Image Forming Instruments - The Camera

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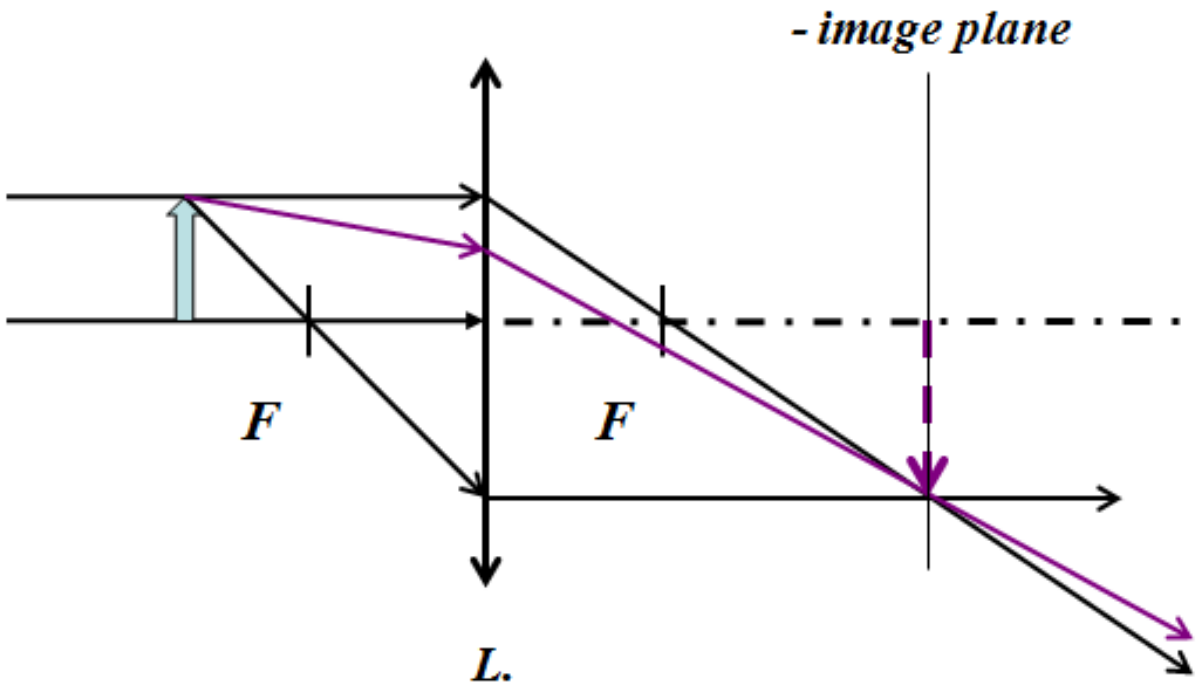
Image Forming Instruments

- - the simplest optical instruments consist of a single convergent lens
- - forming a real image of an object upon a light-sensitive material;
- - such examples are:
  - the eye and the photographic camera;



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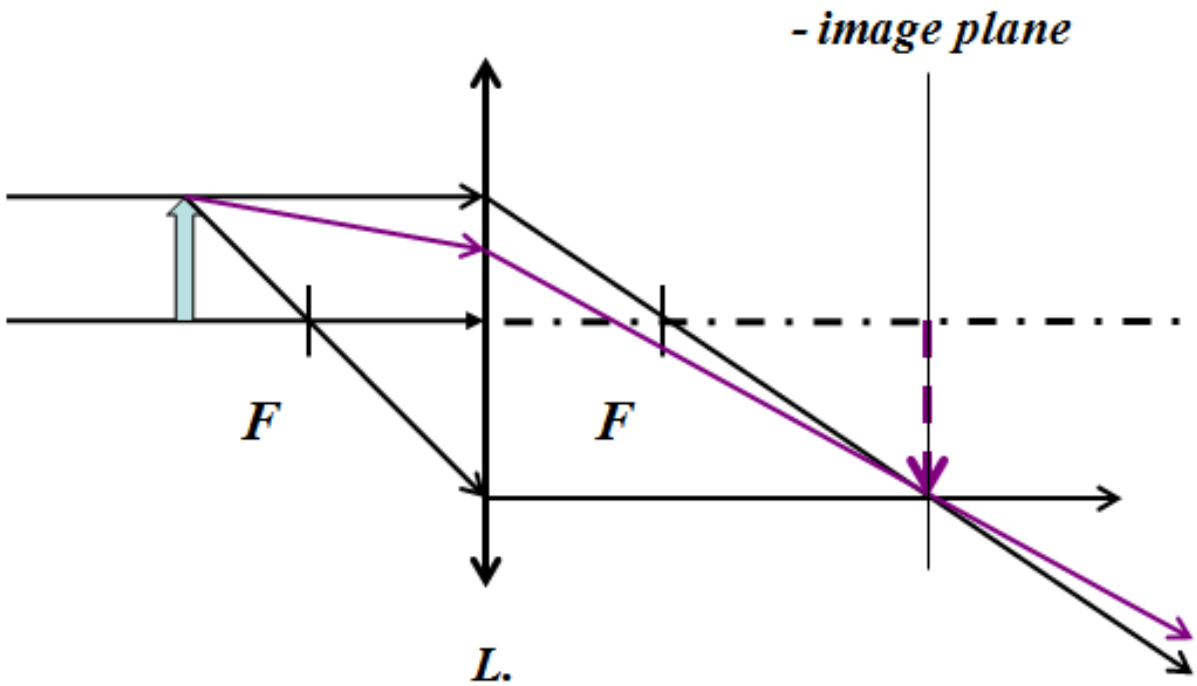

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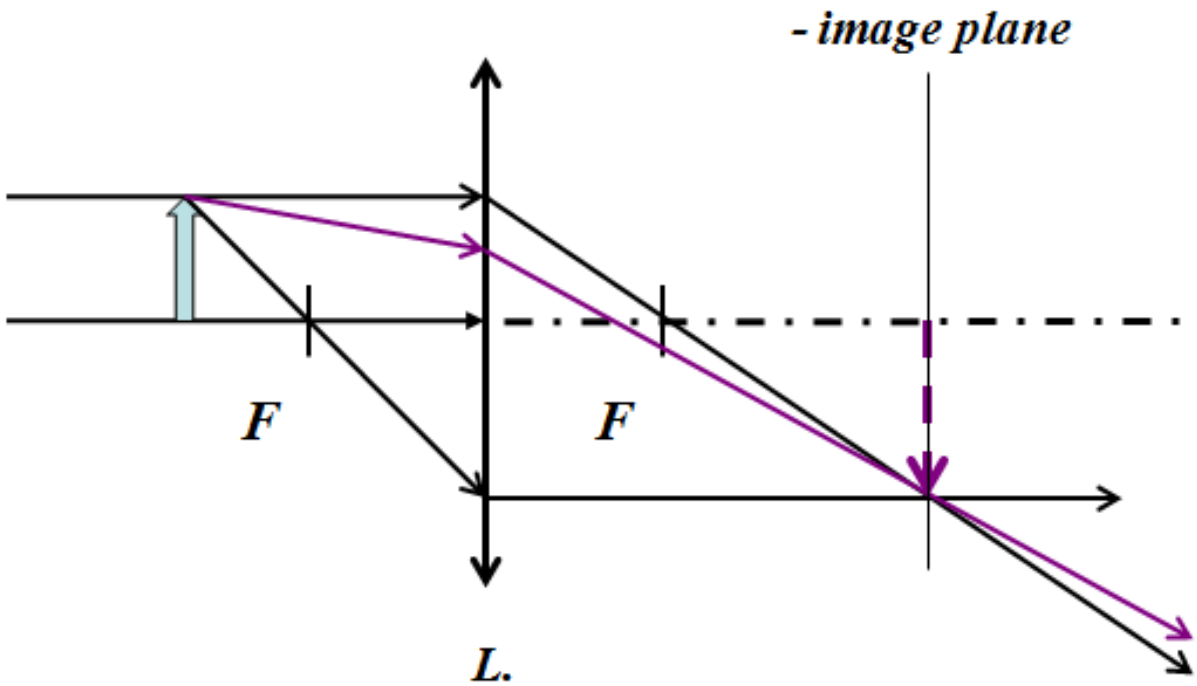

The Camera

- - a camera is an optical instrument for recording images;
- - the word camera comes from camera obscura, which means "dark chamber"
- - and is the Latin name of the original device for projecting an image of external reality onto a flat surface;
- - the modern photographic camera evolved from the camera obscura;
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- - a camera may work with the light of the visible spectrum
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- - the first permanent photograph of a camera image
- - was made in 1826 by Joseph Nicéphore Niépce;
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- - he succeeded in developing a high-contrast and sharp image
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- - after an image had been focused on the screen,
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Geometrical Optics

- Ray Optics
- Image Formation
- The Spherical Mirror

Geometrical Optics

- - there are many evidences, which suggest
  - that light travels in straight line
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- - geometrical optics is that part of optics in which we neglect the wave property of light;
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Fermat's Principle

- - light travels in the form of rays;
  - the rays are emitted by light sources and can be observed when they reach an optical "detector";
- - an optical medium is characterized by a quantity $n \geq 1$, called refractive index;
  - the refractive index is the ratio of the speed of light in free space c, to that in the medium v;
- - in an inhomogeneous medium, the refractive index
  - $n(r)$ is a function of the position;
- - Fermat's Principle:
  - optical rays traveling between two points A and B follow a path such that the time of travel between the two points is an extremum relative to neighboring paths;

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Plane Mirror

- - a plane mirror reflects the rays originating
  - from a point so that the reflected rays
  - appear to originate from a point behind the mirror,
  - called image;
- - image formation by a plane mirror:

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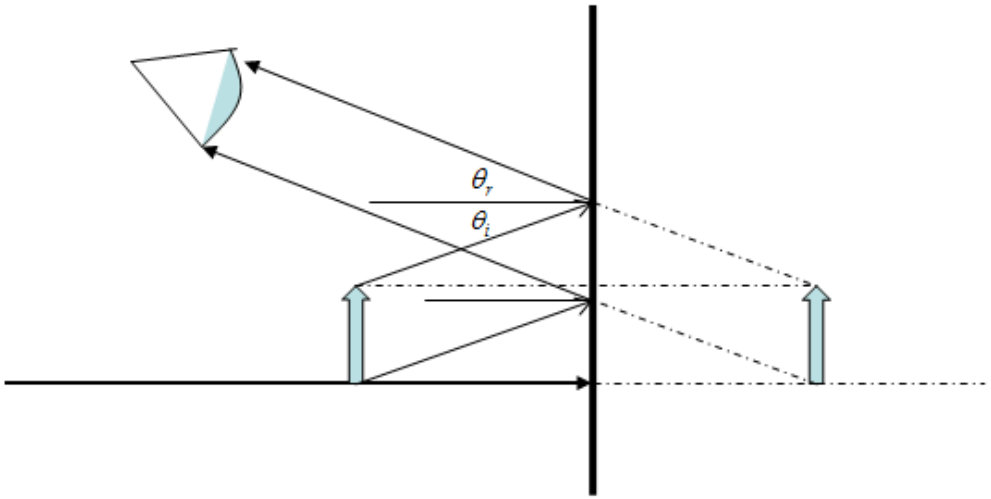

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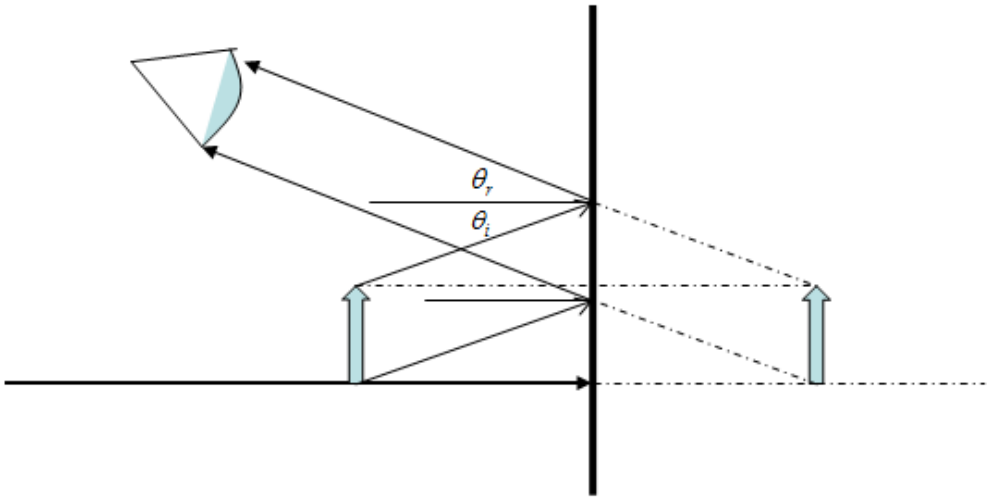

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The Laws of Reflection and Refraction

- - the angle of incidence θ_i, is the angle an incident ray makes with the normal to the surface;
- - the angle of reflection θ_r is the angle the reflected ray makes with the normal of the surface;
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The Camera - Overview

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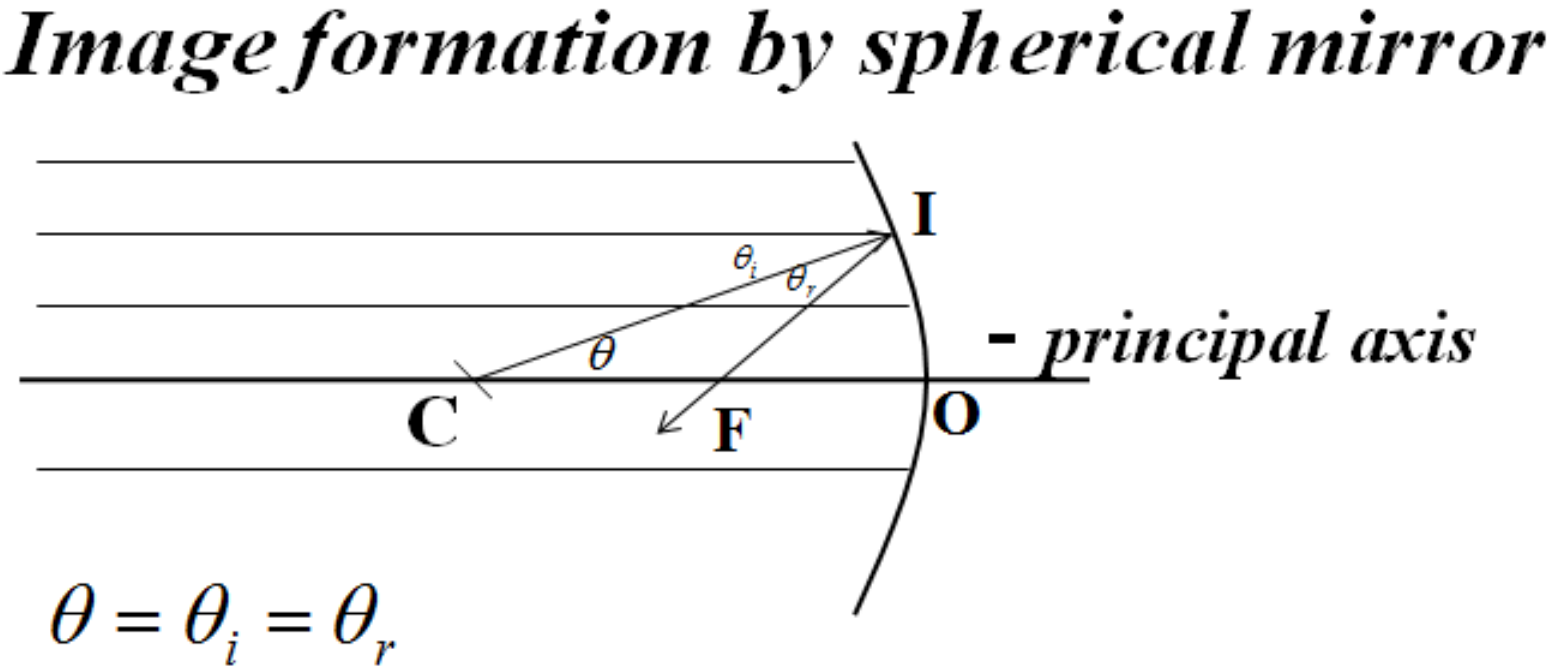
Reflection by Spherical Mirrors

- - a spherical mirror of radius R,
  - acts like a paraboloidal mirror,
  - of focal length $f = R/2$;



The Concave Mirror

- - a spherical mirror is called concave
  - if the reflecting surface is on the inner surface of the sphere;
- - the triangle CIF is isosceles; that is, CF=IF;
- - if the rays are paraxial, FO can be approximated by IF and for the focal length we get:
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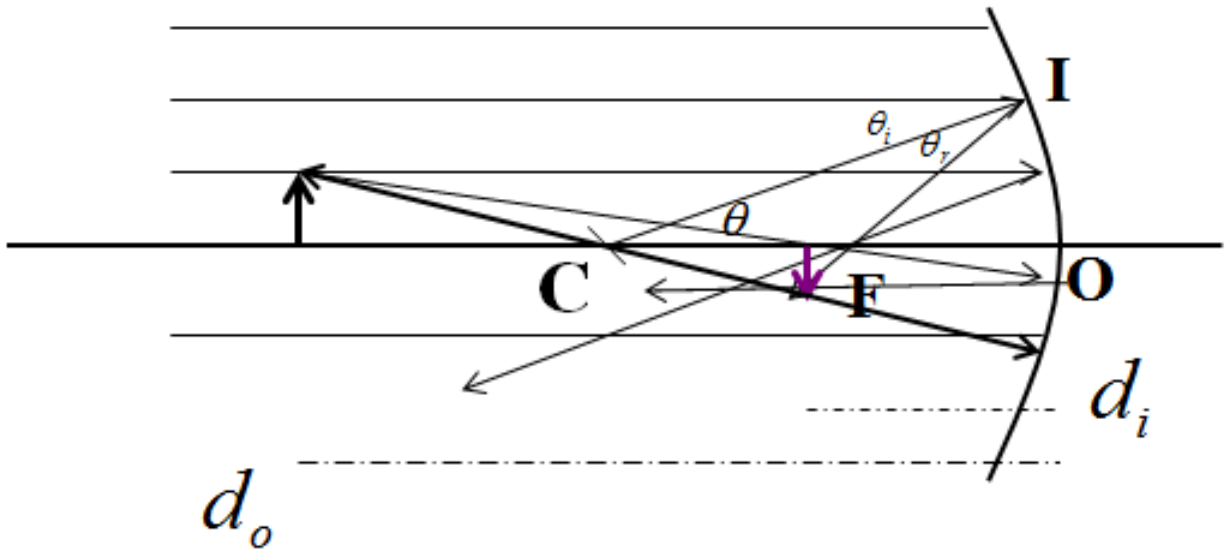

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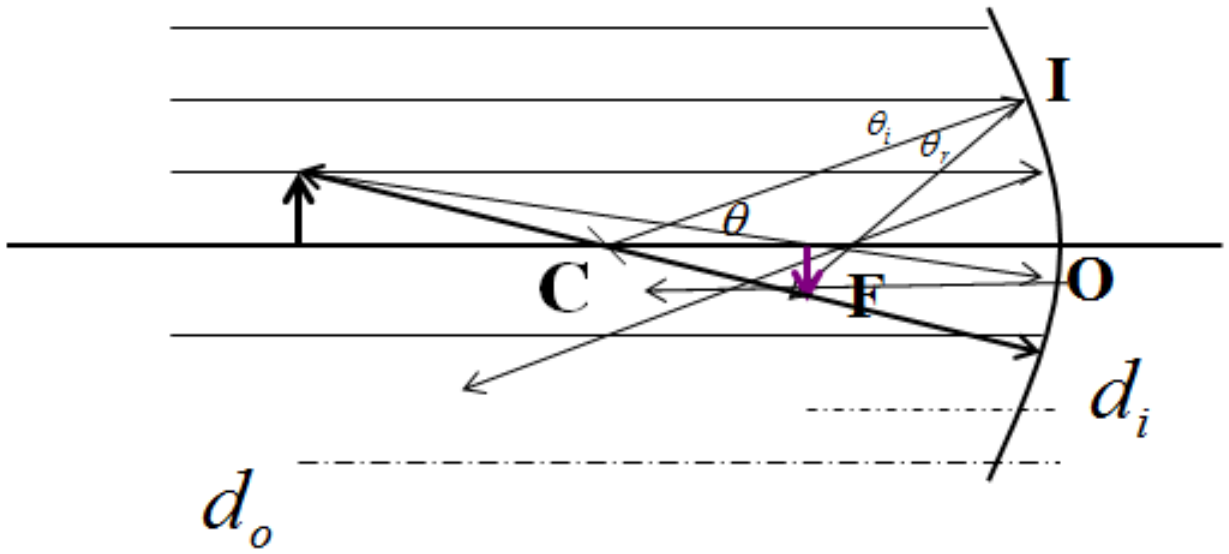

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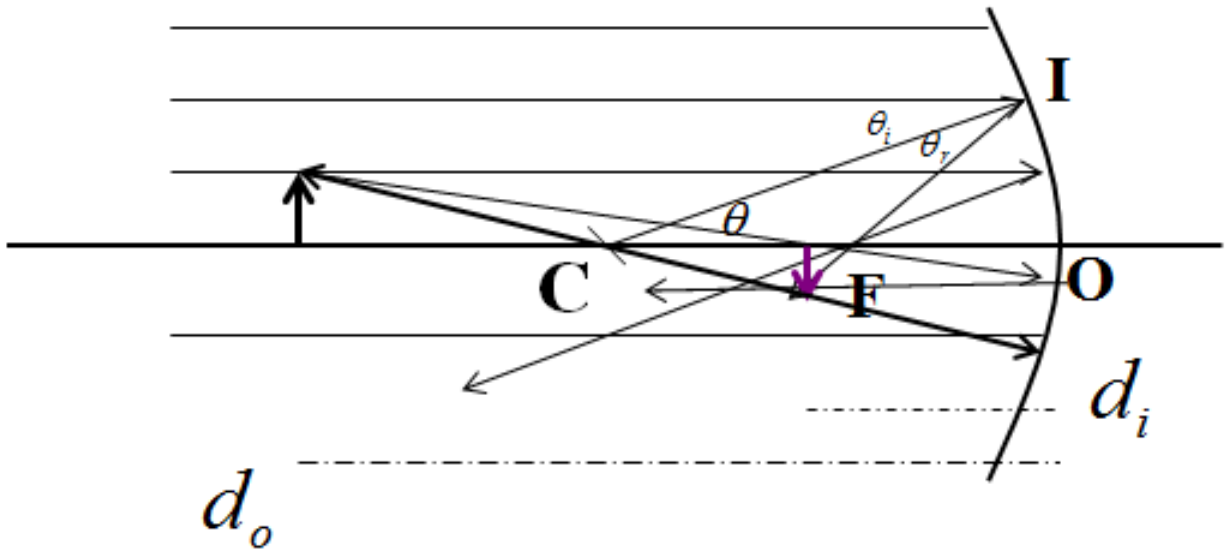

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- - denoting the height of the object and image by o, and i respectively, it results in:

$$\begin{aligned} \frac{o}{d_0} &= \frac{i}{d_i}; \\ \frac{o}{d_0 - r} &= \frac{i}{r - d_i}; \end{aligned} \tag{1}$$

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