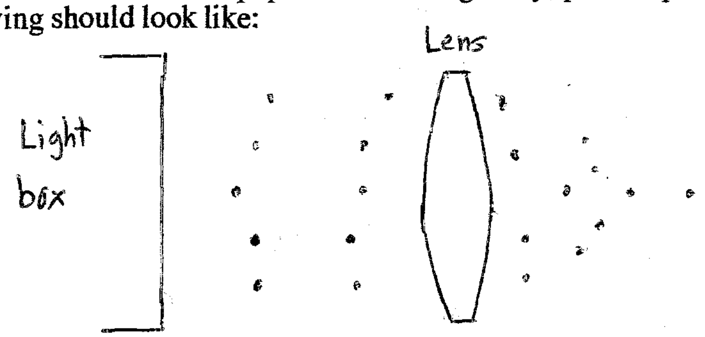
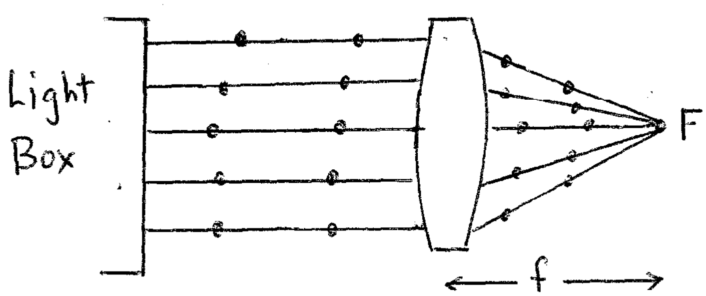
RAY TRACING

Bring small ruler (with cm scale), protractor and soft pencils to class.
APPARATUS: Light box, lens, mirrors, prisms
OBJECTIVE: To use ray tracing to determine the focal lengths of lens and mirrors visually; to sutdy “total internal reflection”; to determine critical angle for glass.
CONVEX LENS:

Place the light box and convex lens on a sheet of paper on the table. Turn down the lights in the room. You should see the “light rays” (bright lines) clearly shining on the paper. Use 5 light rays. Make sure that the center ray pass through the center of the lens. Draw the outlines of the light box and the convex lens on paper. For each light ray, place a pair of dots at some distance apart. Your drawing should look like:

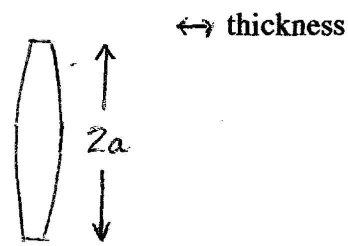


Remove the light box and the lens. Use your ruler to connect each pair of dots into a straight line. This is your “RAY TRACING” and should be submitted as one of your “data sheets”:



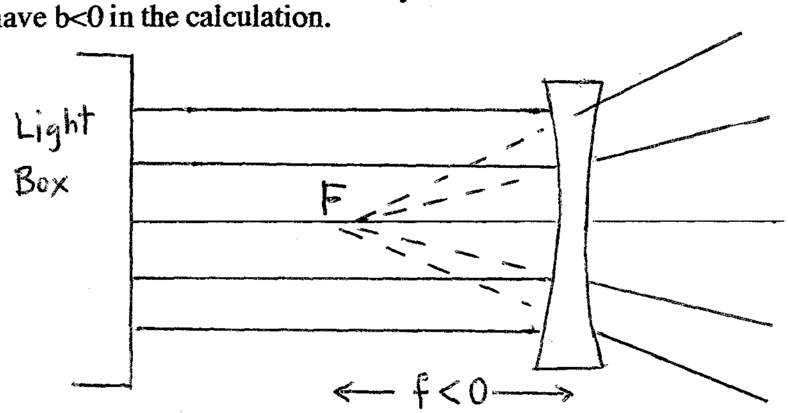
On the right side, all rays converge (intersect) at the common point F known as the “focal point” or “focus”. The distance between the point F and the lens is defined as the “focal length” f. Measure and record this distance f and compare wth the theoretical value:

$$f = \frac{a^2}{2b(n-1)} \text{ for lens}$$



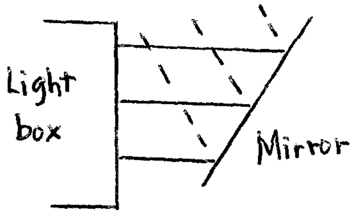
a=radius of lens (in cm)
b=bulge (in cm)=(center thickness)–(edge thickness)
(b is positive for convex lens as shown)
n=refractive index of plastic (typically, n=1.5)

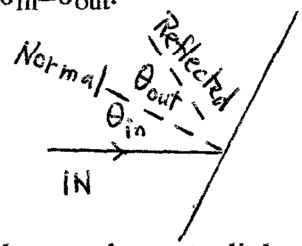
CONCAVE LENS: The “ray tracing” is obtained the same way. On the right side, the ray diverges and is extended toward the left by dashed lines to meet at the focal point F. We have $f<0$. We also have $b<0$ in the calculation.



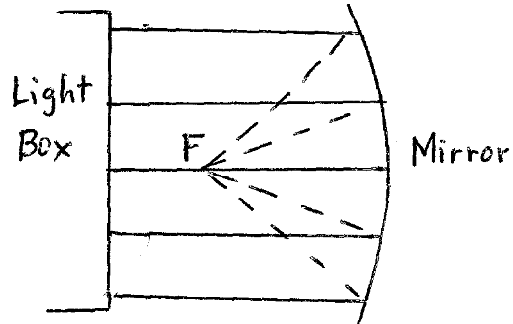
MIRRORS: Draw reflected rays as dashed lines to avoid confusion.

PLANE MIRROR: Draw the normal (perpendicular line) to the mirror. Use protractor to measure the angles θ_{in} and θ_{out}. Verify the relation $\theta_{in}=\theta_{out}$.



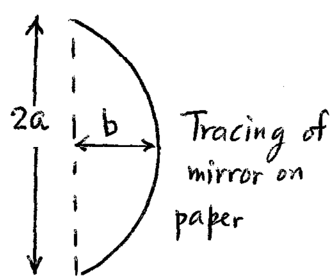


CONCAVE MIRROR: Use 5 light rays. Make sure the center lighr ray hits the center of the mirror. The reflected rays converge at the common point F known as the "focus" or "focal point". Measure the distance f from F to the mirror. This distance f is known as the fccal length.

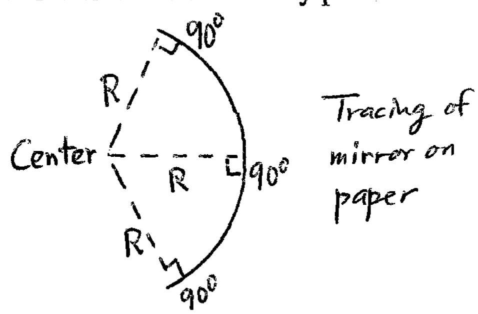


Compare your experimental value of f with theoretical value f=R/2, where R is the radius of curvature of the mirror. Trace the mirror on paper. This trace has the shape of an arc. R can be detrmined by either method:

$R=a^2/(2b)$



Dashed lines are normals (perndicular at 90^o to) to mirror. All dashed lines intersect at the center. R is the distance from the center to any point on the mirror.



CONVEX MIRROR: The reflected rays diverge from mirror.The reflected beams should be extended to meet at the focal point F. The focal length f is negative.