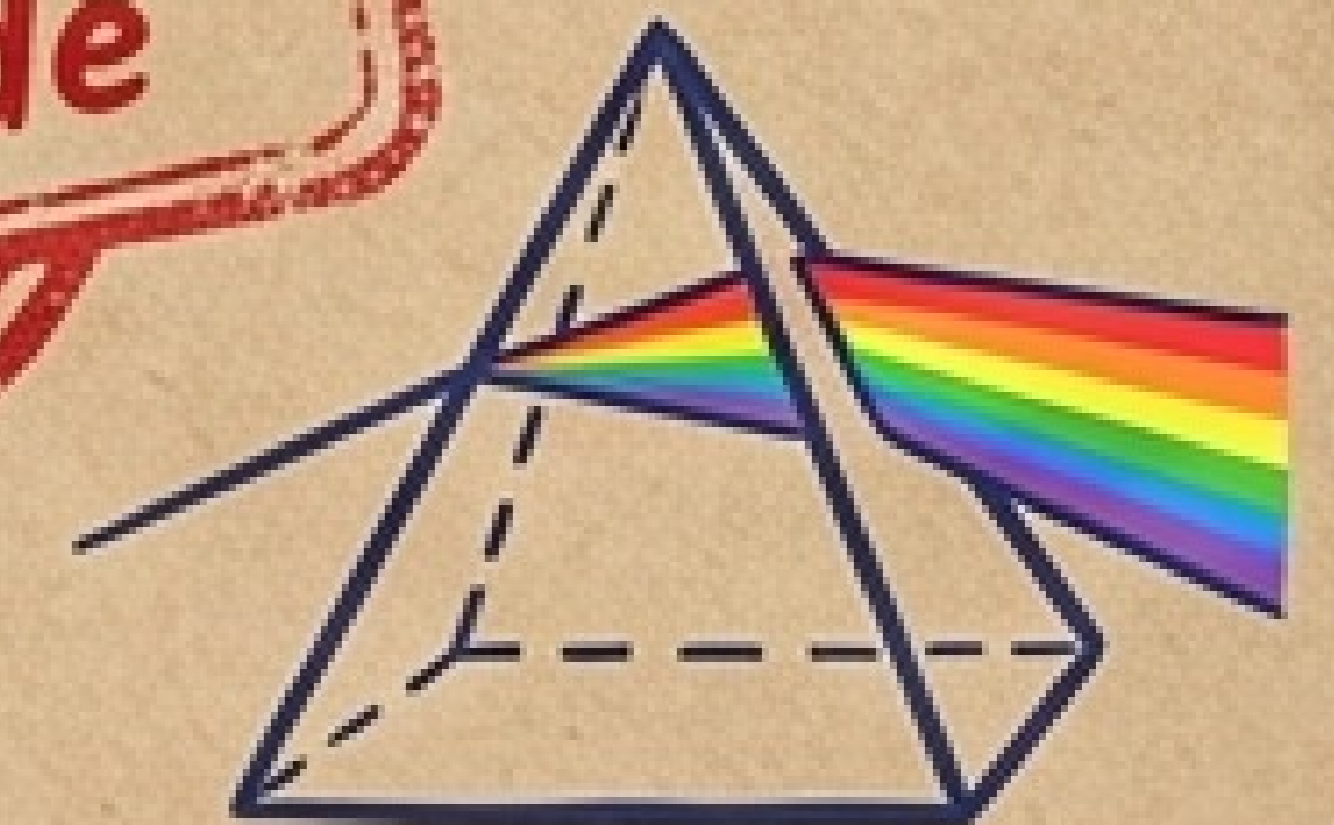
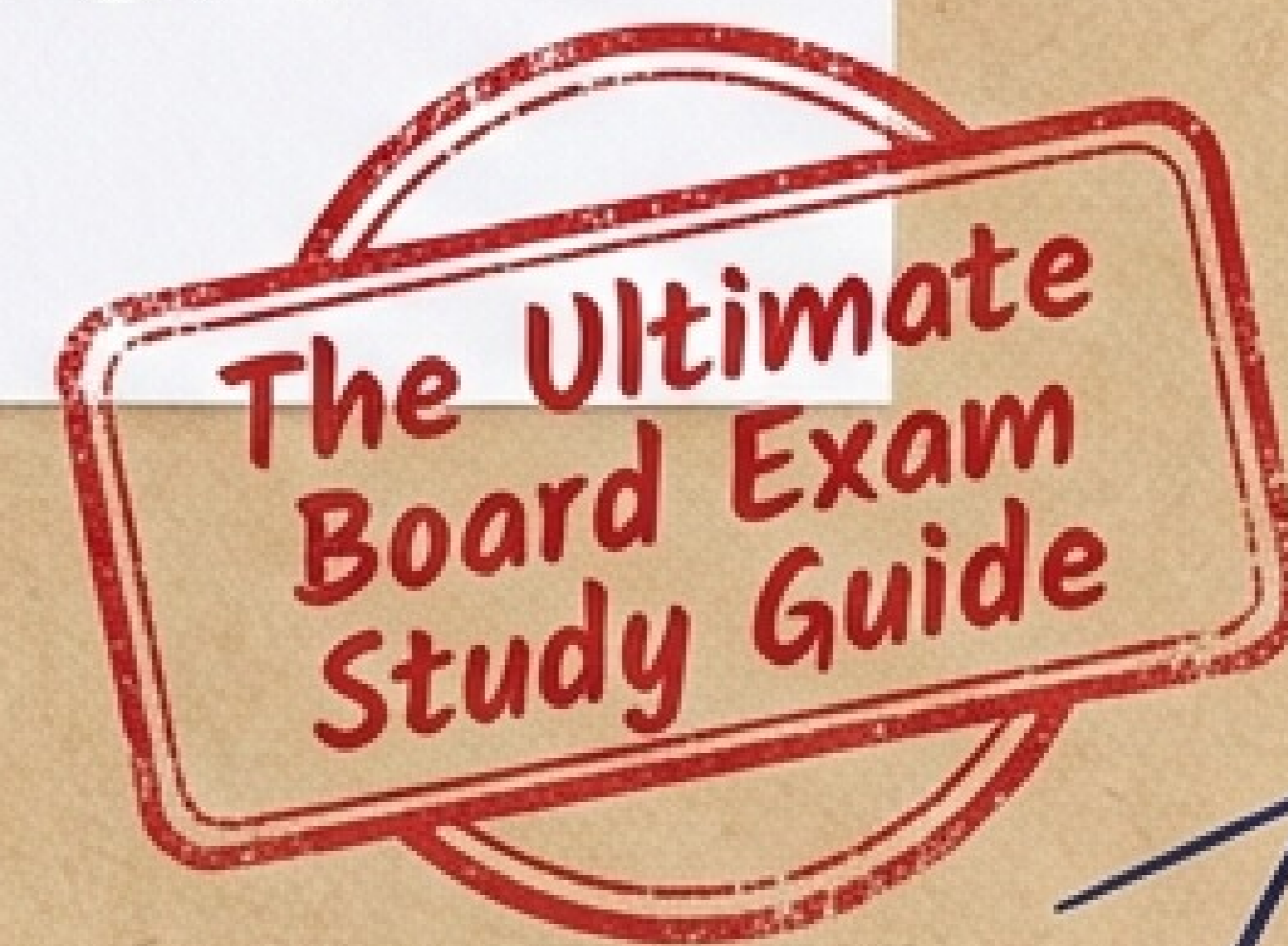
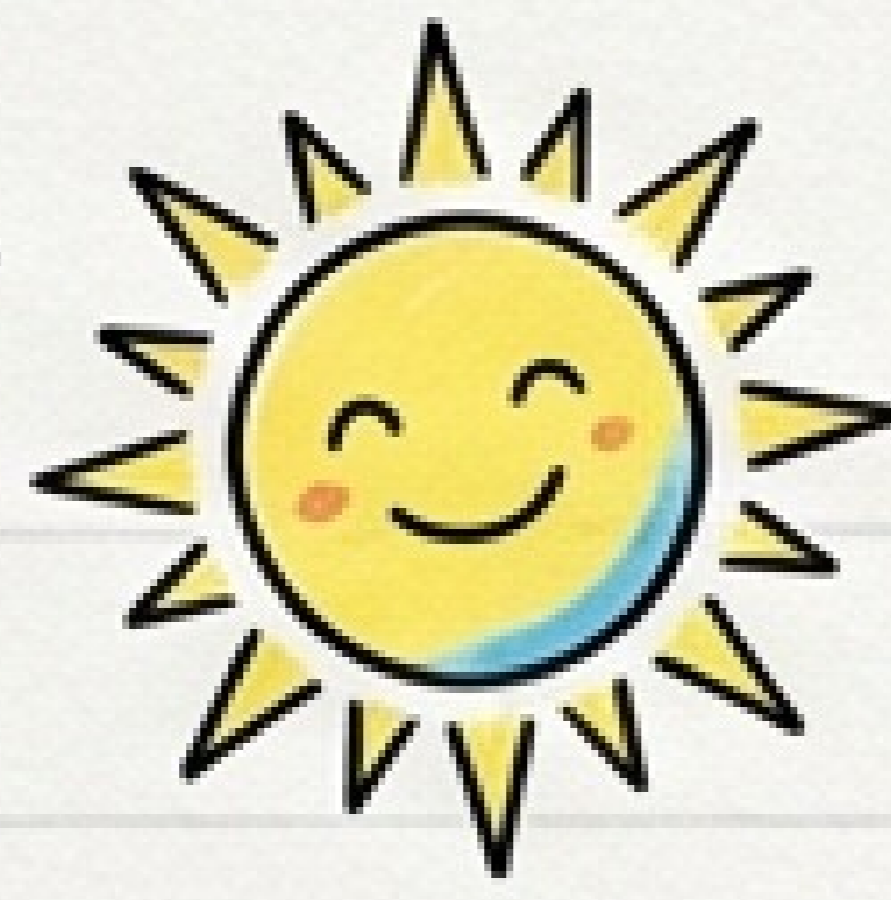




Chapter 10: Light
Reflection & Refraction



Natural Source



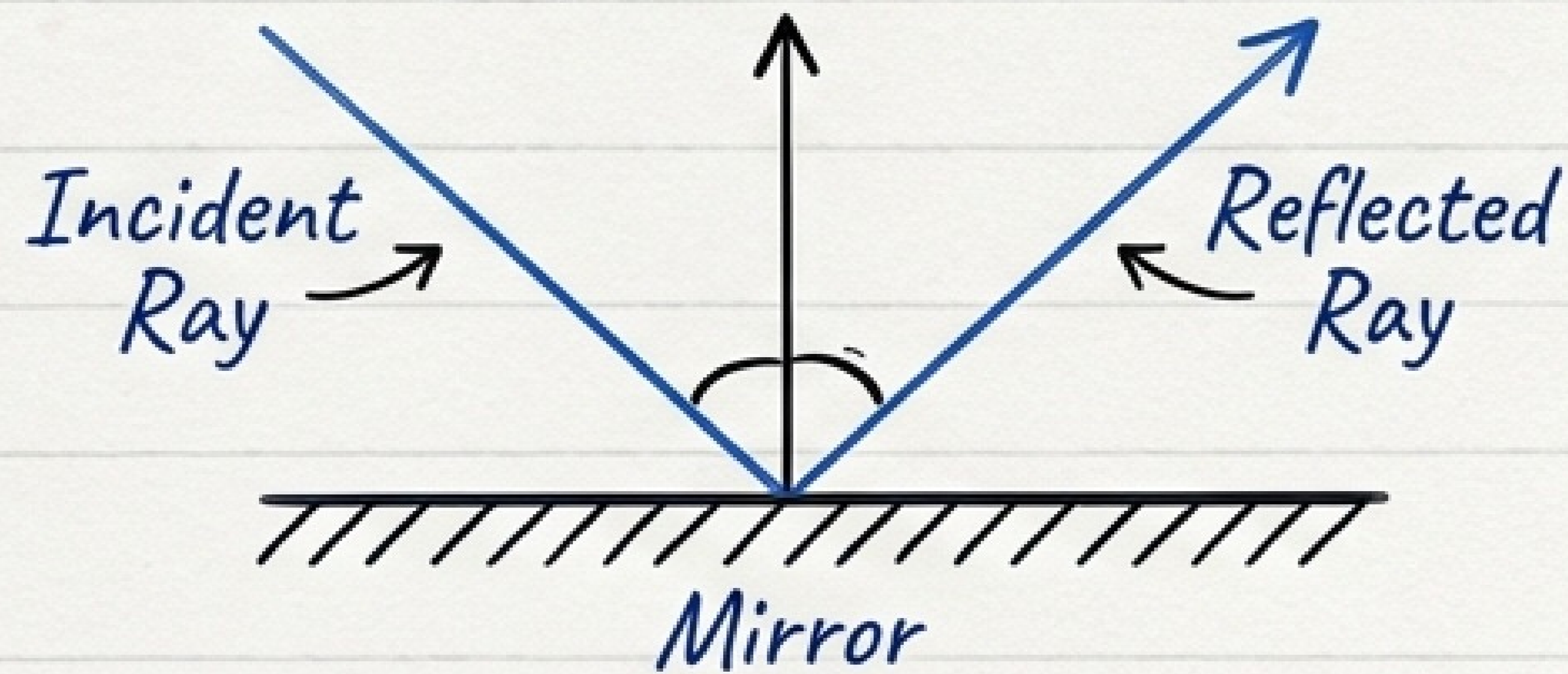
What is Light?



Artificial Source

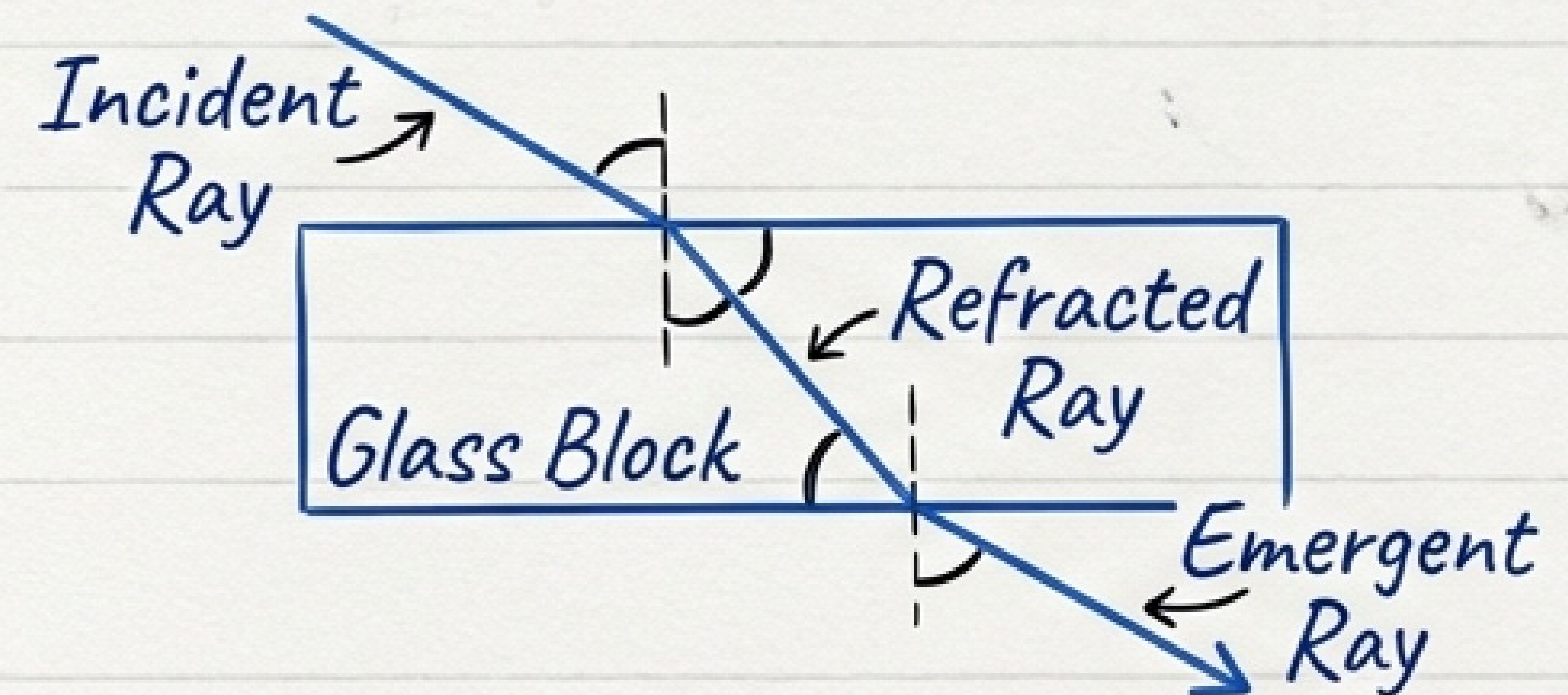
A form of energy that helps us see objects in the dark.

Property 1: Reflection (The Bounce)



Light bounces back from a smooth surface.

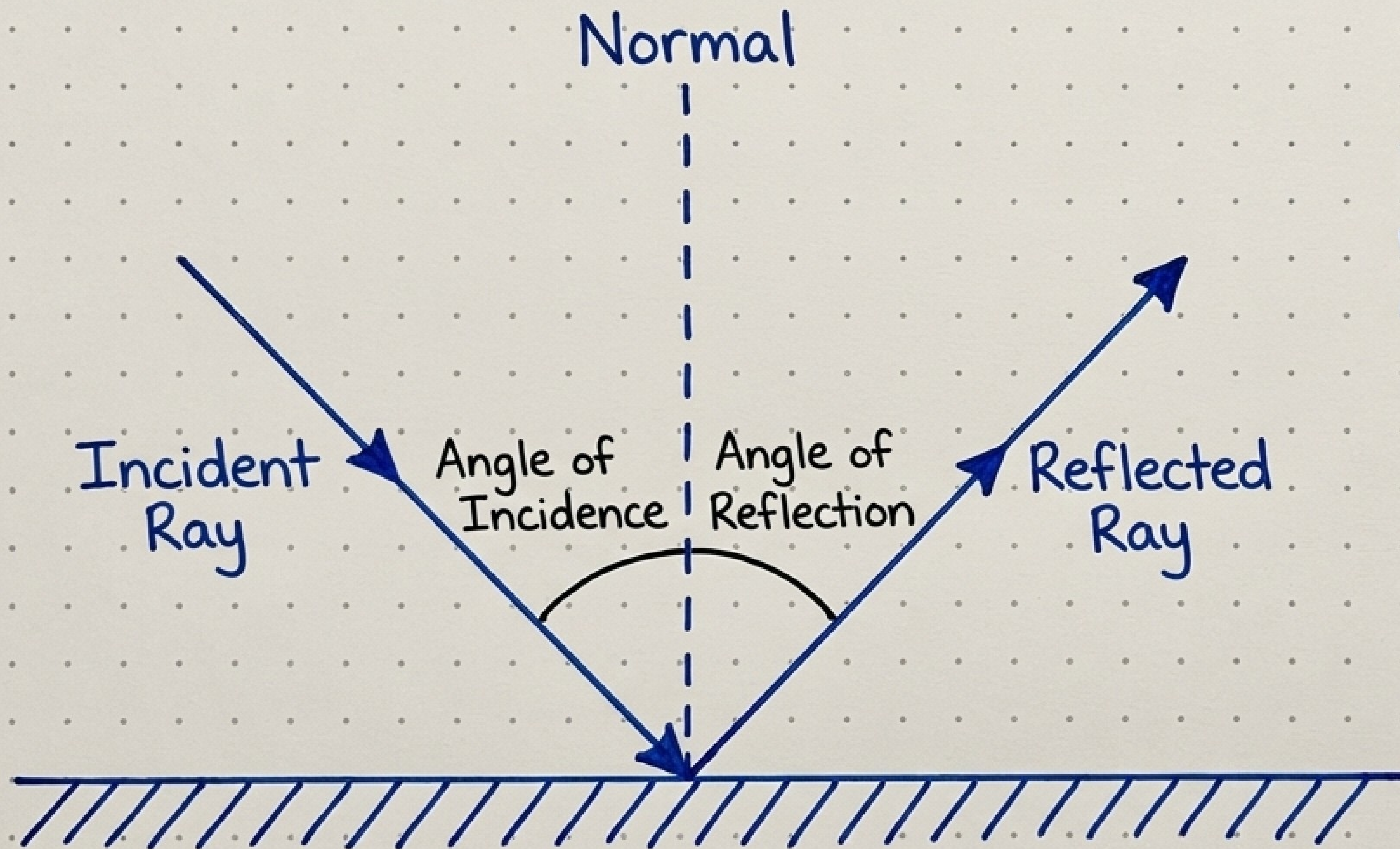
Property 2: Refraction (The Bend)



Light bends when entering a new medium (like glass or water).

These 2 properties explain **EVERYTHING**: twinkling stars, rainbows, and how your glasses work!

The Laws of Reflection



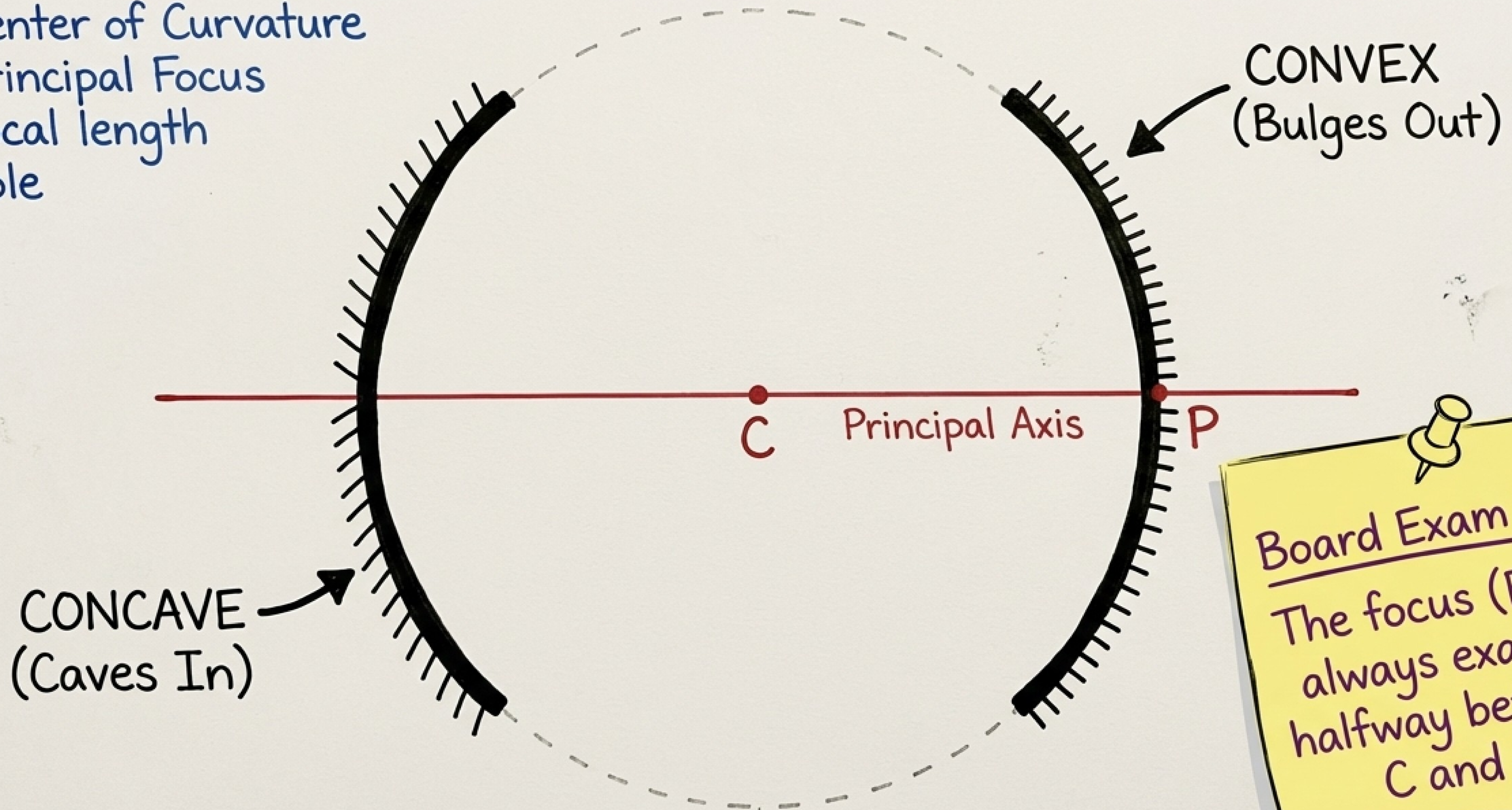
Rule 1: Angle of Incidence (i) = Angle of Reflection (r)

$$i = r$$

Rule 2: The incident ray, reflected ray, and the normal all lie in the SAME plane.

Anatomy of Spherical Mirrors

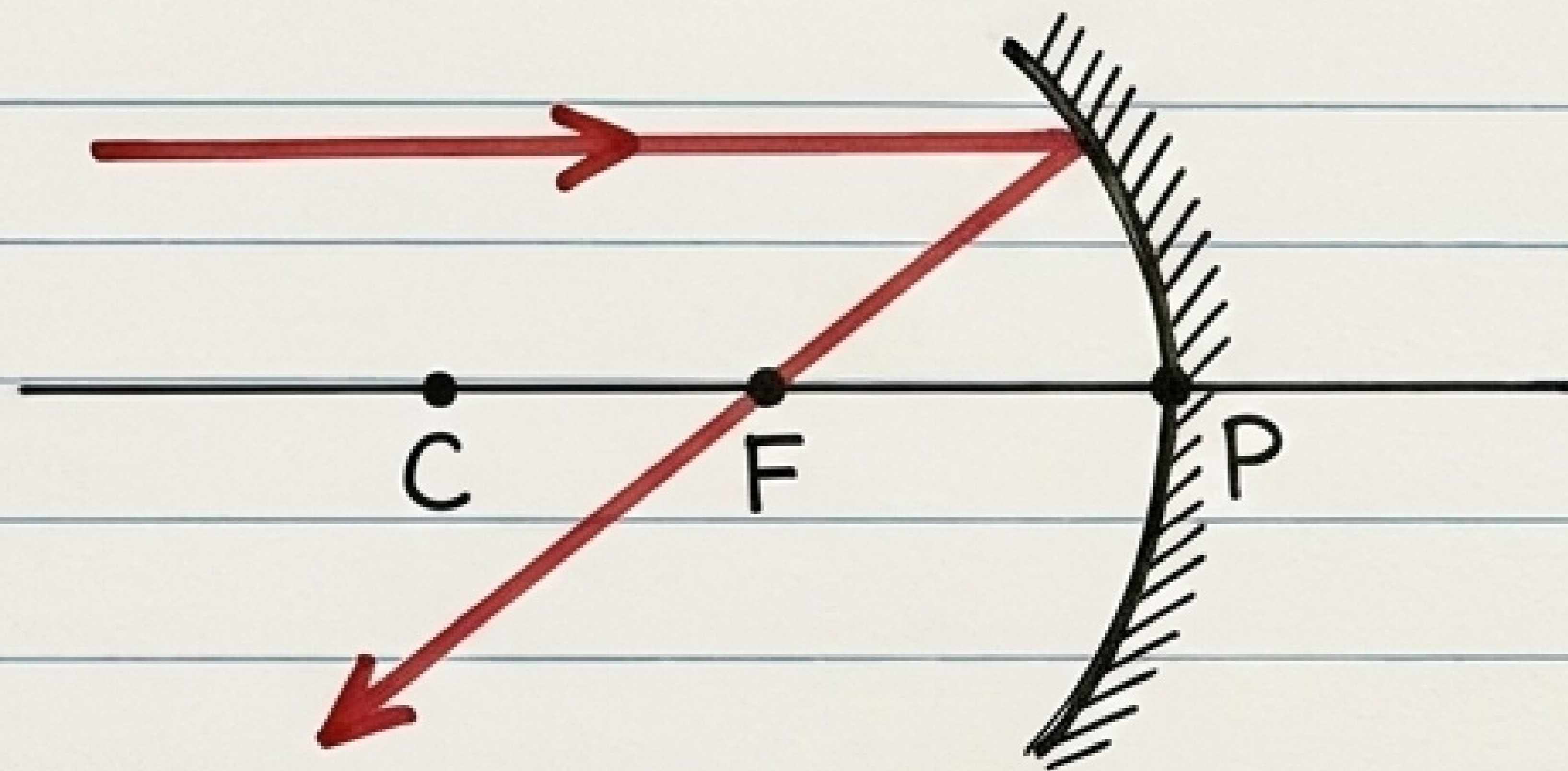
C = Center of Curvature
F = Principal Focus
f = focal length
P = Pole



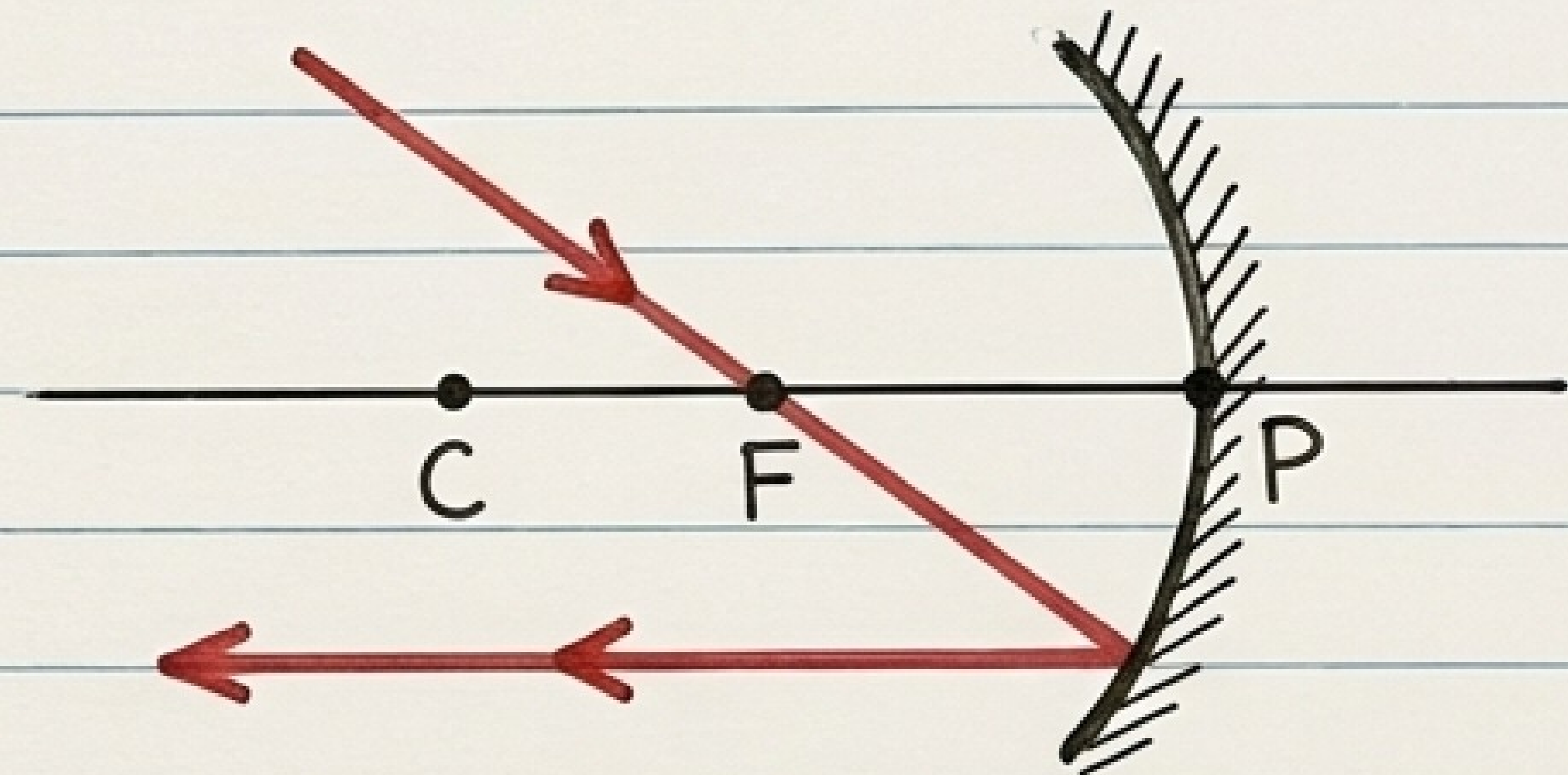
Board Exam Tip:
The focus (F) is always exactly halfway between C and P!

The 3 Golden Rules of Ray Tracing (Mirrors)

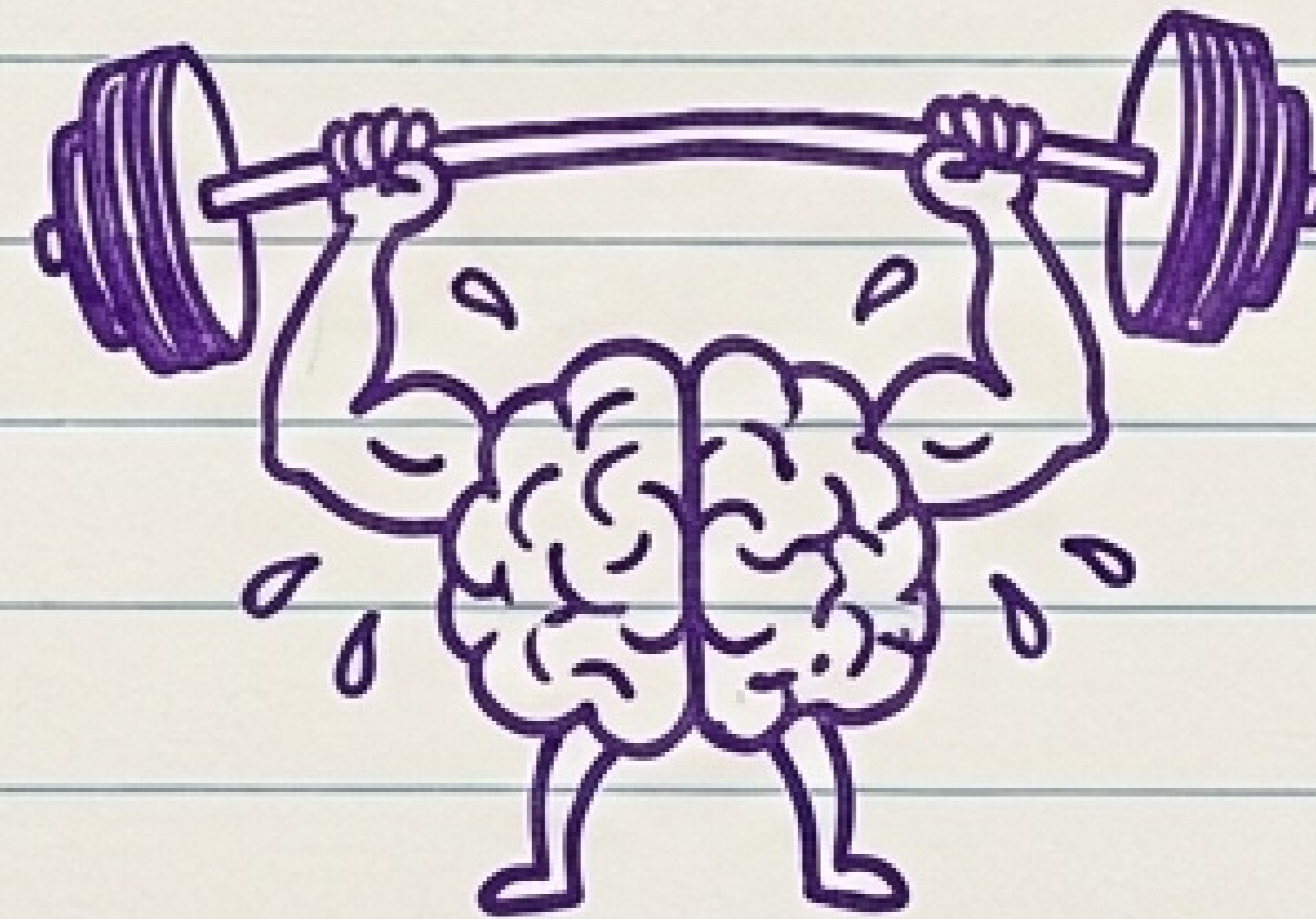
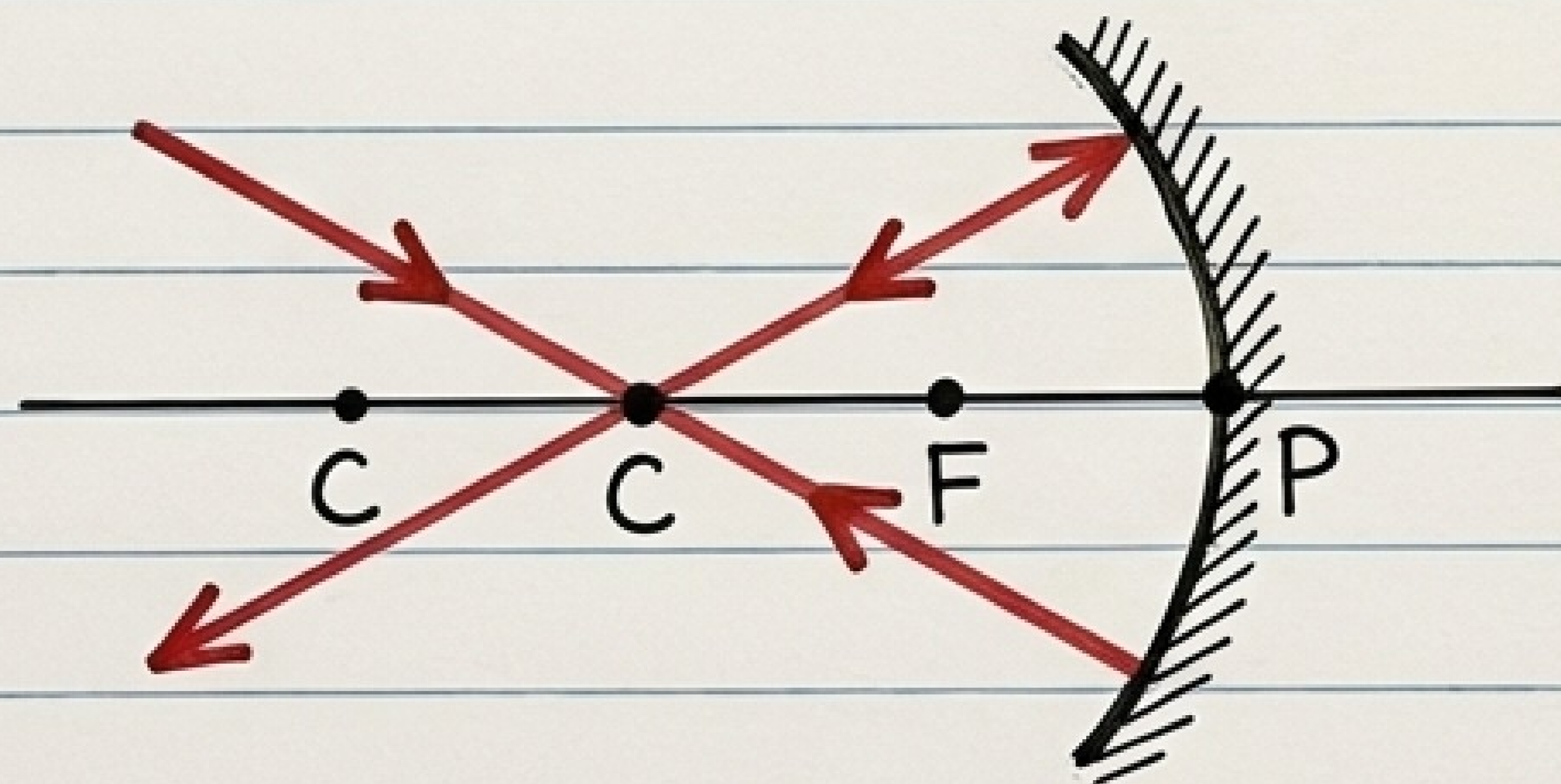
Parallel \rightarrow Focus



Focus \rightarrow Parallel



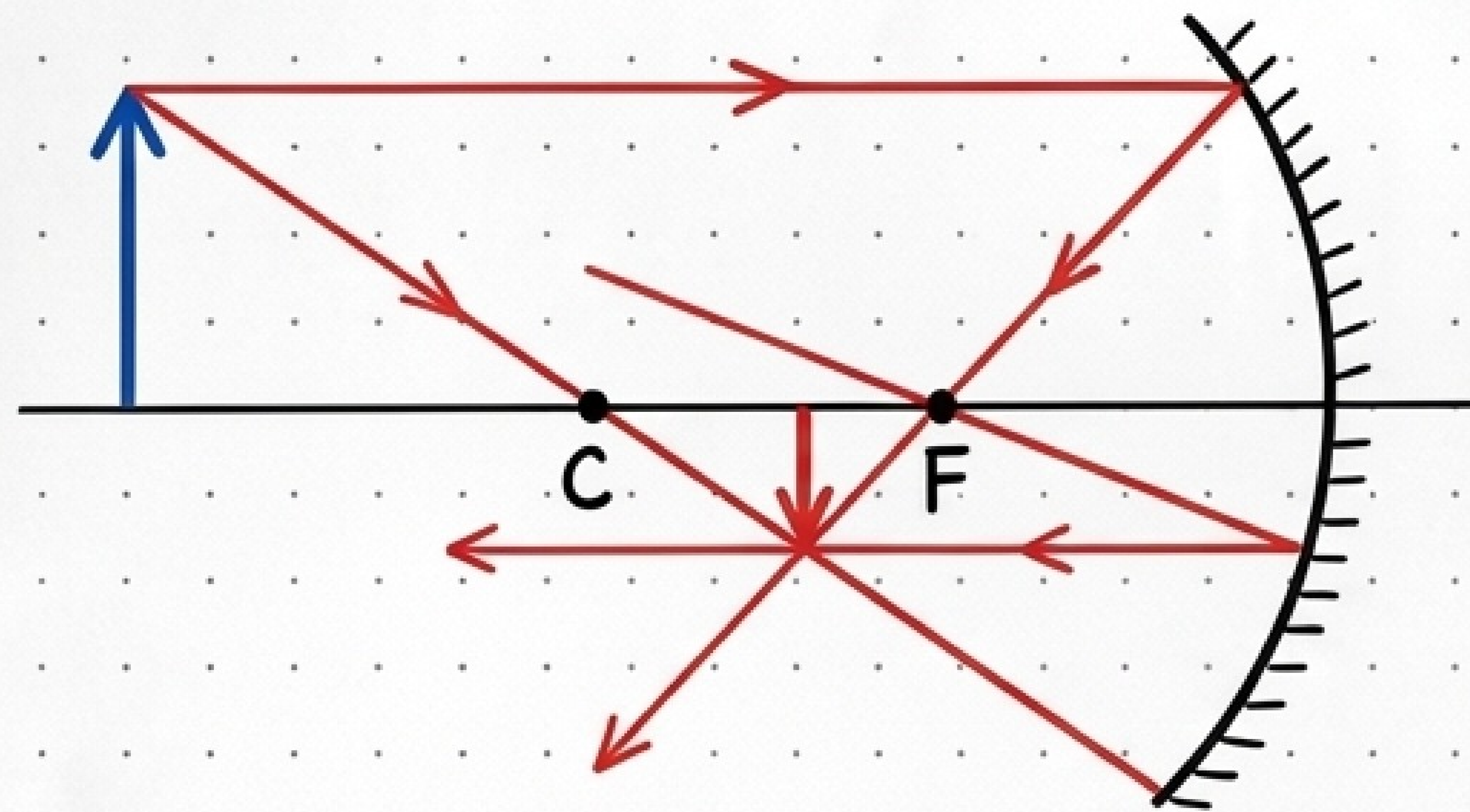
Center \rightarrow Bounces Back



Master these
3 moves, and
you can draw
ANY image!

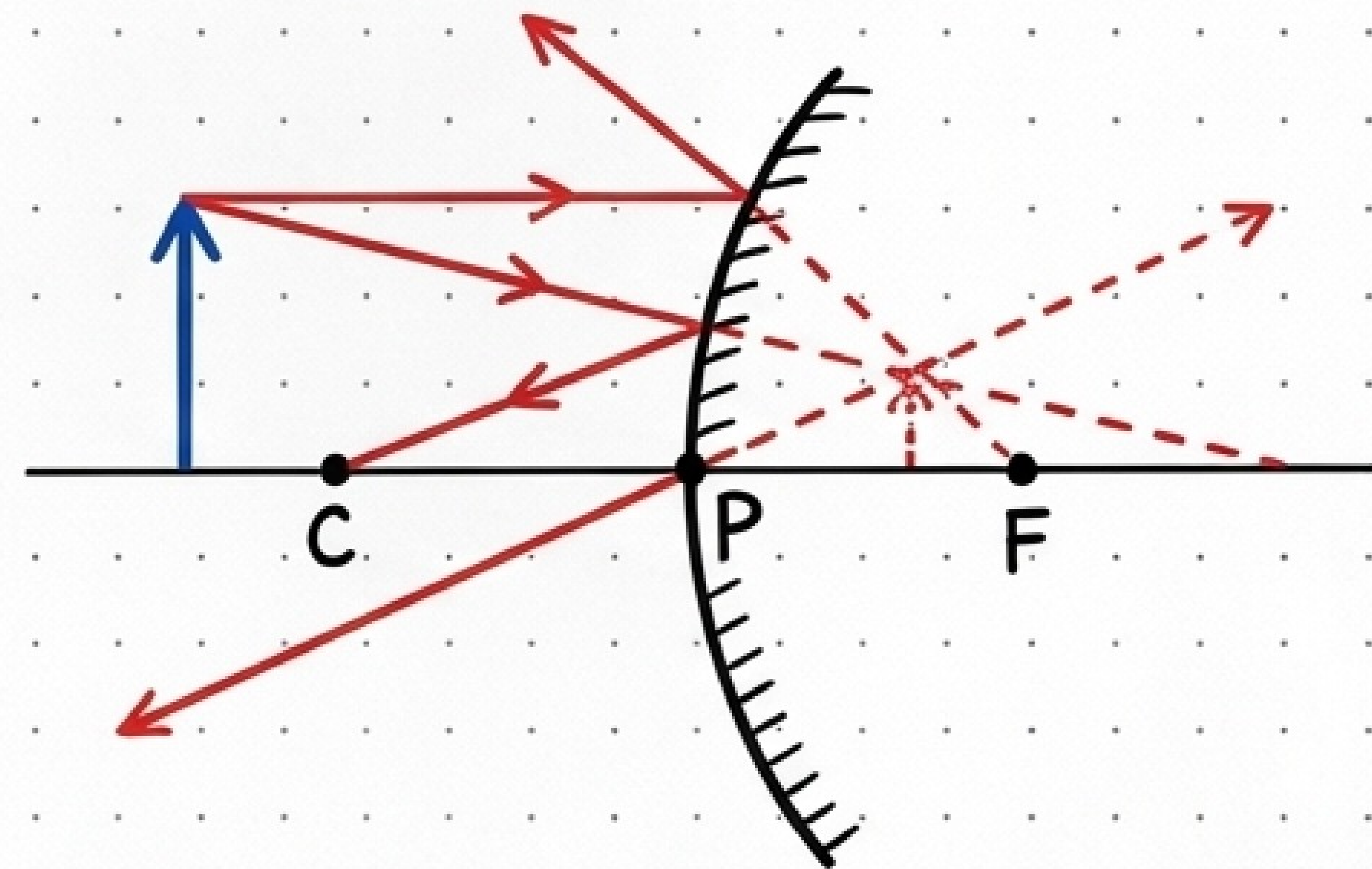
Image Formation: The Two Must-Know Cases

Concave Mirror (Object beyond C)



REAL & INVERTED

Convex Mirror (Object anywhere)



VIRTUAL, UPRIGHT & DIMINISHED

Convex mirrors are used for car rear-view mirrors because they always show a smaller, upright image!

The Mirror Math Cheat Sheet

u = object distance

v = image distance

f = focal length

$$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$$
$$m = \frac{h'}{h} = -\frac{v}{u}$$



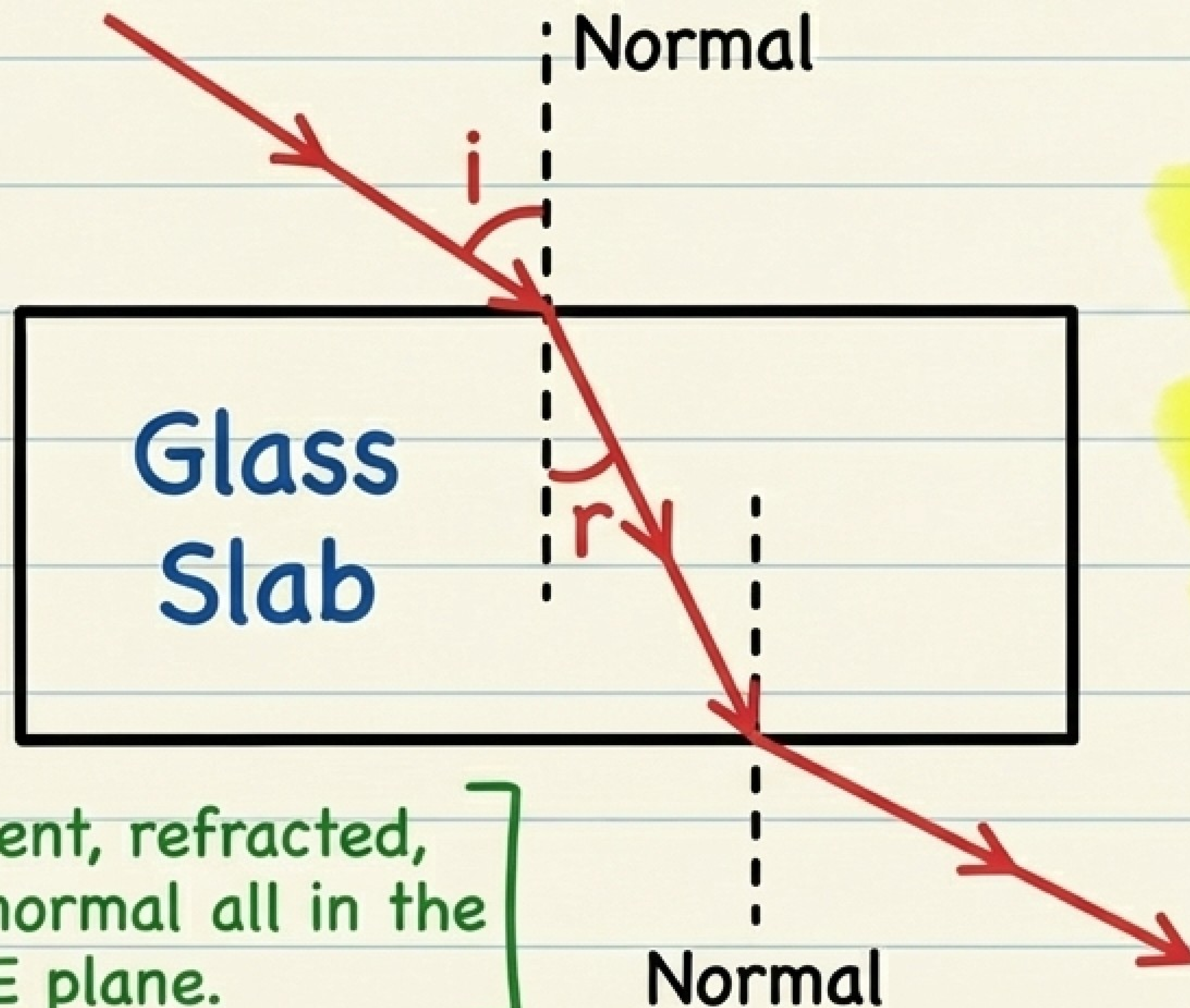
Don't forget the negative sign!
 $m = -\frac{v}{u}$ for mirrors.

If m is negative, the image is REAL.

If m is positive, the image is VIRTUAL.

Welcome to Refraction (The Bend)

Light changes speed and bends when moving from one medium to another.



$$\frac{\sin(i)}{\sin(r)} = \frac{n_2}{n_1}$$

[Law 1: Incident, refracted, and normal all in the SAME plane.]

The Refractive Index (n)

$$n = \frac{c}{v}$$

$\left(\frac{\text{Speed of light in vacuum}}{\text{Speed in medium}} \right)$

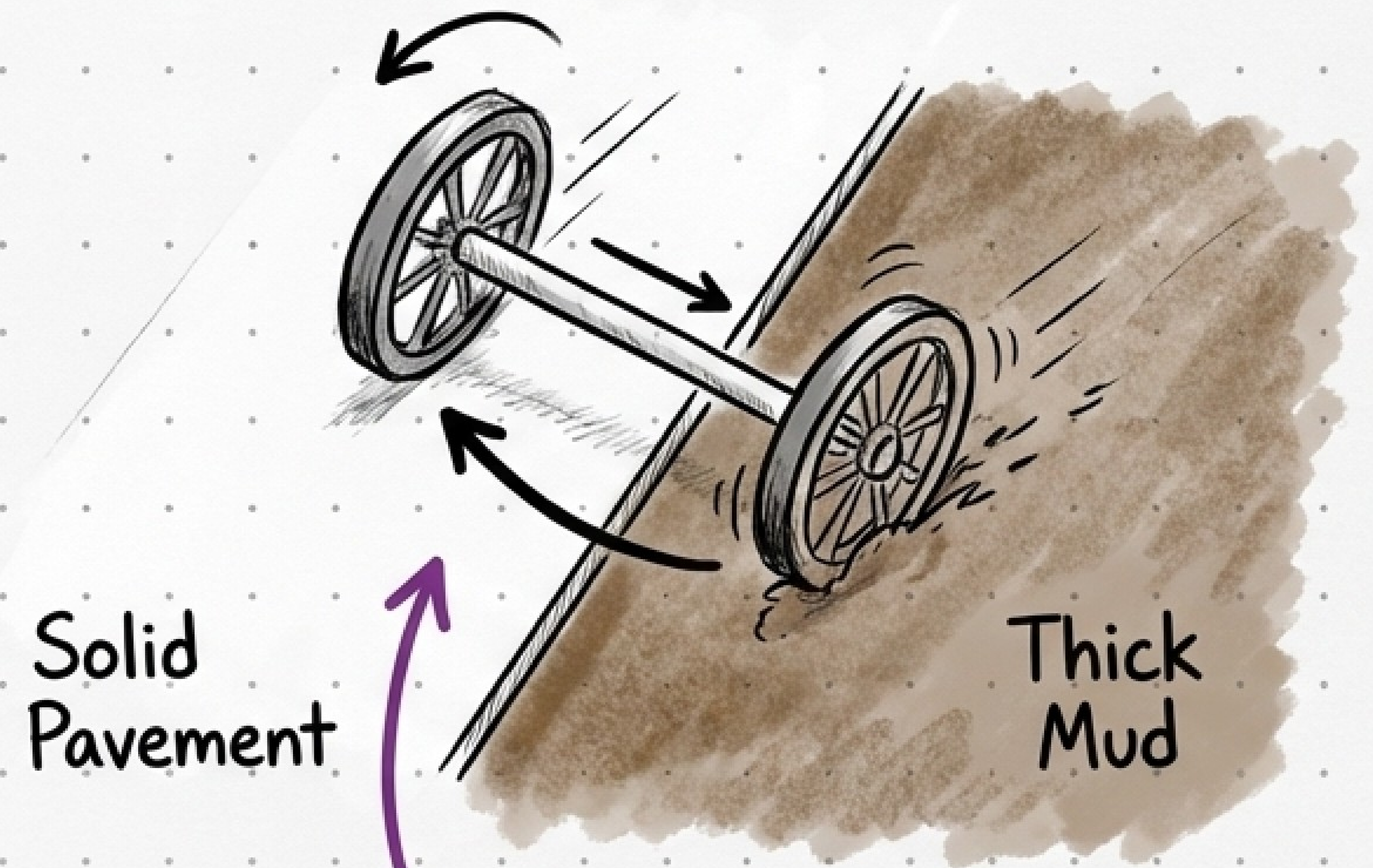
- Common Values to Memorize:

- Water ≈ 1.33

- Glass ≈ 1.5

- Diamond ≈ 2.42

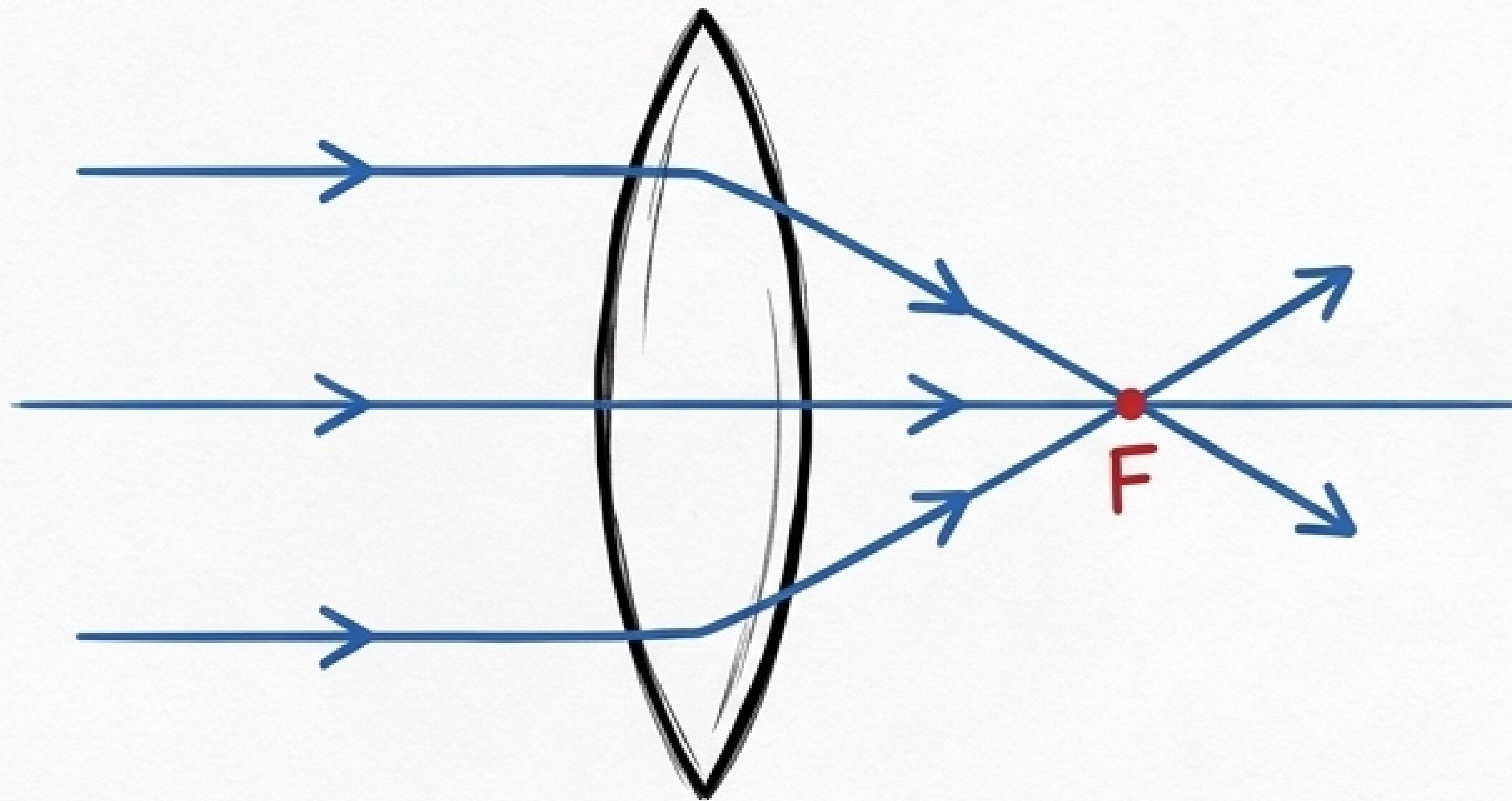
Greater n =
More bending
of light!



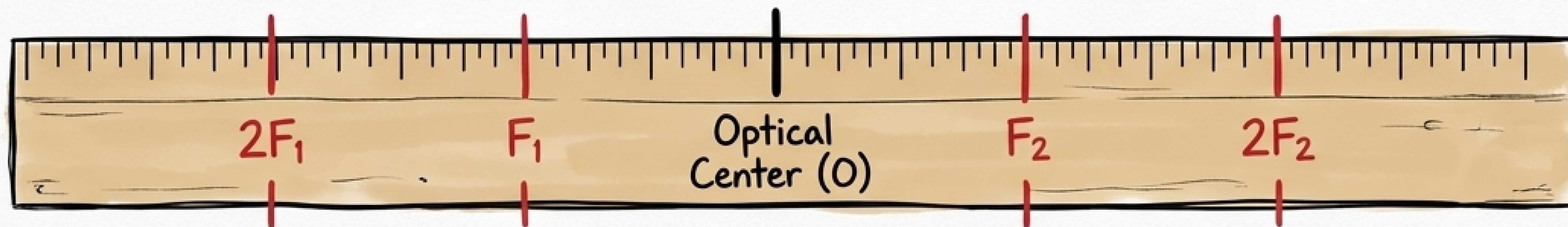
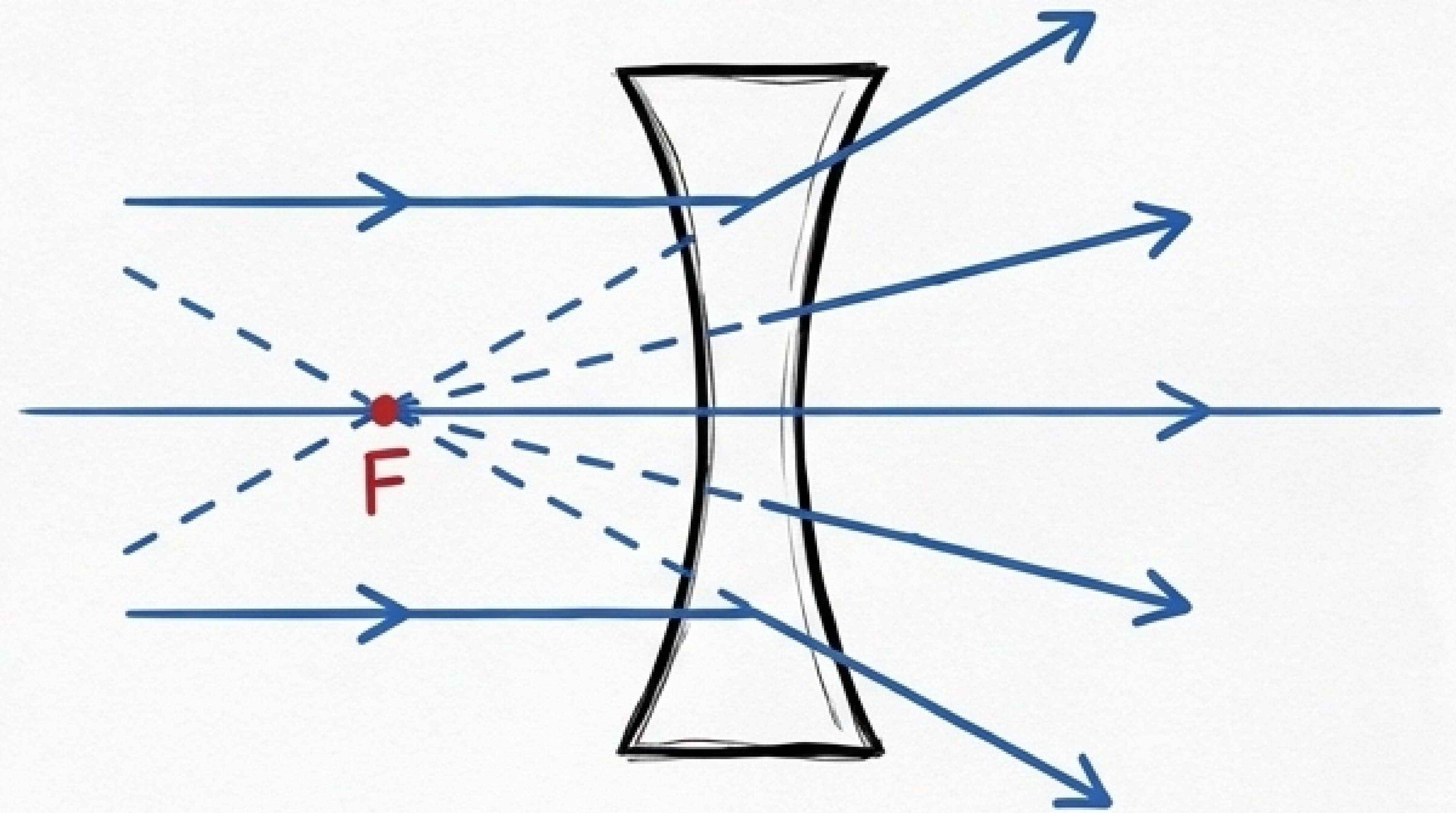
Why light bends
toward the normal!

Anatomy of Spherical Lenses

Convex (Converging Lens)



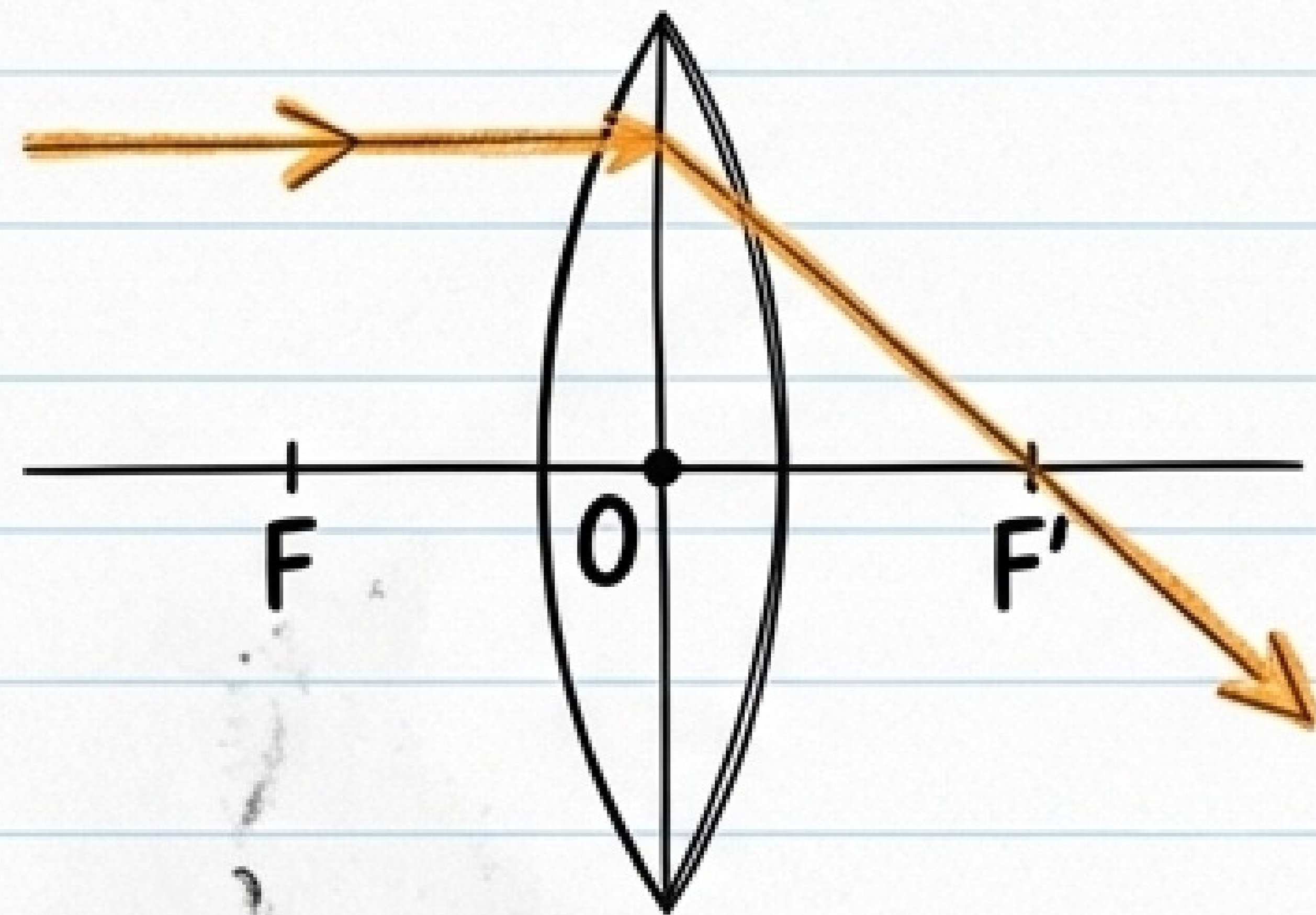
Concave (Diverging Lens)



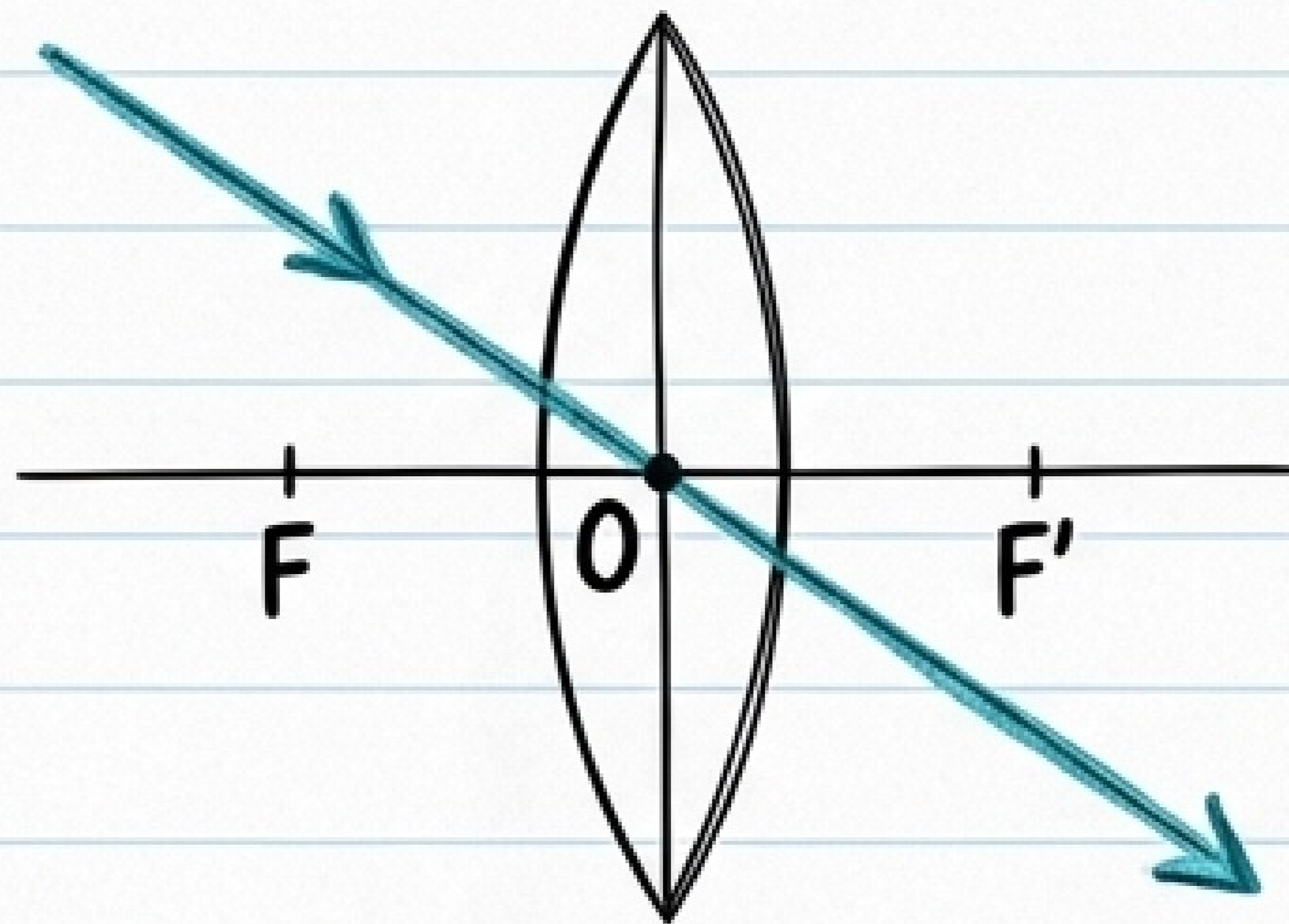
Lenses have TWO focal points because light can pass through from either side!

The 3 Golden Rules of Ray Tracing (Lenses)

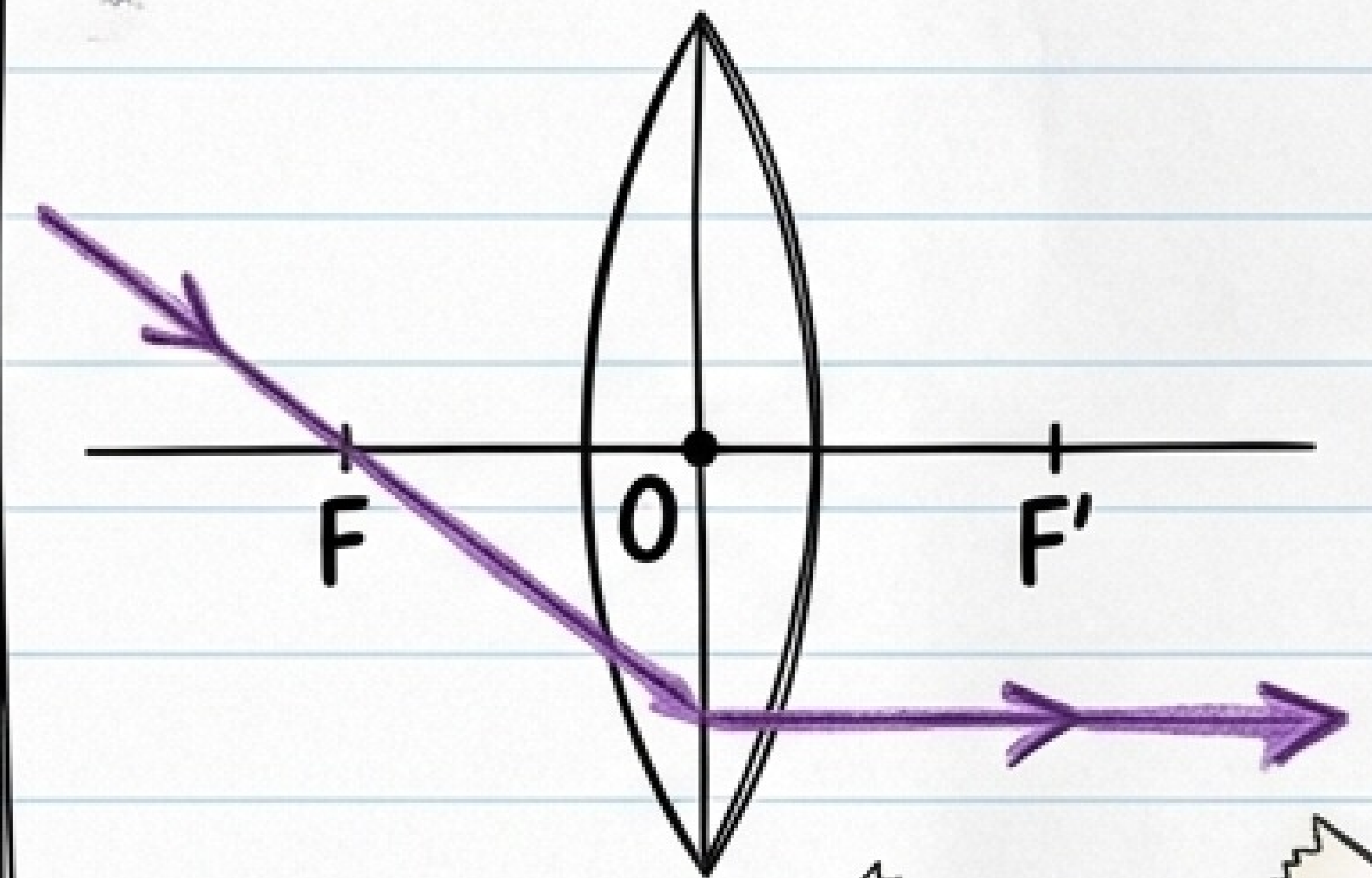
Parallel → Passes through Focus



Through Optical Center
→ Goes straight through! 



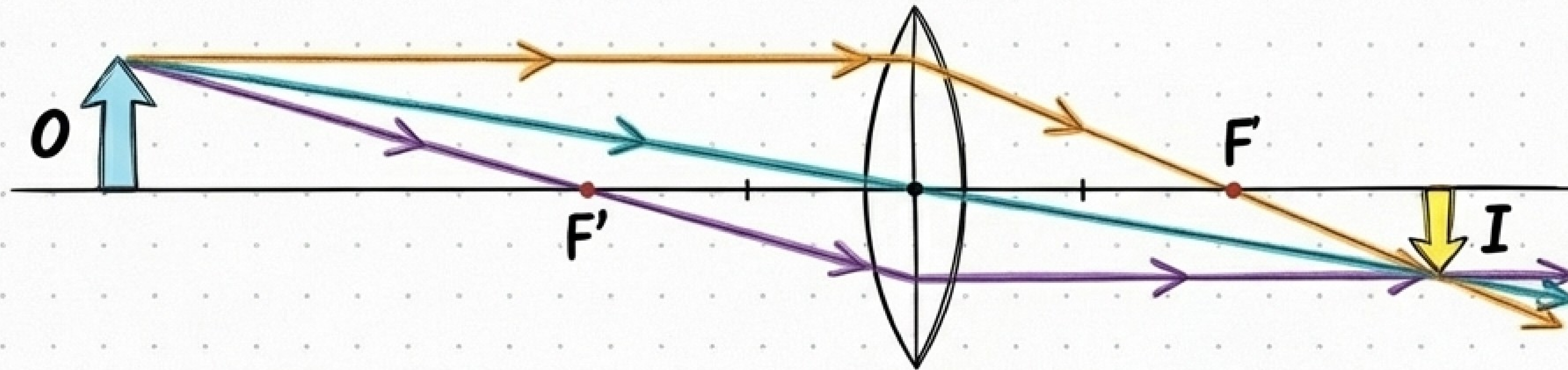
Through Focus → Exits Parallel



Rule #2 is your best friend. It's the easiest line to draw!

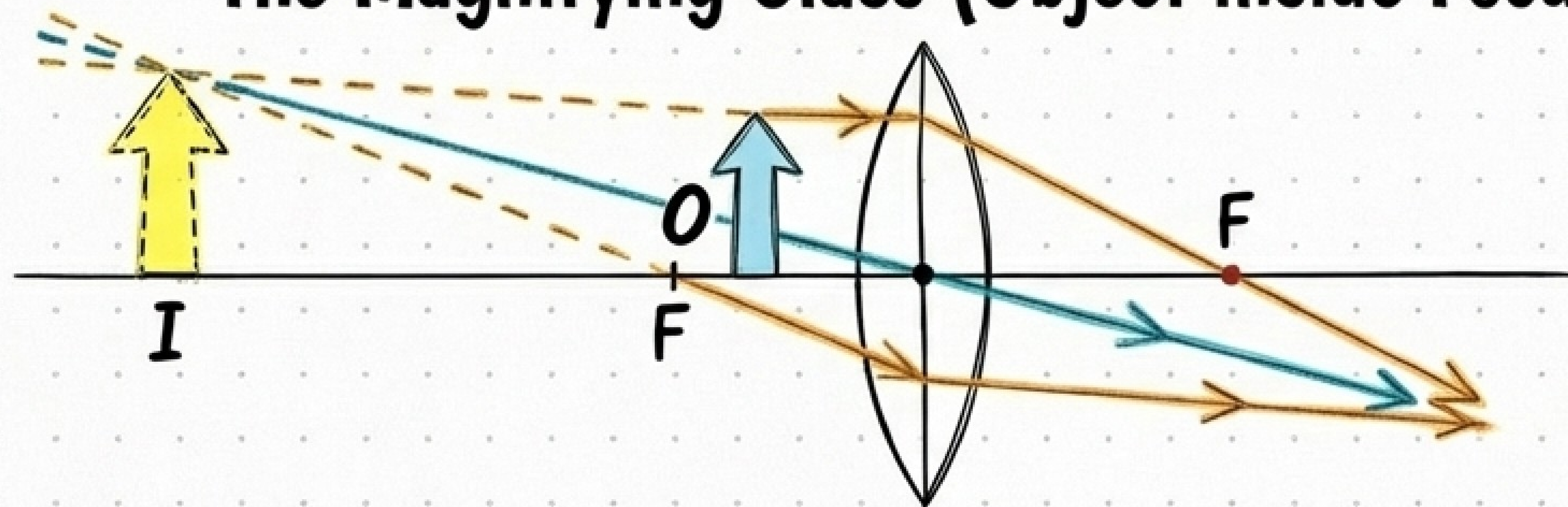
Lenses in Action: Image Formation

The Real Image (Object outside Focus)




**REAL &
INVERTED**

The Magnifying Glass (Object inside Focus)




**VIRTUAL,
UPRIGHT &
MAGNIFIED**

The Lens Math Cheat Sheet

$$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$$


DANGER!
Mirrors use (+),
Lenses use (-)!

$$m = \frac{h'}{h} = \frac{v}{u}$$


Notice! No minus
sign here for
lenses!

Variables are exactly the same:
u = object distance
v = image distance
f = focal length

Power of a Lens (P)

The reciprocal of focal length. It measures how strongly a lens bends light.

$$P = \frac{1}{f}$$

Unit: Diopter (D)



Focal length MUST be in meters before dividing!

Example 1:
Convex Lens (Converging)

$$f = +0.5 \text{ m}$$

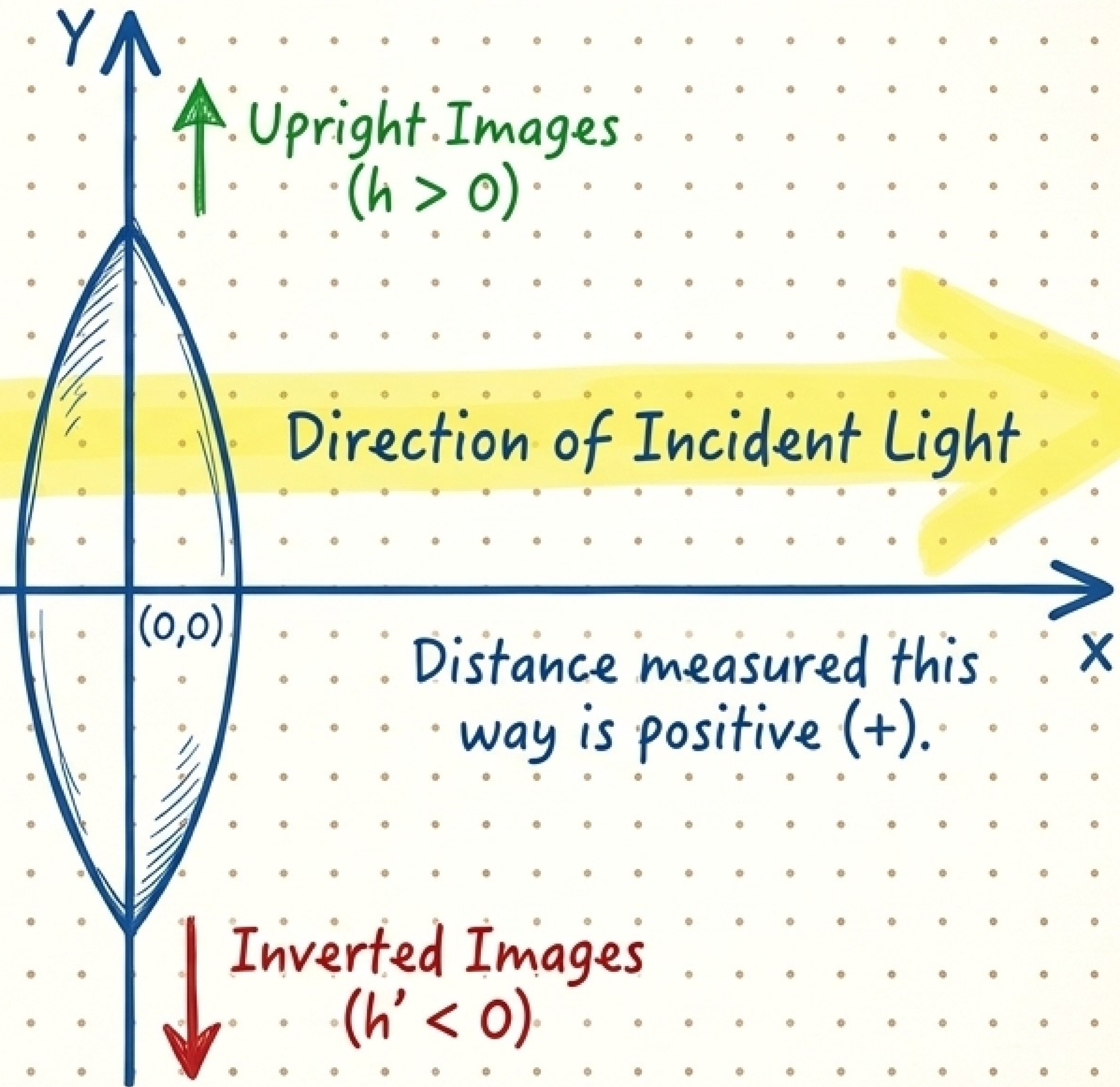
$$P = \frac{1}{0.5} = +2 \text{ D}$$

Example 2:
Concave Lens (Diverging)

$$f = -0.5 \text{ m}$$

$$P = \frac{1}{-0.5} = -2 \text{ D}$$

The Ultimate Sign Convention Cheat Map



Distance measured this way is negative (-).

Distance measured this way is positive (+).

The Grand Matrix: Mirrors vs. Lenses



Memorize this matrix before
before walking into the exam hall!!!

	MIRRORS	LENSES
Action	Bounces (Reflection)	Bends (Refraction)
Formula	$\frac{1}{f} = \frac{1}{v} + \frac{1}{u}$	$\frac{1}{f} = \frac{1}{v} - \frac{1}{u}$
Magnification	$m = -\frac{v}{u}$	$m = \frac{v}{u}$
Converging Type	Concave (f is -)	Convex (f is +)
Diverging Type	Convex (f is +)	Concave (f is -)

Test Yourself: Top Board Exam Questions

1. State the laws of reflection. ✓

2. Differentiate between real and virtual images. ✓

3. Derive/Use the mirror formula for a concave mirror.

4. Calculate the power of a lens with $f = 20$ cm.
(Trick: convert to m!)

5. Why does a pencil appear bent in water?

