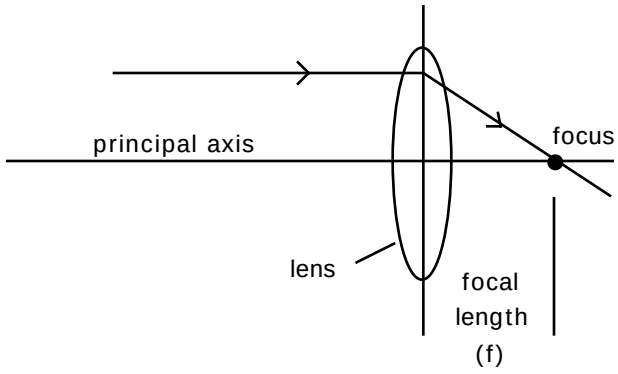
Lenses : Notes/W.S.-30

Lenses

Lenses are used in eye glasses, cameras, telescopes and microscopes. They are used to collect light from an object and form magnified or reduced images of that object.

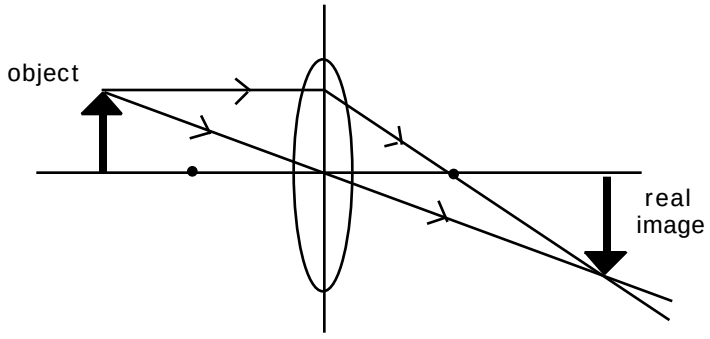
Converging Lenses

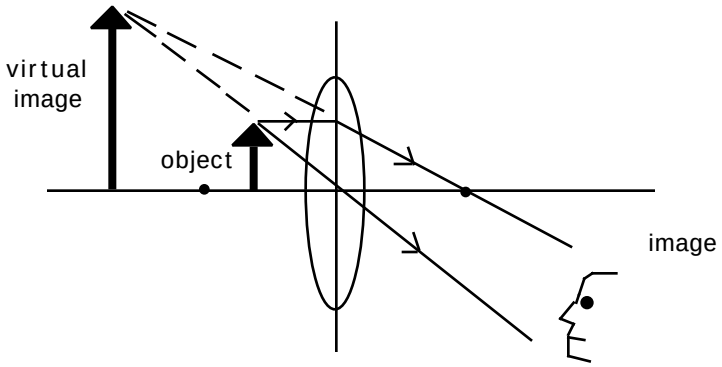
Rays that are parallel to the principal axis of a converging lens are bent towards the focus.



The focal length is the distance f from the lens center to the focus. It can be found by finding the distance between the lens and a piece of paper when the paper has an image of a distant object on it.

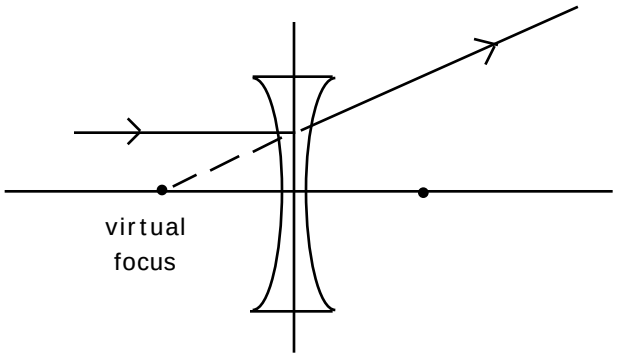
The image of an object can be located by finding the intersection point of two rays. The parallel ray is bent through the focus. Another ray will pass straight through the middle of the lens. This assumes that the lens is thin and that the rays are close to the center of the lens.





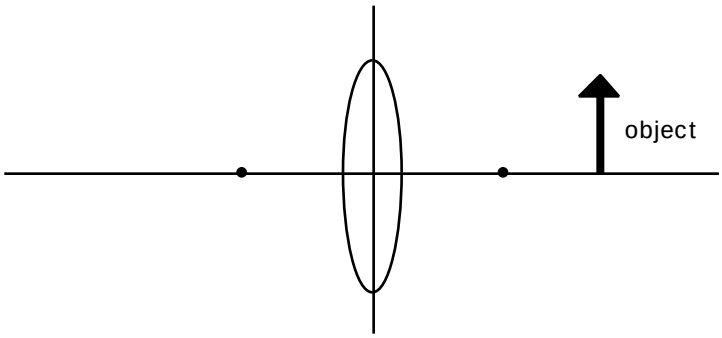
Diverging Lenses

A diverging lens will cause rays parallel to the principal axis to radiate from a virtual focus. Rays passing through the center are not deflected.

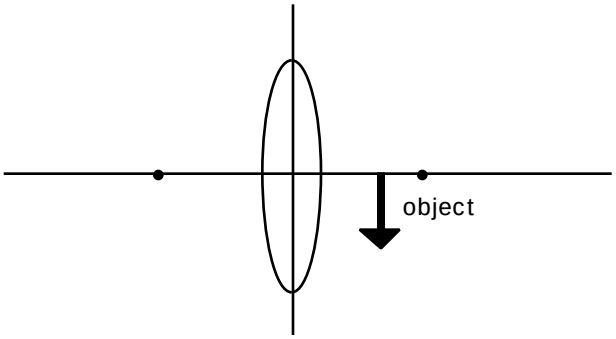


Problems:

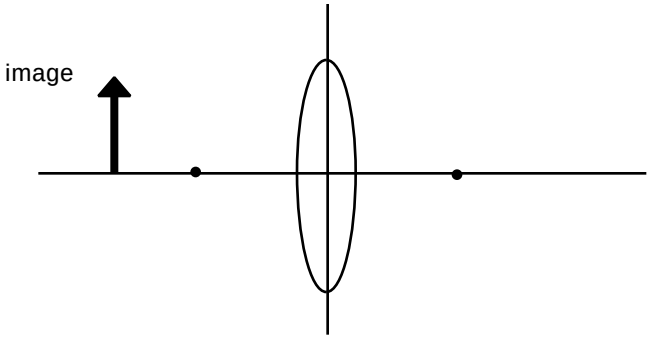
1)a) Locate the image. Use a pencil and ruler. A solid line represents a light ray. Show the ray direction. A dashed line represents the extension of a ray.



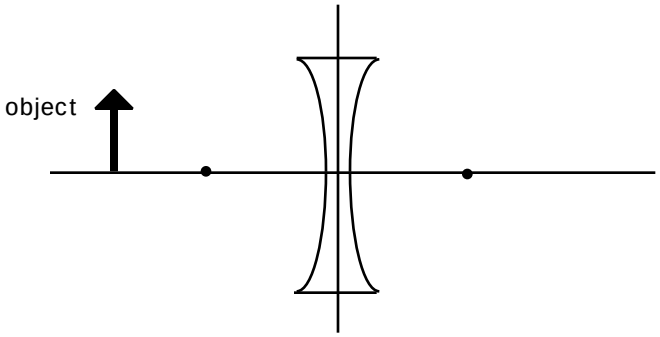
b) Locate the image.



c) The image is shown. Locate the object on the right side of the lens.

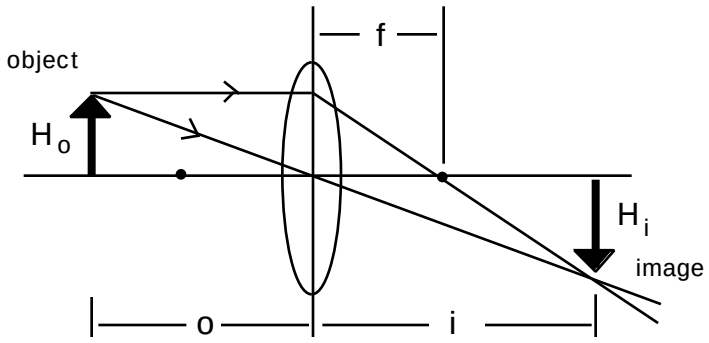


2) Locate the image of the object for the diverging lens.



3) For the converging lens, the object distance is **o**, the image distance is **i**, the focal length is **f**, the object height is $\mathbf{H_o}$ and the image height is $\mathbf{H_i}$.

The **magnification M**, is $\mathbf{H_i / H_o = i / o}$ (using similar triangles).



Prove the lens formula (use similar triangles):

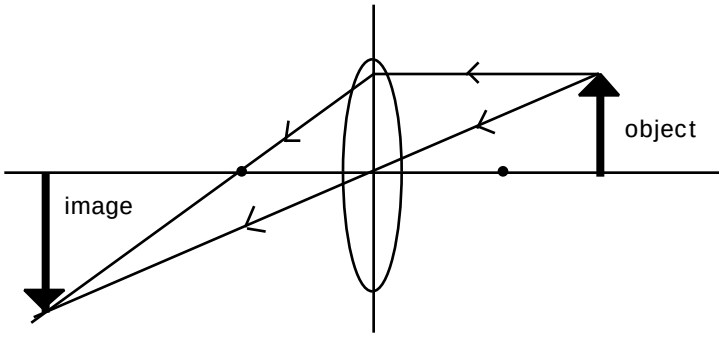
$$\frac{1}{i} + \frac{1}{o} = \frac{1}{f}$$

4) Use the lens formula to fill in the blanks for a converging lens.

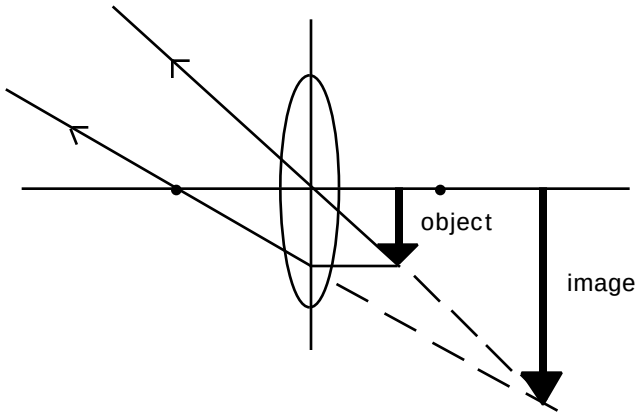
i	**o**	**f**	**M**
72	36	___	___
___	6	___	1
20	___	4	___
___	___	7.5	3
10	___	___	0.5

Answers:

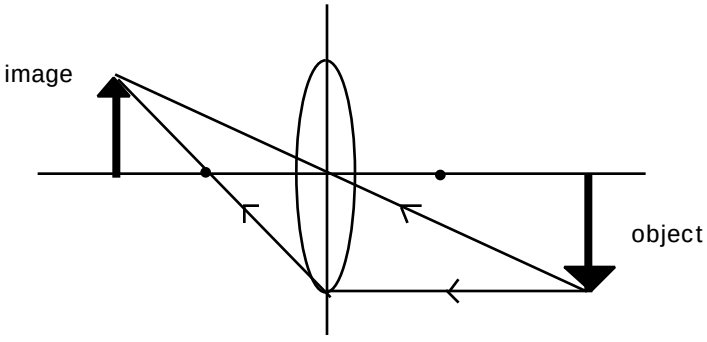
1)a)



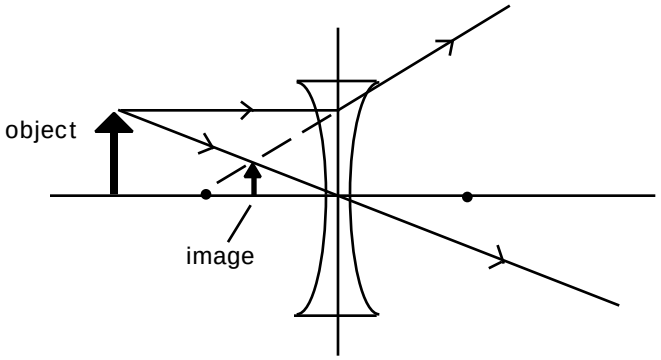
b)



c)



2)



3) Using similar triangles, we have: $H_i/H_o = i/o$, and $H_i/(i-f) = H_o/f$. Eliminating H_o and H_i, we have $(i-f)/f = i/o$, the lens equation follows.

4) 24, 2; 6, 3; 5, 4; 30, 10; 20, 6.7.