Chapter 1: Optics

1. In the phenomenon of interference, there is

A Annihilation of light energy

B Addition of energy

C Redistribution energy

D Creation of energy

2. Interference fringes are obtained using two coherent sources whose intensities are in the ratio 9 : 4. Then ratio of the intensities of the resultant maximum and minimum will be

A 5 : 1

B 9 : 4

C 25 : 1

D 4 : 1

3. In double slit experiment two monochromatic sources of light produce fringe width 0.2 mm and 0.3 mm respectively. Their wavelengths are in the ratio of

A 1 : 5

B 4 : 9

C 9 : 4

D 2 : 3

4. The path difference between two interfering light waves at a point is $\lambda/4$. The ratio of intensity at this point with that at the central spot is

A 1

B 0.5

C 3

D 1.5

5. Yellow light emitted by sodium lamp in Young's double slit experiment is replaced by monochromatic blue light of the same intensity then

A Fringe width will decrease

B Fringe width will increase

C Fringe width will remain unchanged

D Fringe width will become less intense

6. Ratio of intensities of two waves is given by 4:1. The ratio of the amplitudes of the waves is

A 2:1

B 1:2

C 4:1

D 1:4

7. If two waves, each of intensity I_0, having the same frequency but differing by a constant phase angle of 60^o, superpose at a certain point in space, then the intensity of resultant wave is

A $2I_0$

B $\sqrt{3}\ I_0$

C $3I_0$

D $4I_0$

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

A Unchanged

B Halved

C Doubled

D Quadrupled

9. Instead of using two slits as in Young's experiment, if we use two separate but identical sodium lamps, which of the following occurs?

A General illumination

B Large fringe width

C Very bright maximum

D Very dark minimum

10. Suppose the entire arrangement of Newton's rings set up (in air) is immersed in water without changing other parameters, then

A Number of fringes increases

B Number of fringes decreases

C Number of fringes remains same

D No fringes

11. The unique and distinguishable characteristic of a monochromatic light wave, irrespective of the medium is

A Velocity

B Wavelength

C Intensity

D Frequency

12. Phase difference of $\pi/4$ corresponds to path difference of

A $\lambda/8$

B λ

C $\lambda/4$

D $8/\lambda$

13. How will the diffraction pattern of single slit change when yellow light is replaced by blue light of same intensity? Central maximum

A Width increases
B Width decreases
C Intensity increases
D Intensity decreases

14. The angular width of the central maximum in single slit diffraction pattern varies

A Directly with slit width
B Inversely with wavelength
C Directly with wavelength
D Directly with slit to screen distance

15. Which of the following colours will be best suited for obtaining a sharp image of a narrow circular aperture on a screen?

A Red light
B Green light
C Violet light
D Blue light

16. In a certain region of a thin film we get 6 fringes with light of wavelength 500 nm. How many fringes do we get in the same region with wavelength 600 nm?

A 6
B 5
C 30
D 36

17. The angle of diffraction for the first minimum due to Fraunhofer diffraction with source of light of wavelength 550 nm and slit of width 0.55 mm is

A 1 rad
B 0.1 rad
C 0.01 rad
D 0.001 rad

18. When white light is incident on diffraction grating, the first order principal maxima will be

A Absent
B Spectrum of component colours
C One of the component colours
D White

19. A telescope has an aperture of 140 cm. The least angular separation for two stars which can be resolved by a telescope for light of wavelength 5.6×10^{-7} m is

A 4.88×10^{-7} radian
B 0.35×10^{7} radian
C 0.25×10^{-7} radian

D 4×10^{-7} radian

20. Two telescopes have objectives of diameters 10 cm & 15 cm respectively. The ratio of their resolving powers for light of wavelength 500 nm will be

A 3 : 2
B 2 : 3
C 9 : 4
D 4 : 9

21. In a two-slit experiment with sodium light, fringes are obtained on a screen placed at some distance from the slits. If the screen is moved by 2×10^{-2} m towards the slits, the change in fringe width is 1×10^{-5}m and separation between the slits is 10^{-3}m, wavelength of light used is

A 4000 $\overset{0}{A}$
B 4500 $\overset{0}{A}$
C 5500 $\overset{0}{A}$
D 5000 $\overset{0}{A}$

22. For a circular aperture of the objective of width 'a', the limit of resolution of a telescope for wavelength λ of incident light is given by

A $\frac{a}{\lambda}$
B $\frac{1.22\lambda}{a}$
C $\frac{a}{1.22\lambda}$
D $\frac{\lambda}{a}$

23. In single slit diffraction, as the slit width increases

A Sharpness of central fringe decreases
B Sharpness of central fringe increases
C Sharpness remains same
D There is a drastic variation in the intensity of central fringe

24. In case of multiple slits, as the number of slits increase

A The fringe width decreases
B The fringe width increases
C The intensity of maxima decreases
D No change in fringe width

Chapter 2: Applied Optics

1. Photons in a laser beam have the same energy, wavelength, polarization direction, and phase because:
   - A) each is produced in an emission that is stimulated by another
   - B) all come from the same atom
   - C) the lasing material has only two quantum states
   - D) all photons are alike, no matter what their source

2. The atoms in the lasing medium must be pumped to achieve:
   - A) a metastable state
   - B) fast response
   - C) stimulated emission
   - D) population inversion

3. Photons in a laser beam are produced by:
   - A) transitions from a metastable state
   - B) transitions from a state that decays rapidly
   - C) absorption
   - D) spontaneous emission

4. Which of the following is essential for laser action to occur between two energy levels of an atom?
   - A) the lower level is metastable
   - B) the upper level is metastable
   - C) the lower level is the ground state
   - D) the are more atoms in the lower level than in the upper level

5. Which of the following is essential for the laser action to occur between two energy levels of an atom?
   - A) the lower level is metastable
   - B) there are more atoms in the upper level than in the lower level
   - C) there are more atoms in the lower level than in the upper level
   - D) the lower level is the ground state

6. Population inversion is important for the generation of a laser beam because it assures that:
   - A) spontaneous emission does not occur more often than stimulated emission
   - B) more photons are absorbed than emitted
   - C) more photons are emitted than absorbed
   - D) photons do not collide with each other

7. A metastable state is important for the generation of a laser beam because it assures that:
   - A) spontaneous emission does not occur more often than stimulated emission
   - B) more photons are absorbed than emitted
   - C) more photons are emitted than absorbed

D) photons do not collide with each other

8. In a helium-neon laser, the laser transition takes place in :

A) He atoms only
B) Ne atoms only
C) Either He or Ne atoms
D) Both He and Ne atoms

9. The purpose of the mirrors at the ends of a helium-neon laser is:

A) to assure that no laser light leaks out
B) to increase the number of stimulated emissions
C) to decrease the number of stimulated emissions
D) to keep the light used for pumping inside the laser

10. A beam of electromagnetic waves might

I. be monochromatic II. be coherent III. have the same polarization direction .

Which of these describe the waves from a laser?

A) I only
B) II only
C) III only
D) I, II, and III

11. A laser beam can be sharply focused because it is:

A) highly coherent
B) plane polarized
C) intense
D) highly directional

12. The "E" in acronym of LASER stands for:

A) Electromagnetic
B) Excitation
C) Energy
D) Emission

13. Acceptance angle is defined as the _______ angle of incidence at the end face of an optical fibre, for which the ray can be propagated in the optical fibre is

A) Maximum
B) Minimum
C) Either a or b
D) None of the above

14. In multimode graded index fibre, light rays travel _______ in different parts of the fibre

A) At different speeds
B) With same speed
C) Both a and b

D) With velocity c (3 x 10^8m/s)

15. Step index fibre sustains only

A) Single mode of propagation
B) Multimode of propagation
C) Both single mode and multimode of propagation
D) None of the above

16. In an optical fiber, the inner core is _______ the cladding.

A) Greater than
B) Denser than
C) Less dense than
D) The same density as

17. In fiber optics, the signal is _______ waves.

A) Light
B) Radio
C) Infrared
D) Micro

18. In a fiber-optic cable, the signal is propagated along

A) The core
B) The cladding
C) Both core and cladding
D) Surface of the cladding

19. The inner core of an optical fiber is _______ in composition.

A) glass or plastic
B) copper
C) aluminum
D) bimetallic

20. The average lifetime of an atom in metastable state is

A) 10^{-3} sec
B) 10^{-6} sec
C) 10^{-8} sec
D) 10^{-10} sec

Chapter 3 : Quantum Physics

1. The units of the Planck constant *h* are that of:

A) energy

B) power

C) momentum

D) angular momentum

2.The quantization of energy, $E = nhf$, is not important for an ordinary pendulum because:

A) the formula applies only to mass-spring oscillators

B) the allowed energy levels are too closely spaced

C) the allowed energy levels are too widely spaced

D) the formula applies only to atoms

4.The frequency of light beam A is twice that of light beam B. The ratio E_A/E_B of photon energies is:

A) 1/2

B) 1/4

C) 1

D) 2

5.A photon in light beam A has twice the energy of one in light beam B. The ratio $\square_A/\square_B$ of the wavelengths is:

A) 1/2

B) 1/4

C) 1

D) 2

6.A photon in light beam A has twice the energy of a photon in light beam B. The ratio p_A/p_B of their momenta is:

A) 1/2

B) 1/4

C) 1

D) 2

7. Which of the following electromagnetic radiations has photons with the greatest energy?

A) blue light

B) yellow light

C) x-rays

D) radio waves

8. Which of the following electromagnetic radiations has photons with the greatest momentum?

A) blue light

B) yellow light

C) x-rays

D) radio waves

9. The intensity of a light beam with a wavelength of 500 nm is 2000 W/m^2. The photon flux (in number/m$^2 \cdot$ s) is about:

A) 5×10^{17}

B) 5×10^{19}

C) 5×10^{21}

D) 5×10^{23}

10. The intensity of a light beam with a wavelength of 500 nm is 2000 W/m^2. The concentration of photons in the beam is:

A) 1.7×10^{13} photons/m^3

B) 5.0×10^{15} photons/m^3

C) 5.0×10^{21} photons/m^3

D) 1.7×10^{22} photons/m^3

11. Light beams A and B have the same intensity but the wavelength associated with beam A is longer than that associated with beam B. The photon flux (number crossing a unit area per unit time) is:

    A) greater for A than for B

    B) greater for B than for A

    C) the same for A and B

    D) greater for A than for B only if both have short wavelengths

12. In a photoelectric effect experiment the stopping potential is:

    A) the energy required to remove an electron from the sample

    B) the potential energy of the most energetic electron ejected

    C) the photon energy

    D) the electric potential that causes the electron current to vanish

13. In a photoelectric effect experiment at a frequency above cut off, the stopping potential is proportional to:

    A) the energy of the least energetic electron before it is ejected

    B) the energy of the most energetic electron before it is ejected

    C) the energy of the most energetic electron after it is ejected

    D) the electron potential energy at the surface of the sample

14. In a photoelectric effect experiment at a frequency above cut off, the number of electrons ejected is proportional to:

    A) their kinetic energy

    B) the work function

    C) the frequency of the incident light

    D) the intensity of light

15. In a photoelectric effect experiment no electrons are ejected if the frequency of the incident light is less than A/h, where h is the Planck constant and A is:

    A) the maximum energy needed to eject the least energetic electron

    B) the minimum energy needed to eject the least energetic electron

    C) the maximum energy needed to eject the most energetic electron

    D) the minimum energy needed to eject the most energetic electron

16. Of the following, Compton scattering from electrons is most easily observed for:

A) infrared light

B) visible light

C) ultraviolet light

D) X rays

17. In Compton scattering from electrons the largest change in wavelength occurs when the photon is scattered through:

A) 0°

B) 45°

C) 90°

D) 180°

18. In Compton scattering from electrons the frequency of the emitted light is independent of:

A) the frequency of the incident light

B) the scattering angle

C) the electron recoil energy

D) none of the above

19. In Compton scattering from electrons the largest change in wavelength that can occur is:

A) 2.43×10^{-15} m

B) 2.43×10^{-12} m

C) 2.43×10^{-9} m

D) dependent on the frequency of the incident light

20. Evidence for the wave nature of matter is:

A) electron diffraction experiments of Davisson and Germer

B) Thompson's measurement of e/m

C) Young's double slit experiment

D) the Compton effect

21. Which of the following is NOT evidence for the wave nature of matter?

A) The photoelectric effect

B) The diffraction pattern obtained when electrons pass through a slit

C) Electron tunneling

D) The validity of the Heisenberg uncertainty principle

22. Of the following which is the best evidence for the wave nature of matter?

A) The photoelectric effect

B) The Compton effect

C) The spectral radiancy of cavity radiation

D) The diffraction of electrons by crystals

23. Monoenergetic electrons are incident on a single slit barrier. If the energy of each incident electron is increased, the central maximum of the diffraction pattern:

A) widens

B) narrows

C) remains same

D) shifts

24. A free electron and a free proton have the same kinetic energy. This means that, compared to the matter wave associated with the proton the matter wave associated with the electron has:

A) a shorter wavelength and a greater frequency

B) a longer wavelength and a greater frequency

C) a shorter wavelength and the same frequency

D) a longer wavelength and the same frequency

25. A free electron and a free proton have the same momentum. This means that, compared to the matter wave associated with the proton the matter wave associated with the electron has:

A) a shorter wavelength and a greater frequency

B) a longer wavelength and a greater frequency

C) the same wavelength and the same frequency

D) the same wavelength and a greater frequency

26. A free electron and a free proton have the same speed. This means that, compared to the matter wave associated with the proton the matter wave associated with the

electron has:

A) a shorter wavelength and a greater frequency

B) a longer wavelength and a greater frequency

C) the same wavelength and the same frequency

D) a longer wavelength and a smaller frequency

27.A free electron has a momentum of 5.0×10^{-24}kg · m/s. The wavelength (in m) of its wave function is:

A) 1.3×10^{-8}

B) 1.3×10^{-10}

C) 1.3×10^{-12}

D) 1.3×10^{-14}

28.The frequency and wavelength of the matter wave associated with a 10-eV free electron are:

A) 1.5×10^{34} Hz, 3.9×10^{-10} m

B) 1.5×10^{34} Hz, 1.3×10^{-34} m

C) 2.4×10^{15} Hz, 1.2×10^{-9} m

D) 2.4×10^{15} Hz, 3.9×10^{-10} m

29.If the kinetic energy of a non-relativistic electron doubles, the wavelength of matter wave changes by the factor:

A) $1/\sqrt{2}$

B) 1/2

C) 1/4

D) $\sqrt{2}$

30.The probability that a particle is in a given small region of space is proportional to:

A) its energy

B) its momentum

C) the wavelength of its wave function

D) the square of the magnitude of its wave function

31 $\psi(x)$ is the wave function for a particle moving along the x axis. The probability that the particle is in the interval from $x = a$ to $x = b$ is given by:

A) $\psi(b) - \psi(a)$

B) $|\psi(b)|^2 - |\psi(a)|^2$

C) $\int_a^b \psi(x)dx$

D) $\int_a^b |\psi(x)|^2 dx$

32.The significance of $|\psi|^2$ is:

A) probability

B) energy

C) probability density

D) energy density

33.A free electron in motion along the x axis has a localized wave function. The uncertainty in its momentum is decreased if the wave function:

A) is made narrow

B) is made wide

C) remains the same but the energy of the electron is increased

D) remains the same but the energy of the electron is decreased

34.The uncertainty in position of an electron in a certain state is 5×10^{-10} m. The uncertainty in its momentum (in kg ⍰ m/s) must be

A) less than 10^{-26}

B) less than 10^{-22}

C) greater than 10^{-25}

D) greater than 10^{-23}

35.The reflection coefficient R for a certain barrier tunneling problem is 0.80. The corresponding transmission coefficient T is:

A) 0.80

B) 1.00

C) 0.50

D) 0.20

36.An electron with energy E is incident upon a potential energy barrier of height $U > E$ and thickness L. The transmission coefficient T:

A) is zero

B) decreases exponentially with L

C) is proportional to $1/L$

D) is proportional to $1/L^2$

37.An electron with energy E is incident on a potential energy barrier of height U and thickness L. The probability of tunneling increases if:

A) E decreases without any other changes

B) U increases without any other changes

C) L decreases without any other changes

D) E and U increase by the same amount

Chapter 4: Quantum Mechanics

1.If a wave function ψ for a particle moving along the x axis is "normalized" then:

A) $\int|\psi|^2 dt = 1$
B) $\int|\psi|^2 dx = 1$
C) $\partial\psi/\partial x = 1$
D) $\partial\psi/\partial t = 1$

2.The energy of a particle in a one-dimensional box is proportional to (n = quantum number):

A) n
B) $1/n$
C) $1/n^2$
D) n^2

3.The ground state energy of an electron in a one-dimensional box is 2.0 eV. If the width of the well is doubled, the ground state energy will be:

A) 0.5 eV
B) 1.0 eV
C) 2.0 eV
D) 4.0 eV

4.An electron is in an one-dimensional infinitely deep potential well. The ratio E_3/E_1 of the energy for $n = 3$ to that for $n = 1$ is:

A) 1/3
B) 1/9
C) 3/1
D) 9/1

5.The ground state energy of an electron in a one-dimensional box:

A) is zero
B) decreases with temperature
C) increases with temperature
D) is independent of temperature

6. A particle is trapped in an infinite potential energy well. It is in the state with quantum number $n = 14$. How many nodes does the probability density have (counting the nodes at the ends of the well)?

A) 7
B) 13
C) 14
D) 15

7.A particle is trapped in an infinite potential energy well. It is in the state with quantum number $n = 14$. How many maxima does the probability density have?

A) 7
B) 13
C) 14
D) 15

8.A particle is confined to a one-dimensional trap by infinite potential energy walls. Of the following states, designed by the quantum number n, for which one is the probability density greatest near the center of the well?

A) $n = 2$
B) $n = 3$

C) $n = 4$
D) $n = 6$

9. An electron is in a one-dimensional well with finite potential energy barriers at the walls. The matter wave:
A) is zero at the barriers
B) is zero everywhere within each barrier
C) is zero in the well
D) extends into the barriers

10. A particle is confined by finite potential energy walls to a one-dimensional trap from $x = 0$ to $x = L$. Its wave function in the region $x > L$ has the form:
A) $\psi(x) = A \sin(kx)$
B) $\psi(x) = Ae^{kx}$
C) $\psi(x) = Ae^{-kx}$
D) $\psi(x) = Ae^{ikx}$

11. A particle is trapped in a finite potential energy well that is deep enough so that the electron can be in the state with $n = 3$. For this state how many nodes does the probability density have?
A) 4
B) 1
C) 2
D) 3

12. An electron in an atom drops from an energy level at -1.1×10^{-18} J to an energy level at -2.4×10^{-18} J. The wave associated with the emitted photon has a frequency of:
A) 2.0×10^{17} Hz
B) 2.0×10^{15} Hz
C) 2.0×10^{13} Hz
D) 2.0×10^{11} Hz

13. The quantum number n is most closely associated with what property of the electron in a hydrogen atom?
A) Energy
B) Orbital angular momentum
C) Spin angular momentum
D) Magnetic moment

14. According to the quantum theory of the hydrogen atom the energy E_n of a state with principal quantum number n is proportional to:
A) n
B) n^2
C) $1/n$
D) $1/n^2$

15. The ground state energy of a hydrogen atom is –13.6 eV. The minus sign indicates:
A) the kinetic energy is negative
B) the potential energy is positive
C) the electron might escape from the atom
D) the electron and proton are bound together

16. If the wave function ψ is spherically symmetric then the radial probability density is given by:
A) $4\pi r^2 \psi$

B) $|\psi|^2$
C) $4\pi r^2|\psi|^2$
D) $4\pi|\psi|^2$

17. If $P(r)$ is the radial probability density then the probability that the separation of the electron and proton is between r and $r + dr$ is:
A) $P\,dr$
B) $|P|^2\,dr$
C) $4\pi r^2 P\,dr$
D) $4\pi r^2|P|\,dr$

Chapter 5: Solid State Physics

1. The probability that a particular state having energy E is occupied by an electron in metals is given by

A) $f(E) = \dfrac{1}{\exp\left(\dfrac{E - E_F}{kT}\right) + 1}$

C) $f(E) = \dfrac{1}{\exp\left(\dfrac{E_F - E}{kT}\right) + 1}$

B) $f(E) = \dfrac{1}{\exp\left(\dfrac{E - E_F}{kT}\right) - 1}$

D) $f(E) = \dfrac{1}{\exp\left(\dfrac{E_F - E}{kT}\right) - 1}$

2. Fermi energy in metal is
   A) Highest energy possessed by an electron at zero K
   B) Lowest energy possessed by an en electron at 300 K.
   C) Highest energy possessed by an electron at 300 K.
   D) Lowest energy possessed by an electron at zero K
3. The average energy of a free electron in a metal at 0 K is
   A) $E_{av} = (3/5)E_F$.
   C) $E_{av} = (5/3)E_F$
   B) $E_{av} = (1/2)E_F$
   D) $E_{av} = E_F$
4. In intrinsic semiconductor Fermi level at zero K lies
   A) Close to conduction band
   B) Close to valence band
   C) Halfway between conduction and valance band
   D) Inside the conduction band
5. When temperature is increased, resistivity of a conductor
   A) Decreases
   B) Increases
   C) Remains same
   D) Becomes zero
6. Superconductors are
   A) Diamagnetic
   B) Paramagnetic
   C) Ferromagnetic
   D) Ferrimagnetic
7. Cooper pair is …
   A) Proton and neutron are bound together
   B) Proton and electron is bound together
   C) Two electrons are bound together
   D) Proton- proton bound together

8. Boson is …
   A) Particle with integral spin
   B) Particle with half integral spin
   C) Particle with positive charge
   D) Particle with negative charge