FERMILAB
ENGINEERING NOTE

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SUBJECT

Physics 2C 3/3

NAME

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(1) Some Hard Clickers

(2) 3 Situations w/ Lenses

(3) Lens Eq. & Magnification

(4) Lensmaker's Eq.

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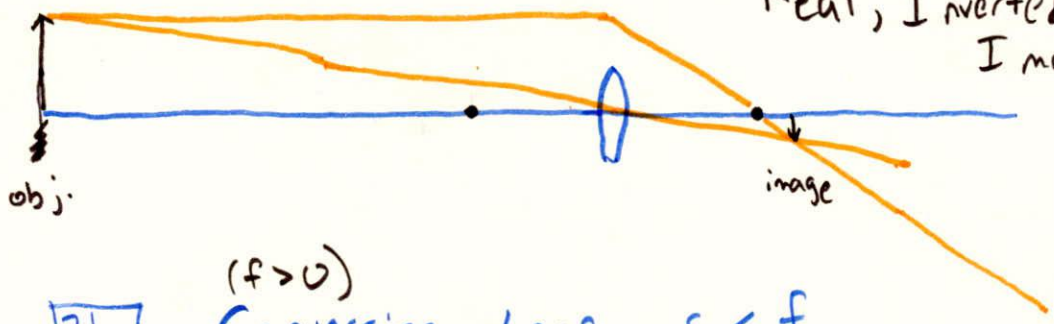
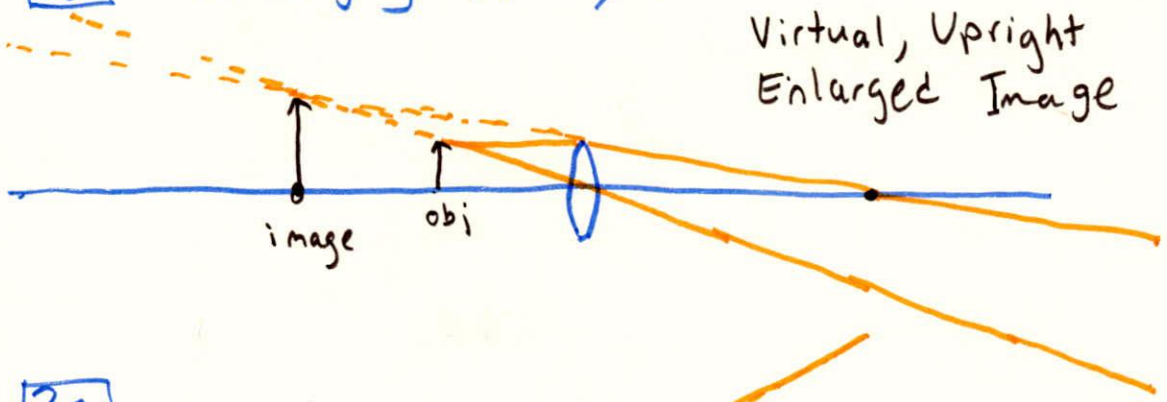
(2) 2a (f > 0) Converging Lens $s > f$

Real, Inverted Image (Reduced or Magnified or same)



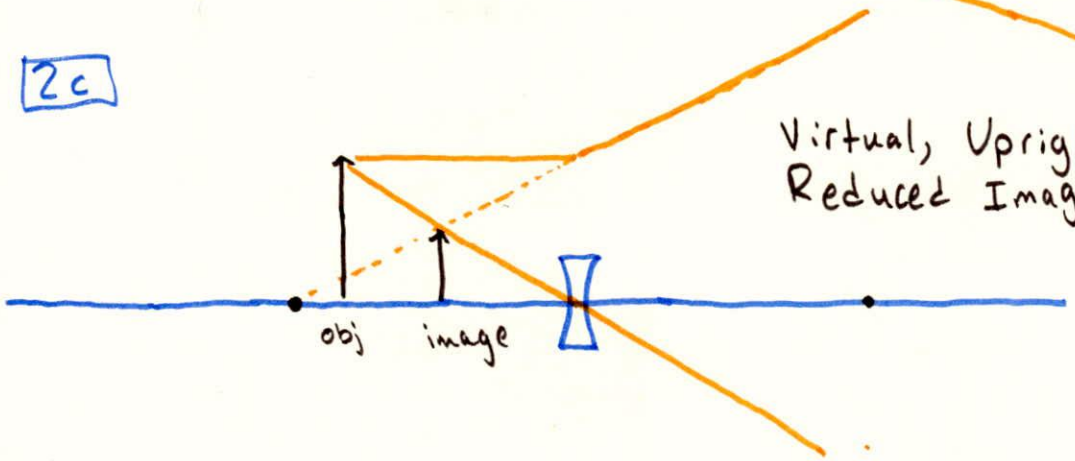
2b (f > 0) Converging Lens, $s < f$

Virtual, Upright Enlarged Image



2c

Virtual, Upright Reduced Image



(3) Two Eq:

Lens Eq.

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

$s > 0$ is obj. distance (obj. on left)

s' is image distance

f is focal length
* $f > 0$ converging
* $f < 0$ diverging

* $s' < 0$ if same side as obj. (left)
* $s' > 0$ if opp. side (right)

Magnification

$$m = \frac{-s'}{s}$$

* $m > 0 \Rightarrow$ upright
* $m < 0 \Rightarrow$ inverted
* $|m|$ size ratio of image w.r.t. obj.

What are allowed values if m for diverging lens

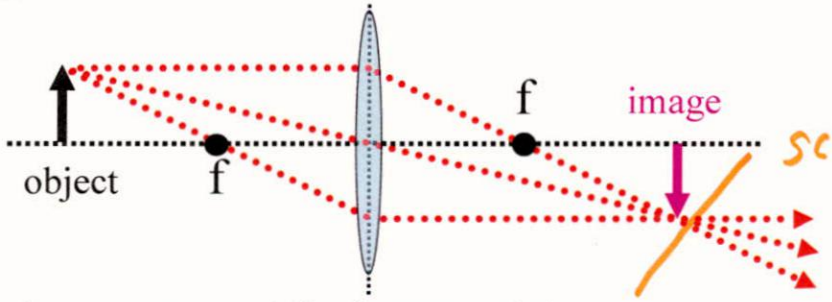
$$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f} \Rightarrow \frac{1}{s'} = \underbrace{\frac{1}{f}}_{(-)} \underbrace{-\frac{1}{s}}_{(-)} < -\frac{1}{s} < 0$$

$$\frac{1}{s'} < \frac{-1}{s} < 0$$

$$m_{div} = \frac{-s'}{s} = \frac{-1/s}{1/s'}$$

$$\boxed{1 > m_{div} > 0}$$

A lens is used to make an image; three light rays are drawn out of the infinite number coming from the arrowhead. The image given in this sketch could be seen:

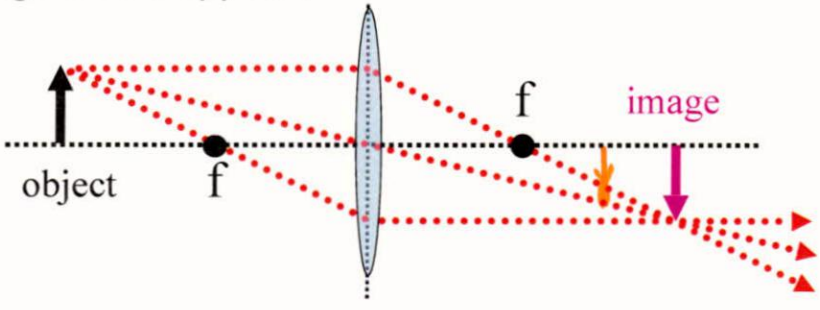


screen ✓

✓

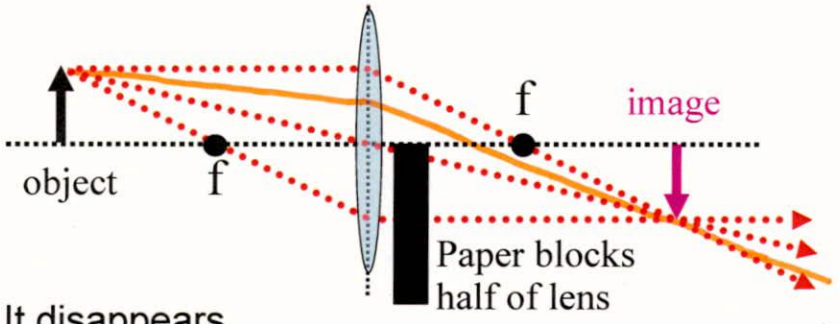
1. By placing a screen at the image point.
2. Without a screen by looking back at the lens.
3. By both techniques (1) and (2).
4. Only if the lens is big enough.
5. None of the above answers is 100% correct.

A screen is placed at the position of the image, and a "sharp" image appears on the screen. Next, Jennifer moves the screen a ***SHORT*** distance ***TOWARD*** the lens. The image would appear:



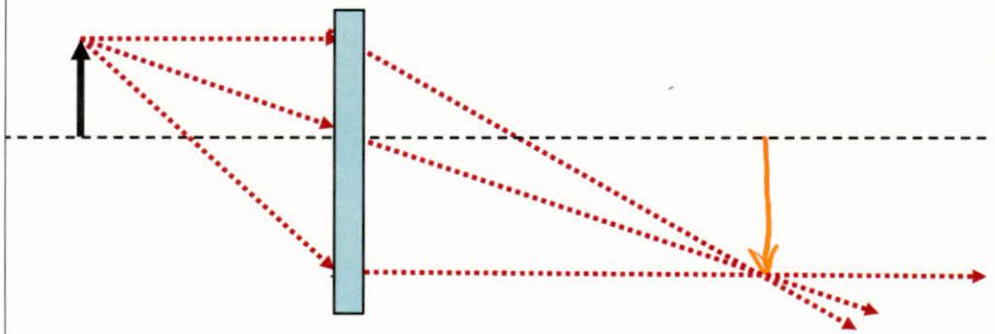
1. Smaller and "sharper".
2. Smaller and "fuzzier".
3. Larger and "sharper".
4. Larger and "fuzzier".
5. Would disappear.

Finally, Jennifer blocks half the lens, as shown, with a piece of paper. What happens to the image?



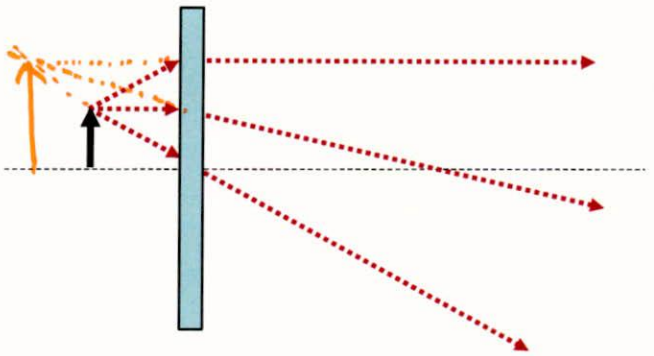
1. It disappears.
2. Only half of it is still seen
3. It looks the same, but gets ***slightly*** dimmer.
4. It gets fuzzy.
5. It depends on what part of the lens is blocked.

A lens has been hidden behind a blue curtain, but you've been given three light (red) rays used to construct an image. Your task is to determine the type of lens and the type of image.



1. Convex (converging) lens, real image
2. Convex (converging) lens, virtual image
3. Concave (diverging) lens, real image
4. Concave (diverging) lens, virtual image

For the figure below, determine the lens and type of image.



1. Convex (converging) lens, real image
2. Convex (converging) lens, virtual image
3. Concave (diverging) lens, real image
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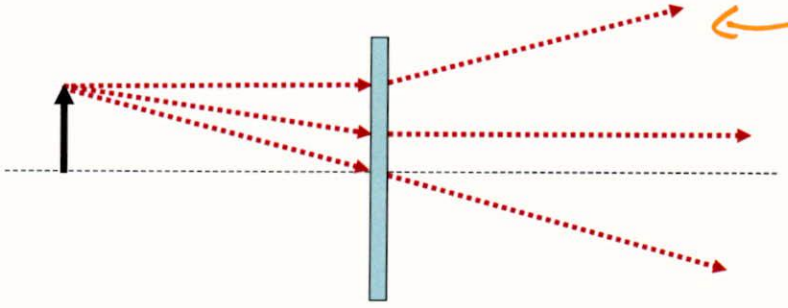
demo website

For the figure below, determine the lens and type of image.



clearly diverging when looking at horizontal principal ray

1. Convex (converging) lens, real image
2. Convex (converging) lens, virtual image
3. Concave (diverging) lens, real image
4. Concave (diverging) lens, virtual image

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④ Lensmakers

Converging

(Double) - Convex

Plano - Convex

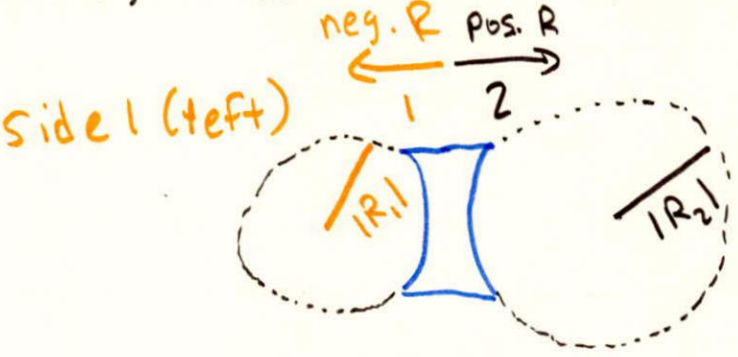
Convex - Meniscus

Diverging

(Double) - Concave

Plano - Concave

Concave - Meniscus



side 2 (right

for this example,
$R_1 < 0$
$R_2 > 0$

Lensmakers Eq.

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

0 < m < 1 for diverging

Suppose a lens produces an image with m=+2.0 when an object is 15 cm from the lens.

(a) What kind of lens is this?
(b) What's the focal length of the lens?
(c) Draw a ray diagram of the situation.

(a) Converging

$m = -\frac{s'}{s} = +2.0$

(b) $\frac{1}{f} = \frac{1}{s} + \frac{1}{s'}$

$s' = -30\ cm$

$\frac{1}{15cm} - \frac{1}{30cm} = \frac{1}{30cm}$

$f = 30cm$

c)