LEVEL –A QESTIONS-OPTICS

1. Draw a ray diagram to show the formation of image of an object placed between f and 2f of a thin convex lens. Deduce the relation between the object distances, the image distance and the focal length of the lens under this condition   (3m)

2. By stating sign conventions and assumptions, derive the relation between u, v and f in case of a concave mirror?   (3m)

3. Derive an expression for the refractive index of the prism in terms of angle of prism and angle of minimum deviation   (3m)

4. How does the focal length of the lens change when red light is replaced by blue light?   (1m)

5. How is a wave front different from a ray? Draw the geometrical shape of the wave fronts when (i) light diverges from a point source (ii) light emerges out of the convex lens when a point source is placed at its focus.   (3m)

6. Show with a ray diagram, how an image is produced in total reflecting prism?   (1m)

7. State Huygens's principle.   (1m)

8. What are coherent sources? Why are coherent sources required to produce interference of light? (2m)

9. What is interference of light? Using Young's double slit experiments deduce the conditions for
   (i) constructive and (ii) destructive interference at a point on the screen.   (2m)

10. Draw the diagram showing intensity distribution of light on the screen for the interference of light in Young's double slit experiment.   (1m)

11. Draw labeled ray diagram of compound microscope.   (1m)

12. Write the expression for magnifying power and resolving power of i) microscope ii) telescope   (2m)

13. Draw a labeled diagram of telescope when the image is formed at the least distance of distinct vision? Hence derive the expression for its magnifying power?   (3m)

14. State Brewster law? Using this law prove that, at the polarizing angle of incidence, the reflected and transmitted rays are perpendicular to each other?   (2m)

15. State any two essential conditions for observing sustained interference of light.   (1m)

16. Explain the phenomenon of diffraction of light at a single slit, to show the formation of diffraction fringes. Show graphically the variation of the Intensity, with angle, in this single slit diffraction pattern.   (3m)

17. A convex lens made up of refractive index n_1 is kept in a medium of refractive index n_2. Parallel rays of light are incident on the lens. Complete the path of rays of light emerging from the convex lens if
    (1) $n_1 > n_2$ (2) $n_1 = n_2$ (3) $n_1 < n_2$ (3m)

18. Give reasons for the following in one word or sentence: (3m)
    (a) Sky appears blue during day time as seen from the earth.
    (b) A rainbow is never observed from the surface of moon.
    (c) Sunset and sunrise are abrupt as seen from moon.

19. Derive the expression for the fringe width in young's double slit experiment.   (3m)

20. How does the fringe width in the interference pattern change, when the Whole apparatus is immersed of refractive index 4/3?   (1m)

21. State any two differences between interference and diffraction.   (2m)

22. When a monochromatic light travels from one medium to another, why its wavelength changes but frequency remains the same.   (1m)

23. Why does bluish colour predominate in a clear sky.   (1m)

24. No interference pattern is detected when two coherent sources are infinitely close to each other   (1m)

25. State the essential condition for diffraction of light to take place.   (1m)

26. What is the shape of wave front on earth for sunlight   (1m)

27. What type of lens is an air bubble inside water?   (1m)

28. Define magnifying power of a telescope. Write its expression. (1m)

29. What is power of a lens? State its unit. (1m)

30. Draw a ray diagrams for the following: (17 × 1m = 17 m)

 (a) Image formed by concave mirror when the object is placed between centre of curvature and principle focus.

(b) Image formed by convex mirror when the object is placed at a distance.

(c) Image formed by convex lens when the object is placed beyond 2F

(d) Image formed by concave lens when the object is placed at certain distance

(e) Lens maker's formula

(f) Image formed by convex spherical refracting surface when the object is placed in rarer medium

(g) Simple microscope – image is formed at least distance of distinct vision

(h) Compound microscope – image is formed at least distance of distinct vision and at infinity

(i) Astronomical telescope - image is formed at least distance of distinct vision and at infinity.

(j) Reflecting telescope

(k) Young's double slit experiment – for fringe width derivation

(l) Interference pattern – for constructive and destructive interference.

(m) Diffraction through a single slit.

(n) Brewster's law

(o) Verification of reflection and refraction of light using Huygen's principle.

(p) Graph on interference – distance, diffraction – angle, law of malus

(q) Refraction through prism and its graph

Question Bank Very Short Answer – ray optics

1) Give the ratio of velocities of light rays of wavelengths 4000 Å and 8000 Å in vacuum.
2) What is the principle of reversibility of light?
3) Define critical angle for total internal reflections
4) Define power of a lens.
5) Why dose sky appear blue?
6) What should be the position of an object relative to a convex lens so that it behaves like a magnifying lens?
7) For which colour in visible region, the refractive index of glass is maximum?
8) Define refractive index of a medium in terms of wavelength of light.
9) State the factors on which the refractive index of a medium depends.
10) Do the frequency and wavelength change when light passes from a rarer to a denser medium and vice-versa?
11) For the same angle of incidence, the angles of refraction in three different media A,B, and C are 15° , 20° and 30° respectively . In which medium will the velocity of light be minimum?
12) Does critical angle depend on colour of light?
13) What is the value of critical angle for a material of refractive index $\sqrt{2}$?
14) If $^an_g=3/2$ and $^an_w=4/3$, then what will be the value of ^wn_g?
15) What type of a lens is an air-bubble inside water?
16) A convex lens is held in water what change, if any, do you expect in its focal length?
17) A equiconvex lens of focal length 15cm is cut into two equal halves as shown in fig. What is the focal length of each half?
18) Name the factors on which the angle of deviation produced by a prism depends.
19) A lens immersed in a transparent liquid is not visible. Under what condition can it happen?
20) An object is first seen in red light through a simple microscope. In which case is the magnifying power bigger?
21) Write the expression for linear magnification produced by a convex lens and a concave lens.
22) A ray of light is incident normally on the glass slab. What will be the angle of refraction?
23) State the expression for magnifying power of a simple microscope.
24) Can a microscope function as a telescope by inverting it?
25) What is the effect of increasing the diameter of the objective of a telescope on its (i) magnifying power (ii) resolving power?
26) How can we increase the resolving power of a microscope?
27) What is the use of inverting lens in an astronomical telescope?

Short Answer Type Questions

1. Why does a ray of light having oblique incidence deviate towards the normal as it passes from air to glass? Explain.
2. What is the twinkling effect of a star due to?
3. A microscope is focused on a dot at the bottom of a beaker. Some oil is poured into the beaker to a height of y cm and it is found necessary to raise the microscope through a vertical distance of x cm to bring the dot again into the focus. Express refractive index of oil in terms of x and y.
4. The Sun near horizon appears flattened at Sunset and Sunrise. Why?
5. Why does the rising Sun appear bigger?
6. Mention two important applications of the optic fibers.
7. A lens whose radii of curvature are different is forming the image of an object placed on its axis. If the lens is reversed, will the position of the image change? Explain.

LEVEL – C - OPTICS HOTS QUESTIONS

REFLECTION AT A SPHERICAL SURFACE:

1. If you look into a shiny spoon, you see an inverted image on one side and an upright image on the other side. Why? Could you see upright image on both sides?   (2m)
2. A moth flies towards a concave mirror. Does its image become larger or smaller as it approaches the mirror's focal point? What kind of image is it? What happens when the moth is at the focal point?   (2m)

REFRACTION AT A PLANE SURFACE:

3. For the same angle of incidence, the angles of refraction in three media A,B and C are 15^0, 25^0 and 35^0 respectively. In which medium would the velocity of light be minimum?   (2m)
4. In the H.G.Wells novel, THE INVISIBLE MAN, a person becomes invisible by altering his index of refraction to match that of air. If the invisible man could actually do this, would he be able to see? Explain.   (2m)
5. The length of a wave in water diminishes μ times, μ being the refractive index of water. Does this mean that a diver cannot see surrounding objects in their natural colours?   (2m)
6. The covered print is not visible from any of the four sides of a glass cube placed on a book. Explain what happens by a simple diagram. (for air to glass, when i = 90^0 , r = 42^0)   (2m)

REFRACTION AT SPHERICAL SURFACES AND LENSES:

7. A man wishing to get a picture of a zebra photographed a white donkey after fitting a glass with black streaks on the objective of his camera. What will be on the photograph?   (1m)
8. Why do the sunglasses (goggles) which have curved surfaces, not have any power?   (1m)
9. A concave mirror and a convex lens are held in water. What change, if any, do you expect to find in the focal length of either?   (1m)
10. A virtual image, we always say, cannot be caught on a screen. Yet when we 'see' a virtual image, we are obviously bringing it on to the 'screen' (i.e., the retina) of our eye. Is there a contradiction?   (2m)
11. A convex lens made of a variety of glass of high dispersive power has a focal length of 15 cm. A parallel beam of white light is incident on one side of the lens and a screen is placed on the other side. Describe the chromatic aberration of the lens i.e, describe the colours on the spot focused on the screen as the screen is moved away from the lens.   (2m)

OPTICAL INSTRUMENTS:

12. What is the minimum distance between two points that you are able to resolve from a distance of 100 m, if you have normal visual acuity? Could you recognize a familiar face 100 m away?   (2m)
13. The angle subtended at the eye by an object is equal to the angle subtended at the eye by the virtual image produced by a magnifying glass. In what sense then does a magnifying glass provide angular magnification?   (2m)
14. If your near point distance is N, how close can you stand to a mirror and still be able to focus on your image?   (1m)
15. Magnifying power of a simple microscope is inversely proportional to the focal length of the lens. What then stops us from using a convex lens of smaller and smaller focal length and achieving greater and greater magnifying power?   (2m)
16. Four double convex lenses, with the following specifications are available:

lens	Focal length	aperture
A	100 cm	10 cm
B	100 cm	5 cm
C	10 cm	2 cm
D	5 cm	2 cm

Which two of the given four lenses should be selected as the objective and eyepiece to construct an astronomical telescope and why? What will be the magnifying power and normal length of the telescope so constructed?   (3m)

17. Which of the four lenses (Q.No.16) should be selected as objective and eyepiece of a compound microscope and why? How can the magnifying power of such a microscope be increased?(3m)
18. Which of two main considerations are kept in mind while designing the objective of an astronomical telescope?   (2m)
19. The Mt. Palomar telescope is used to observe Moon, 3.8×10^8 m away. The objective has a focal length of 17 m and the eyepiece has a focal length of 17 cm. find the minimum distance between object points on the moon that are just barely resolved by an eye looking through the telescope. Assume that the resolution is limited by the eye's acuity and that the minimum angle of resolution is 5.0×10^{-4} rad.   (3m)
20. Two convex lenses A and B of an astronomical telescope having focal length 5 cm and 20 cm respectively, are arranged as shown in fig.   (3m)
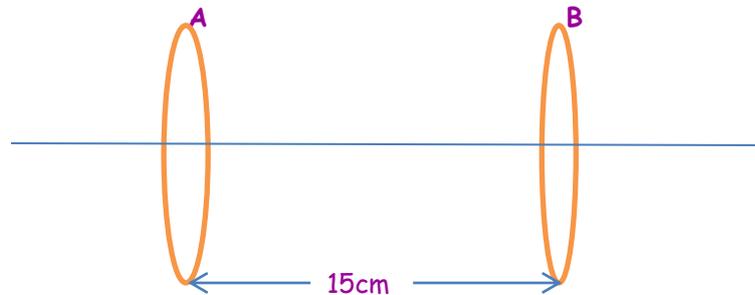
    (i)   Which one of the two lenses you will select to use as the objective lens and why?
    (ii)   What will be the change in the distance between the lenses to have the telescope in normal adjustment?
    (iii)   Calculate the magnifying power of the telescope in the normal adjustment position.
21. How does diffraction limit the resolving power of an optical instrument?   (1m)

WAVE OPTICS:

22. The speed of light in still water is c/μ, where μ is the refractive index of water. What is the speed of light in a stream of water flowing at a steady of speed of 'v' relative to the observer?(2m)
23. Fig shows an experimental set up similar to Young's double slit experiment to observe interference of light. Here, $SS_2 - SS_1 = \lambda/4$. Write the condition of (i) constructive (ii) destructive interference at any point P in terms of path difference, $\Delta = S_2P - S_1P$. Does the central fringe observed in the above set lie above or below O? Give reason in support of your answer.   (2m)

24. White light is used to illuminate two slits in Young's double-slit experiment. The separation between the slits is 'b', and the screen is at a distance d(>>b) from the slits. At a point on the screen directly in front of one of the slits, which wavelengths are missing?   (2m)
25. Suppose a sheet of glass is placed in front of one of the slits in a Young's double slit experiment. If the thickness of the glass is such that the light reaching the two slits is 180^0 out of phase, how does this affect the interference pattern?   (2m)
26. You want to check the time while wearing your Polaroid sunglasses. If you hold your forearm horizontally, you can read the time easily. If you hold your forearm vertically, however, so that you are looking at your watch sideways, you notice that the display is black. Explain.   (2m)

27. The electromagnetic waves we pick up on our radios are typically polarized. In contrast, the indoor light we see every day is typically unpolarised. Explain. (2m)

28. Modern day 3-D movies are produced by projecting two different images onto the screen, with polarization directions that are 90^0 relative to one another. Viewers must wear headsets with polarizing filters to experience the 3-D effect. Explain how this works. (2m)

29. While you drive through a city or mountain areas, the quality of your radio reception varies sharply from place to place, with stations seeming to fade out and reappear. Could diffraction be a cause of this? Which of the following bands would you expect to be least affected by it:
    (a) 162 MHz   (b) (88-108 MHz)   (c) (525-1610 KHz) (2m)

30. Light from sodium lamp is passed through two Polaroid sheets P_1 and P_2 kept one after the other. Keeping P_1 fixed, P_2 is rotated so that its pass-axis can be at different angles θ with respect to the pass-axis of P_1. An experimentalist records the following data for the intensity of light coming out of P_2 as a function of θ.

s.no.	θ(angle between the pass-axis of two polaroids)	I (intensity of light coming out of P_2)
1.	0^0	$I_0/2$
2.	30^0	$(3/8)I_0$
3.	45^0	$(1/2\sqrt{2})I_0$
4.	60^0	$I_0/8$
5.	90^0	0

Here I_0= intensity of beam falling on P_1.

One of these observations is not in agreement with the expected theoretical variation of I.

Identify the observation and write the correct expression. (3m)