Wave and Motion: Optical Instruments & Dispersion– Typical Questions

No of Questions: 80 **Time Allotted: 10 Hours (in 3 parts)**

All questions are compulsory

[Note: a. Figures are conceptual only and not to the scale**]**

[b. Solutions may be taken up in Three parts as, Part I: 1 to 25 of Three Hours; Part II: 26 to 50 of Three Hours; Part III: 51 to 80 of Four Hours]

[c. It is advised to attempt question under examination conditions**]**

Q-1	Can virtual image be formed on the retina in a seeing process?
Q-2	Can the image formed by a simple microscope be projected on a screen without using any additional lens or mirror?
Q-3	The angular magnification of an optical system is less than one. Does it mean that the image formed is inverted?
Q-4	A simple microscope using single lens often shows coloured image of a white source. Why?
Q-5	A magnifying glass is a converging lens placed close to the eye. A farsighted person uses spectacles having converging lenses. Compare the functions of a converging lens used as a magnifying glass and as spectacles.
Q-6	A person is viewing an extended object. If a converging lens is placed in front of his eyes, will he feel that the size has increased?
Q-7	The magnifying power of a converging lens used as a simple microscope is $\left(1+\frac{D}{f}\right)$. A compound microscope is a combination of two such converging lenses. Why don't we have magnifying $\left(1+\frac{D}{f_o}\right)\left(1+\frac{D}{f_e}\right)$? In other words, why can the object piece not be treated as a simple microscope but the eyepiece can?
Q-8	By mistake, an eye surgeon puts a concave lens in place of lens in the eye after cataract operation. Will the patient be able to see clearly any object placed at any distance?
Q-9	Magnifying power of a simple microscope is given by $1+\frac{D}{f}$, where D is the least distance for clear vision. For farsighted persons, D is greater than usual. Does it mean that the magnifying power of a simple microscope is greater for a farsighted person as compared to a normal person? Does it mean that a farsighted person can see an insect more clearly under a microscope than a normal person?
Q-10	Why are the magnification properties of microscope and telescopes defined in terms of the ratio of angles and not in terms of the ratio of sizes of objects and images?
Q-11	An object is placed at a distance of 30 cm from a converging lens of focal length 15 cm. A normal eye (near point 25 cm, far point infinity) is placed close to the lens on the other side. (a) Can the eye see the object clearly? (b) What should be the minimum separation between the lens and the eye so that eye can clearly see the object?

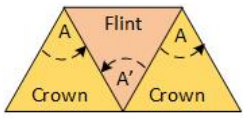
	(c) Can a diverging lens, placed in contact with the converging lens, help in seeing the object clearly when the eye is close to the lens?
Q-12	A compound microscope forms an inverted image of an object. In which of the following cases it is likely to create difficulties? (a) Looking at small germs, (b) Looking at circular spots, (c) Looking at vertical tube containing water.
Q-13	The size of an object as perceived by an eye depends primarily on (a) Actual size of the object (b) Distance of the object from the eye (c) Aperture of the pupil (d) Size of the image formed on the retina
Q-14	The muscles of a normal eye are least strained when the eye is focused on an object (a) Far away from the eye (b) Very close to the eye (c) At about 25 cm from the eye (d) At about 1 m from the eye
Q-15	A normal eye is not able to see objects closer than 25 cm because (a) Focal length of eye is 25 cm (b) Distance of the retina from the eye-lens is 25 cm (c) The eye is not able to decrease the distance between the eye-lens and the retina beyond a limit (d) The eye is not able to decrease the focal length beyond a limit.
Q-16	When objects at different distances are seen by the eye, which of the following remain constant (a) The focal length of the eye-lens. (b) The object-distance from the eye-lens. (c) The radii of curvature of the eye-lens. (d) The image-distance from the eye-lens.
Q-17	A person P can clearly see objects between 25 cm and 200 cm. Which of the following may represent the range of clear vision for a person Q having muscles stronger than P, but all other parameters of the eye identical to that of Q? (a) 25 cm to 200 cm (b) 18 cm to 200 cm (c) 25 cm to 300 cm (d) 18 cm to 300 cm
Q-18	The focal length of a normal eye-lens is about (a) 1 cm (b) 2 cm (c) 25 cm (d) 1m
Q-19	Distance of an eye-lens from retina is x, For a normal eye, the maximum focal length of the eye lens (a) $= x$ (b) $< x$ (c) $> x$ (d) $= 2x$
Q-20	A man wearing glasses of focal length +1 m cannot clearly see beyond 1m (b) If he is farsighted (b) if he is nearsighted (c) If his vision is normal (d) in each of these cases
Q-21	An object is placed at a distance u from a simple microscope of focal length f. The angular magnification obtained depends (a) On f but not on u (b) On u but not on f (c) On f as well as u (d) Neither on f as well as u
Q-22	To increase the angular magnification of a simple microscope, one should increase (a) Focal length of the lens (b) The power of lens (c) The aperture of the lens (d) Object size

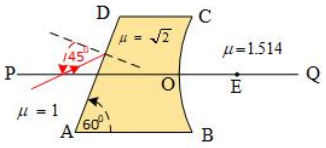
Q-23	A man is looking at a small object placed at his near point. Without altering the position of his eye or the object, he puts a simple microscope of magnifying power 5X infront of his eyes. The angular magnification achieved is (a) 5 (b) 2.5 (c) 1 (d) 0.2
Q-24	When we see an object, the image formed on the retina is (a) Real (b) Virtual (c) Erect (d) Inverted
Q-25	In which of the following the final image is erect? (a) Simple microscope (b) Compound microscope (c) Astronomical telescope (d) Galilean telescope
Q-26	The maximum focal length of the eye-lens of a person is greater than its distance from the retina. The eye is (a) Always strained in looking at an object (b) Strained for objects at large distances only (c) Strained for objects at short distances only (d) Unstrained for all distances
Q-27	Mark the correct options (a) If the far point goes ahead, the power of the divergent lens should be reduced (b) If near point goes ahead, the power of the convergent lens should be reduced (c) If far point is 1m away from the eye, divergent lens should be used (d) If near point is 1m away from the eye, divergent lens should be used
Q-28	The focal length of the object-piece of a compound microscope is f_o and its distance from eyepiece is L. The object is placed at a distance u from the object-piece. For proper working of the instrument (a) $L < u$ (b) $L > u$ (c) $f_o < L < 2f_o$ (d) $L > 2f_o$
Q-29	A person looks at different trees in an open space with the following details. Arrange trees in decreasing order of their apparent size. Tree Height (m) Distance from the eye (m) A 2.0 50 B 2.5 80 C 1.8 70 B 2.8 100
Q-30	An object is to be seen through a simple microscope of focal length 12 cm. Where should the object be placed so as to produce maximum angular magnification? The least distance for clear vision is25 cm.
Q-31	A simple microscope has a magnifying power of 3.0 when the image is formed at the near point (25 cm) of a normal eye. (a) What is the focal length? (b) What will be its magnifying power if the image is formed at infinity?
Q-32	A child has near point 10 cm. What is the maximum angular magnification the child can have with a convex lens of focal length 10 cm?

Q-33	A simple microscope is rated 5X for a normal relaxed eye. What will be its magnifying power for a relaxed farsighted eye whose near point is 40 cm?
Q-34	Find the maximum magnifying power of a compound microscope having a 25 diopter lens as a object piece, a 5 diopter lens as the eyepiece and a separation 30 cm between the two lenses. The least distance for clear vision is 25 cm.
Q-35	Separation between object piece and eye piece of a compound microscope can be adjusted between 9.8 cm to 11.8 cm. If focal lengths of the object piece and the eye piece are 1.0 cm and 6 cm respectively, find the range of magnifying power if image is always needed at 24 cm from eye.
Q-36	An eye can distinguish between two points of an object if they are separated by more than 0.22 mm when object is placed at 25 cm from the eye. The object is now seen by a compound microscope having 20 D object-piece and 10D eyepiece separated by 20 cm. The final image is formed at 25 cm from the eye. What is the minimum separation between two points of the object which can be distinguished?
Q-37	A compound microscope has a magnifying power of 100 when image is formed at infinity. The object-piece has focal length of 0.5 cm and the tube length is 6.5 cm. Find the focal length of the eye piece.
Q-38	A compound microscope consists of an object-piece of focal length 1 cm and an eye piece of focal length 5 cm. An object is placed at a distance of 0.5 cm from the object piece. What should be separation between the lenses so that the microscope projects an inverted real image of the object on a screen 30m behind the eyepiece?
Q-39	An optical instrument used for angular magnification has a 25 D object-piece and a 20 D eyepiece. The tube length is 25 cm when the eye is least strained. (a) Whether it is microscope or a telescope? (b) What is the angular magnification produced?
Q-40	An astronomical telescope is to be designed to have a magnifying power of 50 in normal adjustment. If length of the tube is 102 cm, find the powers of the object-piece and the eye piece.
Q-41	The eyepiece of an astronomical telescope has a focal length of 10 cm. The telescope is focused for normal vision of distant objects when the tube length is 1.0 m. Find focal length of the object-piece and magnifying power of the telescope.
Q-42	A Galilean telescope is 27 cm long when focused to form an image at infinity. If the object-piece has a focal length of 30 cm, what is the focal length of the eyepiece?
Q-43	A farsighted person cannot see objects placed closer to 50 cm. Find power of the lens needed to see the objects at 20 cm.
Q-44	A near sighted person cannot clearly see beyond 200 cm. Find power of the lens needed to see the objects at large distances.
Q-45	A person wears glasses of power -2.5 D. Is the person farsighted or nearsighted? What is the far point of the person without glasses?

Q-46	A professor reads a greeting card received on his 50th birthday with +2.5D glasses keeping the card 25 cm away. Ten years later, he reads his farewell letter with same glasses but he has to keep the letter 50 cm away. What power of lens should he use now?
Q-47	A normal eye has a retina 2 cm behind the eye-lens. What is the power of eye-lens when the eye is (a) fully relaxed, (b) most strained?
Q-48	The near point and far point of a child are 10 cm and 100 cm. If retina is 2.0 cm behind the eye-lens, what is the range of power of the eye-lens?
Q-49	A nearsighted person cannot see beyond 25 cm. Assuming that separation of the glass from eye is 1 cm, find the power of lens needed to see distant objects.
Q-50	A person has near point at 100 cm. What power of lens is needed to read at 20 cm if he uses (a) contact lens, (b) spectacles having glasses 2.0 cm separated from the eyes?
Q-51	A lady uses +1.5 D glasses to have a normal vision from 25 cm onwards. She uses a 20D lens as a simple microscope to see an object. Find maximum magnifying power if she uses the microscope- (a) Together with her glass (b) Without the glass. (c) Do the answers at (a) and (b) suggest that an object can be more clearly seen through a microscope without using the correcting glasses?
Q-52	A lady cannot see objects closer than 40 cm from left eye and closer than 100 cm from right eye. While on a mountaineering trop, she is lost from her team. She tries to make an astronomical telescope from her reading glasses to look for her teammates. (a) Which glass should she use as the eyepiece? (b) What magnification can she get with relaxed eye?
Q-53	The equation $\omega = \frac{\mu_v - \mu_r}{\mu - 1}$ was derived for a prism having small refracting angle. Is it also valid for a prism of large refracting angle? Is it also valid for a glass slab or a sphere?
Q-54	Can dispersive power $\omega = \frac{\mu_v - \mu_r}{\mu - 1}$ be (-)ve ? What is sign of ω if a hollow prism is immersed into water?
Q-55	If three identical prisms are combined, is it possible to pass a beam that emerges undeviated? Undispersed?
Q-56	"Monochromatic light should be used to produce pure spectrum". Comment on this statement.
Q-57	Does focal length of a lens depend on the colour of the light used? Does focal length of a mirror depend on the colour?
Q-58	Suggest a method to produce a rainbow in your house.
Q-59	The angular dispersion produced by a prism – (a) increases if average refractive index increases (b) increases if the average refractive index decreases (c) remains constant whether the average refractive index increases or decreases

	(d) has no relation with the average refractive index
Q-60	If a prism is dipped in water, its dispersive power (a) increases (b) decreases (c) does not change (d) may increase or decrease depending on whether the angle of prism is less than or greater than 60^0.
Q-61	A prism can produce a minimum deviation δ in a light beam. If three prisms are combined, the minimum deviation that can be produced in this beam is – (a) 0 (b) δ (c) 2δ (d) 3δ
Q-62	Consider the following statements – (A) Line spectra contains information about atoms (B) Band spectra contains information about molecules (a) Both A and B are wrong (b) A is correct but B is wrong (c) B is correct but A is wrong (d) Both A and B are correct
Q-63	The focal length of a converging lens are f_v and f_r for violet and red light respectively (a) $f_v > f_r$ (b) $f_v = f_r$ (c) $f_v < f_r$ (d)Any of these three is possible depending on the value of the average refractive index μ
Q-64	A narrow beam of white light goes through a slab having parallel faces – (a) The light never splits in different colours (b) The emergent beam is white (c) The light inside the slab is split into different colours (d) The light inside the slab is white
Q-65	By properly combining two prisms made of different materials, it is possible to (a) Have dispersion without average deviation (b) Have deviation without dispersion (c) Have both dispersion and average deviation (d) Have neither dispersion nor average deviation
Q-66	In producing a pure spectrum, the incident light is passed through a narrow slit placed in the focal plane of an achromatic lens because a narrow slot (a) Produce less diffraction (b) Increase intensity (c) Allow only one colour at a time (d) Allow a more parallel beam when it passes through the lens
Q-67	Which of the following quantities related to a lens depend on the wavelength or wavelengths of the incident light? (a) Power (b) Focal length (c) Chromatic aberration (d) Radii of curvature
Q-68	Which of the following quantities increase when wavelength is increased? Consider only the magnitudes

	(a) The power of a converging lens. (b) The focal length of a converging lens. (c) The power of a diverging lens. (d) The focal length of a diverging lens.
Q-69	A flint glass prism and a crown glass prism are to be combined in such a way that the deviation of the mean ray is zero. The refractive index of the flint and crown glasses for the mean ray are 1.620 and 1.518 respectively. If the refracting angles of the flint prism is 6^0, what should be the refracting angle of the crown prism?
Q-70	Certain material has refractive index 1.56, 1.60, and 1.68 for red, yellow and violet light respectively. (a) Calculate the dispersion power (b) Find the angular dispersion produced by a thin prism of angle 6^0 made of this material
Q-71	The focal lengths of a convex lens for red, yellow and violet rays are 100 cm, 98 cm and 96 cm respectively. Find the dispersive power of the material of the lens.
Q-72	The refractive index of a material changes by 0.014 as the colour of the light changes from red to violet. A rectangular slab of height 2.00 cm made of this material is placed on a newspaper. When viewed normally in yellow light, the letter appears 1.32 cm below the top surface of the slab. Calculate the dispersive power of the material.
Q-73	A thin prism is made of a material having refractive indices 1.61 and 1,65 for red and violet light. The dispersive power of the material is 0.07. It is found that a beam of yellow light passing through the prism suffers a minimum deviation of 4.0^0 in favourable conditions. Calculate the angle of the prism.
Q-74	The minimum deviation suffered by red, yellow and violet beams passing through an equilateral transparent prism are 38.4^0, 38.7^0 and 39.2^0 respectively. Calculate the dispersive power of the medium.
Q-75	Two prisms of identical geometrical shape are combined with their refracting angles oppositely directed. The material of the prisms have refractive indices 1.52 and 1.62 for violet light. A violet ray is deviated by 1.0^0 when passes symmetrically through this combination. What is the angle of the prism?
Q-76	Three thin prisms are combined as shown in the figure. The refractive if the crown glass for red, yellow and violet rays are μ_r, μ_y and μ_v respectively and for the flint glass are μ'_r, μ'_y and μ'_v respectively. Find the ratio $\frac{A'}{A}$ for which  (a) There is no net angular dispersion, (b) There is no net deviation in the yellow ray
Q-77	A thin prism of crown glass having $\mu_r = 1.515$, $\mu_v = 1.525$ and a thin prism of flint glass $\mu_r = 1.612$, $\mu_v = 1.632$ are placed in contact with each other. Their refracting angles are 5.0^0 each and are similarly directed. Calculate the angular dispersion produced by the combination.
Q-78	A thin prism of angle 6.0^0, $\omega = 0.07$ and $\mu_y = 1.50$ is combined with another thin prism having $\omega = 0.08$ and $\mu_y = 1.60$. The combination produces no deviation in the mean ray. (a) Find the angle of the second prism

	(b) Find the net angular dispersion produced by the combination when a beam of white light passes through it. (c) If the prisms are similarly directed, what will be the deviation in the mean ray? (d) Find the angular dispersion in the situation described in (c)
Q-79	The refractive index of material M1 changes by 0.014 and that of another material M2 changes by 0.024 as the colour of the light is changed from red to violet. Two thin prisms one made of M1 ($A=5.3^0$) and the other made of M2 ($A=3.7^0$) are combined with the refracting angles oppositely directed. (a) Find the angular dispersion produced by the combination (b) The prisms are now combined with their refracting angles similarly directed. Find the angular dispersion produced by the combination
Q-80	Figure shows an irregular block of material of refractive index $\sqrt{2}$. A lay of light strikes the face AB as shown in the figure. After refraction it is incident on spherical surface CD of radius of curvature 0.4 m and enters a medium of refractive index 1.514 to meet PQ at E. Find distance OE upto two places of decimal. 

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