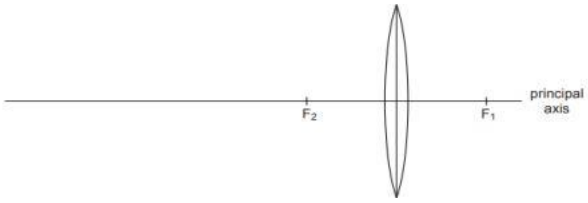
9. Light Reflection and Refraction

1. 

The above image shows a thin lens of focal length 5m.

(i) What is the kind of lens shown in the above figure?

(ii) If a real inverted image is to be formed by this lens at a distance of 7m from the optical centre, then show with calculation where should the object be placed?

(iii) Draw a neatly labelled diagram of the image formation mentioned in (ii)

Answer.

(i) Convex lens

(ii) $\frac{1}{f}=\frac{1}{v}-\frac{1}{u}$

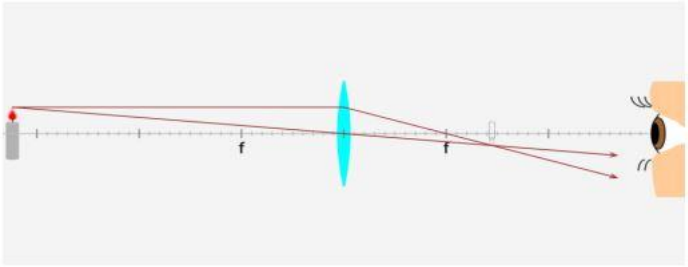
In this case, v= 7m and f=5m. Putting the values in the equation we get

$$\frac{1}{5}=\frac{1}{7}-\frac{1}{u}$$

$$\frac{1}{u}=\frac{1}{7}-\frac{1}{5}=\frac{5-7}{35}=\frac{-2}{35}$$

$$u=-\frac{35}{2}=-17.5\,m$$

The object will be placed 17.5 m on the left of the convex lens.

(iii) 

(two rays, arrows, object placed beyond 2f on the left)

2. A 10 cm long pencil is placed 5 cm in front of a concave mirror having a radius of curvature of 40 cm.

(i) Determine the position of the image formed by this mirror.

(ii) What is the size of the image?

(iii) Draw a ray diagram to show the formation of the image as mentioned in the part (i).

Answer.

(i) $\frac{1}{f}=\frac{1}{v}+\frac{1}{u}$ where u= -5 cm, f=r/2 =-20cm

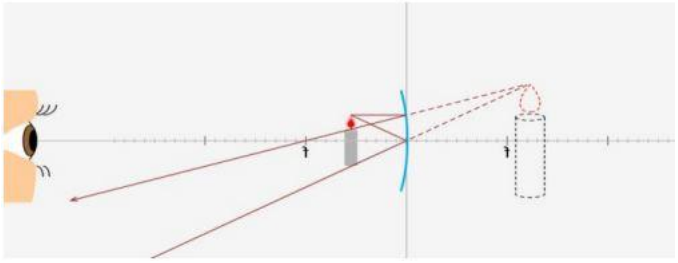
$$-\frac{1}{20}=\frac{1}{v}-\frac{1}{5}$$

$$\frac{1}{v}=-\frac{1}{20}+\frac{1}{5}=\frac{-1+4}{20}=\frac{3}{20}$$

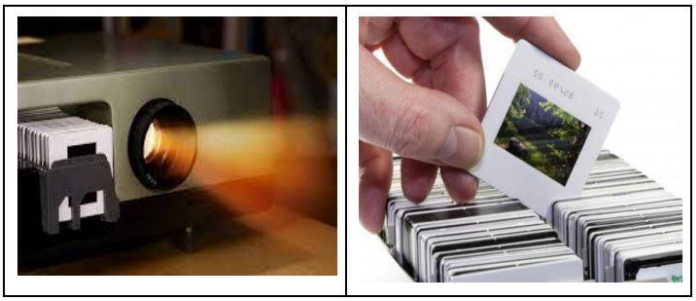
$$v=\frac{20}{3}=6.67\,cm$$

The image is obtained at 6.67m behind the mirror.

(ii) M = h2/h1
= -v/u
= (20/3)/5
= 4/3

(iii) 

(two rays, arrows, object placed between optical centre and the focus)

3. 

The above images are that of a specialized slide projector. Slides are small transparencies mounted in sturdy frames ideally suited to magnification and projection, since they have a very high resolution and a high image quality. There is a tray where the slides are to be put into a particular orientation so that the viewers can see the enlarged erect images of the transparent slides. This means that the slides will have to be inserted upside down in the projector tray.

To show her students the images of insects that she investigated in the lab, Mrs. Iyer brought a slide projector. Her slide projector produced a 500 times enlarged and inverted image of a slide on a screen 10 m away.

(a) Based on the text and data given in the above paragraph, what kind of lens must the slide projector have?

(b) If v is the symbol used for image distance and u for object distance then with one reason state what will be the sign for v/u in the given case?

(c) A slide projector has a convex lens with a focal length of 20 cm. The slide is placed upside down 21 cm from the lens. How far away should the screen be placed from the slide projector's lens so that the slide is in focus?

Answer.

(a) Convex Lens

(b) Negative as the image is real and inverted.

(c)

1/f= 1/v- 1/u

Or, 1/20 = 1/v- 1/-20

Or, 1/v = 1/20 - 1/21

Or, = (21 - 20)/420

Or, = 1/420

Or, v= 420 cm

4. A convex lens has a focal length of 10 cm. At what distance from the lens should the object be placed so that it forms a real and inverted image 20 cm, away from the lens? What would be the size of the image formed if the object is 2 cm high? With the help of a ray diagram show the formation of the image by the lens in this case.?

Answer.

Given,

Focal length of the convex lens as:

f = ±10 cm

Also, given the image formed is real and inverted with the image distance as 20cm.

V = +20cm

From the lens formula,

1/f = 1/v - 1/u

Or, 1/10 = 1/20 - 1/u

Or, 1/u = 1/20 - 1/10

Or, 1/u = -1/20cm

Or, u = -20cm

The object is placed at a distance of 20 cm.

Magnification is given by,

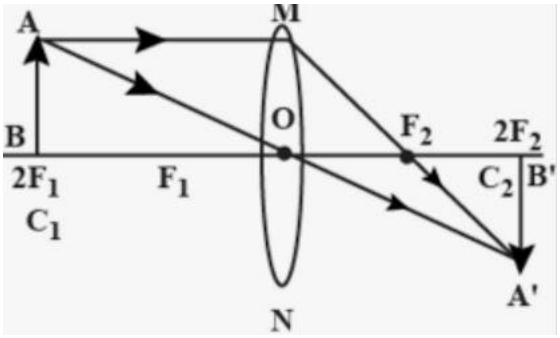
m = height of the image/height of the object

m = height of the image/2

1 = height of the image/2

Height of the image = 2cm

Thus the image is of the same size as that of the object and it is real and inverted.The ray diagram representing the formation of the image by the lens in this case is:



5. A convex lens forms a real and inverted image of a needle at distance of 50 cm from it. Where is the needle placed in front of the convex lens if the image is equal to the size of objects? Also, the power of lens.

Answer.

Given, image is real and inverted at a distance of 50cm.

Height of object = height of image

m = -v/u

Also,

- v/u = height of image/height of object

Or, -50/u = 1

Or u = 50cm

By using lens formula,

1/f = 1/v - 1/u

Or, 1/f = 1/50 - (1/-50)

Or, f = 25 cm

Or, f = 0.25m

The power of lens is given by,

P = 1/f

Or, P = 1/0.25 m

Or, P = +4 D