_1, S_2, P_1, P_2 are the two minima points on either side of P (figure)



At P_2 on the screen, there is a hole and behind P_2 is a second 2 - slit arrangement with slits S_3, S_4 and a second screen behind them

(a) There would be no interference pattern on the second screen but it would be lighted

(b) The second screen would be totally dark

(c) There would be a single bright point on the second screen

(d) There would be a regular two slit pattern on the second screen

6. In a Young's double slit set – up, light from a laser source falls on a pair of very narrow slits separated by 1.0 micrometer and bright fringes separated by 1.0 millimeter are observed on a distant screen. If the frequency of the laser light is doubled, what will be the separation of the bright fringes

(a) 0.25 *mm* (b) 0.5 *mm*

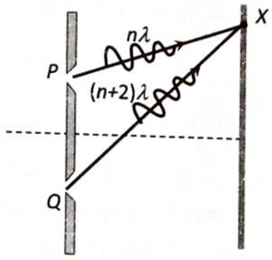
(c) 1.0 *mm* (d) 2.0 *mm*

7. In young's double slit experiment, the distance between the two slits is 0.1*mm*, the distance between the slits and the screen is 1*m* and the wavelength of the light used is 600 *nm*. The intensity at a point on the screen 75% of the maximum intensity. What is the smallest distance of this point from the central fringe

(a) 1.0 *mm* (b) 2.0 *mm*

(c) 0.5 *mm* (d) 1.5 *mm*

8. The figure shows a double slit experiment where P and Q are the slits. The path lengths PX and QX are $n\lambda$ and $(n+2)\lambda$ respectively, where n is a whole number and λ is the wavelength. Taking the central fringe as zero, what is formed at X



(a) First bright
(b) First dark
(c) Second bright
(d) Second dark

9. The Young's experiment is performed with the lights of blue (λ = 4360 Å) and green colour (λ = 5460 Å), if the distance of the 4th fringe from the centre is x, then

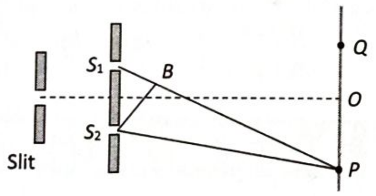
(a) x (Blue) = x (Green) (b) x (Blue) > x (Green)

(c) x (Blue) < x (Green) (d) $\frac{x(Blue)}{x(Green)} = \frac{5460}{4360}$

10. A narrow slit of width $2mm$ is illuminated by monochromatic light of wavelength $500nm$. The distance between the first minima on either side on a screen at a distance of $1m$ is

(a) $5mm$ (b) $0.5mm$
(c) $1mm$ (d) $10mm$
(e) $2.5mm$

11. In the figure is shown Young's double slit experiment. Q is the position of the first bright fringe on the right side of O. P is the 11^{th} fringe on the other side, as measured from Q. If the wavelength of the light used is $6000\times10^{-10}m$, then S_1B will be equal to



(a) $6\times10^{-6}m$
(b) $6.6\times10^{-6}m$
(c) $3.138\times10^{-7}m$
(d) $3.144\times10^{-7}m$

12. In Young's double slit experiment, the phase difference between the light waves reaching third bright fringe from the central fringe will be (λ =6000 Å)

(a) Zero (b) 2π
(c) 4π (d) 6π

13. Consider a ray of light incident from air onto a slab of glass (refractive index n) of width d, at an angle θ. The phase difference between the ray reflected by the top surface of the glass and the bottom surface is

(a) $\frac{4\pi d}{\lambda}\left(1-\frac{1}{n^2}\sin^2\theta\right)^{1/2}+\pi$

(b) $\frac{4\pi d}{\lambda}\left(1-\frac{1}{n^2}\sin^2\theta\right)^{1/2}$

(c) $\frac{4\pi d}{\lambda}\left(1-\frac{1}{n^2}\sin^2\theta\right)^{1/2}+\pi/2$

(d) $\frac{4\pi d}{\lambda}\left(1-\frac{1}{n^2}\sin^2\theta\right)^{1/2}+2\pi$

14. Consider Fraunhofer diffraction pattern obtained with a single slit at normal incidence. At the angular position of first diffraction minimum, the phase difference between the wavelets from the opposite edges of the slit is

(a) $\pi/4$ (b) $\pi/2$
(c) π (d) 2π

15. In Young's double slit experiment with slit separation d, a monochromatic light of wavelength λ is used. The angular separation of the fringes is

(a) d/λ (b) λ/d
(c) $2\lambda/d$ (d) $\lambda/2d$
(e) $\lambda/4d$

16. In a Young's double slit experiment (slit distance d) monochromatic light of wavelength λ is used and the figure pattern observed at a distance D from the slits. The angular position of the bright fringes are

(a) $\sin^{-1}\left(\frac{N\lambda}{d}\right)$ (b $\sin^{-1}\left(\frac{\left(N+\frac{1}{2}\right)\lambda}{d}\right)$

(c) $\sin^{-1}\left(\frac{N\lambda}{D}\right)$ (d) $\sin^{-1}\left(\frac{\left(N+\frac{1}{2}\right)\lambda}{D}\right)$

17. In double slit experiment, the angular width of the fringes is 0.20° for the sodium light (λ =5890 Å). In order to increase the angular width of the fringes by 10%, the necessary change in the wavelength is

(a) Increase of 589 Å (b) Decrease of 589 Å
(c) Increase of 6479 Å (d) Zero

18. In Young's double slit experiment, angular width of fringes is 0.20° for sodium light of wavelength 5890 Å. If complete system is dipped in water, then angular width of fringes becomes

(a) 0.11° (b) 0.15°
(c) 0.22° (d) 0.30°

19. In Young's double slit experiment, distance between two sources is 0.1 mm. The distance of screen from the sources is 20 cm. Wavelength of light used is 5460 Å. Then angular position of the first dark fringe is

(a) 0.08° (b) 0.16°
(c) 0.20° (d) 0.313°

20. The maximum intensity of fringes in Young's experiment is I. If one of the slit is closed, then the intensity at that place becomes I_o. Which of the following relation is true

(a) $I = I_o$
(b) $I = 2I_o$
(c) $I = 4I_o$
(d) There is no relation between I and I_o

21. In Young's double slit experiment, if the widths of the slits are in the ratio 4 : 9, the ratio of the intensity at maxima to the intensity at minima will be

(a) 169 : 25 (b) 81 : 16

(c) 25 : 1 (d) 9 : 4

22. In Young's double slit experiment, the intensity of light coming from the first slit is double the intensity from the second slit. The ratio of the maximum intensity to the minimum intensity on the interference fringe pattern observed is

(a) 34 (b) 40

(c) 25 (d) 38

23. If the two slits in Young's double slit experiment are of unequal width, then

(a) The bright fringes will have unequal spacing

(b) The bright fringes will have unequal brightness

(c) The fringes do not appear

(d) The dark fringes are not perfectly dark

24. In Young's double slit experiment, the ratio of intensities of bright and dark bands is 16 which means

(a) The ratio of their amplitudes is 5

(b) Intensities of individual sources are 25 and 9 units respectively

(c) The ratio of their amplitudes is 4

(d) Intensities of individual sources are 4 and 3 units respectively

25. The maximum intensity in Young's double slit experiment is I_0. Distance between the slits is $d = 5\lambda$, where λ is the wavelength of monochromatic light used in the experiment. What will be the intensity of light in front of one of the slits on a screen at a distance $D = 10d$

(a) $\frac{I_0}{2}$ (b) $\frac{3}{4}I_0$

(c) I_0 (d) $\frac{I_0}{4}$

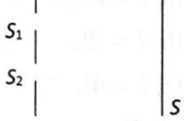
26. In a Young's double slit experiment the intensity of light at each slit is I_0. Interference pattern is observed along a direction parallel to the line $S_1 S_2$ on screen, S. The minimum, maximum, and the intensity averaged over the entire screen are respectively

(a) $0, 4I_0, 2I_0$

(b) $I_0, 2I_0, 3I_0/2$

(c) $I_0, 4I_0, I_0$

(d) $I_0, 2I_0, I_0$



27. In Young's double slit experiment, a mica slit of thickness t and refractive index μ is introduced in the ray from the first source S_1. By how much distance the fringes pattern will be displaced

(a) $\frac{d}{D}(\mu-1)t$ (b) $\frac{D}{d}(\mu-1)t$

(c) $\frac{d}{(\mu-1)D}$ (d) $\frac{D}{d}(\mu-1)$

28. A thin plastic sheet of refractive index 1.6 is used to cover one of slits of a double slit arrangement. The central point on the screen is now occupied by what would have been the 7th bright fringe before the plastic was used. If the wavelength of light is 600 nm, what is the thickness (in μm) of the plastic

(a) 7 (b) 4

(c) 8 (d) 6

29. A flake of glass (refractive index 1.5) is placed over one of the openings of a double slit apparatus. The interference pattern displaces itself through seven successive maxima towards the side where the flake is placed. If wavelength of the diffracted light is $\lambda = 600nm$, then the thickness of the flake is

(a) 2100 *nm* (b) 4200 *nm*

(c) 8400 *nm* (d) None of these

30. In Young's double slit experiment, the aperture screen distance is 2m. The fringe width is 1 mm. Light of 600 nm is used. If a thin plate of glass (μ = 1.5) of thickness 0.06 mm is placed over one of the slits, then there will be a lateral displacement of the fringes by

(a) 0 *cm* (b) 5 *cm*

(c) 10 *cm* (d) 15 *cm*

3. Diffraction of Light

1. The bending of beam of light around corners of obstacles is called

(a) Reflection (b) Diffraction

(c) Refraction (d) Interference

2. Conditions of diffraction is

(a) $\frac{a}{\lambda} = 1$ (b) $\frac{a}{\lambda} >> 1$

(c) $\frac{a}{\lambda} << 1$ (d) None of these

3. Consider sunlight incident on a slit of width $10^4\,\AA$. The image seen through the slit shall

(a) Be a fine sharp slit white in colour at the centre

(b) A bright slit white at the centre diffusing to zero intensities at the edges

(c) A bright slit white at the centre diffusing to regions of different colours

(d) Only be a diffused slit white in colour

4. A single slit of width 0.20 *mm* is illuminated with light of wavelength 500 *nm*. The observing screen is placed 80 *cm* from the slit. The width of the central bright fringe will be

(a) 1 *mm* (b) 2 *mm*

(c) 4 *mm* (d) 5 *mm*

5. Light of wavelength $589.3\,nm$ is incident normally on the slit of width $0.1\,mm$. What will be the angular width of the central diffraction maximum at a distance of $1\,m$ from the slit

(a) 0.68° (b) 1.02°

(c) 0.34° (d) None of these

6. What will be the angular width of central maxima in Fraunhoffer diffraction when light of wavelength $6000\,Å$ is used and slit width is $12\times10^{-5}\,cm$

(a) 2 *rad* (b) 3 *rad*

(c) 1 *rad* (d) 8 *rad*

7. A plane wavefront $(\lambda = 6\times10^{-7}\,m)$ falls on a slit $0.4\,mm$ wide. A convex lens of focal length $0.8\,m$ placed behind the slit focuses the light on a screen. What is the linear diameter of second maximum

(a) $6\,mm$ (b) $12\,mm$

(c) $3\,mm$ (d) $9\,mm$

8. Red light is generally used to observe diffraction pattern from single slit. If blue light is used instead of red light, then diffraction pattern

(a) Will be more clear (b) Will contract

(c) Will expanded (d) Will not be visualized

9. In a single-slit diffraction experiment, the width of the slit is reduced by half. Which of the following needs to be done if the width of the central maxima has to remain the same

(a) Reduce the distance between the slit and screen by half

(b) Reduce the distance between the slit and the screen to $\left(\frac{1}{4}\right)^{th}$ the original separation

(c) Double the distance between the slit and the screen

(d) No need to do anything, as the width of the central maxima does not depend on the slit width

10. Light of wavelength $\lambda = 5000\,Å$ falls normally on a narrow slit. A screen placed at a distance of 1 *m* from the slit and perpendicular to the direction of light. The first minima of the diffraction pattern is situated at 5 *mm* from the centre of central maximum. The width of the slit is

(a) 0.1 *mm* (b) 1.0 *mm*

(c) 0.5 *mm* (d) 0.2 *mm*

11. A single slit of width *a* is illuminated by violet light of wavelength 400 *nm* and the width of the diffraction pattern is measured as *y*. When half of the slit width is covered and illuminated by yellow light of wavelength 600 *nm*, the width of the diffraction pattern is

(a) The pattern vanishes and the width is zero

(b) $y/3$

(c) $3y$

(d) None of these

12. Angular width of central maxima in the Fraunhoffer diffraction pattern of a slit is measured. The slit is illuminated by light of wavelength 6000 Å. When the slit is illuminated by light of another wavelength, the angular width decreases by 30%. The wavelength of this light will be

(a) 6000 Å (b) 4200 Å

(c) 3000 Å (d) 1800 Å

13. Radius of central zone of circular zone plate is $2.3\,mm$. Wavelength of incident light is 5893 Å. Source is at a distance of $6\,m$. Then the distance of first image will be

(a) $9\,m$ (b) $12\,m$

(c) $24\,m$ (d) $36\,m$

14. Light of wave length λ is incident on slit of width *d*. The resulting diffraction pattern is observed on a screen placed at distance *D*. The linear width of central maximum is equal to width of the slit, then $D =$ ______

(a) $\frac{d^2}{2\lambda}$ (b) $\frac{2\lambda^2}{d}$

(c) $\frac{d}{\lambda}$ (d) $\frac{2\lambda}{d}$

4. Polarization of Light

1. An optically active compound

(a) Rotates the plane polarised light

(b) Changes the direction of polarised light

(c) Does not allow plane polarised light to pass through

(d) None of the above

2. The angle of polarisation for any medium is 60°, what will be critical angle for this

(a) $\sin^{-1}\sqrt{3}$ (b) $\tan^{-1}\sqrt{3}$

(c) $\cos^{-1}\sqrt{3}$ (d) $\sin^{-1}\frac{1}{\sqrt{3}}$

3. When unpolarised light beam is incident from air onto glass ($n = 1.5$) at the polarising angle

(a) Reflected beam is polarised 100 percent

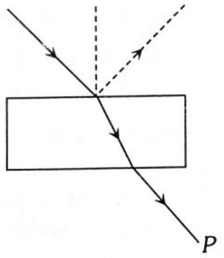
(b) Reflected and refracted beams are partially polarised

(c) The reason for (a) is that almost all the light is reflected

(d) All of the above

4. Consider a light beam incident from air to a glass slab at Brewster's angle as shown in figure.

A polaroid is placed in the path of the emergent ray at point P and rotated about an axis passing through the centre and perpendicular to the plane of the polaroid



(a) For a particular orientation, there shall be darkness as observed through the polaroid

(b) The intensity of light as seen through the polaroid shall be independent of the rotation

(c) The intensity of light as seen through the polaroid shall go through a minimum but not zero for two orientations of the polaroid

(d) The intensity of light as seen through the polaroid shall go through a minimum for four orientations of the polaroid

5. When the angle of incidence on a material is 60°, the reflected light is completely polarized. The velocity of the refracted ray inside the material is (in ms^{-1})

(a) 3×10^8 (b) $\left(\frac{3}{\sqrt{2}}\right)\times10^8$

(c) $\sqrt{3}\times10^8$ (d) 0.5×10^8

6. Two polaroids are placed in the path of unpolarized beam of intensity I_0 such that no light is emitted from the second polaroid. If a third polaroid whose polarization axis makes an angle θ with the polarization axis of first polaroid, is placed between these polaroids then the intensity of light emerging from the last polaroid will be

(a) $\left(\frac{I_0}{8}\right)\sin^2 2\theta$ (b) $\left(\frac{I_0}{4}\right)\sin^2 2\theta$

(c) $\left(\frac{I_0}{2}\right)\cos^4\theta$ (d) $I_0\cos^4\theta$

7. Unpolarized light falls on two polarizing sheets placed one on top of the other. What must be the angle between the characteristic directions of the sheets if the intensity of the final transmitted light is one-third the maximum intensity of the first transmitted beam

(a) 75° (b) 55°

(c) 35° (d) 15°

8. A plane polarized light is incident normally on a tourmaline plate. Its $\vec{E}$ vectors make an angle of 60° with the optic axis of the plate. Find the percentage difference between initial and final intensities

(a) 25% (b) 50%

(c) 75% (d) 90%

9. A plane polarized light passed through successive polarizers which are rotated by $30°$ with respect to each other in the clockwise direction. Neglecting absorption by the polarizers and given that the first polarizer's axis is parallel to the plane of polarization of the incident light, the intensity of light at the exit of the fifth polarizer is closest to

(a) Same as that of the incident light

(b) 17.5% of the incident light

(c) 30% of the incident light

(d) Zero

10. An unpolarized beam of light of intensity I_0 passes through two linear polarizers making an angle of $30°$ with respect to each other. The emergent beam will have an intensity

(a) $\frac{3I_0}{4}$ (b) $\frac{\sqrt{3}I_0}{4}$

(c) $\frac{3I_0}{8}$ (d) $\frac{I_0}{8}$

5. EM Waves

1. The range of wavelength of the visible light is

(a) 10 Å to 100 Å (b) 4,000 Å to 8,000 Å

(c) 8,000 Å to 10,000 Å (d) 10,000 Å to 15,000 Å

2. Radio waves diffract around building although light waves do not. The reason is that radio waves

(a) Travel with speed larger than c

(b) Have much larger wavelength than light

(c) Carry news

(d) Are not electromagnetic waves

3. Energy stored in electromagnetic oscillations is in the form of

(a) Electrical energy (b) Magnetic energy

(c) Both (a) and (b) (d) None of these

4. Heat radiations propagate with the speed of

(a) α-rays (b) β-rays

(c) Light waves (d) Sound waves

5. Which scientist experimentally proved the existence of electromagnetic waves

(a) Sir J.C. Bose (b) Maxwell

(c) Marconi (d) Hertz

6. Light waves travel in vacuum along the y-axis. Which of the following may represent the wavefront

(a) y = constant (b) x = constant

(c) z = constant (d) $x + y + z$ = constant

7. The wavelength of the matter waves is independent of

(a) Charge (b) Momentum

(c) Velocity (d) Mass

8. The electromagnetic theory of light failed to explain

(a) Photoelectric effect (b) Polarisation

(c) Diffraction (d) Interference

9. The average magnetic energy density of an electromagnetic wave of wavelength λ travelling in free space is given by

(a) $\frac{B^2}{2\lambda}$ (b) $\frac{B^2}{2\mu_0}$

(c) $\frac{2B^2}{\mu_0\lambda}$ (d) $\frac{B}{\mu_0\lambda}$

10. Consider the following statements about electromagnetic waves and choose the correct ones

S1 : Electromagnetic waves having wavelengths 1000 times smaller than light waves are called X–rays.

S2 : Ultraviolet waves are used in the treatment of swollen joints.

S3 : Alpha and gamma rays are not electromagnetic waves.

S4 : de Broglie waves are not electromagnetic in nature.

S5 : Electromagnetic waves exhibit polarization while sound waves do not.

(a) S1, S4 and S5 (b) S3, S4 and S5

(c) S1, S3 and S5 (d) S2, S3 and S4

11. In an apparatus, the electric field was found to oscillate with an amplitude of 18 V/m. The magnitude of the oscillating magnetic field will be

(a) $4\times10^{-6}\,T$ (b) $6\times10^{-8}\,T$

(c) $9\times10^{-9}\,T$ (d) $11\times10^{-11}\,T$

12. An electromagnetic wave, going through vacuum is described by $E = E_0 \sin(kx - \omega t)$. Which of the following is independent of wavelength

(a) k (b) ω

(c) k/ω (d) $k\omega$

13. The average electric field of electromagnetic waves in certain region of free space is $9\times10^{-4}\,NC^{-1}$. Then the average magnetic field in the same region is of the order of

(a) $27\times10^{-4}T$ (b) $3\times10^{-12}T$

(c) $\left(\frac{1}{3}\right)\times10^{-12}T$ (d) $3\times10^{12}T$

(e) $\left(\frac{1}{3}\right)\times10^{12}T$

14. A new system of units is evolved in which the values of μ_0 and ϵ_0 are 2 and 8 respectively. Then the speed of light in this system will be

(a) 0.25 (b) 0.5

(c) 0.75 (d) 1

15. A plane electromagnetic wave travelling along the X-direction has a wavelength of 3 mm. The variation in the electric field occurs in the Y-direction with an amplitude 66 $V\,m^{-1}$. The equations for the electric and magnetic fields as a function of x and t are respectively

(a) $E_y = 33\cos\pi\times10^{11}\left(t-\frac{x}{c}\right)$,

$B_z = 1.1\times10^{-7}\cos\pi\times10^{11}\left(t-\frac{x}{c}\right)$

(b) $E_y = 11\cos2\pi\times10^{11}\left(t-\frac{x}{c}\right)$,

$B_y = 11\times10^{-7}\cos2\pi\times10^{11}\left(t-\frac{x}{c}\right)$

(c) $E_x = 33\cos\pi\times10^{11}\left(t-\frac{x}{c}\right)$,

$B_x = 11\times10^{-7}\cos\pi\times10^{11}\left(t-\frac{x}{c}\right)$

(d) $E_y = 66\cos2\pi\times10^{11}\left(t-\frac{x}{c}\right)$,

$B_z = 2.2\times10^{-7}\cos2\pi\times10^{11}\left(t-\frac{x}{c}\right)$

(e) $E_y = 66\cos\pi\times10^{11}\left(t-\frac{x}{c}\right)$,

$B_y = 2.2\times10^{-7}\cos\pi\times10^{11}\left(t-\frac{x}{c}\right)$

16. A point source of electromagnetic radiation has an average power output of 1500 W. The maximum value of electric field at a distance of 3m from this source in Vm^{-1} is

(a) 500 (b) 100

(c) $\frac{500}{3}$ (d) $\frac{250}{3}$

(e) $10\sqrt{5}$

17. The magnetic field in a plane electromagnetic wave is given by

$$B_y = 2\times10^{-7}\sin(0.5\times10^3 x + 1.5\times10^{11} t).$$

This electromagnetic wave is

(a) A visible light (b) An infrared wave

(c) A microwave (d) A radio wave

18. If the total electromagnetic energy falling on a surface is U, then the total momentum delivered (for complete absorption) is

(a) $\frac{U}{c}$
(b) cU
(c) $\frac{U}{c^2}$
(d) c^2U
(e) $\sqrt{\frac{U}{c}}$

19. The electric field of a plane electromagnetic wave varies with time of amplitude $2Vm^{-1}$ propagating along z-axis. The average energy density of the magnetic field is (in Jm^{-3})

(a) 13.29×10^{-12}
(b) 8.86×10^{-12}
(c) 17.72×10^{-12}
(d) 4.43×10^{-12}
(e) 2.22×10^{-12}

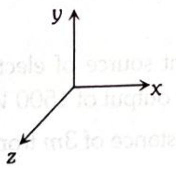
20. A parallel plate capacitor of plate separation 2 *mm* is connected in an electric circuit having source voltage 400 *V*. if the plate area is 60 cm^2, then the value of displacement current for 10^{-6} *s* will be

(a) 1.062 *amp*
(b) 1.062×10^{-2} *amp*
(c) 1.062×10^{-3} *amp*
(d) 1.062×10^{-4} *amp*

21. In an electromagnetic wave, the amplitude of electric field is 1 *V/m*. the frequency of wave is 5×10^{14} *Hz*. The wave is propagating along *z*-axis. The average energy density of electric field, in *Joule/m*^{3}, will be

(a) 1.1×10^{-11}
(b) 2.2×10^{-12}
(c) 3.3×10^{-13}
(d) 4.4×10^{-14}

22. Light wave is travelling along *y*-direction. If the corresponding $\vec{E}$ vector at any time is along the x-axis, the direction of $\vec{B}$ vector at that time is along



(a) *y*-axis
(b) *x*-axis
(c) + *z*-axis
(d) – *z* axis

23. A plane electromagnetic wave is propagating along the *z* direction. If the electric field component of this wave is in the direction $(\hat{i}+\hat{j})$, then which of the following is the direction of the magnetic field component

(a) $(-\hat{i}+\hat{j})$
(b) $(\hat{i}-\hat{j})$
(c) $(-\hat{i}-\hat{j})$
(d) $(\hat{i}+\hat{k})$

24. For skywave propagation of a 10 *MHz* signal, what should be the maximum electron density in ionosphere

(a) $\sim 1.2\times10^{12}m^{-3}$
(b) $\sim 10^{6}m^{-3}$
(c) $\sim 10^{14}m^{-3}$
(d) $\sim 10^{22}m^{-3}$

25. Pick out the correct statement in the propagation of electromagnetic waves for communication purposes

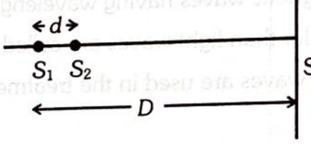
(a) Space wave propagation is achieved by ionospheric reflection
(b) Sky wave propagation is used for line-of-sight communication
(c) Electromagnetic waves of frequencies higher than 30 *MHz* penetrate ionosphere
(d) Satellite communication uses sky wave mode of propagation

6. IIT-JEE/AIEEE

1. To demonstrate the phenomenon of interference, we require two sources which emit radiation **[2003]**

(a) Of the same frequency and having a definite phase relationship
(b) Of nearly the same frequency
(c) Of the same frequency
(d) Of different wavelengths

2. Two coherent point sources S_1 and S_2 are separated by a small distance '*d*' as shown. The fringes obtained on the screen will be **[2013]**



(a) Points
(b) Straight lines
(c) Semi-circles
(d) Concentric circles

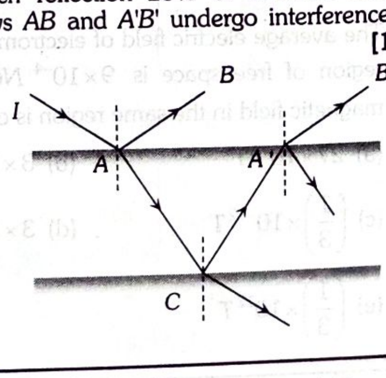
3. Two coherent monochromatic light beams of intensities *I* and 4*I* are superposed. The maximum and minimum possible intensities in the resulting beam are **[1988]**

(a) 5*I* and *I*
(b) 5*I* and 3*I*
(c) 9*I* and *I*
(d) 9*I* and 3*I*

4. Two beams of light having intensities *I* and 4*I* interfere to produce a fringe pattern on a screen. The phase difference between the beams is $\frac{\pi}{2}$ at point *A* and π at point *B*. Then the difference between the resultant intensities at *A* and *B* is **[2001]**

(a) 2*I*
(b) 4*I*
(c) 5*I*
(d) 7*I*

5. A ray of light of intensity *I* is incident on a parallel glass-slab at a point *A* as shown in fig. It undergoes partial reflection and refraction. At each reflection 25% of incident energy is reflected. The rays *AB* and *A'B'* undergo interference. The ratio I_{max}/I_{min} is **[1990]**



(a) 4 : 1
(b) 8 : 1
(c) 7 : 1
(d) 49 : 1

6. A Young's double slit experiment uses a monochromatic source. The shape of the interference fringes formed on a screen is **[2005]**

(a) Straight line (b) Parabola

(c) Hyperbola (d) Circle

7. In Young's experiment, the distance between the slits is reduced to half and the distance between the slit and screen is doubled, then the fringe width **[1981]**

(a) Will not change (b) Will become half

(c) Will be doubled (d) Will become four times

8. In Young's double slit experiment, the wavelength of the light used is doubled and distance between two slits is half of initial distance, the resultant fringe width becomes **[2002]**

(a) 2 *times* (b) 3 *times*

(c) 4 *times* (d) 1/2 *times*

9. A mixture of light, consisting of wavelength 590 *nm* and an unknown wavelength, illuminates Young's double slit and gives rise to two overlapping interference patterns on the screen. The central maximum of both lights coincide. Further, it is observed that the third bright fringe of known light coincides with the 4th bright fringe of the unknown light. From this data, the wavelength of the unknown light is **[2009]**

(a) 393.4 *nm* (b) 885.0 *nm*

(c) 442.5 *nm* (d) 776.8 *nm*

10. In a Young's double slit experiment, 12 fringes are observed to be formed in a certain segment of the screen when light of wavelength 600 *nm* is used. If the wavelength of light is changed to 400 *nm*, number of fringes observed in the same segment of the screen is given by **[2001]**

(a) 12 (b) 180

(c) 24 (d) 30

11. Young's double slit experiment is carried out by using green, red and blue light, one colour at a time. The fringe widths recorded are β_G, β_R and β_B, respectively. Then **[2012]**

(a) $\beta_G > \beta_B > \beta_R$ (b) $\beta_B > \beta_G > \beta_R$

(c) $\beta_R > \beta_B > \beta_G$ (d) $\beta_R > \beta_G > \beta_B$

12. A beam of electron is used in an *YDSE* experiment. The slit width is d. When the velocity of electron is increased, then **[2005]**

(a) No interference is observed

(b) Fringe width increases

(c) Fringe width decreases

(d) Fringe width remains same

13. In a YDSE bi-chromatic light of wavelengths 400 *nm* and 560 *nm* are used. The distance between the slits is 0.1 *mm* and the distance between the plane of the slits and the screen is 1*m*. The minimum distance between two successive regions of complete darkness is **[2004]**

(a) 4 *mm* (b) 5.6 *mm*

(c) 14 *mm* (d) 28 *mm*

14. A thin slice is cut out of a glass cylinder along a plane parallel to its axis. The slice is placed on a flat glass plate as shown. The observed interference fringes from this combination shall be **[1999]**

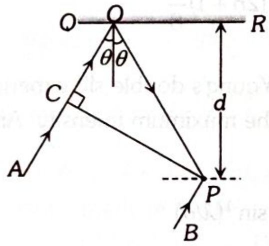
(a) Straight

(b) Circular

(c) Equally spaced

(d) Having fringe spacing which increases as we go outwards

15. In the adjacent diagram, CP represents a wavefront and *AO* & *BP*, the corresponding two rays. Find the condition on θ for constructive interference at *P* between the ray *BP* and reflected ray *OP* **[2003]**



(a) $\cos\theta = 3\lambda/2d$

(b) $\cos\theta = \lambda/4d$

(c) $\sec\theta - \cos\theta = \lambda/d$

(d) $\sec\theta - \cos\theta = 4\lambda/d$

16. In a Young's double slit experiment the intensity at a point where the path difference is $\frac{\lambda}{6}$(λ being the wavelength of the light used) is I. If I_0 denotes the maximum intensity, $\frac{I}{I_0}$ is equal to **[2007]**

(a) $\frac{1}{\sqrt{2}}$ (b) $\frac{\sqrt{3}}{2}$

(c) $1/2$ (d) $3/4$

17. A parallel monochromatic beam of light is incident normally on a narrow slit. A diffraction pattern is formed on a screen placed perpendicular to the direction of incident beam. At the first maxima of the diffraction pattern the phase difference between the rays coming from the edges of the slit is **[1995, 98]**

(a) 0 (b) $\frac{\pi}{2}$

(c) π (d) 2π

18. In a double slit experiment, instead of taking slits of equal widths, one slit is made twice as wide as the other. Then in the interference pattern **[2000]**

(a) The intensities of both the maxima and the minima increase

(b) The intensity of maxima increases and the minima has zero intensity

(c) The intensity of maxima decreases and that of the minima increases

(d) The intensity of maxima decreases and the minima has zero intensity

19. In Young's double slit experiment, one of the slit is wider than other, so that amplitude of the light from one slit is double of that from other slit. If I_m be the maximum intensity, the resultant intensity I when they interfere at phase difference ϕ is given by **[2012]**

(a) $\frac{I_m}{9}(4+5\cos\phi)$ (b) $\frac{I_m}{3}\left(1+2\cos^2\frac{\phi}{2}\right)$

(c) $\frac{I_m}{5}\left(1+4\cos^2\frac{\phi}{2}\right)$ (d) $\frac{I_m}{9}\left(1+8\cos^2\frac{\phi}{2}\right)$

20. In the Young's double slit experiment using a monochromatic light of wavelength λ, the path difference (in terms of an integer n) corresponding to any point having half the peak intensity is **[2013]**

(a) $(2n+1)\frac{\lambda}{2}$ (b) $(2n+1)\frac{\lambda}{4}$

(c) $(2n+1)\frac{\lambda}{8}$ (d) $(2n+1)\frac{\lambda}{16}$

21. In Young's double slit experiment intensity at a point is (1/4) of the maximum intensity. Angular position of this point is **[2005]**

(a) $\sin^{-1}(\lambda/d)$ (b) $\sin^{-1}(\lambda/2d)$

(c) $\sin^{-1}(\lambda/3d)$ (d) $\sin^{-1}(\lambda/4d)$

22. If I_0 is the intensity of the principal maximum in the single slit diffraction pattern, then what will be its intensity when the slit width is doubled **[2005]**

(a) I_0 (b) $\frac{I_0}{2}$

(c) $2I_0$ (d) $4I_0$

23. In Young's double slit experiment, the two slits act as coherent sources of equal amplitude A and wavelength λ. In another experiment with the same set up the two slits are of equal amplitude A and wavelength λ but are incoherent. The ratio of the intensity of light at the mid-point of the screen in the first case to that in the second case is **[2002]**

(a) 1 : 2 (b) 2 : 1

(c) 4 : 1 (d) 1 : 1

24. In the ideal double-slit experiment, when a glass-plate (refractive index 1.5) of thickness t is introduced in the path of one of the interfering beams (wavelength λ), the intensity at the position where the central maximum occurred previously remains unchanged. The minimum thickness of the glass-plate is **[2002]**

(a) 2λ (b) $\frac{2\lambda}{3}$

(c) $\frac{\lambda}{3}$ (d) λ

25. In a Young's double slit experiment, slits are separated by 0.5 *mm*, and the screen is placed 150 *cm* away. A beam of light consisting of two wavelengths, 650 *nm* and 520 *nm*, is used to obtain interference fringes on the screen. The least distance from the common central maximum to the point where the bright fringes due to both the wavelengths coincide is **[2017]**

(a) 15.6 *mm* (b) 1.56 *mm*

(c) 7.8 *mm* (d) 9.75 *mm*

26. The angular width of the central maximum in a single slit diffraction pattern is 60°. The width of the slit is $1\,\mu m$. The slit is illuminated by monochromatic plane waves. If another slit of same width is made near it, Young's fringes can be observed on a screen placed at a distance $50\,cm$ from the slits. If the observed fringe width is $1\,cm$, what is slit separation distance (*i.e.* distance between the centres of each slit.) **[2018]**

(a) $75\,\mu m$ (b) $100\,\mu m$

(c) $25\,\mu m$ (d) $50\,\mu m$

27. Yellow light is used in single slit diffraction experiment with slit width 0.6 *mm*. If yellow light is replaced by X-rays then the pattern will reveal **[1999]**

(a) That the central maxima is narrower

(b) No diffraction pattern

(c) More number of fringes

(d) Less number of fringes

28. A beam of light of wavelength 600 *nm* from a distant source falls on a single slit 1 *mm* wide and the resulting diffraction pattern is observed on a screen 2 *m* away. The distance between the first dark fringes on either side of the central bright fringe is **[1994]**

(a) 1.2 *mm* (b) 1.2 *cm*

(c) 2.4 *cm* (d) 2.4 *mm*

29. The maximum number of possible interference maxima for slit-separation equal to twice the wavelength in Young's double-slit experiment is **[2004]**

(a) Infinite (b) Five

(c) Three (d) Zero

30. The box of a pin hole camera, of length L, has hole of radius a. It is assumed that when the hole is illuminated by a parallel beam of light of wavelength λ the spread of the spot (obtained on the opposite wall of the camera) is the sum of its geometrical spread and the spread due to diffraction. The spot would then have its minimum size (say b_{min}) when **[2016]**

(a) $a=\sqrt{\lambda L}$ and $b_{min}=\left(\frac{2\lambda^2}{L}\right)$

(b) $a=\sqrt{\lambda L}$ and $b_{min}=\sqrt{4\lambda L}$

(c) $a=\frac{\lambda^2}{L}$ and $b_{min}=\sqrt{4\lambda L}$

(d) $a=\frac{\lambda^2}{L}$ and $b_{min}=\left(\frac{2\lambda^2}{L}\right)$

31. A polaroid is placed at 45° to an incoming light of intensity I_0. Now the intensity of light passing through polaroid after polarisation would be **[2013]**

(a) I_0 (b) $I_0/2$

(c) $I_0/4$ (d) Zero

32. The angle of incidence at which reflected light is totally polarized for reflection from air to glass (refractive index n) is **[2004]**

(a) $\sin^{-1}(n)$ (b) $\sin^{-1}\left(\frac{1}{n}\right)$

(c) $\tan^{-1}\left(\frac{1}{n}\right)$ (d) $\tan^{-1}(n)$

33. When an unpolarized light of intensity I_0 is incident on a polarizing sheet, the intensity of the light which does not get transmitted is **[2005]**

(a) Zero (b) I_0

(c) $\frac{1}{2}I_0$ (d) $\frac{1}{4}I_0$

34. Two beams, A and B, of plane polarized light with mutually perpendicular planes of polarization are seen through a Polaroid. From the position when the beam A has maximum intensity (and beam B has zero intensity), a rotation of polaroid through 30° makes the two beams appear equally bright. If the initial intensities of the two beams are I_A and I_B respectively, then $\frac{I_A}{I_B}$ equals **[2014]**

(a) 3 (b) 3/2

(c) 1 (d) 1/3

35. Unpolarized light of intensity I passes through an ideal polarizer A. Another identical polarizer B is placed behind A. The intensity of light beyond B is found to be $\frac{I}{2}$. Now another identical polarizer C is placed between A and B. The intensity beyond B is now found to be $\frac{I}{8}$. The angle between polarizer A and C is **[2018]**

(a) 45° (b) 60°

(c) 0° (d) 30°

36. Which of the following radiations has the least wavelength **[2003]**

(a) γ-rays (b) β-rays

(c) α-rays (d) X-rays

37. Which of the following are not electromagnetic waves **[2002]**

(a) Cosmic rays (b) Gamma rays

(c) β-rays (d) X-rays

38. Electromagnetic waves are transverse in nature is evident by **[2002]**

(a) Polarization (b) Interference

(c) Reflection (d) Diffraction

39. The magnetic field amplitude of an electromagnetic wave is $2\times10^{-7}T$. It's electric field amplitude if the wave is travelling in free space is **[2013]**

(a) $6\,Vm^{-1}$ (b) $60\,Vm^{-1}$

(c) $10/6\,Vm^{-1}$ (d) None of these

40. During the propagation of electromagnetic waves in a medium **[2014]**

(a) Electric energy density is double of the magnetic energy density

(b) Electric energy density is half of the magnetic energy density

(c) Electric energy density is equal to the magnetic energy density

(d) Both electric and magnetic energy densities are zero

41. An electromagnetic wave of frequency $\nu = 3.0\,MHz$ passes from vacuum into a dielectric medium with relative permittivity $\varepsilon_r = 4.0$. Then **[2004]**

(a) Wavelength is doubled and the frequency remains unchanged

(b) Wavelength is doubled and frequency becomes half

(c) Wavelength is halved and frequency remains unchanged

(d) Wavelength and frequency both remain unchanged

42. The intensity of gamma radiation from a given source is I. On passing through 36 mm of lead, it is reduced to $\frac{I}{8}$. The thickness of lead which will reduce the intensity to $\frac{I}{2}$ will be **[2005]**

(a) 18 mm (b) 12 mm

(c) 6 mm (d) 9 mm

43. The *rms* value of the electric field of the light coming from the Sun is 720 N/C. The average total energy density of the electromagnetic wave is **[2006]**

(a) $6.37\times10^{-9}J/m^3$ (b) $81.35\times10^{-12}J/m^3$

(c) $3.3\times10^{-3}J/m^3$ (d) $4.58\times10^{-6}J/m^3$

44. In hydrogen spectrum the wavelength of H_α line is 656 nm whereas in the spectrum of a distant galaxy, H_α line wavelength is 706 nm. Estimated speed of the galaxy with respect to earth is **[1999]**

(a) $2\times10^8 m/s$ (b) $2\times10^7 m/s$

(c) $2\times10^6 m/s$ (d) $2\times10^5 m/s$

45. An electromagnetic wave in vacuum has the electric and magnetic field $\vec{E}$ and $\vec{B}$, which are always perpendicular to each other. The direction of polarization is given by $\vec{X}$ and that of wave propagation by $\vec{k}$. Then **[2012]**

(a) $\vec{X} \parallel \vec{B}$ and $\vec{k} \parallel \vec{B} \times \vec{E}$
(b) $\vec{X} \parallel \vec{E}$ and $\vec{k} \parallel \vec{E} \times \vec{B}$

(c) $\vec{X} \parallel \vec{B}$ and $\vec{k} \parallel \vec{E} \times \vec{B}$
(d) $\vec{X} \parallel \vec{E}$ and $\vec{k} \parallel \vec{B} \times \vec{E}$

46. An observer is moving with half the speed of light towards stationary microwave source emitting waves at frequency 10*GHz*. What is the frequency of the microwave measured by the observer (speed of light $= 3 \times 10^8 ms^{-1}$) **[2017]**

(a) 15.3 *GHz*
(b) 10.1 *GHz*

(c) 12.1 *GHz*
(d) 17.3 *GHz*

47. An *EM* wave from air enters a medium. The electric fields are $\vec{E}_1 =_{\cup}, \hat{x} ----\left[\pi\left(\frac{z}{-}-\right)\right]$ in air and $\vec{E}_2 - E_{02}\hat{x}000$ $[k(2z-ct)]$ in medium, where the wave number k and frequency υ refer to their values in air. The medium is non-magnetic. If ε_{r_1} and ε_{r_2} refer to relative permittivities of air and medium respectively, which of the following options is correct **[2018]**

(a) $\frac{\varepsilon_{r_1}}{\varepsilon_{r_2}} = \frac{1}{4}$
(b) $\frac{\varepsilon_{r_1}}{\varepsilon_{r_2}} = \frac{1}{2}$

(c) $\frac{\varepsilon_{r_1}}{\varepsilon_{r_2}} = 4$
(d) $\frac{\varepsilon_{r_1}}{\varepsilon_{r_2}} = 2$

7. NEET/AIPMT

1. Which one of the following phenomena is not explained by Huygen's construction of wavefront **[1992]**

(a) Refraction
(b) Reflection

(c) Diffraction
(d) Origin of spectra

2. Interference was observed in interference chamber when air was present, now the chamber is evacuated and if the same light is used, a careful observer will see **[1993]**

(a) No interference

(b) Interference with bright bands

(c) Interference with dark bands

(d) Interference in which width of the fringe will be slightly increased

3. If an interference pattern has maximum and minimum intensities in 36 : 1 ratio then what will be the ratio of amplitudes **[1993]**

(a) 5 : 7
(b) 7 : 4

(c) 4 : 7
(d) 7 : 5

4. The interference pattern in obtained with two coherent light sources of intensity ratio *n*. In the interference pattern, the ratio $\frac{I_{max} - I_{min}}{I_{max} + I_{min}}$ will be **[2016]**

(a) $\frac{2\sqrt{n}}{(n+1)^2}$
(b) $\frac{\sqrt{n}}{n+1}$

(c) $\frac{2\sqrt{n}}{n+1}$
(d) $\frac{\sqrt{n}}{(n+1)^2}$

5. In a Young's double slit experiment, the fringe width is found to be 0.4 *mm*. If the whole apparatus is immersed in water of refractive index 4/3 without disturbing the geometrical arrangement, the new fringe width will be **[1990]**

(a) 0.30 *mm*
(b) 0.40 *mm*

(c) 0.53 *mm*
(d) 450 *micron*

6. In Young's double slit experiment, the slits are 2 *mm* apart and are illuminated by photons of two wavelengths $\lambda_1 = 12000 Å$ and $\lambda_2 = 10000 Å$. At what minimum distance from the common central bright fringe on the screen 2 *m* from the slit will a bright fringe from one interference pattern coincide with a bright fringe from the other **[2013]**

(a) 3 *mm*
(b) 8 *mm*

(c) 6 *mm*
(d) 4 *mm*

7. In a double slit experiment, the two slits are 1*mm* apart and the screen is placed 1*m* away. A monochromatic light wavelength 500 *nm* is used. What will be the width of each slit for obtaining ten maxima of double slit within the central maxima of single slit pattern **[2015]**

(a) 0.1*mm*
(b) 0.5*mm*

(c) 0.02*mm*
(d) 0.2*mm*

8. In a Young's experiment, two coherent sources are placed 0.90 *mm* apart and the fringes are observed one metre away. If it produces the second dark fringe at a distance of 1 *mm* from the central fringe, the wavelength of monochromatic light used would be **[1992]**

(a) $60 \times 10^{-4} cm$
(b) $10 \times 10^{-4} cm$

(c) $10 \times 10^{-5} cm$
(d) $6 \times 10^{-5} cm$

9. In the Young's double-slit experiment, the intensity of light at a point on the screen where the path difference is λ is K, (λ being the wavelength of light used). The intensity at a point where the path difference is $\frac{\lambda}{4}$, will be **[2014]**

(a) *K*/2
(b) Zero

(c) *K*
(d) *K*/4

10. Two slits in Young's experiment have widths in the ratio 1 : 25. The ratio of intensity at the maximum and minimum in the interference pattern, $\frac{I_{max}}{I_{min}}$ is **[2015]**

(a) $\frac{121}{49}$ (b) $\frac{49}{121}$

(c) $\frac{4}{9}$ (d) $\frac{9}{4}$

11. The intensity at the maximum in a Young's double slit experiment is I_0. Distance between two slits is $d = 5\lambda$, where λ is the wavelength of light used in the experiment. What will be the intensity in front of one of the slits on the screen placed at a distance $D = 10d$ **[2016]**

(a) I_0 (b) $\frac{I_0}{4}$

(c) $\frac{3}{4}I_0$ (d) $\frac{I_0}{2}$

12. Young's double slit experiment is first performed in air and then in a medium other than air. It is found that 8^{th} bright fringe in the medium lies where 5^{th} dark fringe lies in air. The refractive index of the medium is nearly **[2017]**

(a) 1.25 (b) 1.59

(c) 1.69 (d) 1.78

13. A parallel beam of fast moving electrons is incident normally on a narrow slit. A screen is placed at a large distance from the slit. If the speed of the electrons is increased, which of the following statement is correct **[2013]**

(a) Diffraction pattern is not observed on the screen in the case of electrons

(b) The angular width of the central maxima of the diffraction pattern will increase

(c) The angular width of the central maxima will decrease

(d) The angular width of the central maxima will remain the same

14. A parallel beam of monochromatic light of wavelength 5000 Å is incident normally on a single narrow slit of width 0.001 *mm*. The light is focused by a convex lens on a screen placed on the focal plane. The first minimum will be formed for the angle of diffraction equal to **[1993]**

(a) 0° (b) 15°

(c) 30° (d) 60°

15. In a Fraunhoffer diffraction at single slit of width '*d*' with incident light of wavelength 5500 Å, the first minimum is observed, at angle 30°. The first secondary maximum is observed at an angle $\theta =$ **[2016]**

(a) $\sin^{-1}\frac{1}{\sqrt{2}}$ (b) $\sin^{-1}\frac{1}{4}$

(c) $\sin^{-1}\frac{3}{4}$ (d) $\sin^{-1}\frac{\sqrt{3}}{2}$

16. At the first minimum adjacent to the central maximum of a single-slit diffraction pattern, the phase difference between the Huygen's wavelet from the edge of the slit and the wavelet from the midpoint of the slit is **[2015]**

(a) $\frac{\pi}{2}$ radian (b) π radian

(c) $\frac{\pi}{8}$ radian (d) $\frac{\pi}{4}$ radian

17. For a parallel beam of monochromatic light of wavelength 'λ', diffraction is produced by a single slit whose width 'a' is of the wavelength of the light. If 'D' is the distance of the screen from the slit, the width of the central maxima will be **[2015]**

(a) $\frac{D\lambda}{a}$ (b) $\frac{D\lambda}{a}$

(c) $\frac{2Da}{\lambda}$ (d) $\frac{2D\lambda}{a}$

18. A linear aperture whose width is 0.02 cm is placed immediately in front of a lens of focal length 60 *cm*. The aperture is illuminated normally by a parallel beam of wavelength $5 \times 10^{-5} cm$. The distance of the first dark band of the diffraction pattern from the centre of the screen is **[2016]**

(a) 0.15 *cm* (b) 0.10 *cm*

(c) 0.25 *cm* (d) 0.20 *cm*

19. Light waves can be polarised as they are **[1993]**

(a) Transverse (b) Of high frequency

(c) Longitudinal (d) Reflected

20. Through which character we can distinguish the light waves from sound waves **[1990]**

(a) Interference (b) Refraction

(c) Polarisation (d) Reflection

21. Unpolarised light is incident from air on a plane surface of a material of refractive index 'μ'. At a particular angle of incidence 'i', it is found that the reflected and refracted rays are perpendicular to each other. Which of the following options is correct for this situation **[2018]**

(a) Reflected light is polarised with its electric vector parallel to the plane of incidence

(b) Reflected light is polarised with its electric vector perpendicular to the plane of incidence

(c) $i = \sin^{-1}\left(\frac{1}{\mu}\right)$

(d) $i = \tan^{-1}\left(\frac{1}{\mu}\right)$

22. Two polaroids P_1 and P_2 are placed with their axis perpendicular to each other. Unpolarised light I_0 is incident on P_1. A third Polaroid P_3 is kept in between P_1 and P_2 such that its axis makes an angle 45° with that of P_1. The intensity of transmitted light thought P_2 is **[2017]**

(a) $\frac{I_0}{2}$ (b) $\frac{I_0}{4}$

(c) $\frac{I_0}{8}$ (d) $\frac{I_0}{16}$

23. Pick out the longest wavelength from the following types of radiations [1990]

(a) Blue light (b) γ-rays

(c) X-rays (d) Red light

24. Electromagnetic radiation of highest frequency is [1994]

(a) Infrared radiations (b) Visible radiation

(c) Radio waves (d) γ-rays

25. Which of the following shows green house effect [2002]

(a) Ultraviolet rays (b) Infrared rays

(c) X-rays (d) None of these

26. Biological importance of Ozone layer is [2001]

(a) It stops ultraviolet rays

(b) Ozone rays reduce green house effect

(c) Ozone layer reflects radio waves

(d) Ozone layer controls O_2 / H_2 radio in atmosphere

27. The oscillating electric and magnetic vectors of an electromagnetic wave are oriented along [1994]

(a) The same direction but differ in phase by 90°

(b) The same direction and are in phase

(c) Mutually perpendicular directions and are in phase

(d) Mutually perpendicular directions and differ in phase by 90°

28. If λ_v, λ_r and λ_m represent the wavelength of visible light x-rays and microwaves respectively, then [2005]

(a) $\lambda_m > \lambda_x > \lambda_v$ (b) $\lambda_v > \lambda_m > \lambda_y$

(c) $\lambda_m > \lambda_v > \lambda_x$ (d) $\lambda_v > \lambda_x > \lambda_m$

29. Out of the following options which one can be used to produce a propagating electromagnetic wave [2016]

(a) A charge moving at constant velocity

(b) A stationary charge

(c) A chargeless particle

(d) An accelerating charge

30. Light is an electromagnetic wave. Its speed in vacuum is given by the expression [1993]

(a) $\sqrt{\mu_o \varepsilon_o}$ (b) $\sqrt{\frac{\mu_o}{\varepsilon_o}}$

(c) $\sqrt{\frac{\varepsilon_o}{\mu_o}}$ (d) $\frac{1}{\sqrt{\mu_o \varepsilon_o}}$

31. The ratio of amplitude of magnetic field to the amplitude of electric field for an electromagnetic wave propagating in vacuum is equal to [2012]

(a) The speed of light in vacuum

(b) Reciprocal of speed of light in vacuum

(c) The ratio of magnetic permeability to the electric susceptibility of vacuum

(d) Unity

32. The electric field of an electromagnetic wave in free space is given by $\vec{E} = 10\cos(10^7 t + kx)\hat{j}\, V/m$, where t and x are in seconds and metres respectively. It can be inferred that [2010]

(1) The wavelength λ is 188.4 m

(2) The wave number k is 0.33 rad/m.

(3) The wave amplitude is 10 V/m.

(4) The wave is propagating along $+x$ direction.

Which one of the following pairs of statements is correct

(a) (3) and (4) (b) (1) and (2)

(c) (2) and (3) (d) (1) and (3)

33. The electric field associated with an e.m. wave in vacuum is given by $\vec{E} = \hat{i}\, 40\cos(kz - 6\times10^8 t)$, where E, z and t are in volt/m, meter and seconds respectively. The value of wave vector k is [2012]

(a) $2\ m^{-1}$ (b) $0.5\ m^{-1}$

(c) $6\ m^{-1}$ (d) $3\ m^{-1}$

34. A wave travelling in the $+ve$ x-direction having displacement along y-direction as $1m$, wavelength $2\pi\, m$ and frequency of $\frac{1}{\pi} Hz$ is represented by [2013]

(a) $y = \sin(2\pi x + 2\pi t)$ (b) $y = \sin(x - 2t)$

(c) $y = \sin(2\pi x - 2\pi t)$ (d) $y = \sin(10\pi x - 20\pi t)$

35. Light with an energy flux of $25\times10^4\, Wm^{-2}$ falls on a perfectly reflecting surface at normal incidence. If the surface area is $15 cm^2$, the average force exerted on the surface is [2014]

(a) $1.20\times10^{-6} N$ (b) $3.0\times10^{-6} N$

(c) $1.25\times10^{-6} N$ (d) $2.50\times10^{-6} N$

36. A radiation of energy 'E' falls normally on a perfectly reflecting surface. The momentum transferred to the surface is (c=Velocity of light) [2015]

(a) $\frac{2E}{c}$ (b) $\frac{2E}{c^2}$

(c) $\frac{E}{c^2}$ (d) $\frac{E}{c}$

37. If $\vec{E}$ and $\vec{B}$ are the electric and magnetic field vectors of E.M. waves then the direction of propagation of E.M. wave is along the direction of **[1992, 2002]**

(a) $\vec{E}$ (b) $\vec{B}$

(c) $\vec{E}\times\vec{B}$ (d) None of these

38. An electromagnetic wave travels along z-axis. Which of the following pairs of space and time varying fields would generate such a wave **[1994]**

(a) E_x, B_y (b) E_y, B_x

(c) E_z, B_x (d) E_y, B_z

39. The electric and the magnetic field, associated with an e.m. wave propagating along the $+z$-axis, can be represented by **[2011]**

(a) $[\vec{E}=E_0\hat{j}, \vec{B}=B_0\hat{k}]$ (b) $[\vec{E}=E_0\hat{j}, \vec{B}=B_0\hat{j}]$

(c) $[\vec{E}=E_0\hat{k}, \vec{B}=B_0\hat{i}]$ (d) $[\vec{E}=E_0\hat{j}, \vec{B}=B_0\hat{i}]$

40. In an electromagnetic wave in free space the root mean square value of the electric field is $E_{rms}=6V/m$. The peak value of the magnetic field is **[2017]**

(a) $1.41\times10^{-8}T$ (b) $2.83\times10^{-8}T$

(c) $0.70\times10^{-8}T$ (d) $4.23\times10^{-8}T$

41. An *em* wave is propagating in a medium with a velocity $\vec{V}=V\hat{i}$. The instantaneous oscillating electric field of this em wave is along $+y$ axis. Then the direction of oscillating magnetic field on the em wave will be along **[2018]**

(a) $-z$ direction (b) $+z$ direction

(c) $-y$ direction (d) $-x$ direction

8. AIIMS

1. The phenomenon of interference is shown by **[1999, 2000]**

(a) Longitudinal mechanical waves only

(b) Transverse mechanical waves only

(c) Electromagnetic waves only

(d) All the above types of waves

2. Light appears to travel in straight lines since **[1998, 2002]**

(a) It is not absorbed by the atmosphere

(b) It is reflected by the atmosphere

(c) Its wavelength is very small

(d) Its velocity is very large

3. Colours of thin films result from **[2005]**

or

On a rainy day, a small oil film on water show brilliant colours. This is due to

(a) Dispersion of light (b) Interference of light

(c) Absorption of light (d) Scattering of light

4. For a wave propagating in a medium, identify the property that is independent of the others **[2006]**

(a) Velocity

(b) Wavelength

(c) Frequency

(d) All these depend on each other

5. The dual nature of light is exhibited by [2001]

(a) Photoelectric effect

(b) Refraction and interference

(c) Diffraction and reflection

(d) Diffraction and photoelectric effect

6. When a beam of light is used to determine the position of an object, the maximum accuracy is achieved if the light is **[2003]**

(a) Polarised (b) Of longer wavelength

(c) Of shorter wavelength (d) Of high intensity

7. What is the path difference of destructive interference **[2002]**

(a) $n\lambda$ (b) $n(\lambda+1)$

(c) $\frac{(n+1)\lambda}{2}$ (d) $\frac{(2n+1)\lambda}{2}$

8. In Young's double slit experiment, if monochromatic light is replaced by white light **[2001]**

(a) All bright fringes become white

(b) All bright fringes have colours between violet and red

(c) Only the central fringe is white, all other fringes are coloured

(d) No fringes are observed

9. The ratio of intensities of two waves is 9 : 1. They are producing interference. The ratio of maximum and minimum intensities will be **[2000]**

(a) 10 : 8 (b) 9 : 1

(c) 4 : 1 (d) 2 : 1

10. A stone thrown into still water, creates a circular wave pattern moving radially outwards. If r is the distance measured from the centre of the pattern, the amplitude of the wave varies as **[2006]**

(a) $r^{-1/2}$ (b) r^{-1}

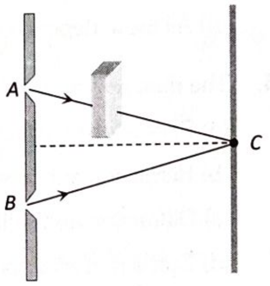
(c) r^{-2} (d) $r^{-3/2}$

11. The waves of wavelength 5900 Å emitted by any atom or molecule must have some finite total length which is known as coherence length. For sodium light, this length is 2.4 *cm*. The number of oscillations in this length will be **[2010]**

(a) 4.068×10^8 (b) 4.068×10^4

(c) 4.068×10^6 (d) 4.068×10^5

12. In Young's experiment, monochromatic light is used to illuminate the two slits *A* and *B*. Interference fringes are observed on a screen placed in front of the slits. Now if a thin glass plate is placed normally in the path of the beam coming from the slit **[1999, 2004]**



(a) The fringes will disappear

(b) The fringe width will increase

(c) The fringe width will decrease

(d) There will be no change in the fringe width but the pattern shifts

13. A thin mica sheet of thickness $2\times10^{-6}\,m$ and refractive index $(\mu=1.5)$ is introduced in the path of the first wave. The wavelength of the wave used is 5000 Å. The central bright maximum will shift **[2003]**

(a) 2 fringes upward (b) 2 fringes downward

(c) 10 fringes upward (d) None of these

14. If a transparent medium of refractive index μ = 1.5 and thickness $t = 2.5\times10^{-5}\,m$ is inserted in front of one of the slits of Young's Double Slit experiment, how much will be the shift in the interference pattern? The distance between the slits is 0.5 *mm* and that between slits and screen is 100 *cm* **[1999]**

(a) 5 *cm* (b) 2.5 *cm*

(c) 0.25 cm (d) 0.1 cm

15. When a compact disc is illuminated by a source of white light, coloured 'lanes' are observed. This is due to **[2004]**

(a) Dispersion (b) Diffraction

(c) Interference (d) Refraction

16. In case of linearly polarized light, the magnitude of the electric field vector **[2005]**

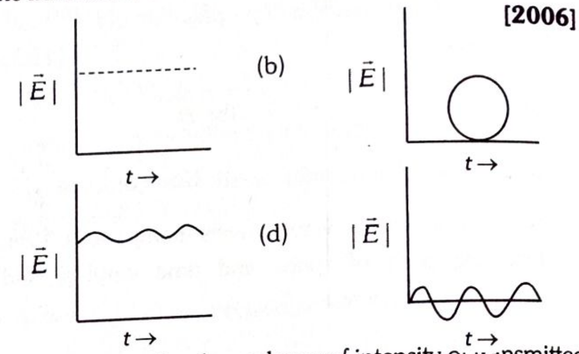
(a) Does not change with time

(b) Varies periodically with time

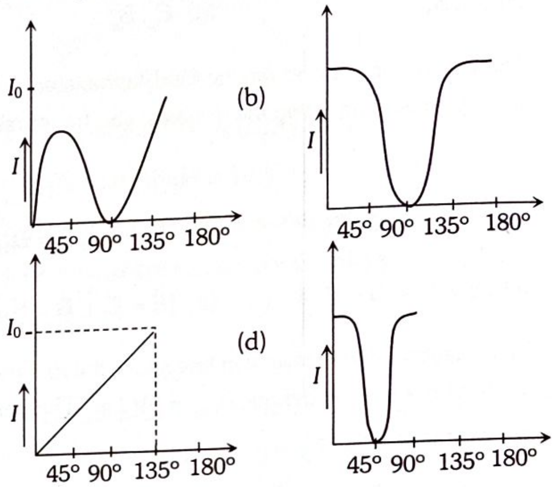
(c) Increases and decreases linearly with time

(d) Is parallel to the direction of propagation

17. Which of the following diagrams represent the variation of electric field vector with time for a circularly polarized light **[2006]**



18. The graph showing the dependence of intensity of transmitted light on the angle between polariser and analyser, is **[2007]**



9. Assertion & Reason

Read the assertion and reason carefully to mark the correct option out of the options given below:

(a) If both assertion and reason are true and the reason is the correct explanation of the assertion.

(b) If both assertion and reason are true but reason is not the correct explanation of the assertion.

(c) If assertion is true but reason is false.

(d) If the assertion and reason both are false.

(e) If assertion is false but reason is true.

1. Assertion : In Young's double slit experiment the two slits are at distance *d* apart. Interference pattern is observed on a screen at distance *D* from the slits. At a point on the screen when it is directly opposite to one of the slits, a dark fringe is observed. Then, the wavelength of wave is proportional to square of distance of two slits.

Reason : For a dark fringe intensity is zero.

2. Assertion : Newton's rings are formed in the reflected system. When the space between the lens and the glass plate is filled with a liquid of refractive index greater than that of glass, the central spot of the pattern is dark.

Reason : The reflection in Newton's ring case will be from a denser to a rarer medium and the two interfering rays are reflected under similar conditions.

3. **Assertion** : In everyday life the Doppler's effect is observed readily for sound waves than light waves.

Reason : Velocity of light is greater than that of sound.

4. **Assertion** : In Young's experiment, the fringe width for dark fringes is different from that for white fringes.

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

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

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

6. **Assertion** : 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 : Destructive interference occurs at the centre of the shadow.

7. **Assertion** : Thin films 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 the upper surface of the thin film.

8. **Assertion** : Microwave communication is preferred over optical communication.

Reason Microwaves provide large number of channels and band width compared to optical signals.

9. **Assertion** : Corpuscular theory fails in explaining the velocities of light in air and water.

Reason : According to corpuscular theory, light should travel faster in denser medium than, in rarer medium.

10. **Assertion** : Interference pattern is made by using blue light instead of red light, the fringes becomes narrower.

Reason : In Young's double slit experiment, fringe width is given by relation $\beta = \frac{\lambda D}{d}$.

11. **Assertion** : The cloud in sky generally appears to be whitish.

Reason : Diffraction due to clouds is efficient in equal measure at all wavelengths.

12. **Assertion** : Television signals are received through sky-wave propagation.

Reason : The ionosphere reflects electromagnetic waves of frequencies greater than a certain critical frequency.

13. **Assertion** : The pattern and position of fringes always remain same even after the introduction of transparent medium in a path of one of the slits .

Reason : The central fringe is bright or dark does not depend upon the initial phase difference between the two coherence sources.

14. **Assertion** : Short wave bands are used for transmission of radio waves to a large distance

Reason : Short waves are reflected by ionosphere

15. **Assertion** : Ultraviolet radiations of higher frequency waves are dangerous to human being.

Reason : Ultraviolet radiation are absorbed by the atmosphere

16. **Assertion** : Environmental damage has increased the amount of ozone in the atmosphere.

Reason : Increase of ozone increases the amount of ultraviolet radiation on earth.

17. **Assertion** : Radio waves can be polarised.

Reason : Sound waves in air are longitudinal in nature.

18. **Assertion** : The earth without atmosphere would be inhospitably cold.

Reason : All heat would escape in the absence of atmosphere.

19. **Assertion** : Like light radiation, thermal radiations are also electromagnetic radiation.

Reason : The thermal radiations require no medium for propagation.

29. Wave Optics & Electromagnetic Theory – Answers Keys

1. Wave Nature and Interference of Light

1	c	2	c	3	c	4	c	5	b
6	c	7	d	8	a	9	c	10	c
11	d	12	c	13	b	14	c	15	d
16	c	17	b	18	a				

2. Young's Double Slit Experiment and Biprism

1	c	2	b	3	b	4	a	5	d
6	b	7	a	8	c	9	c	10	b
11	a	12	d	13	a	14	d	15	b
16	a	17	a	18	b	19	d	20	c
21	c	22	a	23	d	24	b	25	a
26	a	27	b	28	a	29	c	30	b

3. Diffraction of Light

1	b	2	a	3	a	4	c	5	a
6	c	7	a	8	b	9	a	10	a
11	c	12	b	13	a	14	a		

4. Polarization of Light

1	a	2	d	3	a	4	c	5	c
6	a	7	b	8	c	9	c	10	c

5. EM Waves

1	b	2	b	3	c	4	c	5	b
6	a	7	a	8	a	9	b	10	a
11	b	12	c	13	b	14	a	15	d
16	b	17	c	18	a	19	c	20	b
21	b	22	d	23	a	24	a	25	c

6. IIT-JEE/AIEEE

1	a	2	d	3	c	4	b	5	d
6	a	7	d	8	c	9	c	10	b
11	d	12	c	13	d	14	a	15	b
16	d	17	c	18	a	19	d	20	b
21	c	22	d	23	b	24	a	25	c
26	c	27	b	28	d	29	b	30	b
31	b	32	d	33	c	34	d	35	a
36	a	37	c	38	a	39	b	40	c
41	c	42	b	43	d	44	b	45	b
46	d	47	a						

7. NEET/AIPMT

1	d	2	d	3	d	4	c	5	a
6	c	7	d	8	d	9	a	10	d
11	d	12	d	13	c	14	c	15	c
16	b	17	d	18	a	19	a	20	c
21	b	22	c	23	d	24	d	25	b
26	a	27	c	28	c	29	d	30	d
31	b	32	d	33	a	34	b	35	d
36	a	37	c	38	a	39	b	40	b
41	b								

8. AIIMS

1	d	2	c	3	b	4	c	5	d
6	c	7	d	8	c	9	c	10	b
11	b	12	d	13	a	14	b	15	b
16	b	17	a	18	b				

9. Assertion & Reason

1	b	2	d	3	b	4	d	5	a
6	c	7	c	8	a	9	a	10	a
11	c	12	d	13	d	14	b	15	b
16	d	17	b	18	a	19	b		