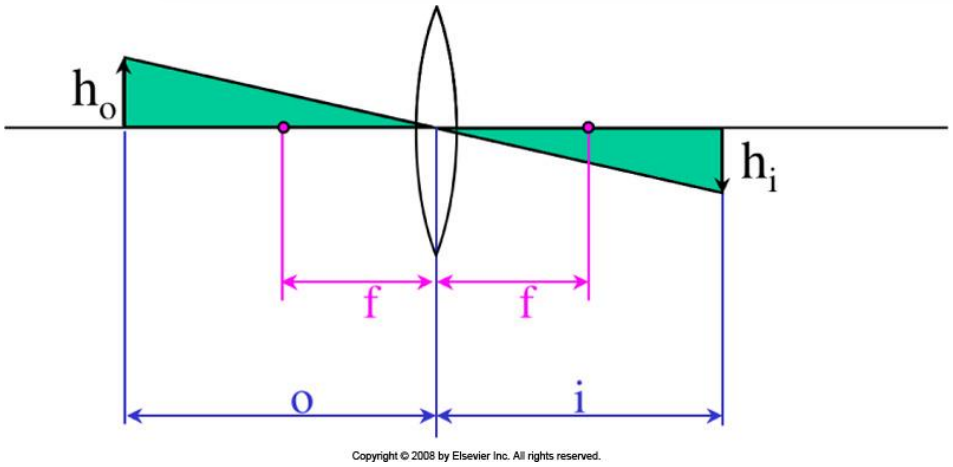
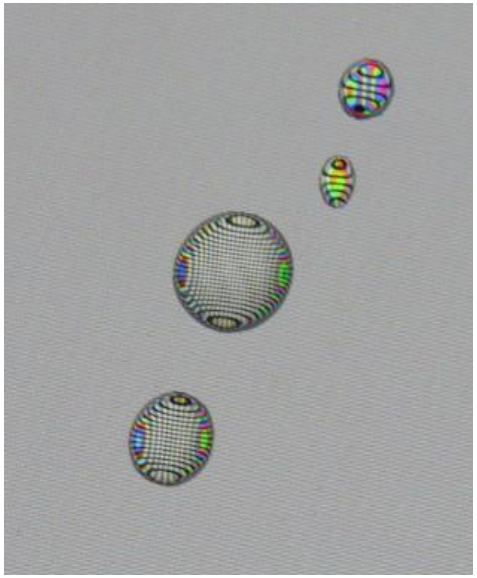
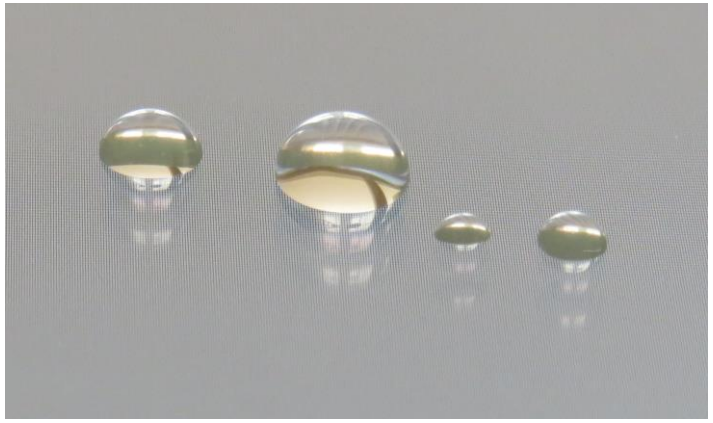
Geometric Optics

1. Converging and Diverging Lenses.
2. Formation of Images.
3. Abberations.





Photos: M. Nenkova



1. Converging and Diverging Lenses.

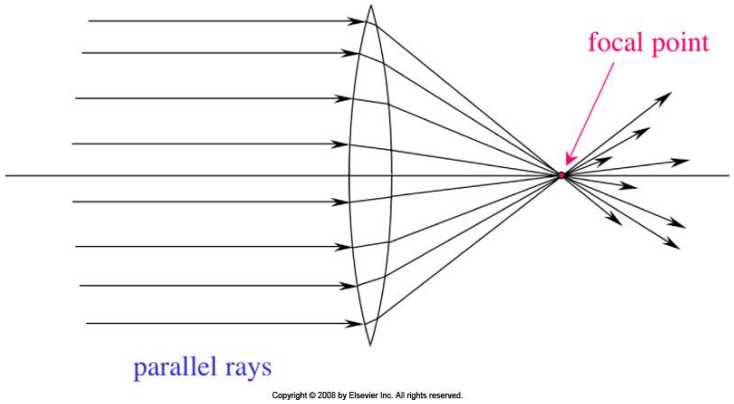


Fig.3-3 Converging lenses are thicker in the middle, so they deflect light rays toward the axis.

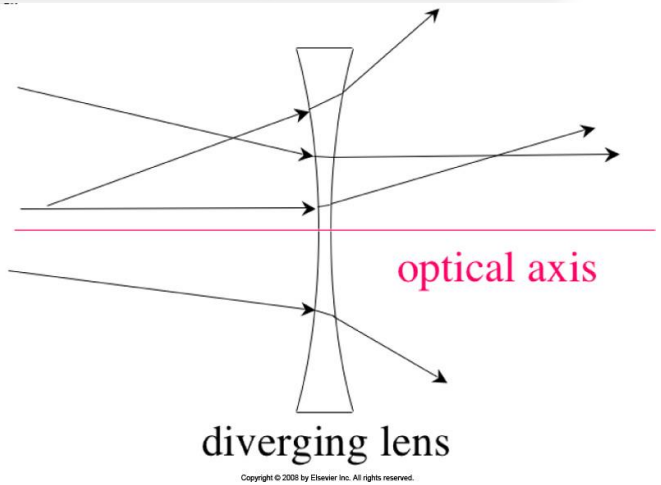
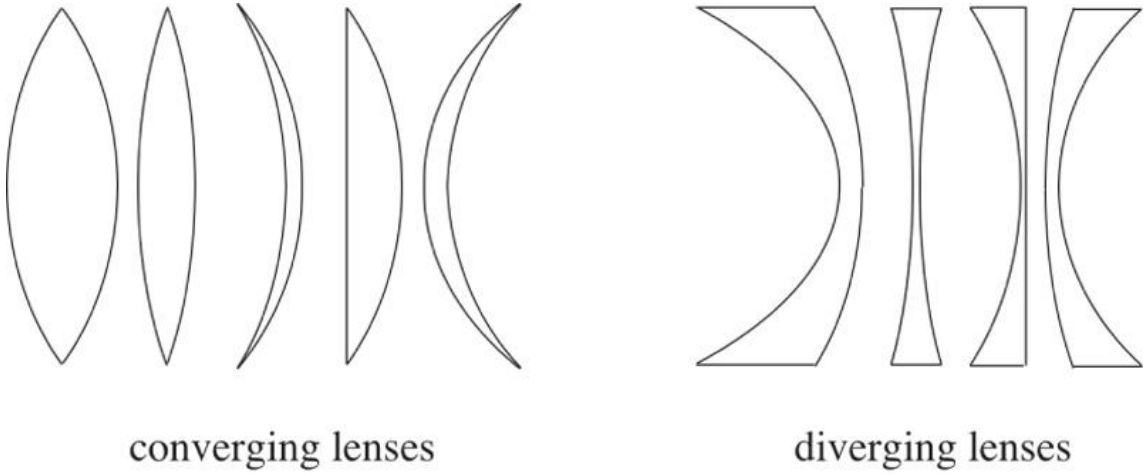


Fig.3-4 Diverging lenses are thinner in the middle, so they deflect light rays away from the axis.



Dioptric Power (D) = $\frac{1}{f(m)}$

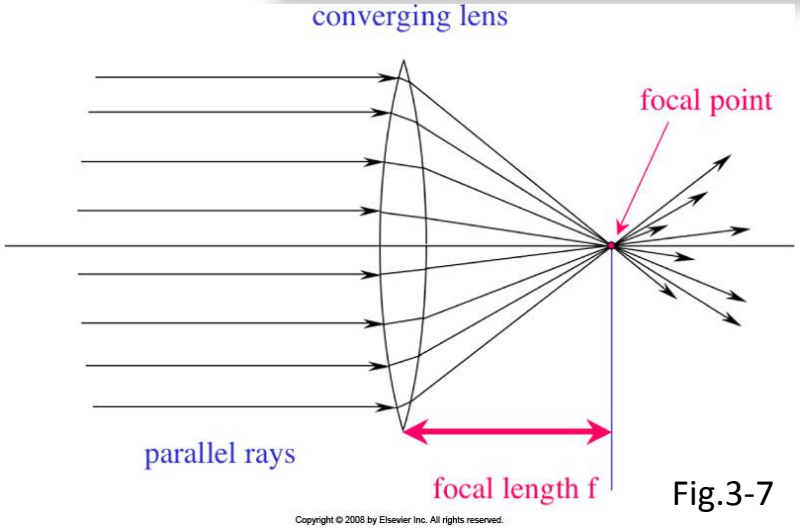


Fig.3-7

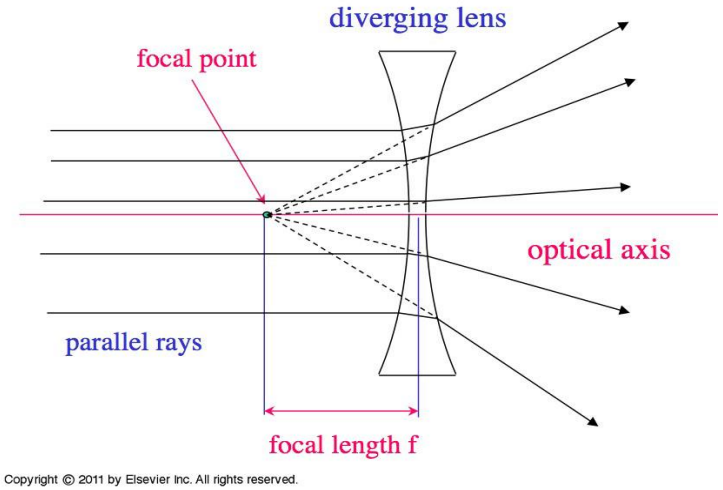


Fig.3-8 The focal length of a diverging lens is stated as a negative number.

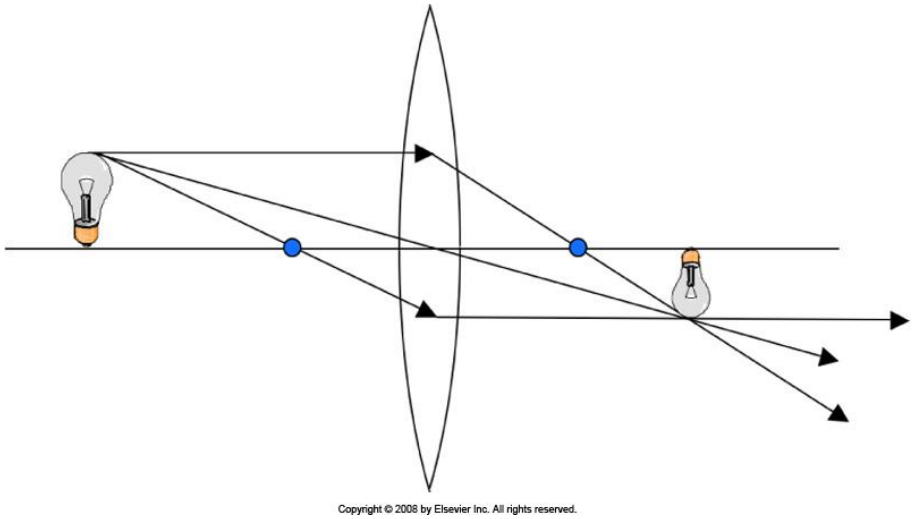
Example 1 : A camera lens has a focal length 50mm = 0.05m. What is the diopter of the lens?

Example 2: Glasses have lenses of -2.5D. What is the focal length of the lenses?

Two lenses will have a combined focal length:

$$\frac{1}{f} = \frac{1}{f_1} + \frac{1}{f_2}$$

2. Formation of Images by thin lenses – use the 3 easy rays:



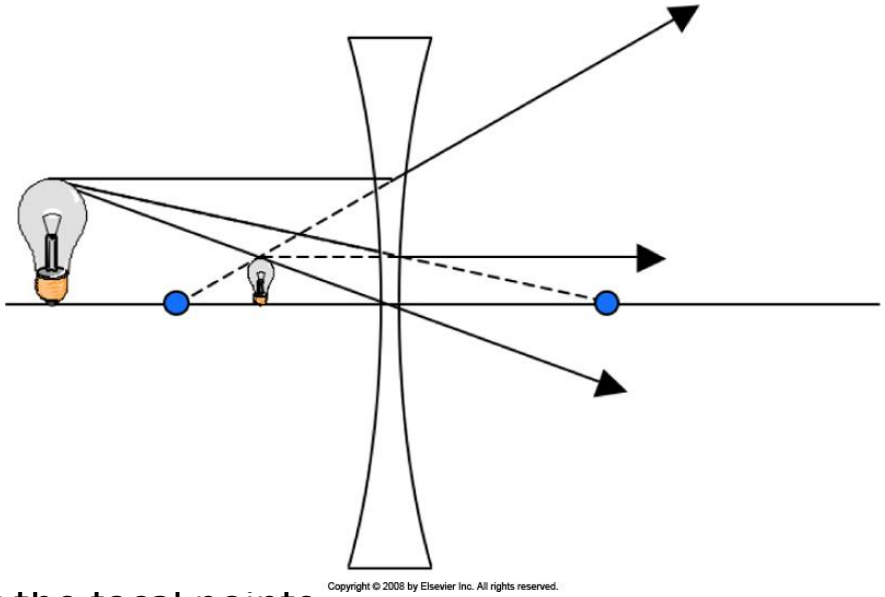


Fig.3-16, 3-17 The blue dots show the focal points.

Play the interactive and analyze the formation of images:
http://www.physicsclassroom.com/Physics-Interactives/Refraction-and-Lenses/Optics-Bench/Optics-Bench-Refraction-Interactive

The lens formula: $\frac{1}{f} = \frac{1}{o} + \frac{1}{i}$

o and *i* are object and image distances from the center of the lens with focal length *f*.
If *i is on the same side of the lens as the o, take i as negative.*

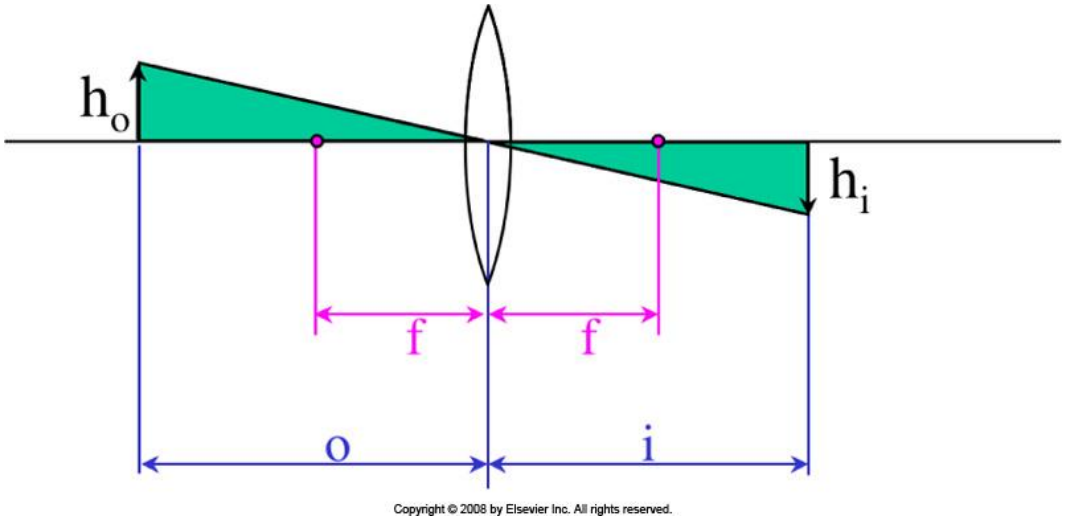
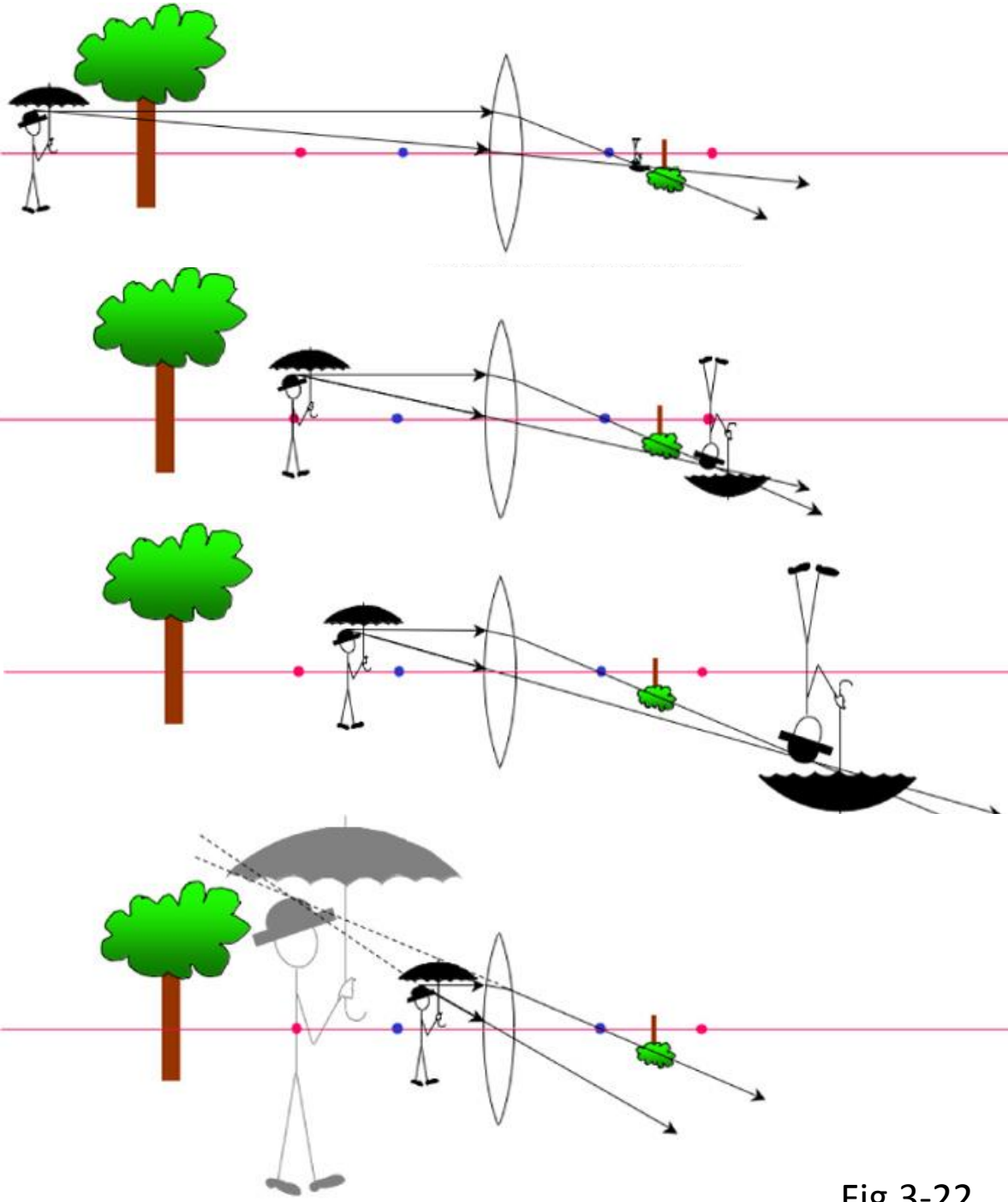


Fig. 3-18

Magnification:

$$M = \frac{h_i}{h_o} = \frac{i}{o}$$

Answer the questions in WS 4.



The magnification increases as the object distance decreases.

What else do you notice?

Fig.3-22

Summary of all possible cases

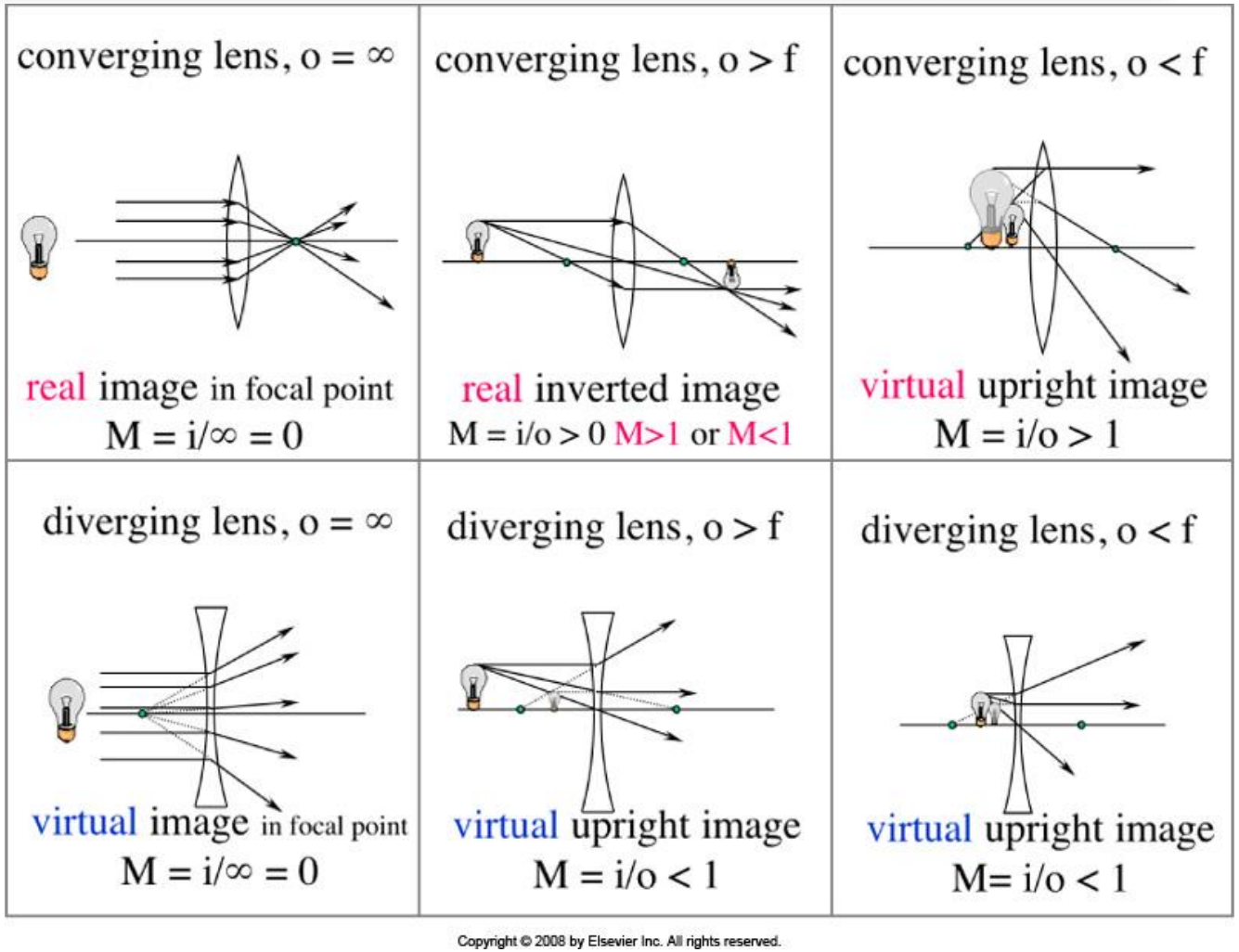


Fig.3-23 Magnification is always less than 1 for diverging lenses.

3. Lens Aberrations

3a) Chromatic aberration

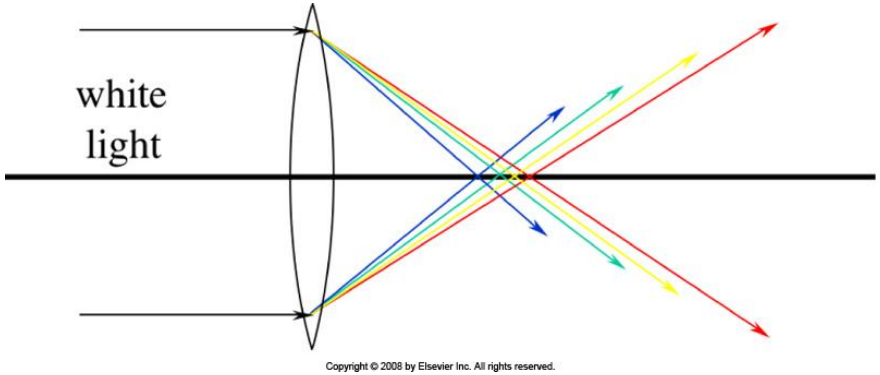


Fig.3-24 Taking rays closer to the axis (i.e. decreasing the aperture) decreases this aberration.

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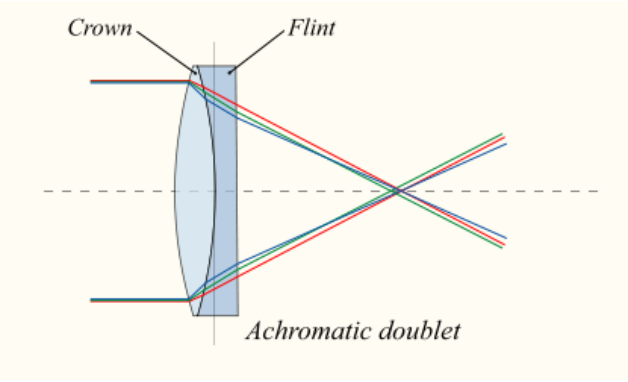
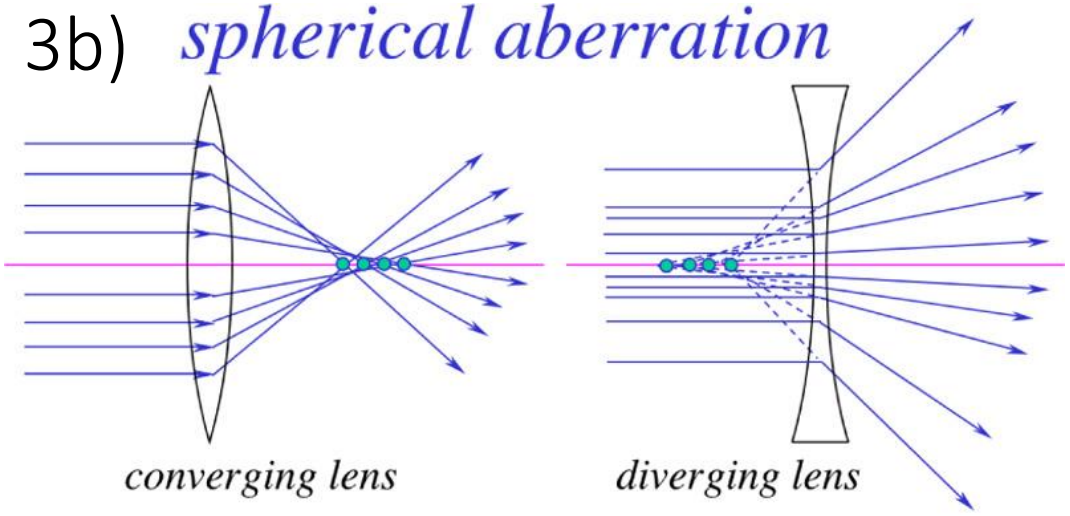


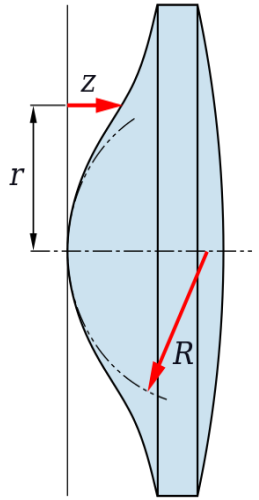
Credit: Dr.Bob. This file is licensed under the Creative Commons Attribution-Share Alike 3.0 Unported license

Chromatic aberration is compensated by combining 2 lenses with different index of refraction.

3b) *spherical aberration*



Spherical aberration is compensated by combining a diverging and converging lens, or by making an aspherical lens.



3c) Distortion

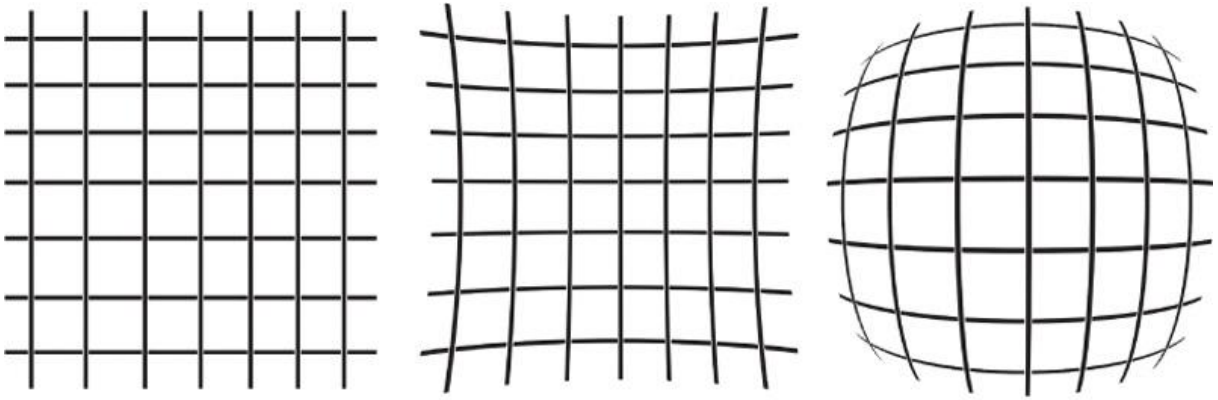


Fig.3-26