

PHY 1202: Waves and Optics

Question Bank

Chapter-1

A) Short Answer Questions

- 1) Explain the concept of wave motion
- 2) Define longitudinal wave and transverse wave
- 3) Give difference between travelling and standing
- 4) Define density of a Wave
- 5) Define progressive wave and give some features of the waves
- 6) A uniform string of length 2.5 m and mass 0.02 kg is placed under a tension of 10 N. What is the frequency of its fundamental mode?
- 7) A steel wire 2.5 cm in diameter is kept under tension of 10 KN. The density of steel is 7.8 g/cm³. Find the speed of transverse waves along the wire.
- 8) Calculate intensity of a sound wave in air at 0°C and 1 atm, if its amplitude is 0.001 mm and its wavelength is 60 cm. The density of air is 1.293 kg/m³. Speed of sound in air is 331 m/s.
- 9) Give normal modes of a string
- 10) Define group velocity and phase velocity

A) Long Answer Questions

- 1) Define transverse wave and calculate the speed of a transverse wave
- 2) Explain the principle of superposition of waves
- 3) Explain standing wave and normal modes
- 4) Derive an expression for group velocity and phase velocity and calculate it for non-relativistic and relativistic particles in terms of energy and momentum
- 5) Explain the concept of wave intensity
- 6) A pipe 30 cm long is open at both ends. Which harmonic mode of the pipe resonates a 1.1 kHz source? Will resonance with the same source be observed if one end of the pipe is closed? Take the speed of sound in air as 330 m/s
- 7) A steel wire 0.72 m long has a mass of 5×10^{-3} kg. If the wire is under a tension of 60 N. What is the speed of transverse wave on the wire?
- 8) The velocity of a wave along a string depends only on the tension or force F exerted on the string and the mass per unit length μ of the string. (a) From a consideration of the units of the following quantities, a dimensional analysis, decide which is the correct expression for a wave along a string: (i) μ / F , (ii) F / μ , (iii) $(\mu / F)^{1/2}$, or (iv) $(F / \mu)^{1/2}$. (b) Standing waves are set up in a string by a vibrator of frequency f . If the tension in the string is increased by a factor of four, what happens to the number of nodal points?

Chapter-2

SOUND

A) Short Answer Type Question

- 1) Define
 - (i) Intensity of Sound
 - (ii) Intensity Level
 - (iii) Threshold of Audibility
 - (iv) Sensation level
 - (v) Decibel
 - (vi) Timber
- 2) State the factors on which pitch of sound depends.
- 3) On which factors loudness of sound depends?
- 4) Define: Reverberation & reverberation time.
- 5) State Sabine's formula for reverberation time.
- 6) What are the factors which affect quality of sound?
- 7) What are the factors which affects the acoustic of hall?
- 8) What is principle of stroboscope?

B) Long Answer Type Question

- 1) Explain intensity of sound. How it is related to loudness of sound?
- 2) Explain following:
 - (i) Loudness
 - (ii) Pitch &
 - (iii) Quality or Timber
- 3) Describe Rayleigh disc method to determine intensity level of sound.
- 4) Derive an expression for acoustic pressure of sound.
- 5) What is reverberation and on what factors it depends?
- 6) Define reverberation time of a hall. Explain clearly what causes reverberation and how it can be minimized.
- 7) Define & explain reverberation time.
- 8) Discuss acoustic of concert halls.
- 9) State and explain Sabine's formula for reverberation time of hall.
- 10) Describe stroboscopic method to determine frequency of tuning for or AC signal.

Chapter-3

GEOMETRIC OPTICS

A) Short Answer Type Question

- 1) Define the terms:
 - (i)Optical centre,
 - (ii)Principal Axis &
 - (iii)Radius of curvature
- 2) Define the terms lens. Draw the sketch of converging lens.
- 3) What happens when two lenses, one convex and other concave type of same material and same radii of curvature are joined together?
- 4) When does a convex lens produces a virtual image?
- 5) Give sign conventions that are used while dealing with ray diagrams.
- 6) What do you mean by cardinal points?
- 7) What do you mean by thin lens?
- 8) Write lens maker's formula.
- 9) Define principal foci and focal planes,
- 10) Define cardinal points of a system of co-axial lenses.
- 11) What are nodal points and nodal planes?
- 12) Explain what do you mean by an equivalent lens.
- 13) What do you mean by power of the lens?

B) Long Answer Type Question

- 1) Derive lens formula.
- 2) Prove that for a combination of two thin lenses of focal lengths f_1 and f_2 separated by a distance x , the focal length of the combination is given by

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2} - \frac{x}{f_1 \cdot f_2}$$
- 3) Show that the derivation produces by thin lens is independent of the position of the object.
- 4) What are cardinal points of a co-axial lens system? What is their importance?
- 5) Describe how you would determine the principal planes in an optical system.
- 6) What are nodal points and nodal planes? Describe how you would determine the nodal points in thick lens.
- 7) Explain principal foci and focal planes. Draw necessary ray diagram.
- 8) Show that, if the medium on the two sides of an optical system is same, the principal points coincide with the nodal points.
- 9) Show that the distance of the first principal plane from the first lens of an optical system is given by $\alpha = \frac{xf}{f_2}$
- 10) Derive the formula for equivalent focal length of two thin lenses placed co-axially in the medium air and separated by a finite distance.
- 11) Derive lens maker's formula for thin lens.

Chapter-4

LENS ABERRATIONS

A) Short Answer Type Question

- 1) What do you mean by aberration?
- 2) What do you understand by the term achromatism?
- 3) State the cause of monochromatic aberration.
- 4) State the cause of chromatic aberration.
- 5) What do you mean by crossed lens?
- 6) What are Seidel aberrations?
- 7) State the cause of comatic aberration.
- 8) State the cause of astigmatism.
- 9) What do you mean by curvature?
- 10) What is meant by circle of least confusion?
- 11) What do you mean by achromatic combination of two lenses?
- 12) What is an aplanatic lens?
- 13) What is distortion?
- 14) What do you mean by barrel shaped distortion?
- 15) What do you mean by pin-cushion distortion?
- 16) Explain the term "coma" in comatic aberration.

B) Long Answer Type Question

- 1) Explain what is meant by spherical aberration for a lens. How it is caused and what are the ways for its minimization?
- 2) Explain what is meant by chromatic aberration in lenses. Derive the condition for achromatism of two thin lenses separated by a distance.
- 3) Explain what is meant by achromatism? Derive the condition for achromatism of two thin lenses in contact.
- 4) What is curvature? State the cause and explain how it is minimized.
- 5) What is distortion? State the cause and explain how it is reduced to minimum.
- 6) Describe and explain with the help of suitable ray diagram (i) longitudinal chromatic aberration and (ii) lateral chromatic aberration.
- 7) Describe astigmatism. How it is minimized?
- 8) Describe comatic aberration.
- 9) What do you mean by spherical aberration? Explain how it is reduced using plano-convex lens.
- 10) Explain how spherical aberration is minimized using crossed lens.
- 11) What do you mean by spherical aberration? With suitable diagram explain how it is reduced using suitable combination of concave and convex lenses.
- 12) Explain spherical aberration and show that the condition for minimum spherical aberration is $f_1 - f_2 = x$, where symbols have their usual meanings.
- 13) Explain various methods of reduction of coma.
- 14) What is curvature? Explain how it is reduced.
- 15) Show that longitudinal chromatic aberration is equal to product of dispersive power and mean focal length.

Chapter-5

OPTICAL INSTRUMENTS

A) Short Answer Type Question

- 1) What is an optical instrument?
- 2) Compare the advantages of the optical instrument with human eye.
- 3) What is simple microscope?
- 4) Define magnifying power (MP) of simple microscope.
- 5) What are the limitations of the simple microscope?
- 6) What is the advantage of compound microscope over simple microscope?
- 7) What is the range of vision of normal eye?
- 8) Draw a labeled diagram for a simple microscope. What is the nature of image formed?
- 9) Draw a labeled diagram showing the formation of image in a compound microscope.
- 10) Define magnifying power of a compound microscope.
- 11) Why must both the objective and the eye-piece of a compound microscope have short focal lengths?
- 12) What is normal adjustment?
- 13) What is an eye-piece? Describe in general.
- 14) Compare the performance of the Huygen's and Ramsden's eye-pieces.
- 15) Can a cross wire be used in Huygen's eye-piece? Comment.
- 16) State merits and demerits of Ramsden's and Huygen's eye-piece.
- 17) What are the advantages of using eyepieces in optical instruments?
- 18) In an eye-piece, generally field lens is large in diameter while eye-lens is small. Why?

B) Long Answer Type Question

- 1) Obtain an expression for M.P. of simple microscope under different conditions:
 - (i) Image at DDV &
 - (ii) Image at infinity
- 2) Describe a simple microscope and prove that smaller the focal length of the lens forming a simple microscope, greater is its magnifying power.
- 3) Explain the working of a simple microscope and show that its magnification M is given by

$$M = 1 + \frac{D}{f}$$

where, f=focal length & D= distance of distinct vision (DDV)

- 4) Define magnifying power of a compound microscope and derive a relation for it.
- 5) Draw a ray diagram to show image formation in a compound microscope. Find an expression for its magnifying power.
- 6) Describe the construction and use of a Ramsden's eye-piece. Why is it termed as a positive eye-piece?

- 7) Describe briefly a Huygen's eye-piece?
- 8) Explain the working of Ramsden's eyepiece. What are the drawbacks in it?
- 9) Briefly describe a Huygen's eyepiece and its action. Compare its performance with that of Ramsden's eyepiece.