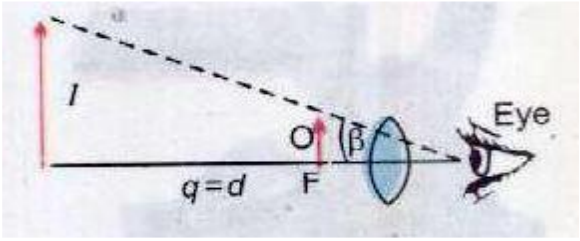
CHAPTER NO. 10 (OPTICAL INSTRUMENTS)

Question 10.1:- What do you understand by linear magnification and angular magnification? Explain how a convex lens is used as a magnifier?

Answer:- Linear Magnification The ratio of size of image to the size of the object is called linear magnification.

Angular Magnification The ratio of angle subtended by the image as seen through the optical device to that subtended at the unaided eye by the object placed at least distance of distinct vision is called angular magnification.

A convex lens of small focal length can be used as a magnifying glass when the object is placed near the lens i.e. between the pole and principal focus of the lens. The image the formed is virtual, erect and magnified.



Question 10.2:- Explain the difference between angular magnification and resolving power of an optical instrument. What limits the magnification of an optical instrument?

Answer:- Angular Magnification The ability of an optical instrument that how enlarged or magnified image of an object can be formed by using it is called its angular magnification or magnifying power.

Resolving Power The ability of an optical instrument to reveal the minor details of an object under examination is called its resolving power.

Magnification of an optical instrument is limited due to defects such as spherical and chromatic aberration. The image thus formed is not well defined and its details are not seen distinctly.

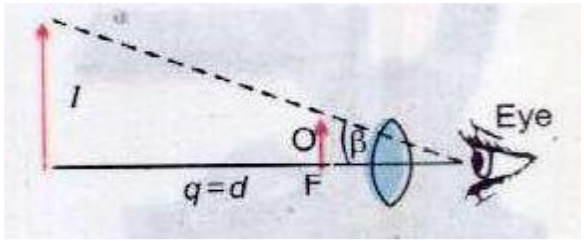
Question 10.3:- Why would it be advantageous to use blue light with a compound microscope?

Answer:- The resolving power of compound microscope depends directly on the diameter (aperture) of objective lens and inversely on wavelength of light used as $R = \frac{D}{1.22\,\lambda}$. The wavelength of blue light is very short (among other colours of visible light spectrum), therefore it is preferred to increase the resolving power of compound microscope and minor details of the object can be observed.

Question 10.4:- One can use a cheap microscope for use by the children. The images seen in such a microscope have coloured edges. Why is this so?

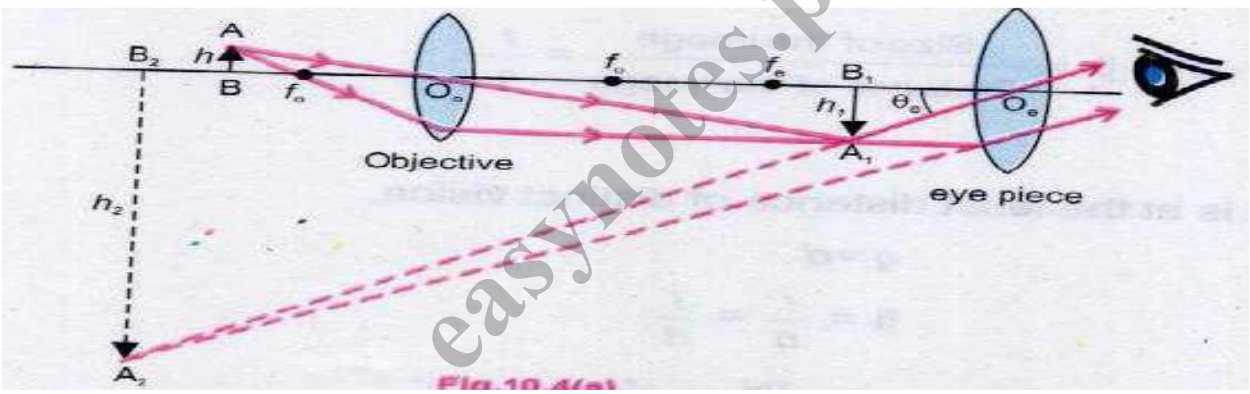
Answer:- The lens used in cheap microscope have not smooth surface and has a defect chromatic aberration. The lens is unable to focus white light coming from object properly at a single point and thus image formed have color edges. This is due to dispersive effects of material used in cheap microscope.

Question 10.5:- Describe with the help of diagrams, how (a) a single biconvex lens can be used as a magnifying glass. (b) biconvex lenses can be arranged to form a microscope.



Answer:- (a) <u>Biconvex lens as magnifying glass</u>:- The ray diagram of a biconvex lens used as a magnifying glass of focal length f to magnify an object of size O to image of size I is given. The image formed is virtual, magnified and erect.

(b) <u>Biconvex lenses can be arranged to form a microscope</u>:- The ray diagram of two biconvex lenses arranged to form a compound microscope is given. The image formed is inverted, erect and magnified. However, final image can be made

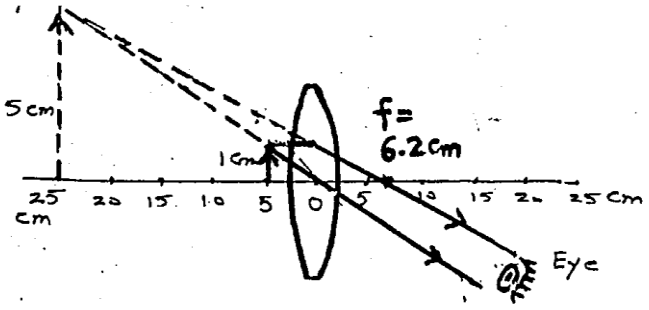


erect by using some external arrangement.

Question 10.6:- If a person was looking through a telescope at the full moon, how would the appearance of the moon be changed by covering half of the objective lens.

Answer:- The person will still look the image of full moon but its image will be much dimmer. When half of the objective lens is covered, less light coming from the moon will pass through it and image thus formed by the eyepiece will be dimmer and less bright.

Question 10.7:- A magnifying glass gives a five times enlarged image at a distance of 25 cm by



the lens. Find, by ray diagram, the focal length of the lens.

Answer:- The ray diagram to the scale when a five times enlarged image is formed at a distance of 25 cm from the lens is given. The focal length is f = 6.2 cm approximately.

Alternately, M = 1 + $\frac{d}{f}$, Given M = 5, d = 25 cm so d = $\frac{d}{M-1} = \frac{25}{5-1}$ = 6.25 cm rounded off to two significant figures is 6.2 cm.

Question 10.8:- Identify the correct answer.

Answer:- (i) The resolving power of a compound microscope depends on;

a. Length of the microscope.

b. The diameter of the objective lens. (Correct)

c. The diameter of the eyepiece.

d. The position of an observer's eye with regard to eye lens.

(ii) The resolving power of an astronomical telescope depends on;

a. The focal length of objective lens.

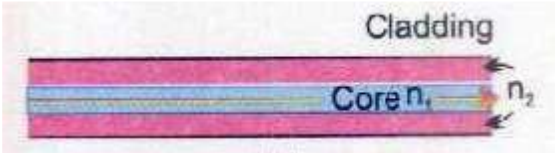
b. The least distance of distinct vision of the observer.

c. The focal length of the eye lens.

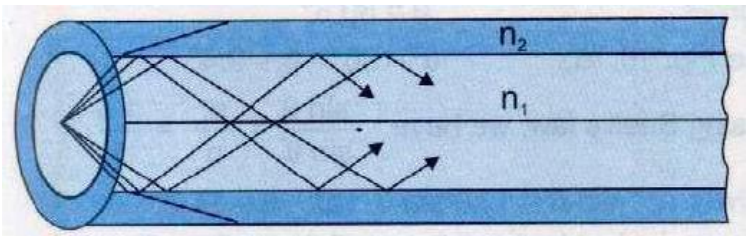
d. The diameter of the objective lens. (Correct)

Question 10.9:- Draw sketches showing the different light paths through a single-mode and a multimode fibre. Why is the single-mode fibre preferred in telecommunications?

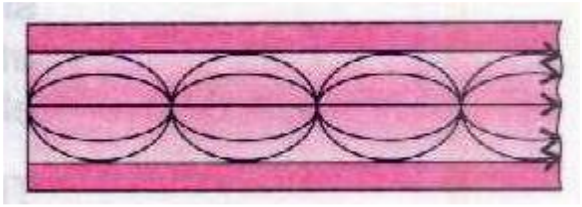
Answer:- (a) The single mode step index fiber cable has a small diameter of core about 5 μm and relatively large cladding. The ray diagram for transmission of information by using light is given in figure. It is preferred because it used a monochromatic source of light, no information can be lost as a result of dispersion. It has enormous data carrying capabilities i.e. data of 14 TV channels and 14000 telephone calls.



(b) The multi-mode step index has relatively larger core of about 50 μm and information can be transmitted by using an impure light source as given in figure.



(c) The multi-mode graded index has relatively larger core of about 50 μm to 1000 μm and information can be transmitted by using an impure light source as given in figure.

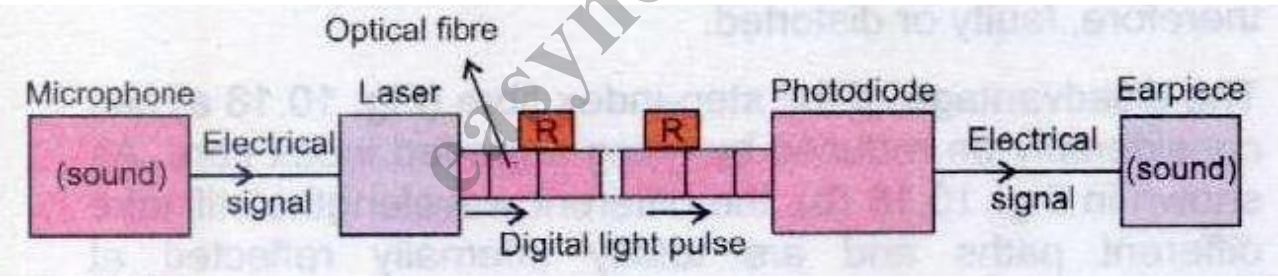


Question 10.10:- How the light signal is transmitted through the optical fibre?

Answer:- An optical fiber communication channel consists of three major parts:-

1) A transmitter that converts electrical signal into light signal
2) An optical fiber which guides the light signal either by total internal reflection or continuous refraction
3) A receiver at the other end, which converts light signal into electrical signal.

To send audio or video signals through fiber communication channel, the waves are modulated. One common modulation technique is digital modulation in which information can be converted into digital signal consisting of 0 (low) and 1 (high) called bits. The data carrying rate is measured in bits per second (bps) or megabits per second (Mbps).



Question 10.11:- How the power is lost in optical fibre through dispersion? Explain.

Answer:- When source of light is not monochromatic, its different components are dispersed while propagating down the core of fiber cable. The different wavelengths λ_1, λ_2 and λ_3 etc. adopt different paths across the core. The wavelength(s) which meet(s) the cladding at greater angle than critical angle, reach earlier at other end while the wavelength which meet the cladding at critical angle lags behind others. Hence, different component reach the other end at different times and signal received is distorted.