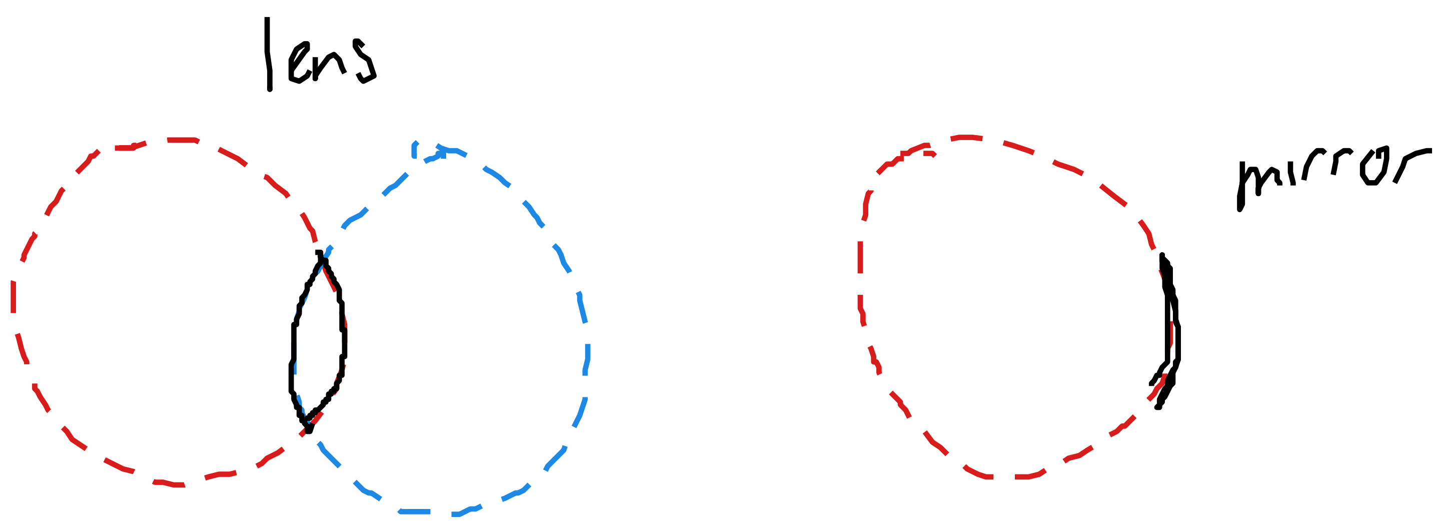
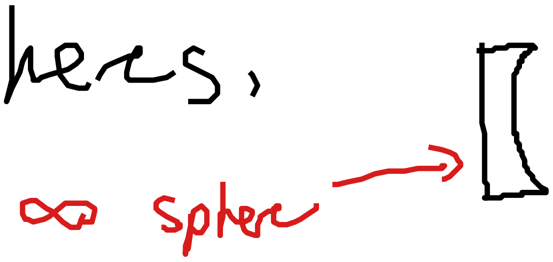
Lenses & Mirrors "Devices"

Thin Spherical Devices

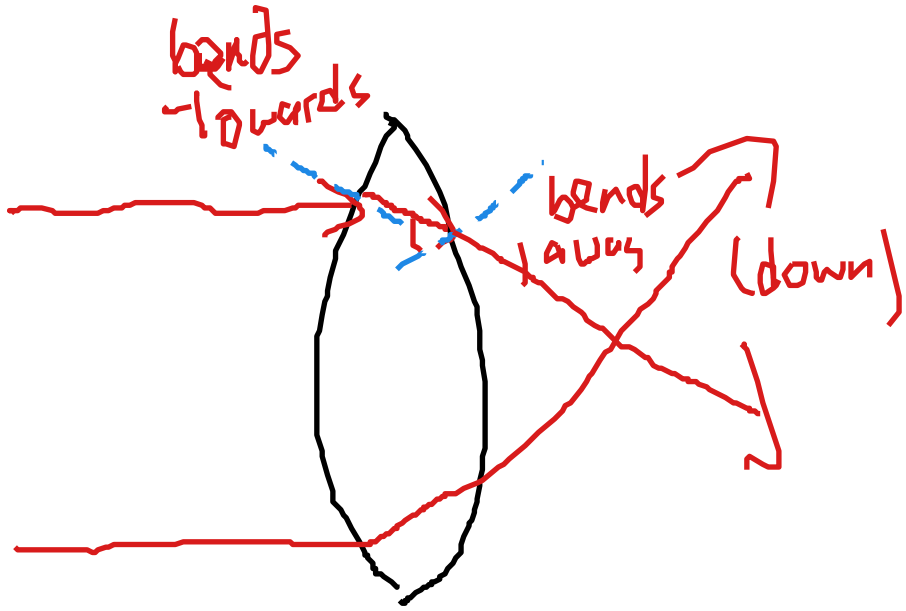
- spherical: surfaces are parts of a sphere



- thin: width of device is much smaller than radii of the spheres.

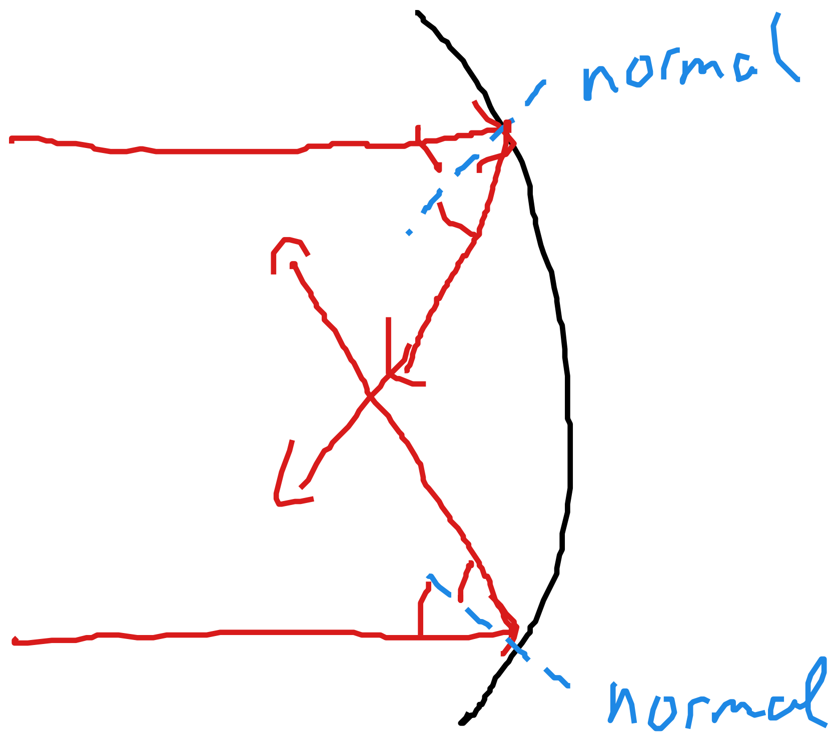


Lenses have two surfaces



Uses Snell's Law

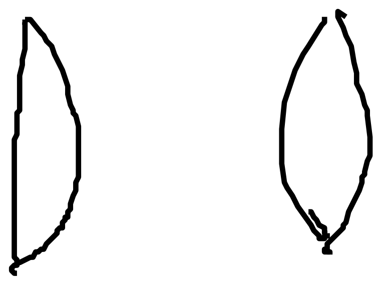
Mirrors: have one surface



Uses Law of Reflection

In both cases, parallel rays end up converging

Converging Devices

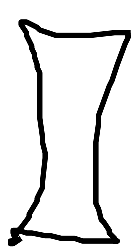


convex lens

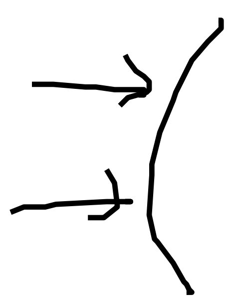
concave mirror

make rays converge or diverge less

Diverging Devices



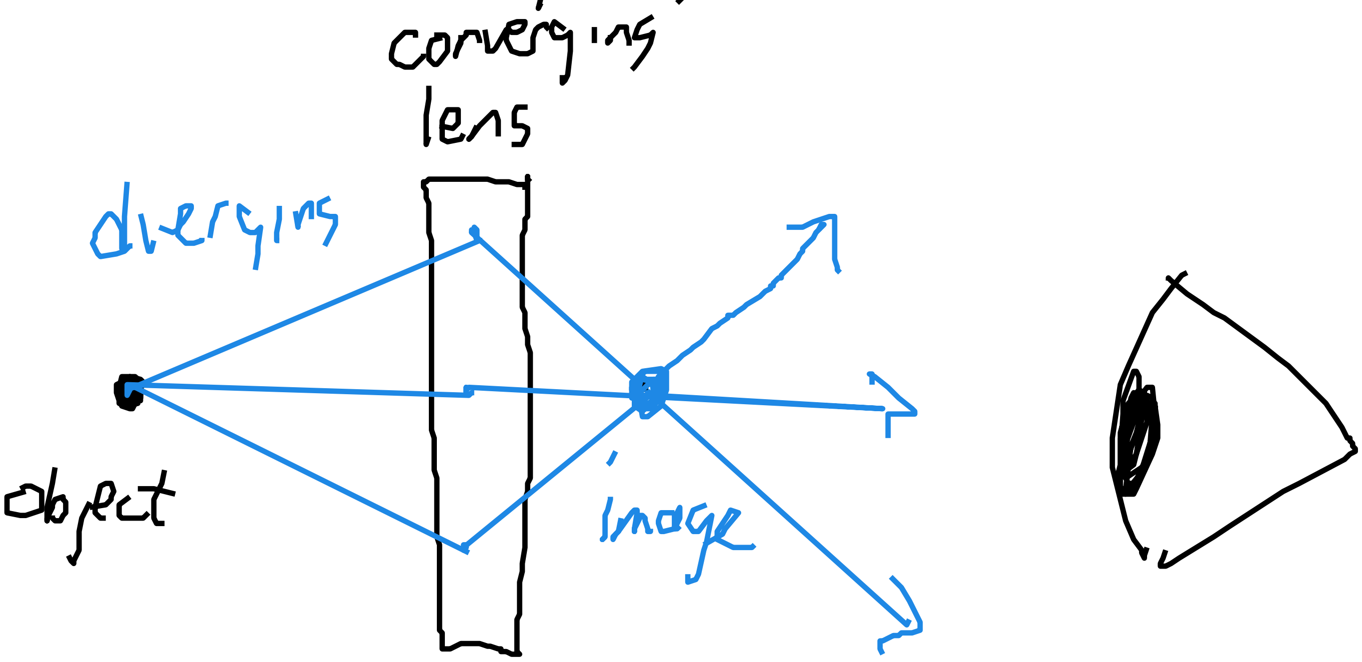
concave lens



convex mirror

make rays diverge or converge less

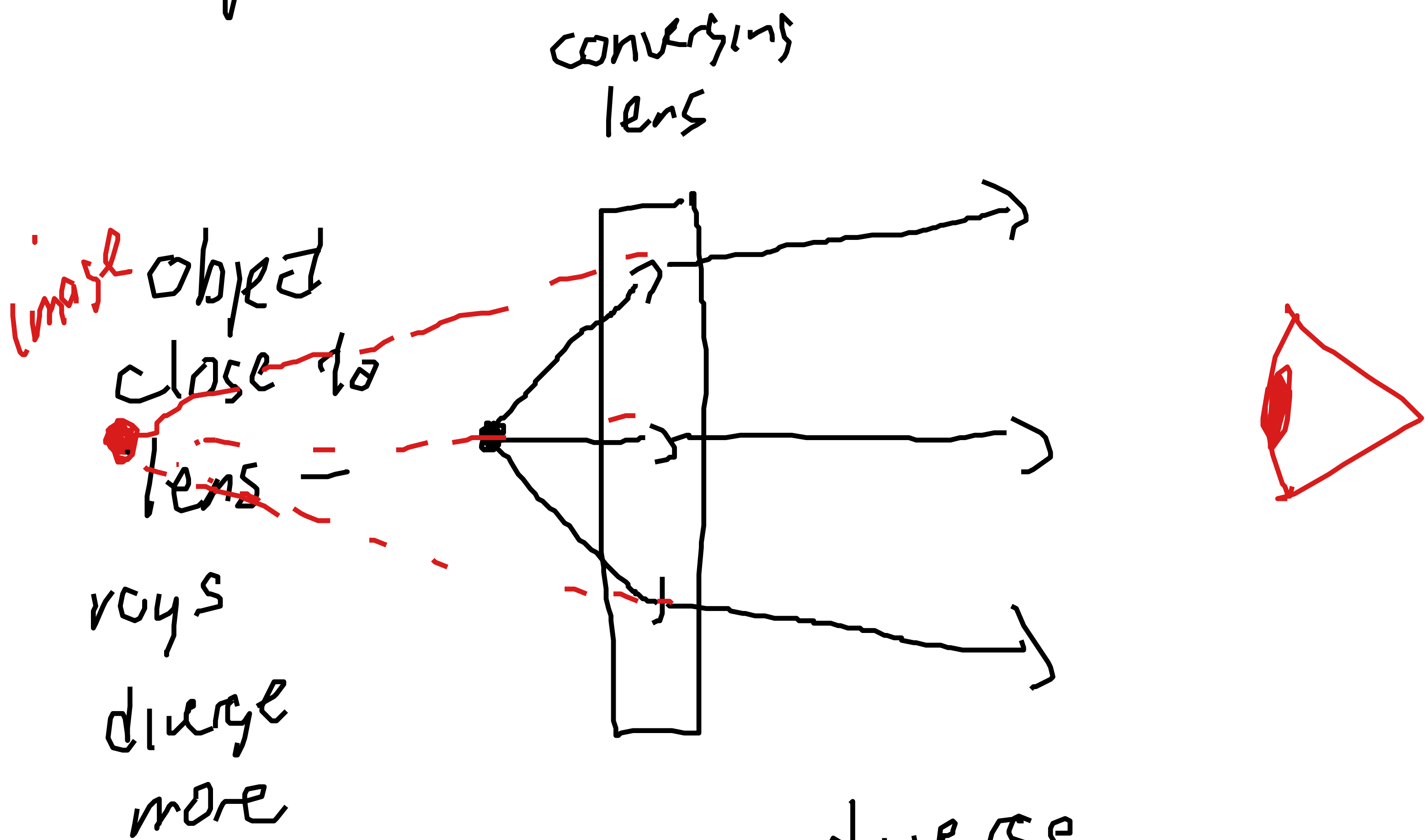
Converging Devices



real image - rays of light really did pass through image

- Real Images are inverted

- Real Images can be projected onto a screen, film, retina, etc.

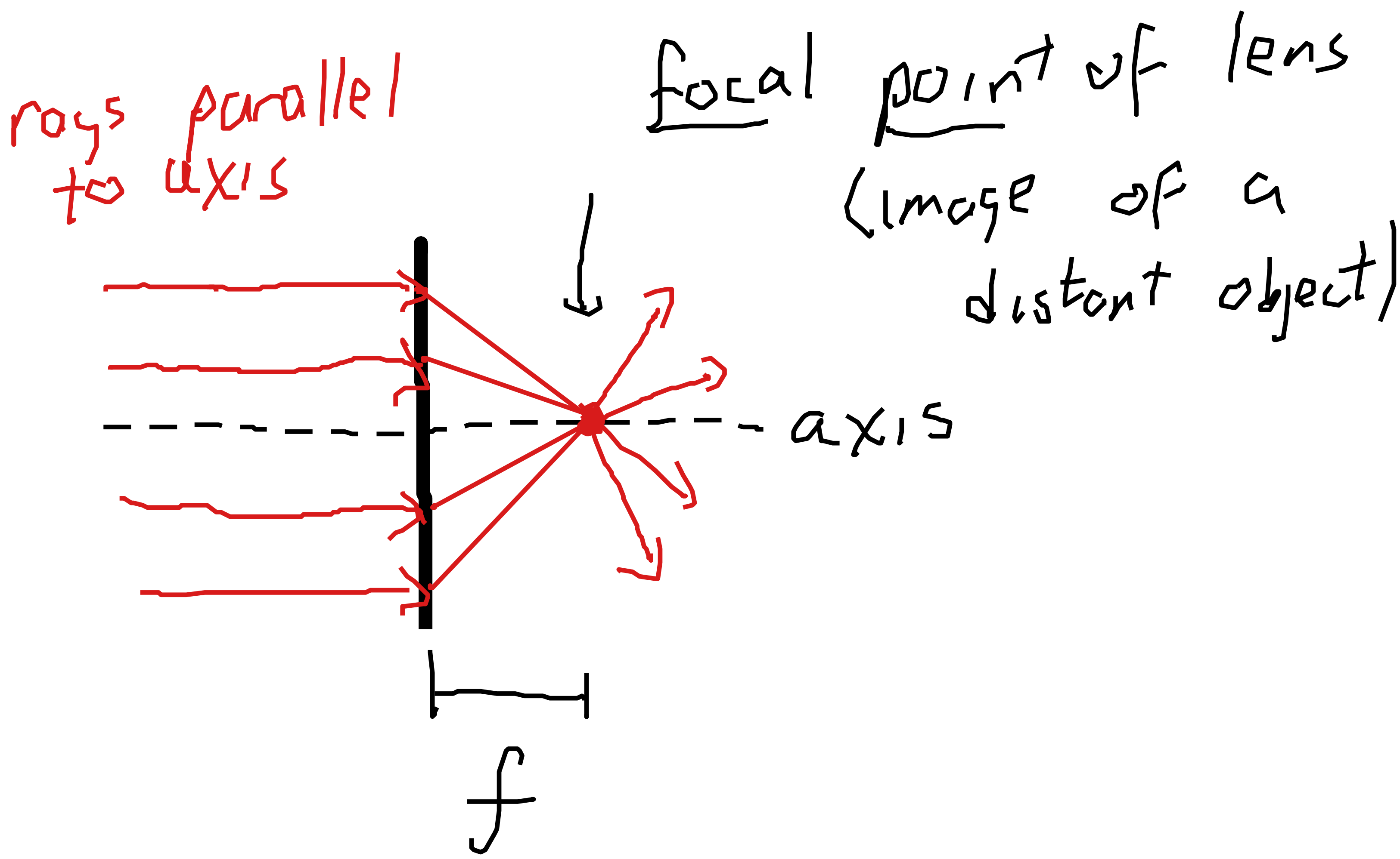


diverge less - creates a virtual image (right side up)

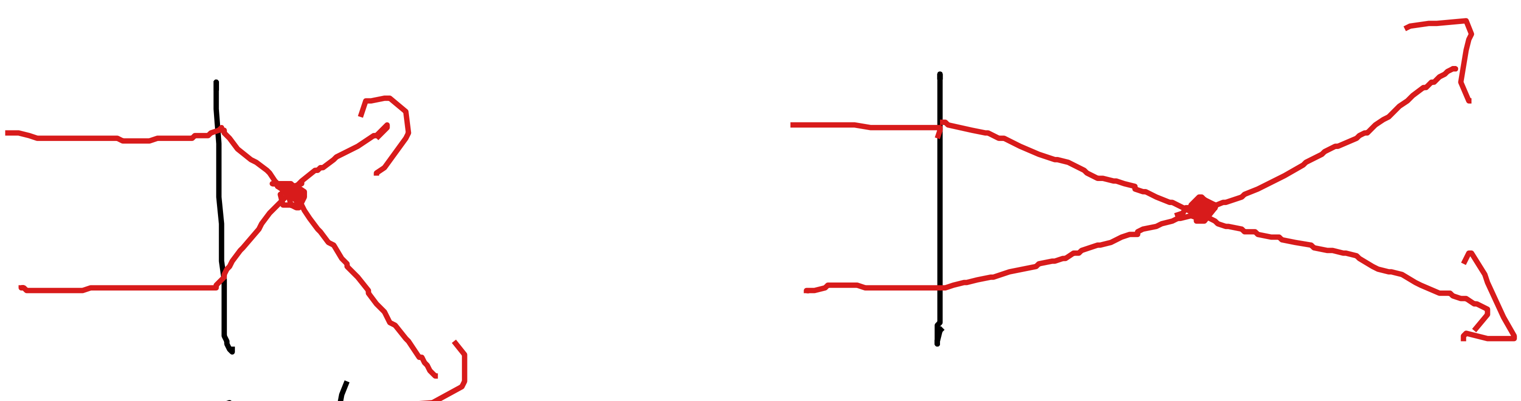
object close to lens, rays diverge more

Converging Devices

create real and virtual images



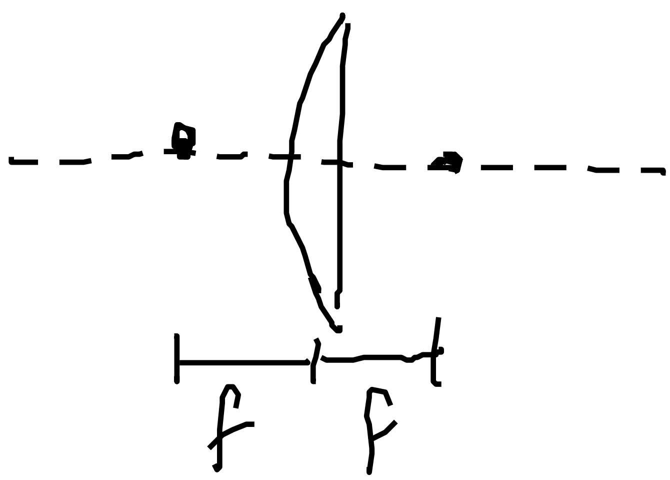
focal length of lens



stronger lens – shorter f

Strength of lens' $1/f$

Lenses have two symmetric focal points



Mirrors have one on the concave side

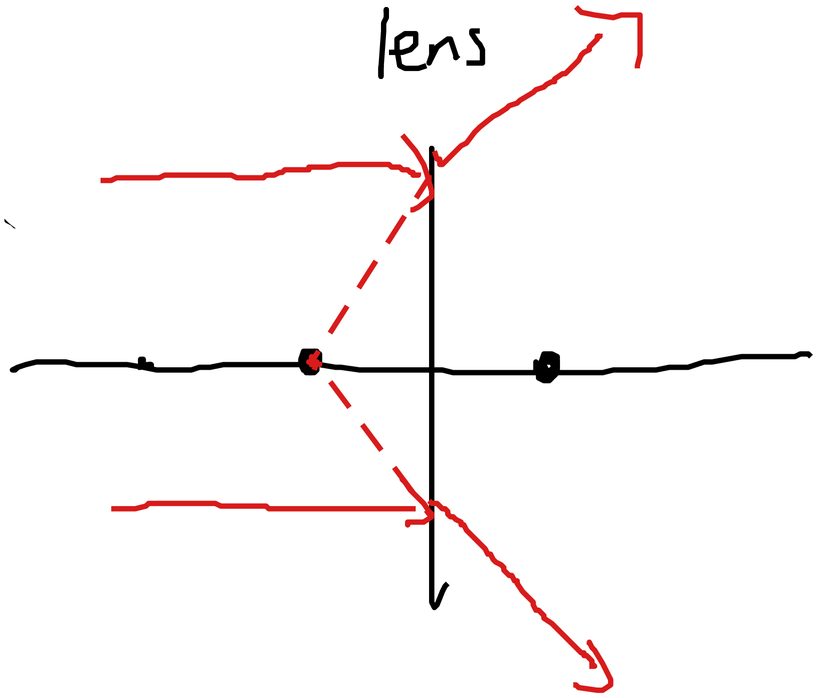
Object outside of focal length? Converging device creates a real image

Inside focal length? It creates a virtual image.

(See Demo on class website — it's fun!)

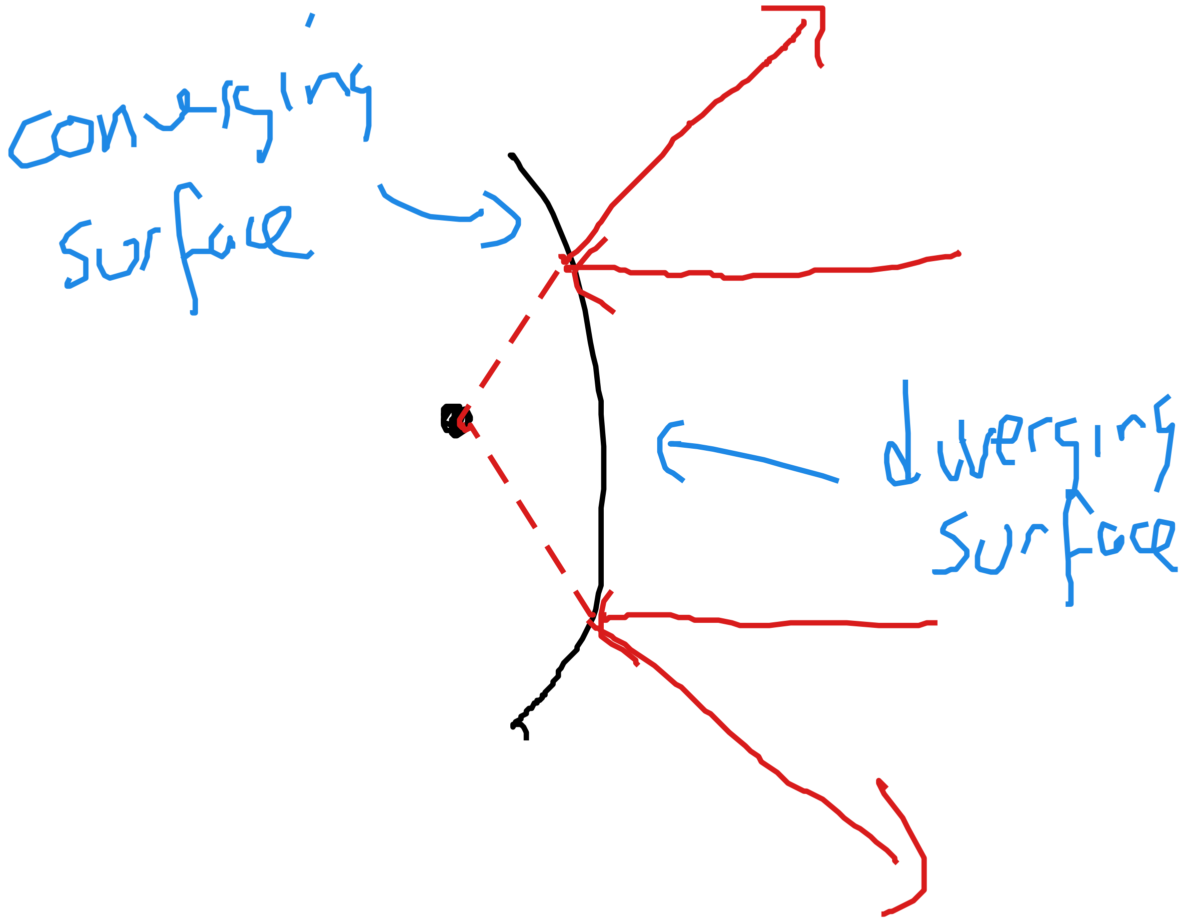
Diverging Devices

make rays diverge more



focal points are reversed

focal lengths f of diverging devices are usually given as negative numbers $f = -20cm$


converging
surface
diverging
surface

Lens or Mirror Equation

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

d_o: object-to-device distance

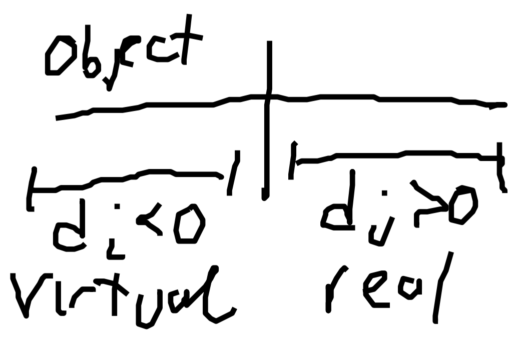
$$d_o > 0$$

d_i: image-to-device distance

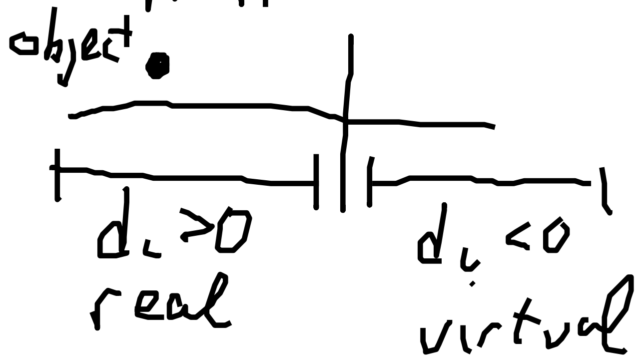
$d_i > 0$: real image

$d_i < 0$: virtual image

lens



mirror



f : focal length

$f > 0$ converging

$f < 0$ diverging

Magnification

$$M = \frac{h_i}{h_o} = -\frac{d_i}{d_o}$$

$m > 0$: upright

$m < 0$: inverted