

The image you is due to
(a) a convex mirror b) a planar mirror
(c) a concave mirror



Figure 34-95 Physics for Engineers and Scientists 3/e
Bo Zaunders/Corbis.

The image we see of the fire is due to
(a) convex mirror (b) concave mirror (c) planar mirror

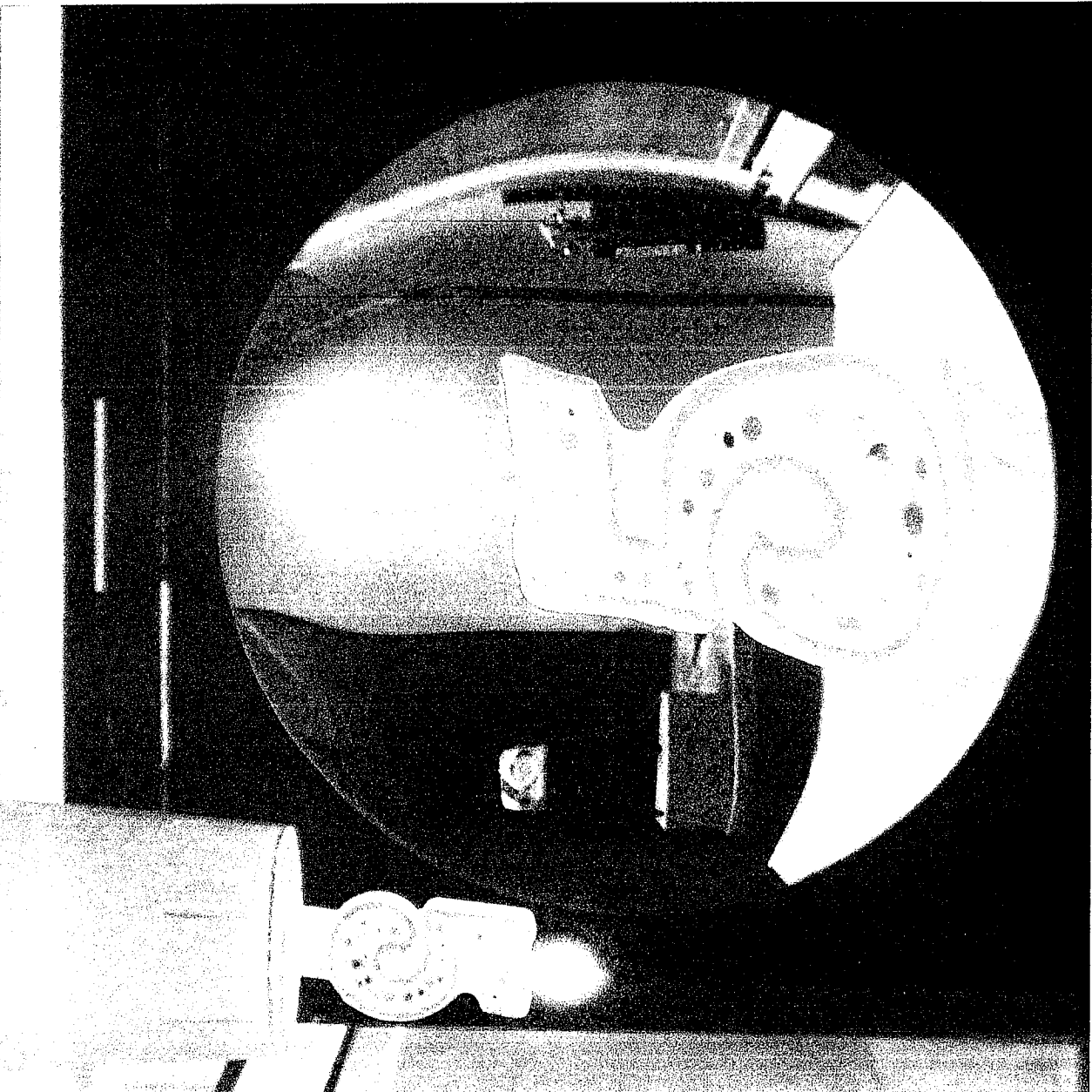


Figure 34-41b Physics for Engineers and Scientists 3/e
Courtesy of John Market

The image you see is
(a) virtual (b) real (c) indetermined

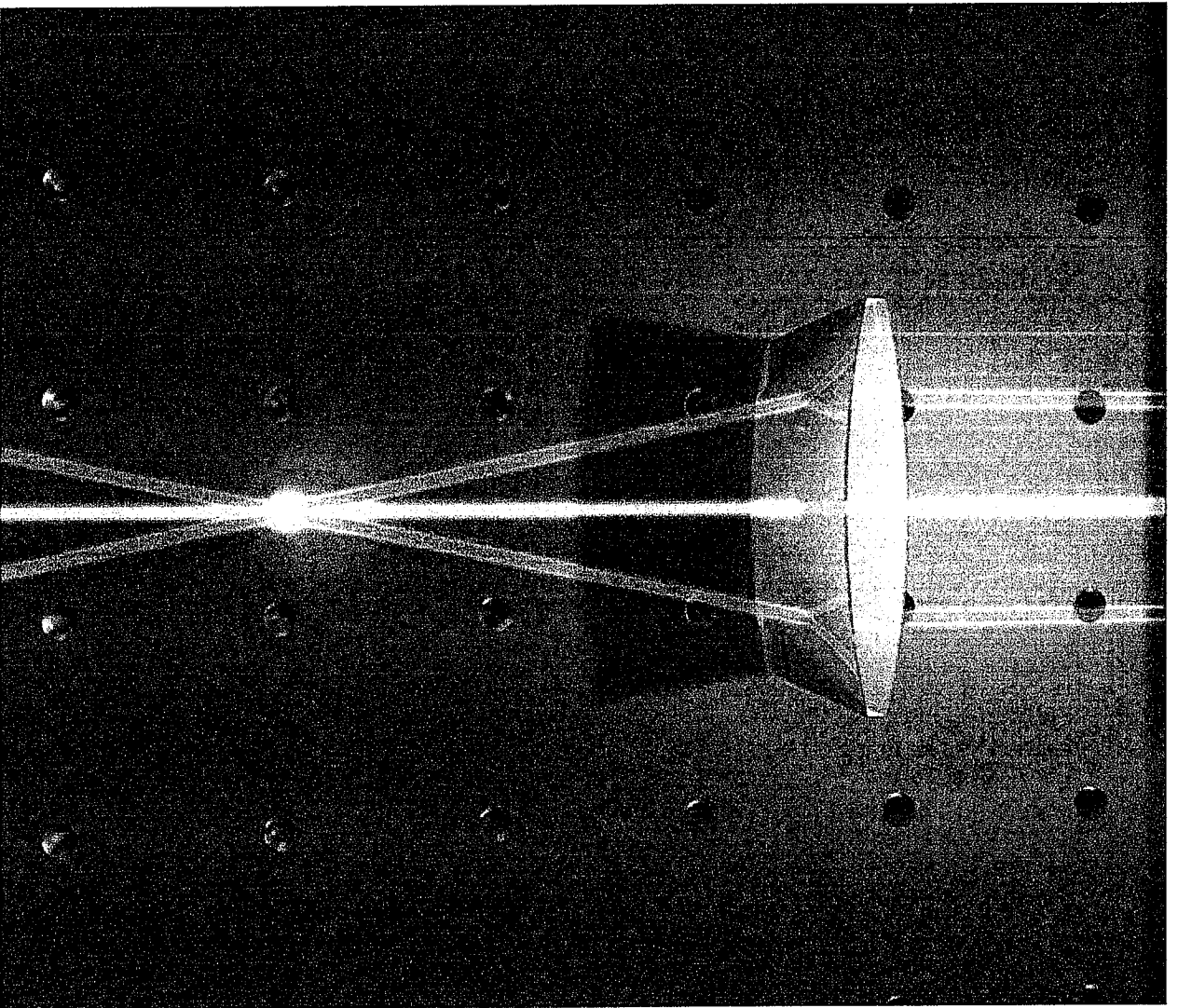
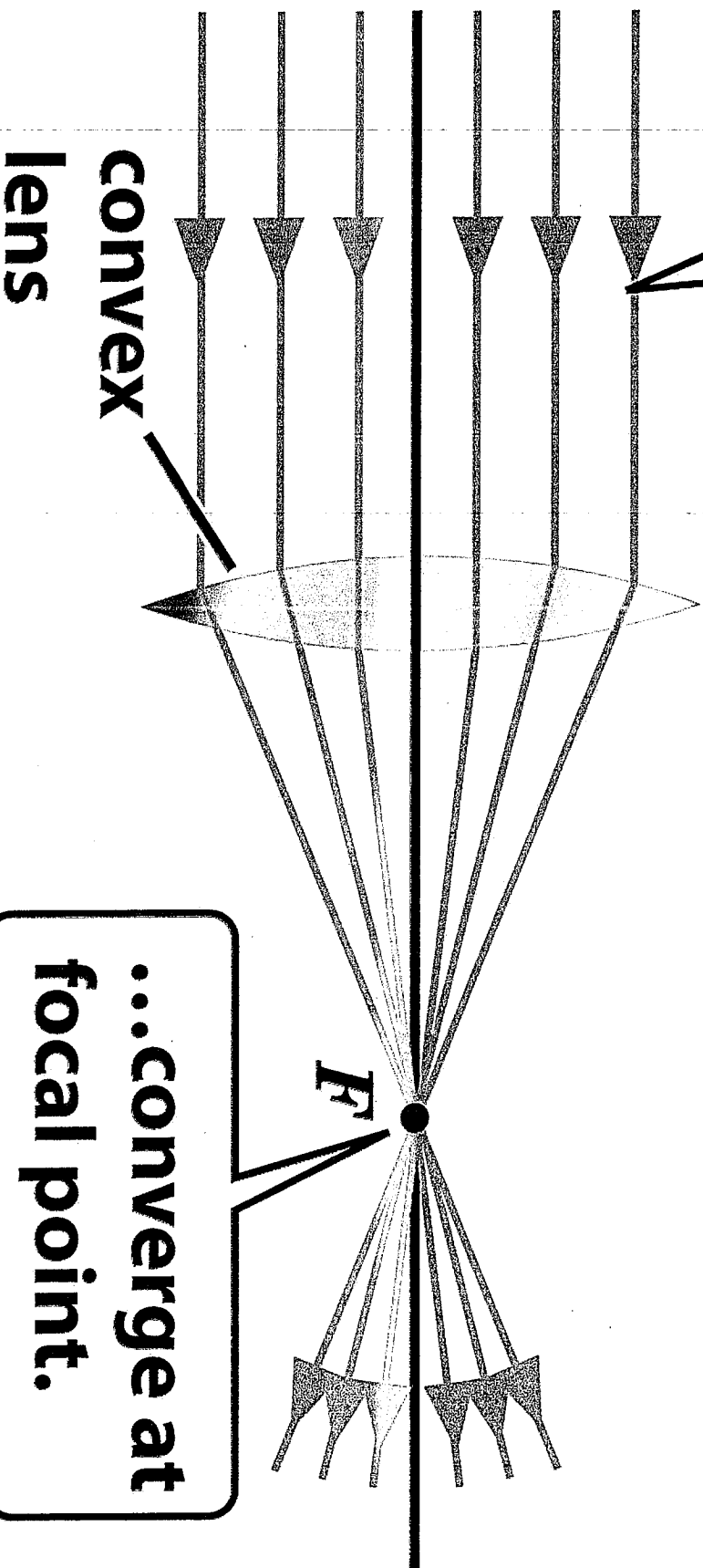


Figure 34-43b Physics for Engineers and Scientists 3/e
David Parker/Photo Researchers, Inc.

Incident parallel rays...

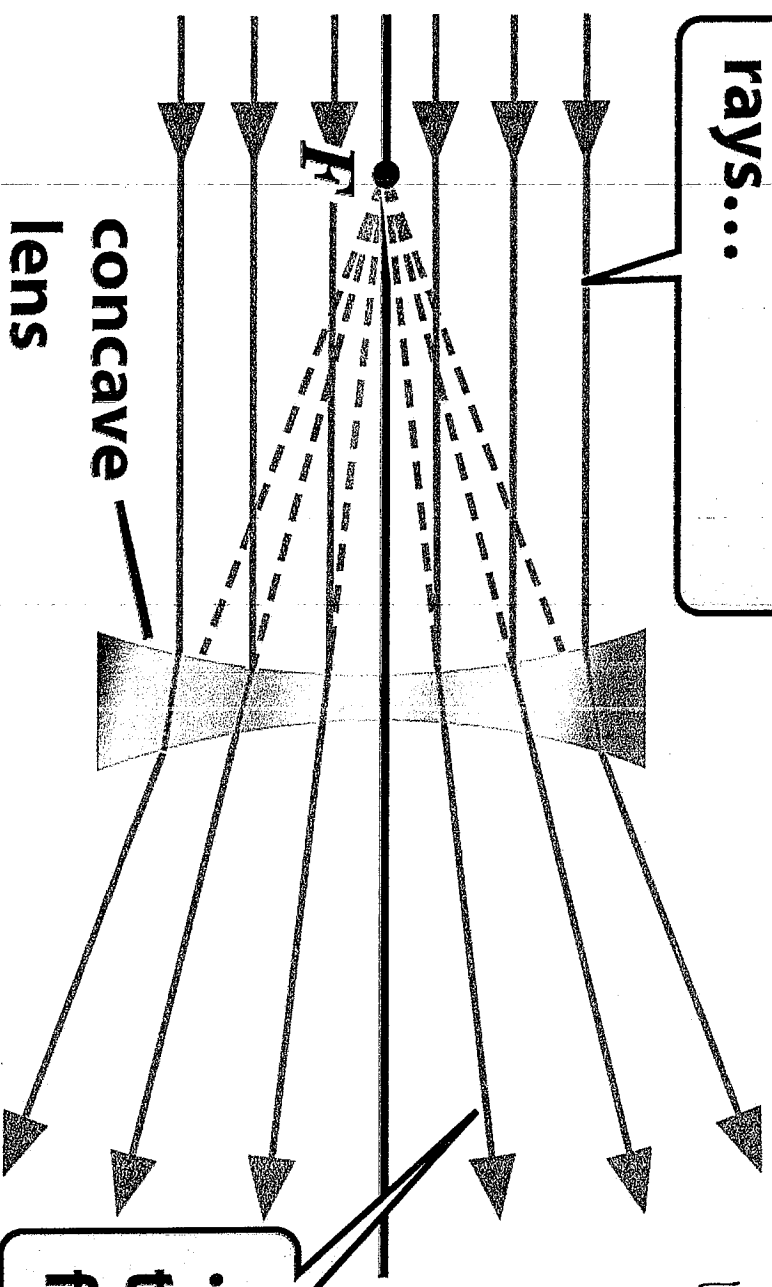


$$\frac{1}{F} = (n-1) \left(\frac{1}{R_1} + \frac{1}{R_2} \right)$$

lens maker equation

Figure 34-43a Physics for Engineers and Scientists 3/e
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Incident parallel rays...



concave lens

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$$

$$f = (n-1) \left(\frac{1}{R_1} + \frac{1}{R_2} \right)$$

here: $R_1 < 0$

$R_2 < 0$

$s' < 0$

...diverge as if they came from focal point.

Figure 34-44a Physics for Engineers and Scientists 3/e
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MIRROR AND LENS EQUATION

But there is a difference in notation between mirror and lens

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}; \quad M = \frac{-s'}{s}$$

$$M \equiv \frac{h'}{h} = -\frac{s'}{s}$$

MIRROR; $s > 0$ on left;

real image (inverted)

$s' > 0$, s' on left

$f = R/2 > 0$, converging concave mirror

virtual upright image

$s' < 0$ on right

$f = R/2 < 0$, diverging convex mirror

LENS; $s > 0$ on left

real image (inverted)

$s' > 0$, s' on right

$1/f = (n-1)(1/R_1 + 1/R_2) > 0$, converging convex lens

virtual upright image

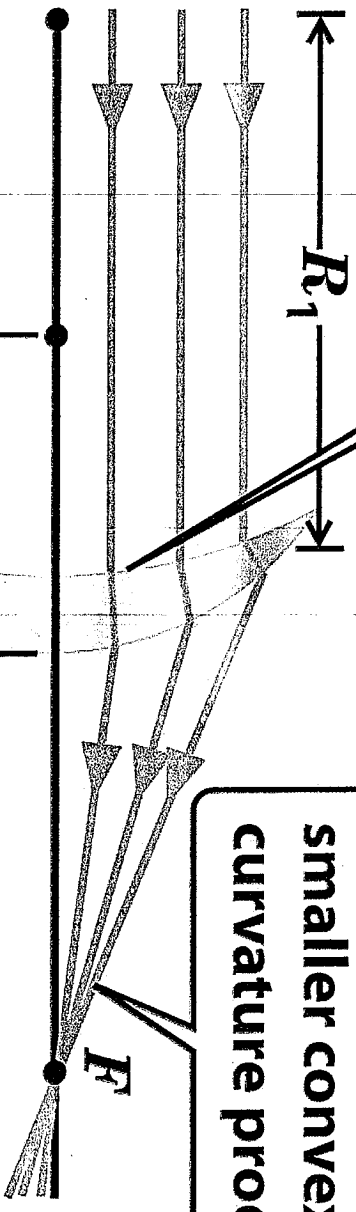
$s' < 0$, on left

$1/f = (n-1)(1/R_1 + 1/R_2) < 0$, diverging concave ~~mirror~~ ^{lens}

Radius of curvature of concave surface (R_1) is reckoned as negative.

Concave-convex lens with smaller convex radius of curvature produces convergence.

Radius of curvature of convex surface (R_2) is reckoned as positive.

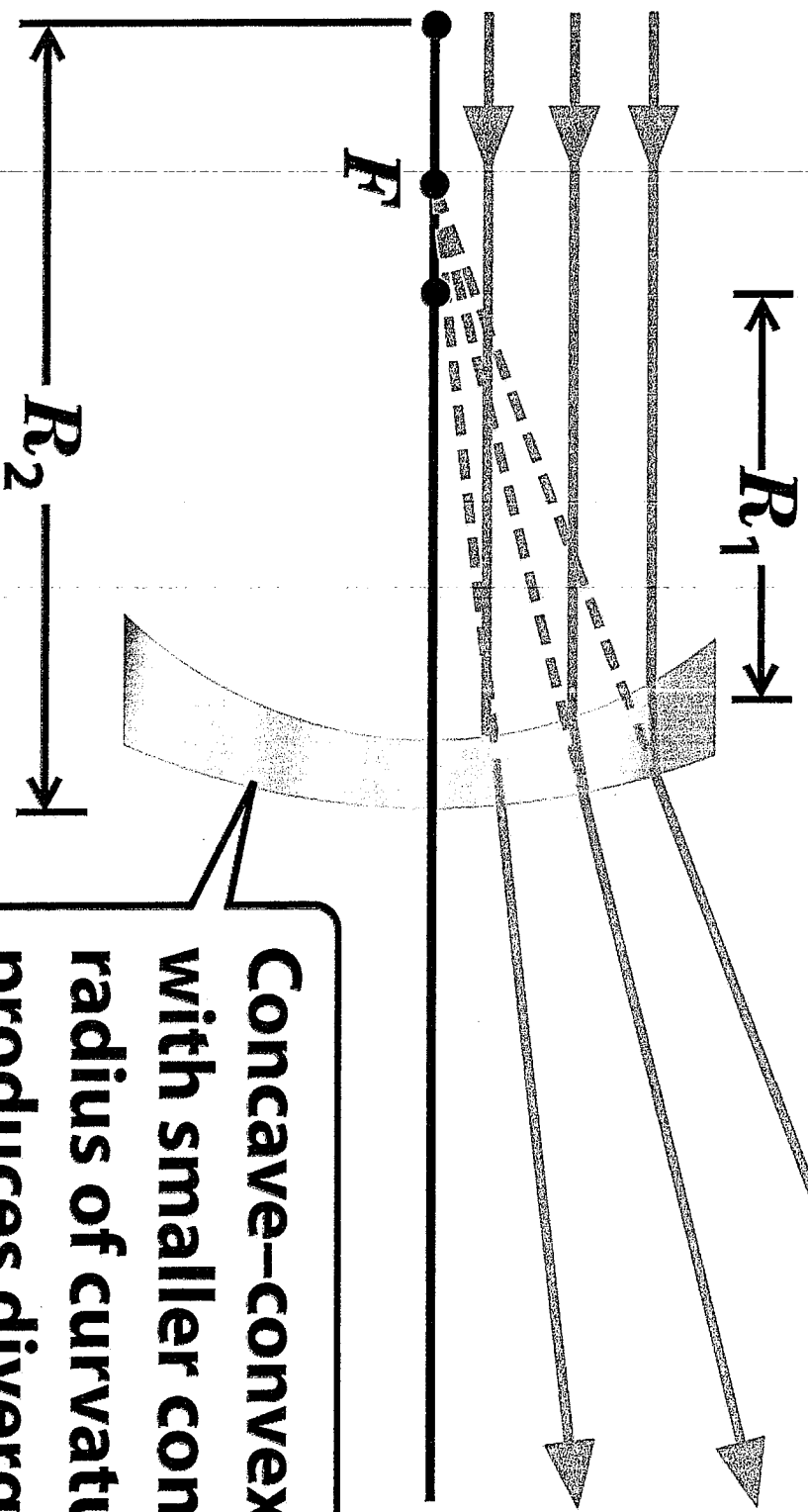


$$\frac{1}{f} = (n-1) \left(\frac{1}{R_1} + \frac{1}{R_2} \right)$$

here $R_1 < 0$, $R_2 > 0$
 $\frac{1}{R_2} > \frac{1}{R_1} \therefore$ focusing

Figure 34-45a Physics for Engineers and Scientists 3/e © 2007 W. W. Norton & Company, Inc.

$$\frac{1}{f} = (n-1) \left(\frac{-1}{|R_1|} + \frac{1}{R_2} \right)$$



Concave-convex lens with smaller concave radius of curvature produces divergence.

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Formation of Inverted Image

Ray parallel to axis passes through far focal point.

$|F'I| = |F'I|$
 $|P| > 2|F|$
 $F < |P'| < 2F$

Ray through near focal point emerges parallel to axis.

Ray through center goes straight through.

Rays converge; image is real and inverted.

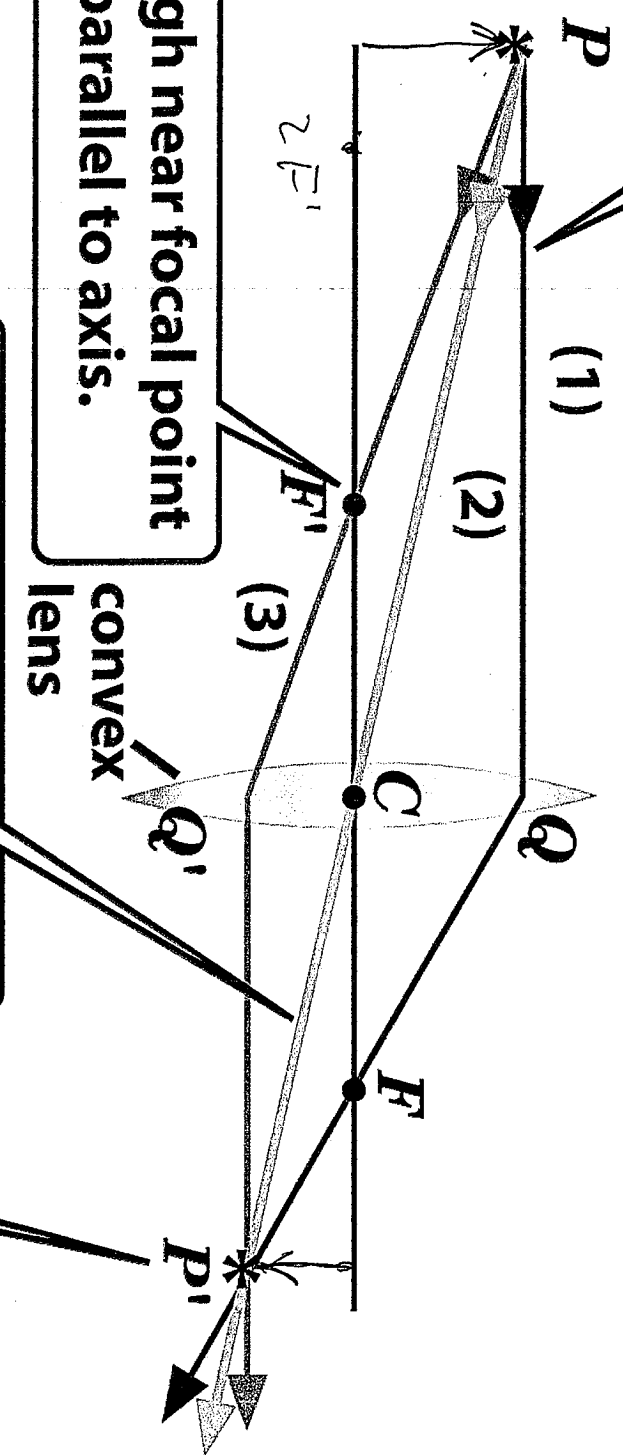


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Formation of reduced upright image

Ray parallel to axis diverges as if it came from near focal point.

Ray heading for far focal point emerges parallel to axis.

Ray through center goes straight through.

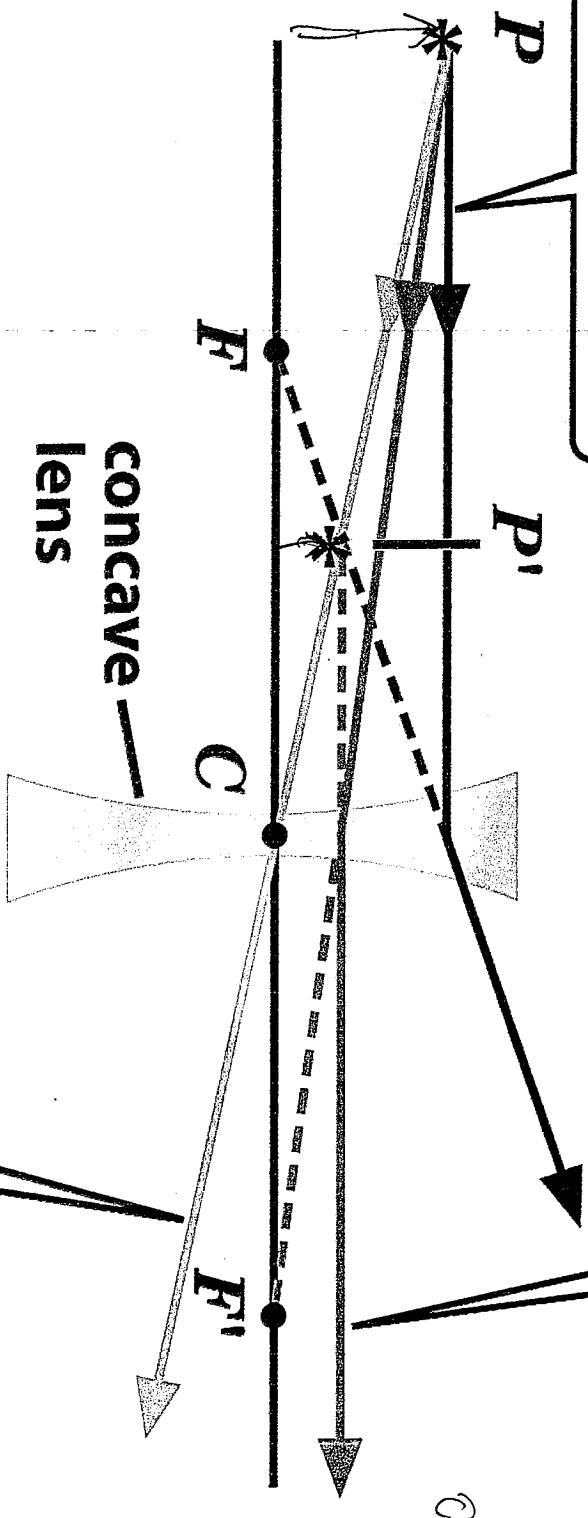


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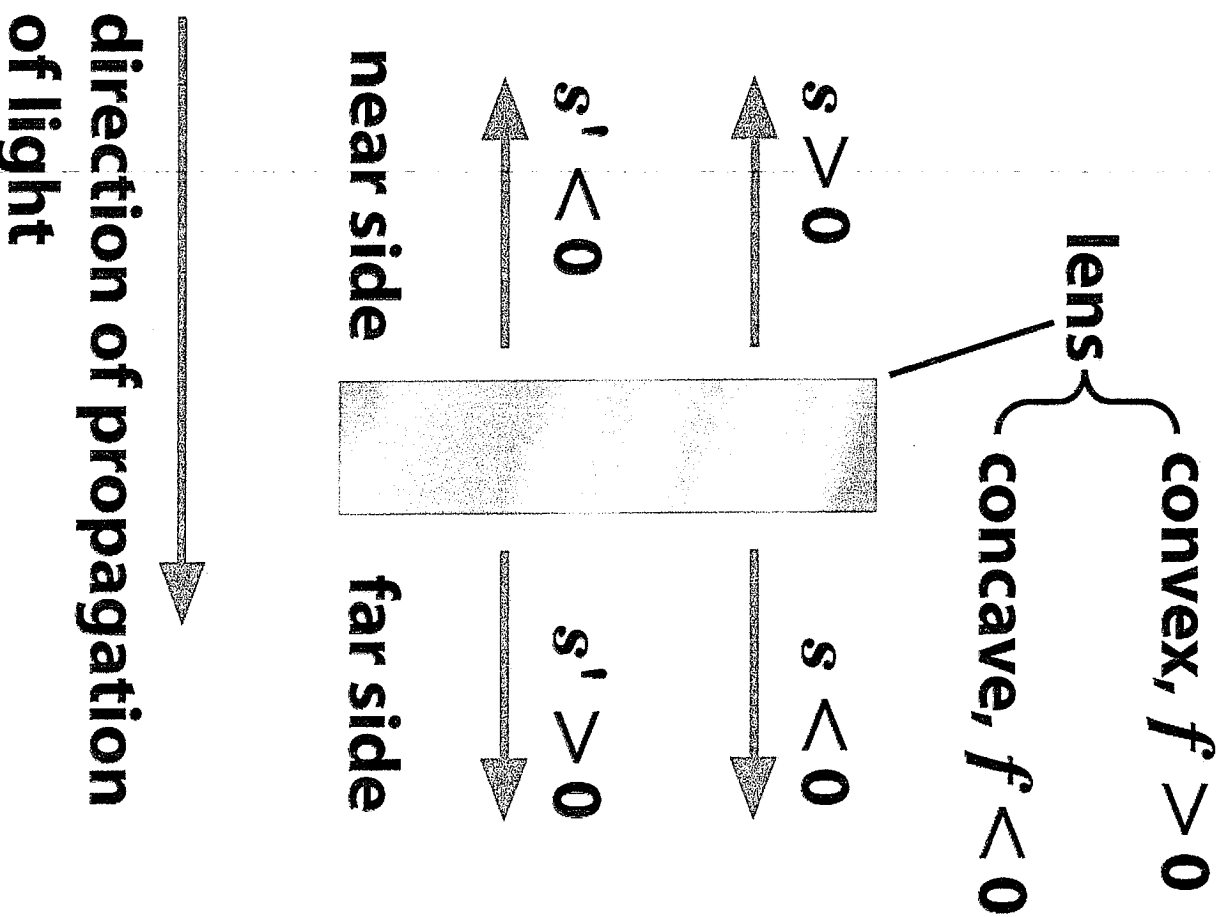
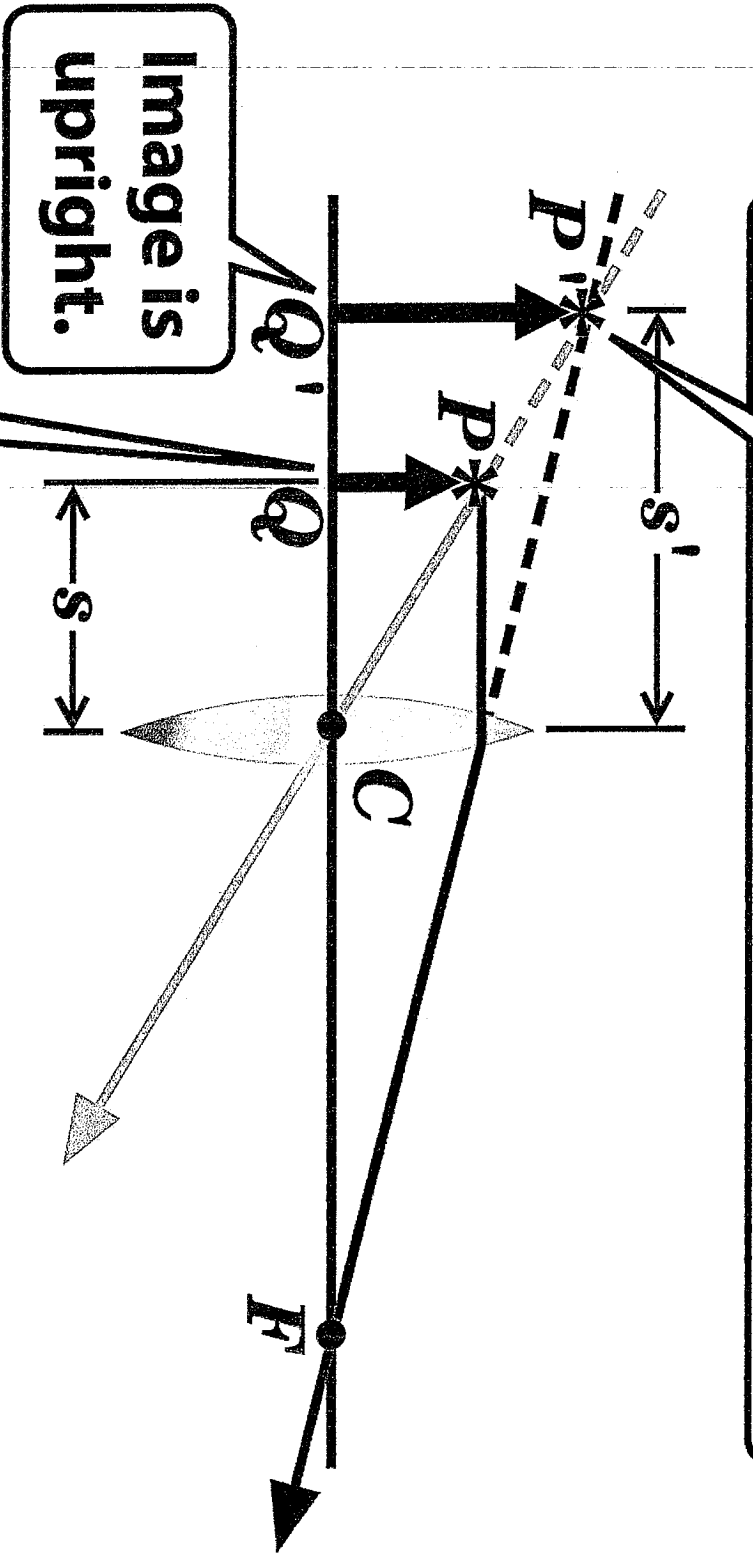


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Formation of virtual enlarged upright image

Since rays only appear to come from image point, image is virtual.



TIP

Image is upright.

Object is closer than focal distance to lens.

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Formation of reduced upright image

Since rays only appear to come from image point, image is virtual.

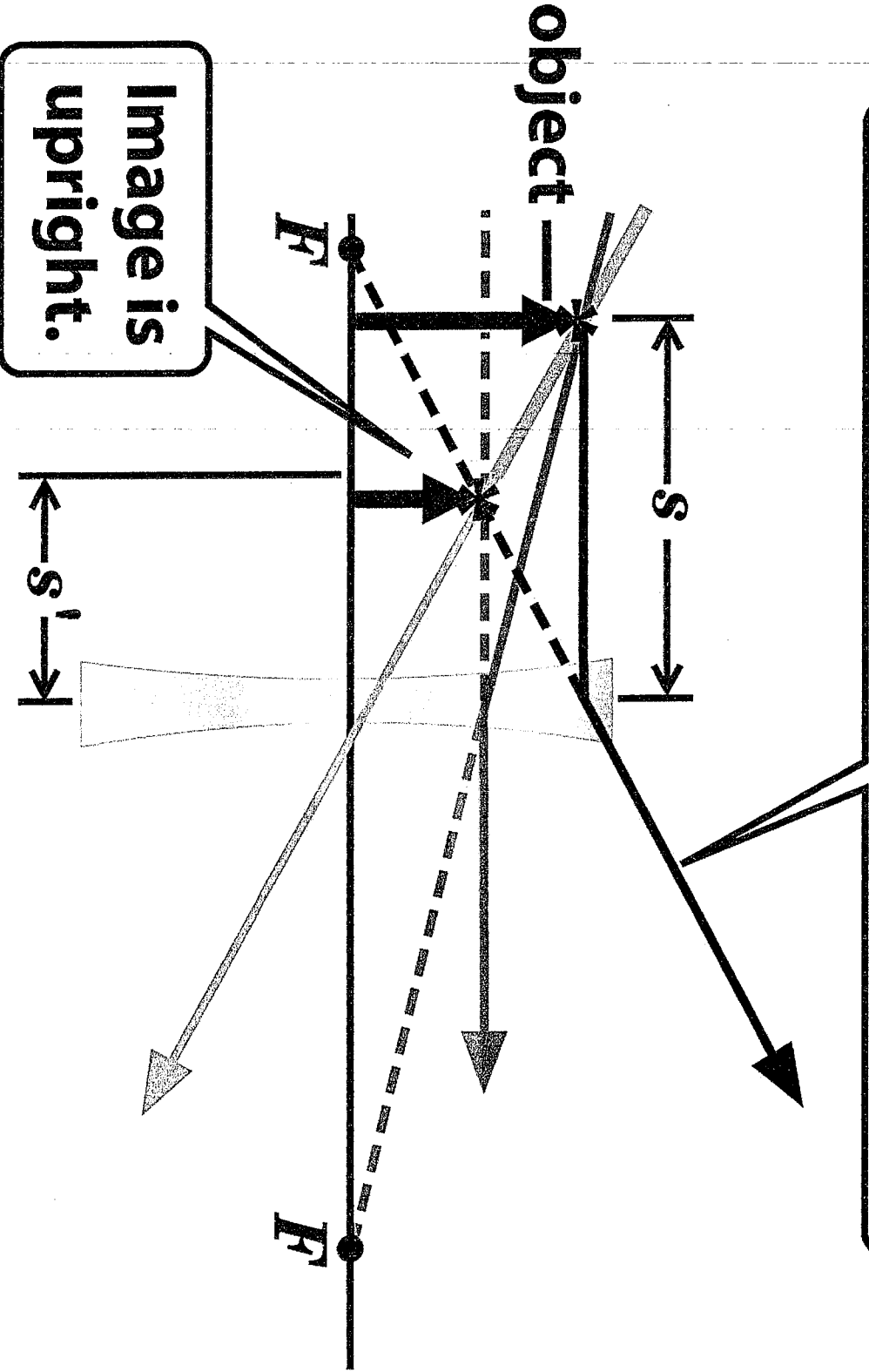


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In camera lens focuses image onto film

$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$$

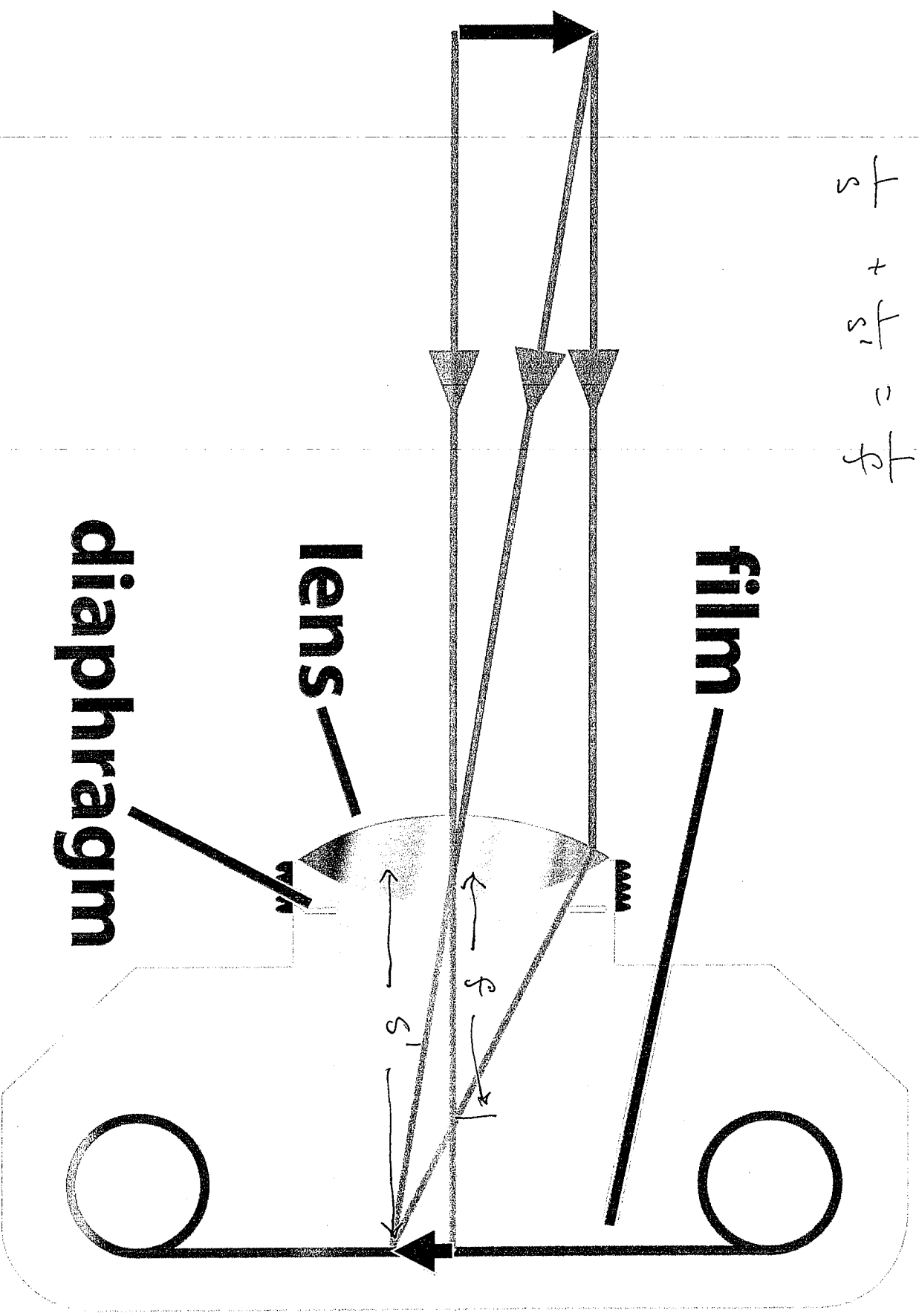


Figure 34-53 Physics for Engineers and Scientists 3/e
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The eye is our "dynamic" camera

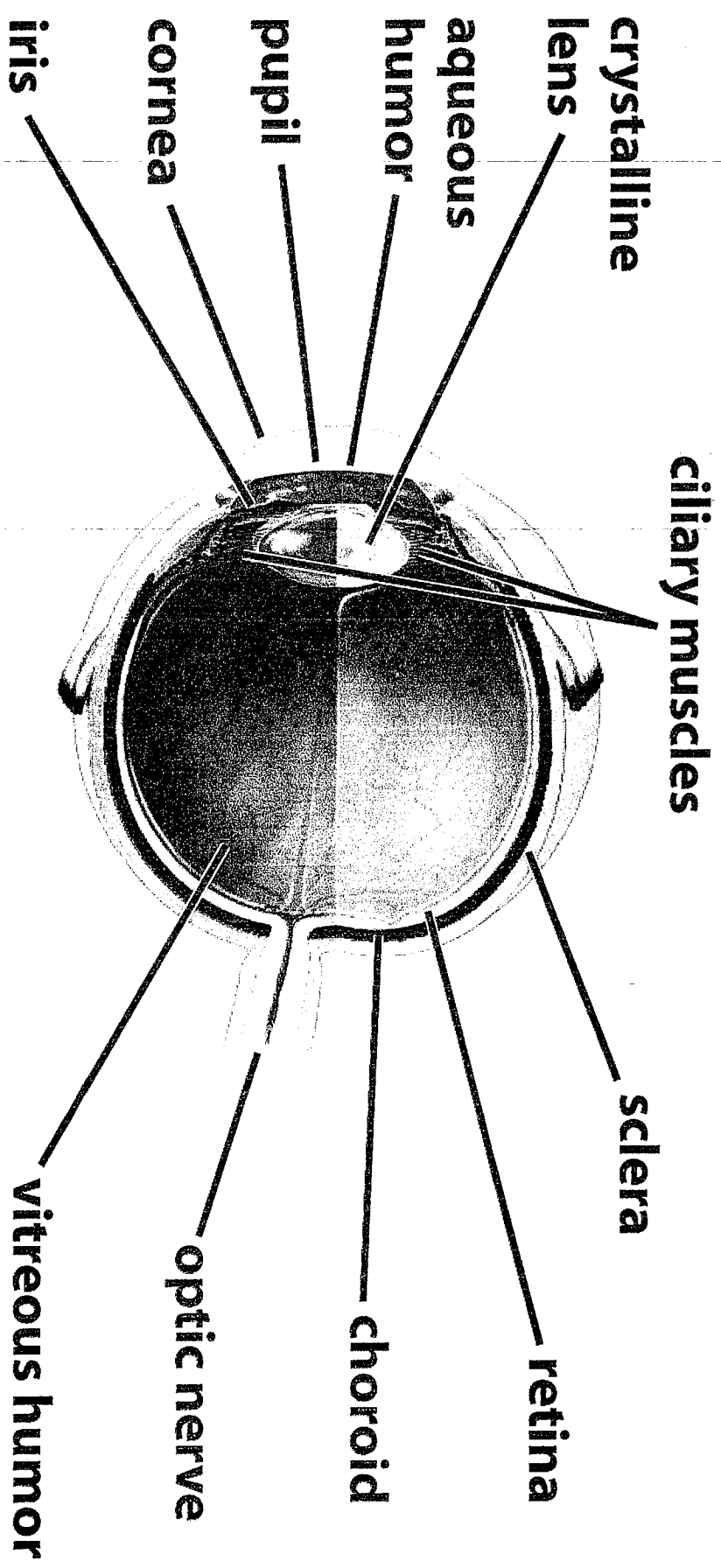


Figure 34-55 Physics for Engineers and Scientists 3/e
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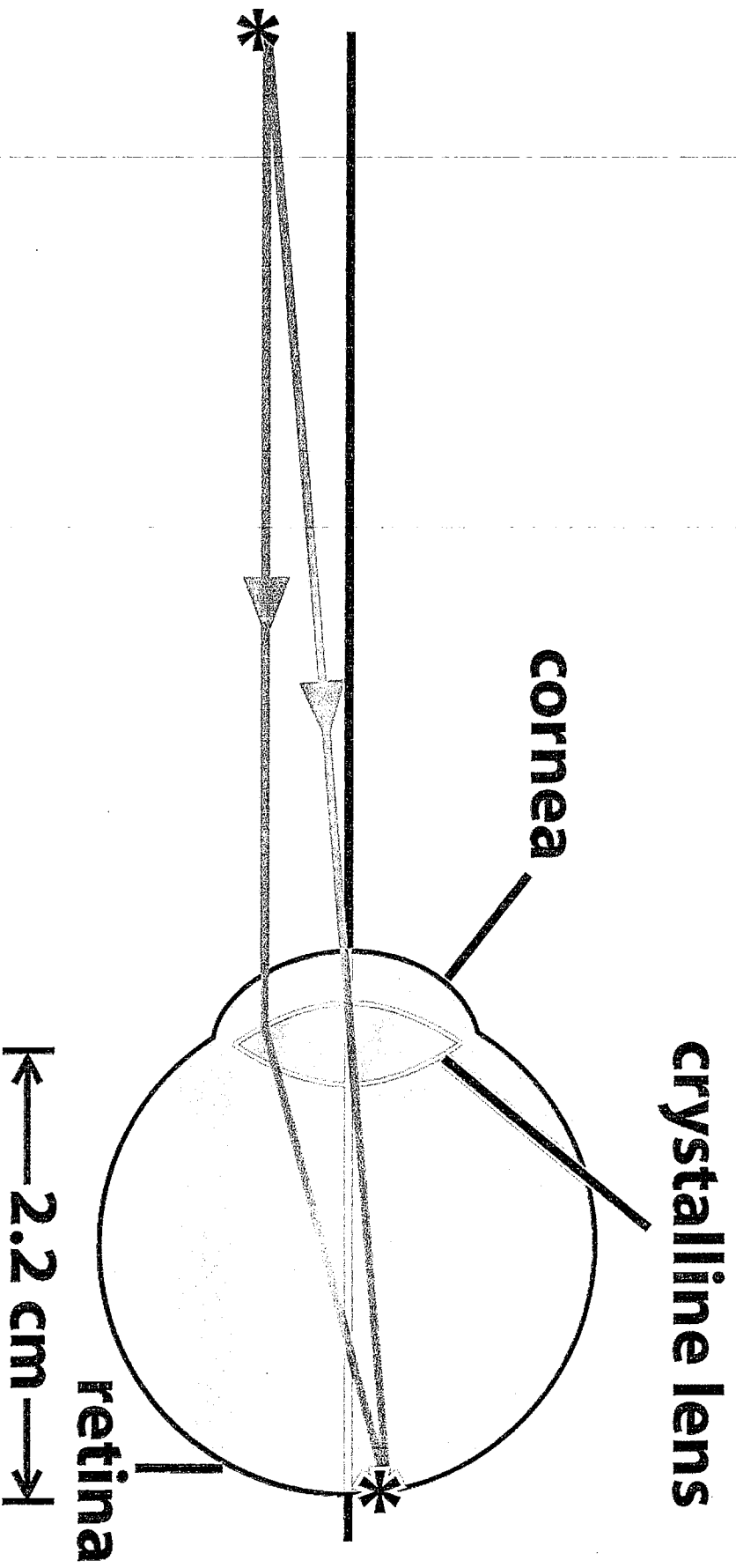
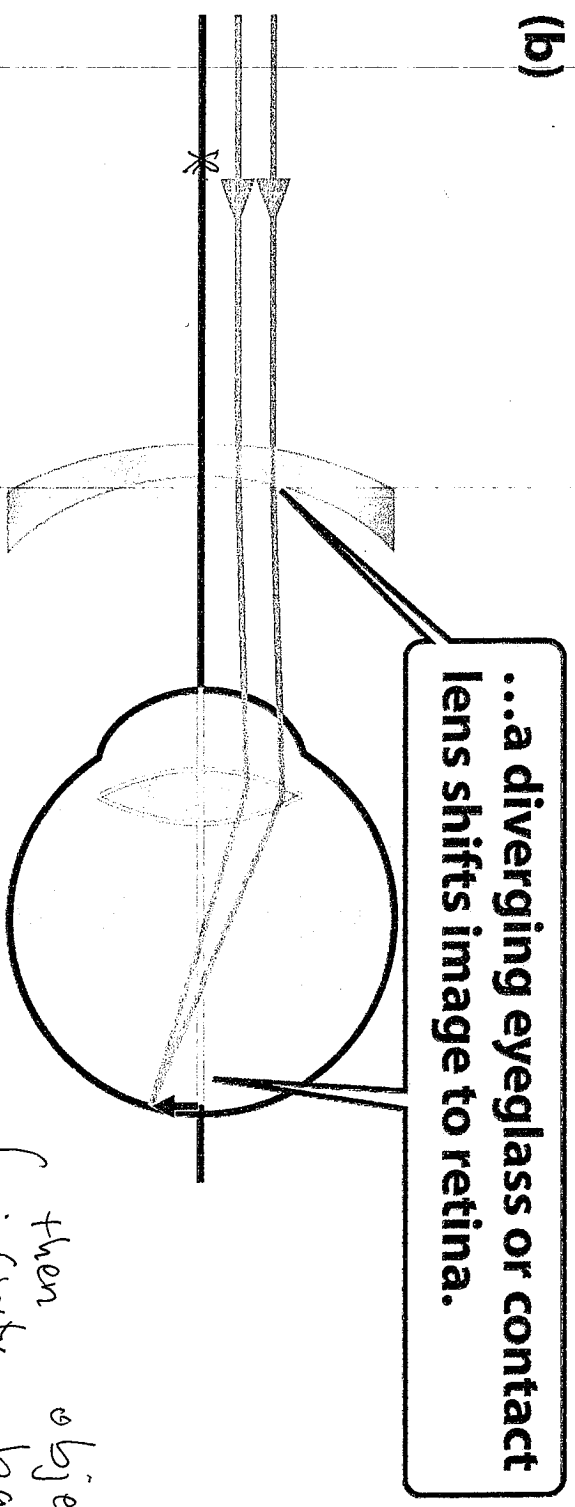
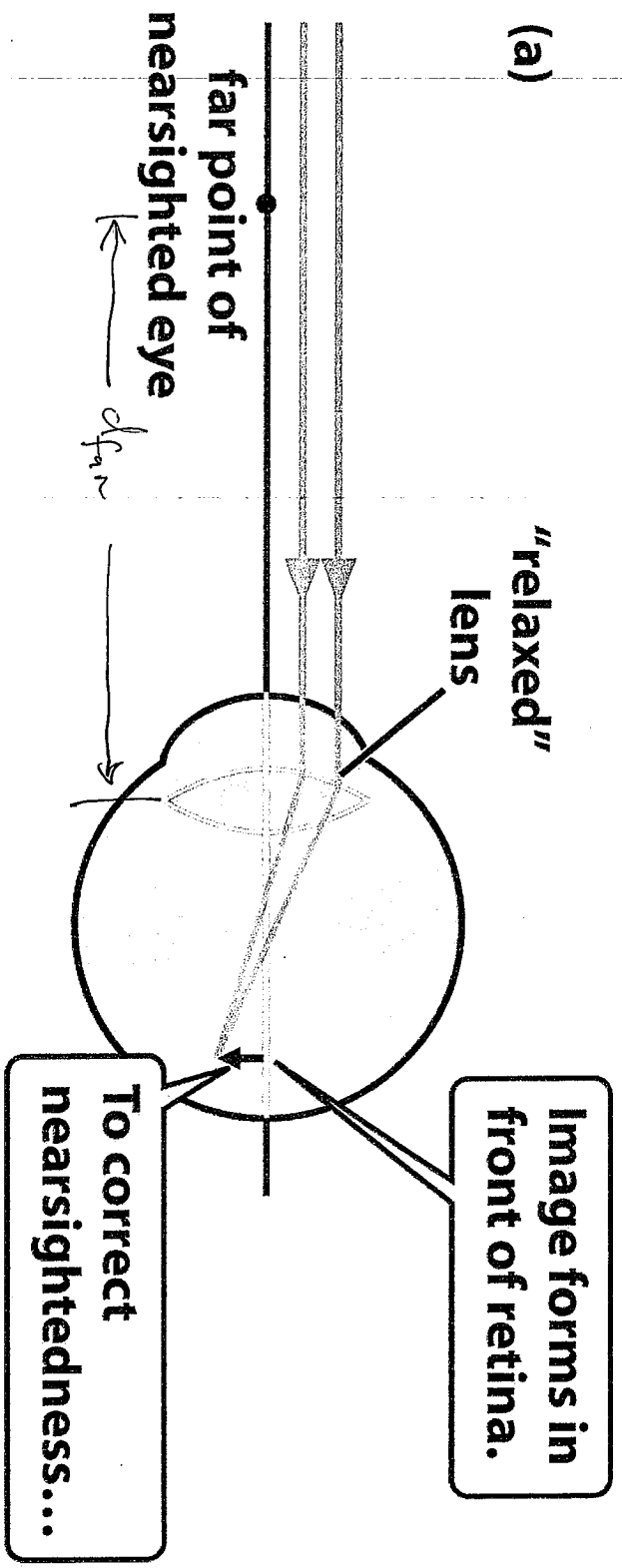


Figure 34-89 Physics for Engineers and Scientists 3/e
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Near sightedness



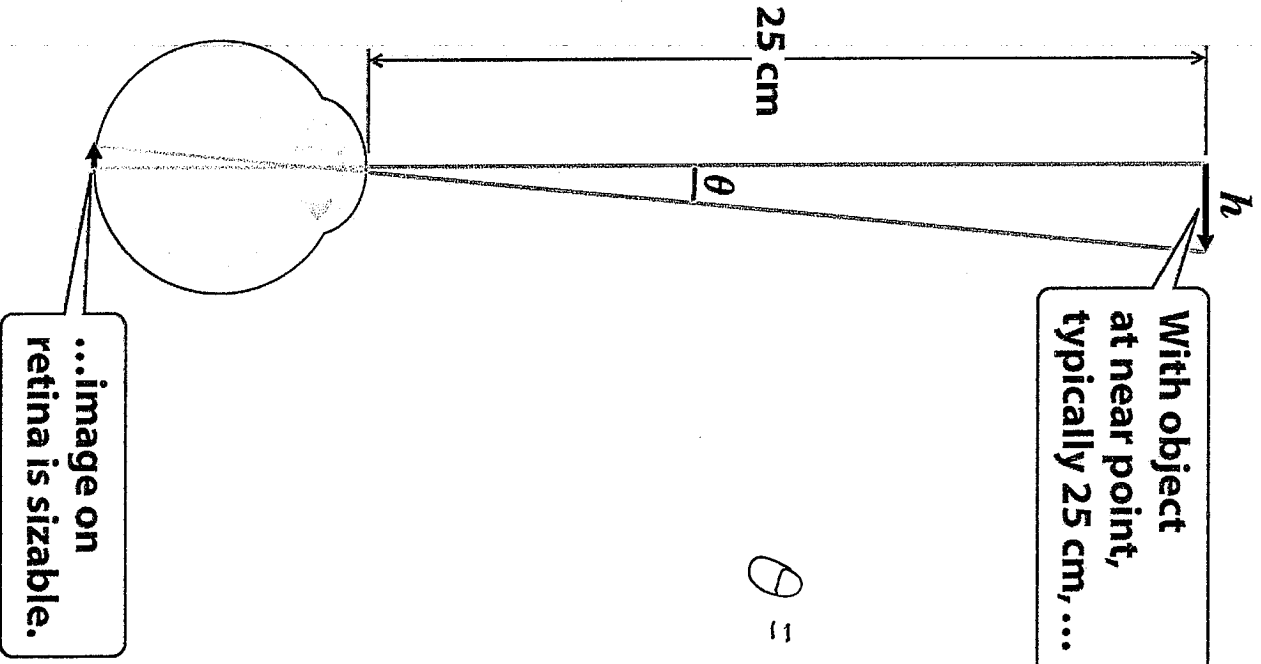
then objects at infinity have virtual image at eye's far point

$f_{lens} = -d_{far}$

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Natural Angular size of an object

With object at near point, typically 25 cm, ...



$$\theta = \frac{h}{25}$$

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Far sightedness

(a)

"contracted" lens

25 cm

object

near point greater than desired 25 cm of normal eye

To have normal near point

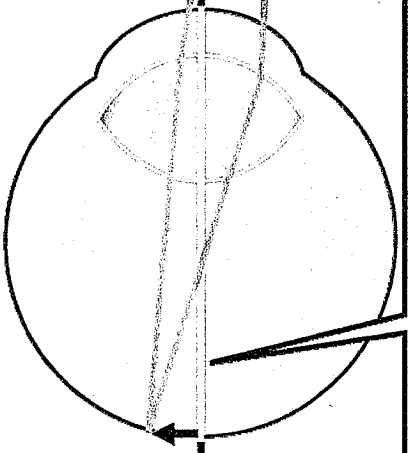
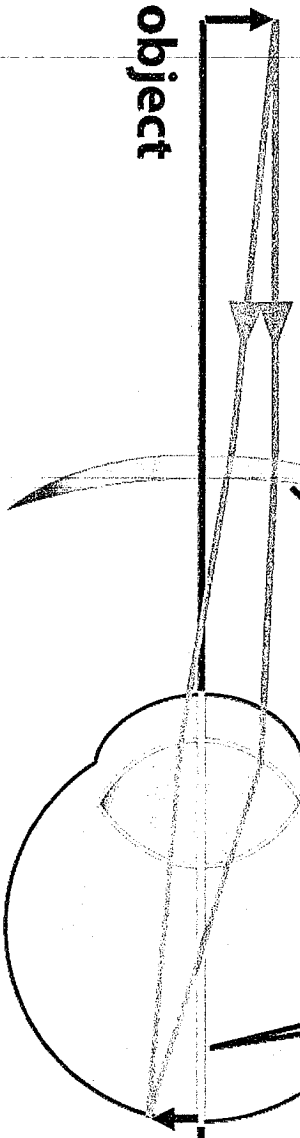
virtual image has to be at eye's near point

(b)

...a converging eyeglass or contact lens shifts image to retina.

Image forms behind retina.

To correct farsightedness...



$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$$

$$s = 25 \text{ cm}$$

$$s' = -s_{np}$$

$$\frac{1}{25} - \frac{1}{s_{np}} = \frac{1}{f}$$

$$f = (s_{np} - 25) / [25 \cdot s_{np}]$$

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