PHY2MN104:Optics and Lasers
Section-A-Mark-3

1. Name and explain the two types of reflection.
2. Tabulate the difference between specular and diffuse reflection?
3. Interpret, how does the roughness of a surface affect the type of reflection that occurs?
4. Define geometric path?
5. Define optical path length ?
6. Describe chromatic dispersion?
7. State, how the refractive index of a medium vary with wavelength?
8. Explain electromagnetic spectrum?
9. Draw electromagnetic spectrum arranged in terms of frequency and wavelength?
10. Discuss the fundamental characteristics of a photon?
11. Express the relation between the momentum of a photon and its wavelength?
12. Mention the concept of rest mass for a photon?
13. State wave-particle duality of light?
14. Define Snell's law?
15. State and explain the law of reflection.
16. Tabulate the difference between reflection and refraction.
17. Define point of incidence, angle of incidence and angle of reflection.
18. Define reflection and state laws of reflection with a neat diagram.
19. Define refraction and state laws of refraction with a neat diagram.
20. Mention thedifference between absolute refractive index and relative refractive index.
21. Define optical density. Differentiate between high optical densive medium and low optical densive medium.

22. Define the terms chromatic dispersion, spectrum, dispersive medium.
23. Define and illustrate electromagnetic spectrum.
24. Define photon and list some characteristics
25. Discuss the laws of reflection.
26. List difference between a convex and concave mirror.
27. Mention the nature of the image formed by a plane mirror.
28. Provide the formula for the number of images formed between two plane mirrors inclined at an angle θ.
29. Describe the working principle of a periscope.
30. Determine the number of images formed when two plane mirrors are placed perpendicular to each other.
31. Describe how the focal length of a concave mirror changes when immersed in water.
32. Show how the mirror formula is applied to solve image formation problems.
33. Explain how the refractive index of a medium affects the speed of light in that medium.
34. Demonstrate how Snell's law is used to determine the path of a ray passing through different media.
35. Calculate the image position for an object placed at twice the focal length of a convex lens.
36. Calculate the image position for an object placed at twice the focal length of a convex lens.
37. Show how a prism deviates a light ray and derive the condition for minimum deviation.
38. State the spherical mirror equation for a concave mirror.
39. Derive the image distance formula for a concave mirror using the spherical mirror equation.
40. How does the nature of the image formed by a convex mirror differ from that formed by a concave mirror?

41. Explain the image formation in a convex mirror using the spherical mirror equation.
42. How does the image size change for an object placed at the focus of a concave mirror?
43. Discuss the image formation of a convex mirror as the object distance decreases.
44. State the refraction equation at a spherical surface.
45. Define the Gaussian relation for refraction at spherical surfaces.
46. Write the relationship between the object distance, image distance, and the radius of curvature in refraction at a spherical surface.
47. For a spherical surface, if the refractive index of the second medium is higher than the first, what happens to the image distance?
48. How does the focal length of a spherical surface depend on the radius of curvature and refractive indices of the media?
49. Explain how the Gaussian relation is used to derive the image formation equation for a spherical surface.
50. State the lens formula and its mathematical expression.
51. Describe the sign conventions used in the lens formula.
52. Express the relationship between focal length, object distance, and image distance for a convex lens.
53. Explain how the lens equation is applied to concave lenses.
54. Define the lens maker's formula and write its mathematical expression.
55. Identify the physical parameters that influence the focal length of a lens according to the lens maker’s formula.
56. Explain why the lens maker’s formula is important in designing optical systems.
57. Analyze how the curvature of lens surfaces affects its focal length according to the lens maker’s formula.
58. Explain the term Principle of superposition of waves.
59. Discuss what happens to the amplitude of wave after superposition

60. Define interference in the context of wave optics.

61. State the conditions required for constructive interference to occur.

62. Explain the principle of superposition as it relates to interference

63. Differentiate between constructive and destructive interference

64. Describe the Young's double-slit experiment and its role in demonstrating interference.

65. Identify the factors that affect the fringe width in an interference pattern.

66. Explain the concept of phase difference in interference.

67. State the conditions for destructive interference to occur in a double-slit experiment.

68. Define coherence and its role in producing an interference pattern.

69. Describe the difference between interference of light and diffraction of light.

70. Make a comment on the term 'path difference' in interference?

71. Define the term "fringe separation" in the context of interference.

72. Explain the phenomenon of interference in a thin film of soap solution.

73. State the conditions for constructive and destructive interference in thin films.

74. Define the phase difference between two sinusoidal waves and explain its effect on the resultant amplitude.

75. Illustrate the use of a phasor diagram to represent the addition of two sinusoidal waves with a phase difference.

76. draw the graph showing interference in terms of intensity distribution

77. explain what happens if incoherent waves superimpose.

78. Discuss the terms Coherence time and coherence length

79. Determine the conditions for bright and dark fringes in Interference due to transmitted light.

80. In a Newton's rings experiment, the diameter of 10th dark ring due to wavelength 6000 Å in air is 0.5 cm. Find the radius of curvature of the lens

81. Discuss the theory of Newton´s rings.

82. Diferentiate between Interference and diffraction

83. Explain the difference between Fresnel diffraction and Fraunhofer diffraction.

84. What is the significance of the phase of secondary wavelets in Fresnel diffraction?

85. How does the distance of the point on the screen (P) affect the diffraction pattern in Fresnel diffraction?

86. Describe the conditions required for observing Fraunhofer diffraction.

87. What is the role of the source and screen distances in determining whether Fresnel or Fraunhofer diffraction occurs?

88. State the key difference in the wavefront characteristics in Fresnel and Fraunhofer diffraction.

89. Define the condition for minima in the diffraction pattern of a single slit.

90. State the relationship between the width of the slit (a) and the wavelength (λ) for the occurrence of secondary minima.

91. Derive the expression for the angular position of the nth minimum in the diffraction pattern of a single slit.

92. Explain the setup for Fraunhofer diffraction at a double slit

93. Describe how the diffraction pattern of a double slit is affected by the width of the slits and the distance between them.

94. State the condition for interference minima in a double-slit diffraction pattern

95. State the difference between a transmission grating and a reflection grating.

96. State the significance of the spacing between the lines on a grating in terms of the diffraction of light.

97. Define longitudinal and transverse waves. Provide one example of each.

98. Explain the difference between compression and rarefaction in a longitudinal wave.

99. Describe the phenomenon of polarization. Why is it not observed in longitudinal waves?

100. Define polarization in the context of light waves. How is polarized light different from unpolarized light?

101. Explain the concept of plane-polarized light.

102. Describe how natural light is unpolarized.

103. Analyze the direction of the electric field in a plane-polarized light wave

104. Identify the characteristics of circularly polarized light.

105. Define partially polarized light and explain how it differs from unpolarized and fully polarized light.

106. sunlight is reflected from a calm lake,The reflected light is 100%polarized ata certain instant What is the angle between the sun and the horizon at that instant.The refractive index of water is 1.33.

107. Explain how a polarizer transforms unpolarized light into polarized light.

108. Describe the role of the transmission axis in the working of a polarizer.

109. state Malus' Law and explain its significance in polarizer-analyzer systems.

110. Discuss specific rotation in optical activity .on what factors does it depend.

111. write a short note on optical activity

112. Define the term "laser" and explain its significance in optical technology.

113. Describe the process of absorption of light by atoms in a material medium.

114. Explain the concept of population inversion in the context of laser operation.

115. State the difference between spontaneous emission and stimulated emission of radiation.

116. List the factors affecting the relative population N2/N1N_2 / N_1N2/N1 of atoms at two energy levels.

117. Explain the concept of population inversion in the context of laser action.

118. Describe the role of metastable states in achieving population inversion in a laser system

119. Define the term "population inversion" and state why it is essential for laser operation.

120. state the conditions required for a material to achieve population inversion

121. List the factors that contribute to the creation of population inversion in a laser medium

122. Explain the role of the active medium in the operation of a laser.

123. Describe the process of optical pumping and its importance in maintaining population inversion in a laser.

124. Outline the purpose of the optical resonator in a laser system.

125. Analyze the effect of varying the angle of incidence on the colours seen in thin films

126. Compare the formation of dark and bright fringes in thin films with respect to varying thickness and refractive index.

127. Derive the expression for the fringe width (β) in terms of the wedge angle (θ) and wavelength (λ).

128. Discuss how thin films satisfies interference .

129. Explain how parallel film causes interference due to reflection of light

130. Discuss how interference of light causes the formation of newtons rings

131. Explain interference by thin parallel films and write the conditions for maxima and minima

132. What are newtons rings and how they are formed

133. Discuss the interference due to newtons ring and explain the condition of maxima and minima

134. Explain Brewsters law with suitable diagram in reference of polarization

135. Briefly explain different types of lasers

136. Discuss the working of ruby laser

137. Discuss the working of Helium neon laser

Section-B-Mark-6

1. If a light ray strikes a glass surface at an angle of 45° from air (refractive index of air = 1, refractive index of glass = 1.5), Find the angle of refraction in the glass?
2. Given that the speed of light in a vacuum (c) is 3 × 108 m/s, find the refractive index of water if the speed of light in water is 2.25 × 108 m/s.
3. If the refractive index of a medium is 1.5 for yellow light, find the speed of light in this medium?
4. Given that the refractive index of water is 1.33 and the geometric path length is 5 meters, find the optical path length.
5. If the frequency of a photon is 5×10^{14} Hz, find its energy?
6. Given that the speed of light in a vacuum is 3×108m/s, find the momentum of a photon with a wavelength of 600 nm?
7. A person is standing 2 meters in front of a plane mirror. If the mirror is moved 50 cm backward, determine the new distance between the person and their image.
8. Two plane mirrors are placed at an angle of 60∘ to each other. Find the number of images formed.
9. An object is placed at a distance of 5 cm in front of a plane mirror. If the mirror is inclined at an angle of 45∘ with the horizontal, determine the apparent position of the image.
10. A concave mirror has a focal length of 15 cm. An object is placed 30 cm from the mirror. Determine the image position and nature of the image.
11. A convex lens of focal length 20 cm forms an image at 50 cm from the lens. Find the position of the object (Draw a diagram).
12. A ray of light travels from air to glass with a refractive index of 1.5. If the angle of incidence is 30°, determine the angle of refraction.
13. An object is placed 10 cm in front of a concave lens of focal length 20 cm. Determine the image position and magnification.
14. A convex mirror has a focal length of 25 cm. If an object is placed 50 cm in front of the mirror, determine the position and nature of the image formed.

15. A concave mirror has a focal length of 10 cm. An object is placed 30 cm in front of the mirror. Calculate the position and nature of the image formed.
16. A convex mirror has a focal length of 15 cm. An object is placed 45 cm in front of the mirror. Using the mirror equation, find the image distance and the magnification.
17. An object is placed 20 cm in front of a plane mirror. Calculate the image distance and describe the characteristics of the image formed.
18. A concave mirror forms a real image of an object placed at a distance of 40 cm in front of the mirror. The image formed is located at a distance of 60 cm from the mirror. Determine the focal length of the concave mirror.
19. A convex mirror has a focal length of 12 cm. An object is placed 36 cm in front of the mirror. Using the mirror equation, find the image position and the magnification.
20. A ray of light passes from air (refractive index n1=1) to a spherical surface of radius R=20 cm and refractive index n2=1.5. The object is located 30 cm away from the surface. Using the refraction equation at a spherical surface, determine the position and nature of the image formed.
21. A spherical surface separates two media with refractive indices n1=1.2 and n2=1.5, and has a radius of curvature R=25. If the object is placed at a distance of 40 cm from the surface, calculate the image distance using the Gaussian relation.
22. A spherical lens with a radius of curvature of 18 cm and refractive index n=1.6 is used to form an image. If the object is placed 50 cm away from the spherical surface, calculate the image position and magnification. Use the refraction equation and discuss how the image varies with changes in object distance.
23. A thin lens is made of a material with a refractive index of 1.6. The radii of curvature of its two surfaces are 20 cm and 30 cm. Determine its focal length using the lens maker's formula.
24. A convex lens of focal length 10 cm is placed in water (refractive index = 1.33). If the refractive index of the lens material is 1.5, determine the new focal length of the lens.
25. A converging lens of focal length 15 cm is used to form an image at 60 cm. Find the object distance required to form this image.

26. A convex lens is made of glass with a refractive index of 1.5. The radii of curvature of its two surfaces are 10 cm and 15 cm. Determine the focal length of the lens using the lens maker’s formula.
27. A thin concave lens has radii of curvature of 25 cm and 40 cm. If the refractive index of the material is 1.55, determine its focal length.
28. A lens is made of a material with a refractive index of 1.65 and has radii of curvature of 12 cm and 18 cm. Compute its focal length in air.
29. Derive the condition for constructive interference in a double-slit experiment.
30. Explain how the interference pattern changes when the wavelength of light is varied in a Young's double-slit experiment.
31. Calculate the fringe width in a Young’s double-slit experiment given specific values for wavelength, slit separation, and distance to the screen.
32. Analyze how the interference pattern in Young's double-slit experiment would change if the screen distance is halved.
33. Discuss the role of coherent sources in creating stable interference patterns, and explain why incoherent sources cannot produce interference.
34. Explain how interference in thin films is responsible for the rainbow colors observed on the surface of a soap bubble.
35. Using the law of cosines, explain how to calculate the resultant amplitude of two sinusoidal waves with a phase difference. Derive the equation for the amplitude from the phasor diagram.
36. Discuss how the intensity distribution of two waves is affected by their phase difference, using the derived equations for amplitude and interference term.
37. explain the interference in terms of intensity distribution
38. Discuss the conditions to observe a distinct well-defined interference pattern.
39. Derive the condition for Maxima and Minima in interference due to reflected light.
40. Newton’s rings are observed in reflected light of $\lambda = 5.9 \times 10 -5$ cm. The diameter of the 10th dark ring is 0.5 cm. Find the radius of curvature of the lens and the thickness of the air film.

41. In Fraunhofer diffraction, explain how the diffraction pattern can be obtained using two convex lenses. What is the role of each lens in producing the diffraction pattern?

42. Discuss the diffraction pattern formed due to a single slit and explain the appearance of secondary maxima and minima.

43. Derive the expression for the width of the central maximum in a single-slit diffraction pattern and explain its dependence on the wavelength of light.

44. Illustrate the significance of the focal length of lens L2 in determining the diffraction pattern on the screen.

45. Illustrate the relationship between the slit width, the slit separation, and the wavelength of light in determining the angular separation of maxima and minima in double-slit diffraction.

46. Discuss the difference in angular separation of minima and maxima due to interference and diffraction in a double-slit diffraction pattern.

47. Explain the working principle of a diffraction grating and its ability to separate different wavelengths of light.

48. Compare and contrast longitudinal and transverse waves in terms of particle motion and propagation direction.

49. Explain the difference between unpolarized and polarized light. Provide examples of each

50. Compare the three types of polarization: plane (linear) polarization, elliptical polarization, and circular polarization.

51. How does the electric field vector behave in plane-polarized light? Illustrate with a diagram

52. Describe the process of light wave polarization. How is polarized light obtained from unpolarized light?

53. Describe the process of production of plane polarized light by reflection and state Brewster's law.

54. Discuss some of the applications of Brewster's law .

55. Discuss the role of selective absorption in polarizing light.

57. Derive the intensity of transmitted light when an unpolarized light passes through a polarizer at an angle θ.

58. explain the term optical rotation. State any two laws of optical rotation.

59. Explain the process of spontaneous emission and its characteristics.

60. Discuss the role of temperature in determining the population of atoms in energy levels.

61. Derive the expression for the relative population using the Boltzmann law

62. Discuss the process of lasing action and how photons are amplified within the optical resonator.

63. Explain how the threshold condition for lasing is determined and the significance of the threshold value in laser oscillation.

64. Illustrate the process of photon amplification and the role of the mirrors in the laser cavity.

65. discuss in detail various components of laser.

66. State the threshold condition for lasing and justify its importance in laser operation.

67. Find the ratio of populations of the two states in a He-Ne laser that produces light of wavelength 6328Å at 27oC

68. What are the essential components of a laser? Explain their functions briefly.

69. Describe the working of solid state ruby laser.

70. Summarize the method to determine the thickness of the air wedge in a thin film interference experiment.

71. Explain the formation of dark and bright fringes in the interference pattern of a wedge-shaped air film.

72. Analyze the conditions under which maxima and minima occur in the interference pattern of a wedge-shaped air film.

73. Explain laws of reflection and laws of refraction.

74. Explain EM waves and with a proper diagram specify different regions of EM spectrum

75. Explain the dual nature of light waves and write the expression for calculating energy of photons.

76. Briefly explain about any two types of lasers

77. Explain the basic working parts of laser and specify any one of the laser and briefly explain the working

Section-C-Mark-10

1. Briefly describe any three properties of light with the help of diagram.

2. Explain the laws of reflection with necessary derivations and illustrate the behavior of light rays at a plane mirror.

3. Analyze the formation of multiple images using two plane mirrors at an angle and derive an expression for the number of images formed.

4. Describe the working of different optical instruments based on plane mirrors, discussing their principles and applications.

5. Analyze the formation of images by spherical mirrors and lenses using the mirror and lens equations. Discuss the sign conventions, focal length dependence, and practical applications of these optical elements.

6. Illustrate the principles of reflection and refraction using Fermat's principle of least time. Explain how these laws govern the formation of images in mirrors and lenses with appropriate mathematical derivations.

7. Explain the working of a concave mirror in detail, using the spherical mirror equation. Discuss how the image formation changes when the object is placed at various positions (beyond the center of curvature, at the center of curvature, at the focal point, and between the focal point and the mirror) with diagrams.

8. Describe the image formation in a convex mirror with the help of the spherical mirror equation. Discuss the nature of the image formed (real or virtual), its size, and its position for different object distances with diagrams. Also, explain the applications of convex mirrors in daily life.

9. Derive the relationship between the focal length, radius of curvature, and the mirror equation for a concave mirror. Explain the different types of images (real, virtual, erect, inverted) formed by a concave mirror for various object

shaving mirrors, telescopes, and flashlights.

10. Derive the refraction equation at a spherical surface and explain how it is used to determine the image position when light passes from one medium to another. Discuss the significance of the refractive indices of the media involved and provide examples of practical applications where refraction at spherical surfaces is important.

11. Discuss the behavior of light as it undergoes refraction at a spherical surface. Explain the role of the curvature of the surface in determining the focal length and image formation. Using the Gaussian relation, analyze how the focal length changes when the radius of curvature of the surface is altered.

12. Using the Gaussian relation, derive the equation for refraction at a spherical surface. Discuss the concept of principal focus, image magnification, and how the spherical surface curvature affects the formation of images. Provide examples of optical devices that utilize spherical surfaces to achieve specific image properties, such as corrective lenses or telescopes.

13. Derive the lens maker's formula for a thin lens and discuss its significance in determining the focal length of a lens in different media.

14. Analyze the dependence of focal length on the refractive index and curvature of a lens using the lens maker's formula.

15. Determine the conditions for constructive and destructive interference in thin films, and explain how these conditions lead to the formation of bright and dark fringes.

16. Determine an expression for the optical path difference in the interference pattern of a thin parallel film.

17. Discussing Young's double slit experiment a).Find the path difference between waves b). Condition for bright and dark fringe c).Fridge width.

18. Describe with theory, the Newton's rings experiment to determine the wavelength of monochromatic source of radiation

19. Analyze the formation of the diffraction pattern in the Fraunhofer diffraction at a single slit, considering both the constructive and destructive interference. Explain how the diffraction angles are related to the slit width and wavelength.

20. Discuss the role of the path difference in determining both the interference maxima and diffraction minima in the double-slit diffraction pattern, with a detailed derivation of the angular positions for each.

21. Discuss the polarization of light in detail. Explain the difference between different types of polarization, with suitable diagrams and examples.

22. Explain the five optical phenomena in which plane polarized light can be produced from unpolarized light.

23. Explain the phenomenon of double refraction using a calcite crystal, and describe the behavior of ordinary and extraordinary rays.

24. Discuss in detail the quantum mechanical basis for the operation of a laser. Include the processes of absorption, spontaneous emission, and stimulated emission.

25. Make a comment on the components of a laser, focusing on the function of the active medium, pumping agent, and optical resonator. How do these components work together to achieve lasing action?

26. List and explain the three main components of a laser and their contributions to laser operation.

27. Calculate the threshold value for lasing and explain its relation to the losses in the laser cavity.

28. a). Describe the working of solid state ruby laser. b).Explain the principle and working of a He-Ne laser