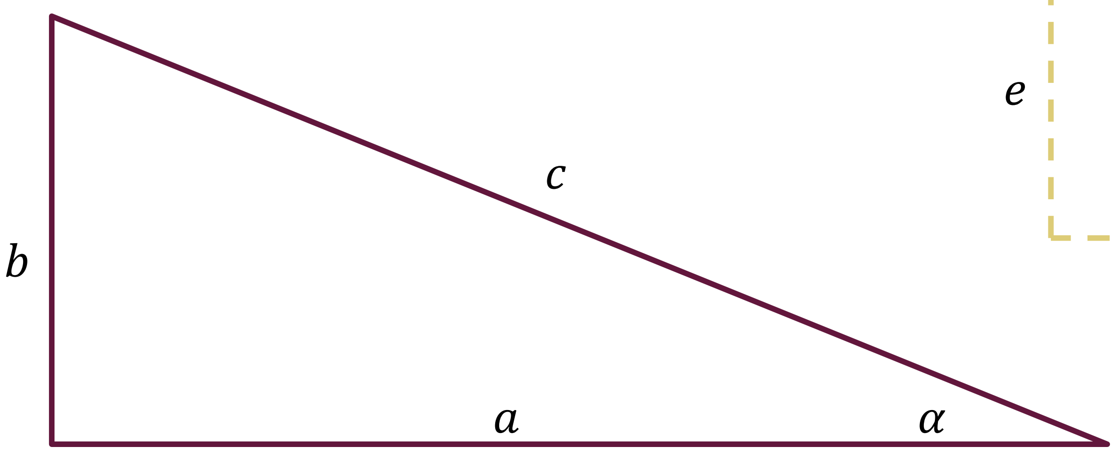
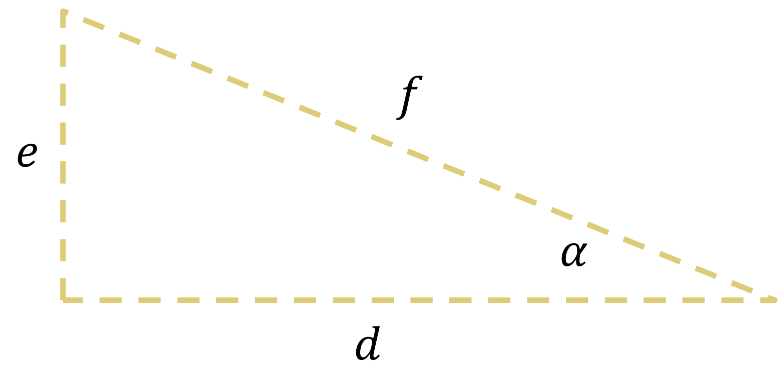
# CHAPTER 23: MIRRORS AND LENSES

# SECTION INCOMES

Properties of similar triangles:




$$\frac{b}{a} = \tan\alpha \qquad \frac{e}{d} = \tan\alpha$$

$$\frac{b}{a} = \frac{e}{d}$$

Reflection: $\theta_i = \theta_r$

Refraction: $n_1 \sin\theta_1 = n_2 \sin\theta_2$

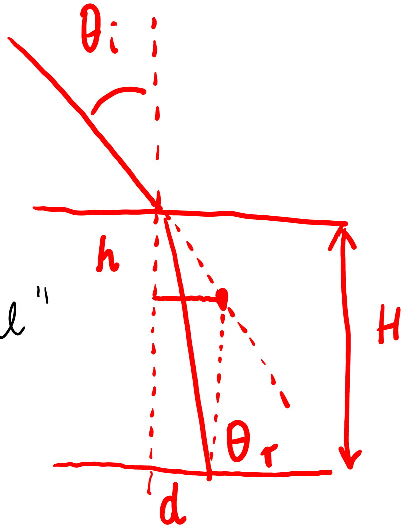
# ZOOM POLL → March 10 learning catalytics

A pool filled with water of $n = 1.25$ appears to be 6 feet deep when viewed at the angle close to the normal to the surface

$\sin\theta \approx \tan\theta$

What is the actual depth of the pool?

a) 4.8 feet
b) 6 feet
c) 7.25 feet
d) 7.5 feet




Note: for angle $\theta_i$ that is not "near normal"

$\therefore \tan\theta \neq \sin\theta$

You need to figure out $\theta_t$ from Snell's law and then determine $h/H$

$$\frac{d}{H} = \tan\theta_t \approx \sin\theta_t$$

$$\frac{d}{h} = \tan\theta_i \approx \sin\theta_i$$

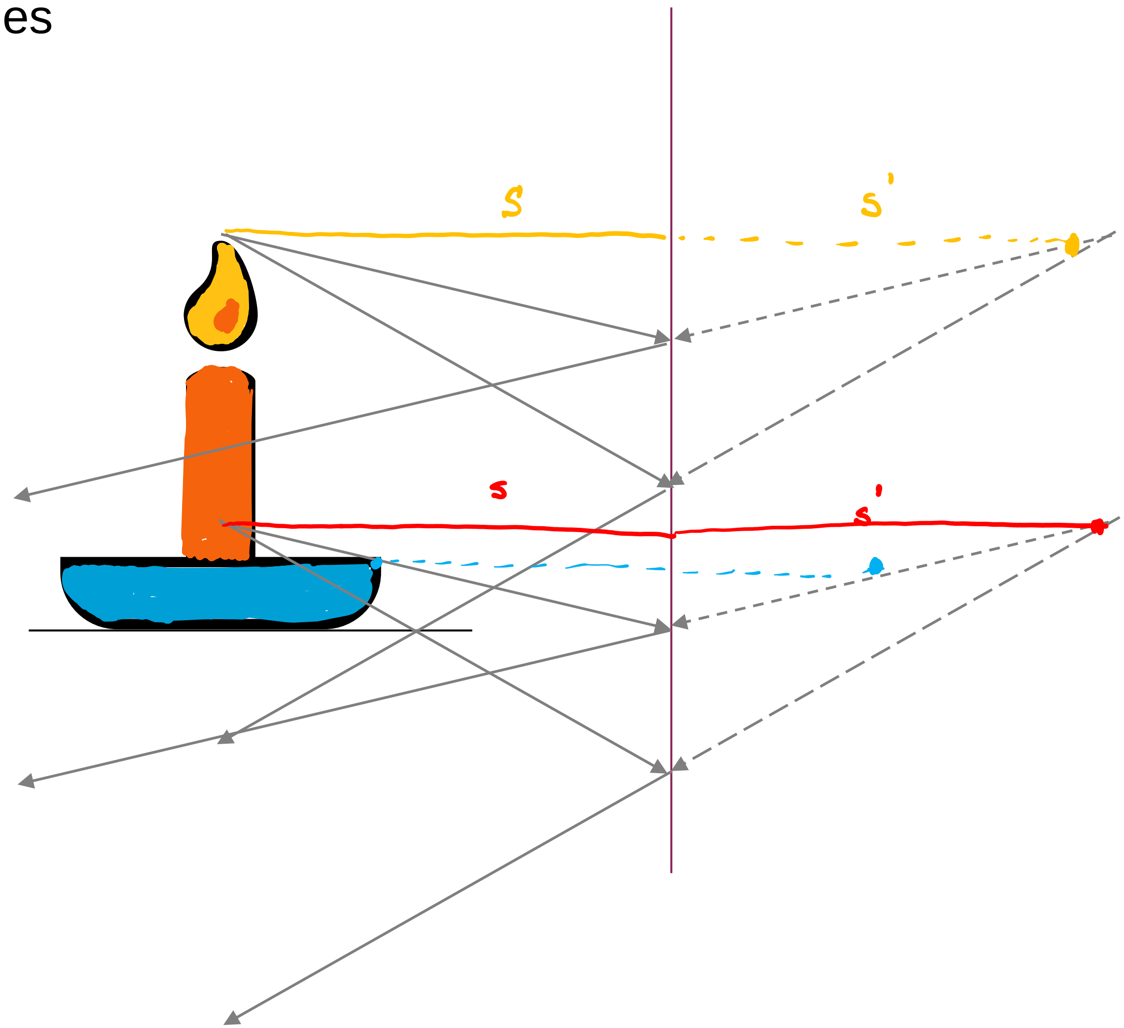
$$n_i \sin\theta_i = n_t \sin\theta_t$$

$$\frac{\sin\theta_t}{\sin\theta_i} = \frac{n_i}{n_t} \approx \text{ratio of } H \,\&\, h$$

# 23.1 Plane Mirrors

Creating the image:

https://www.physicsclassroom.com/Physics-Interactives/Reflection-and-Mirrors/Plane-Mirror-Images



# 23.1 Plane Mirrors

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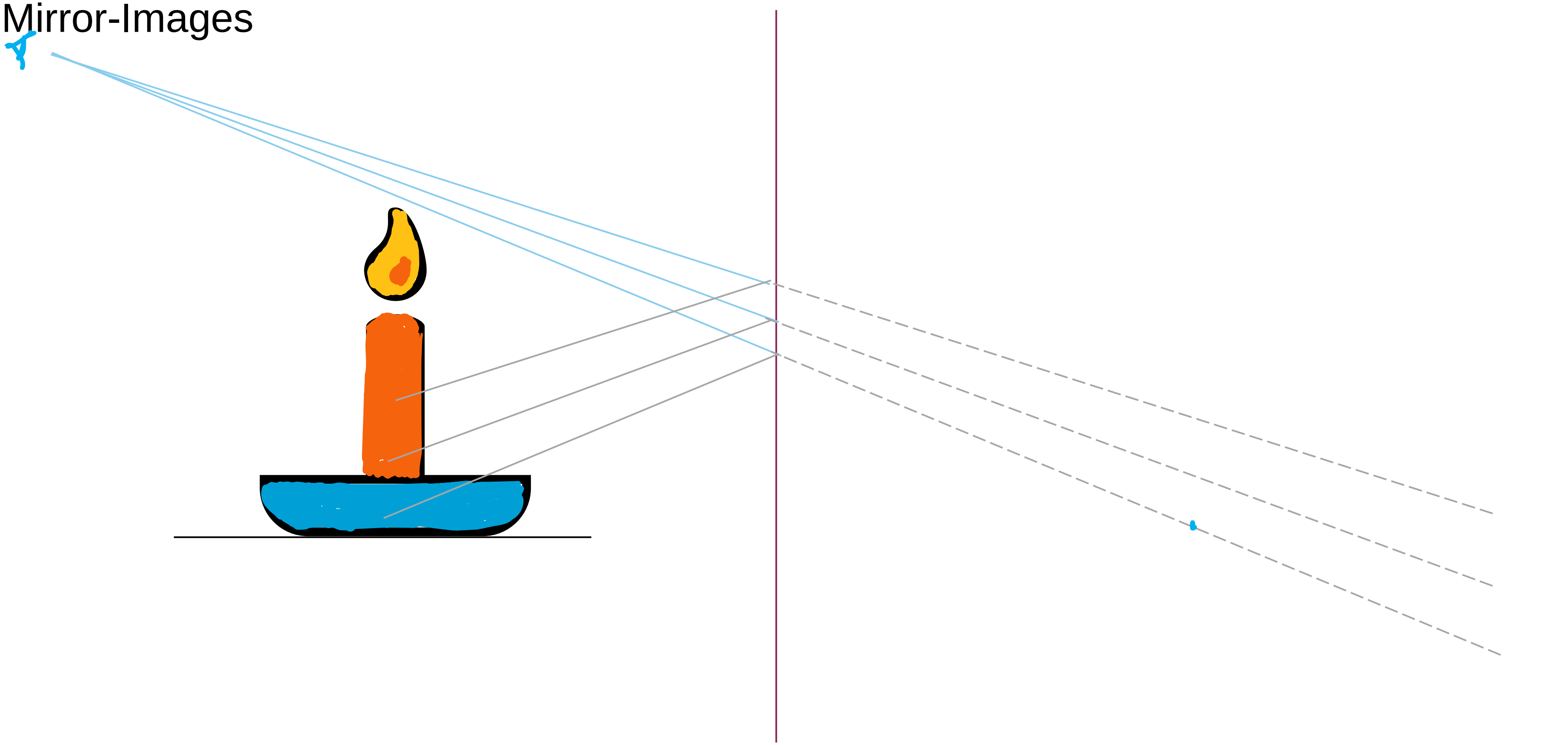
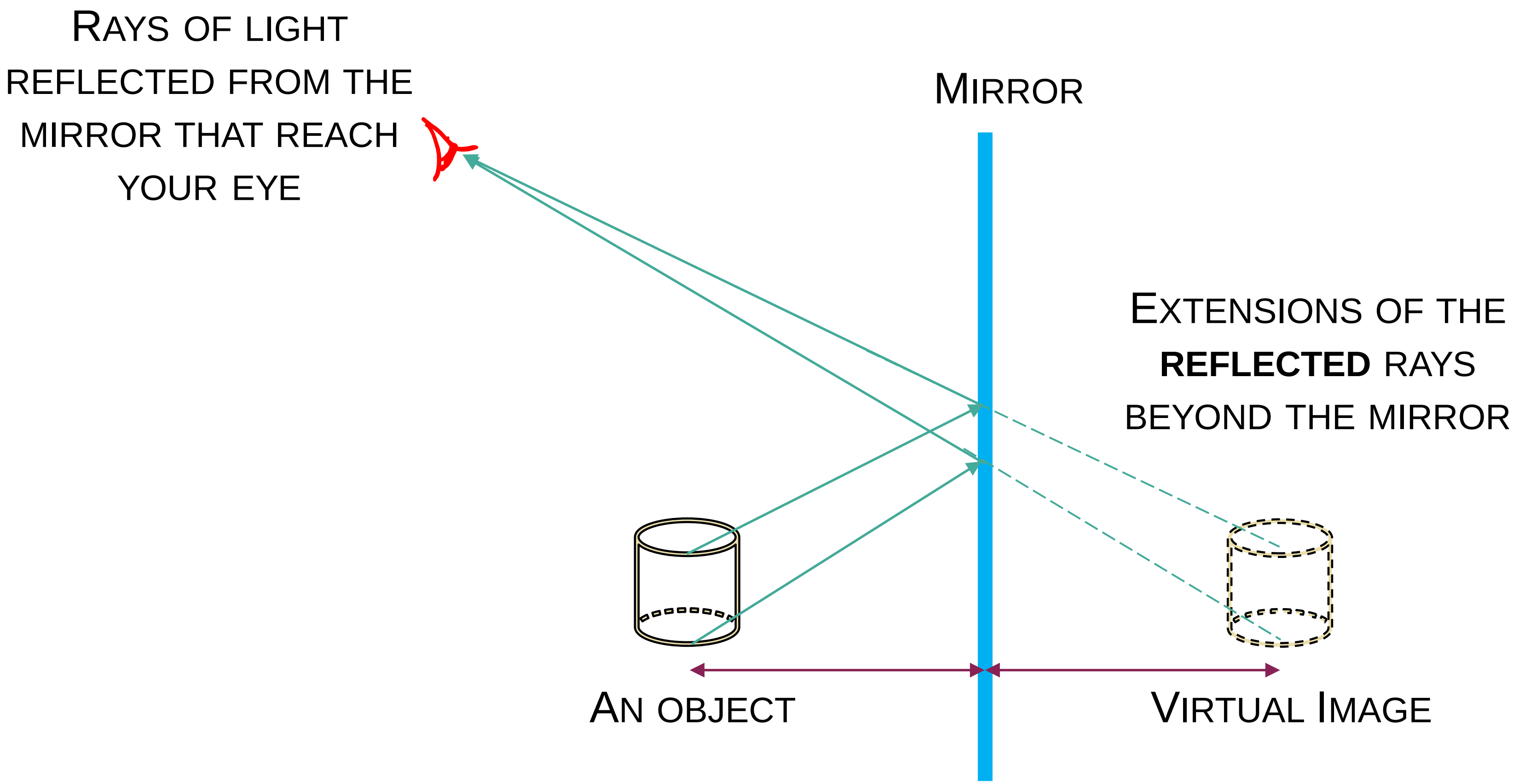


# 23.1 – Plane Mirrors

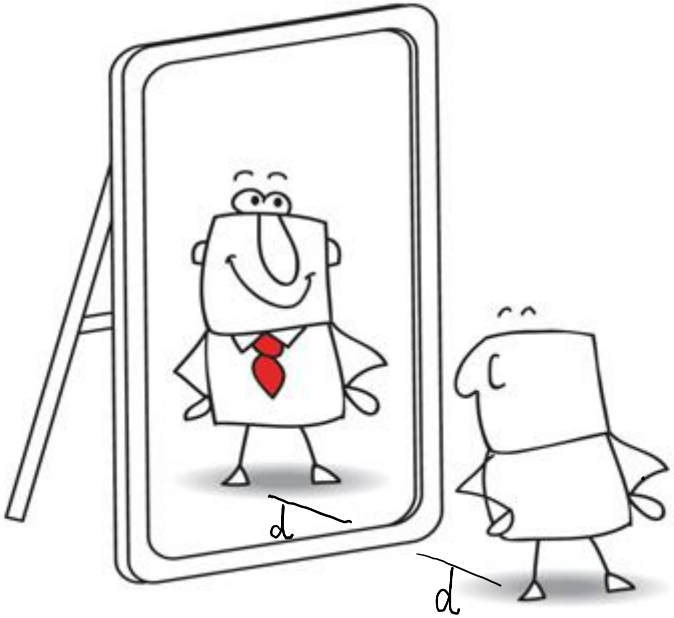
When we think of an image in the mirror we look at the following:




Hint: this is why we reviewed similar triangles!

# LC! → March 10 learning catalytics

How far is the reflection?

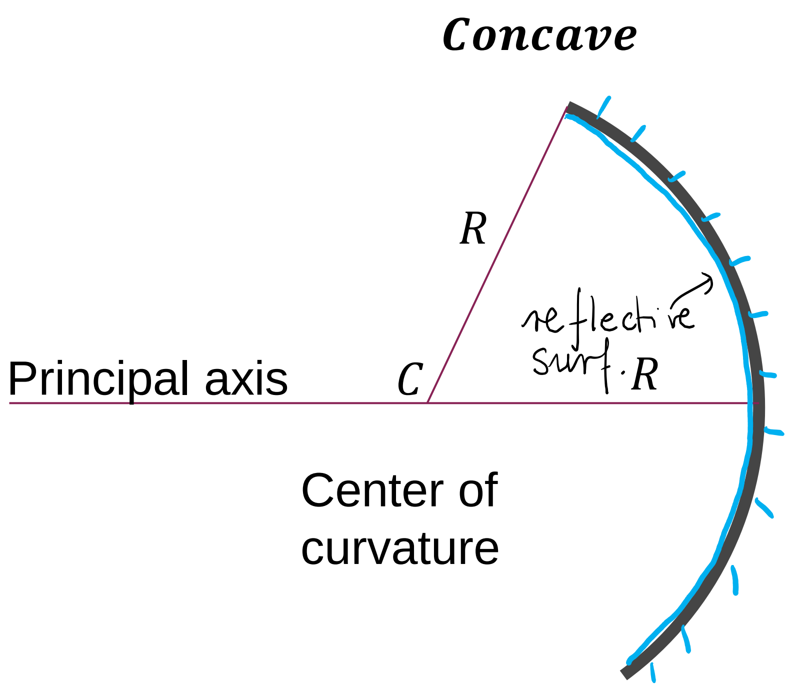


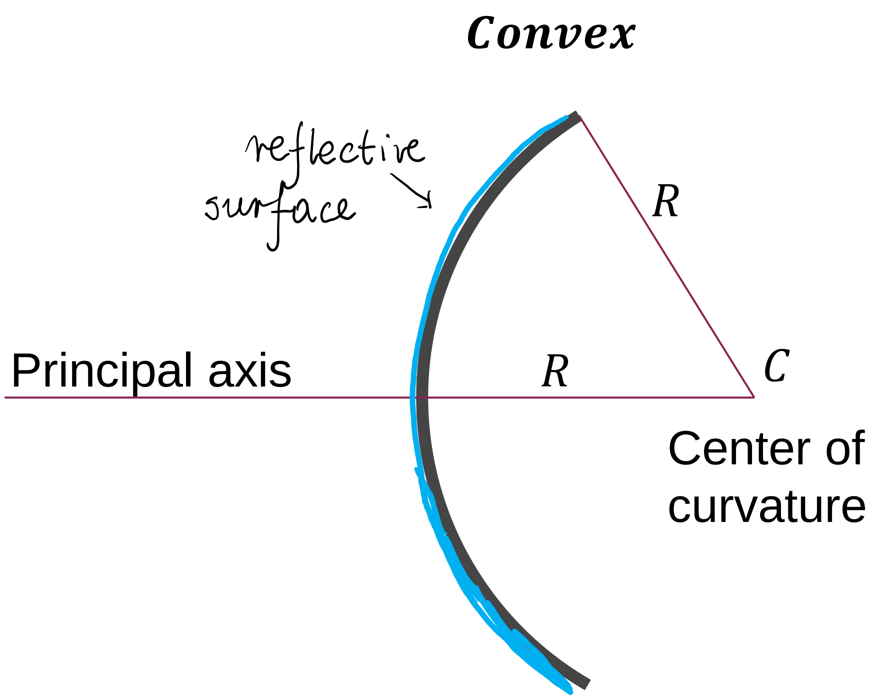

When you are looking at your reflection in the mirror that is 0.75 m away, how far does your reflection appear to be from you?

# 23.2 QUALITATIVE ANALYSIS OF MIRRORS

Everyone today at home: grab a spoon (I am not joking) or some other curved, reflective object (mixing metallic bowl, decorative glass bowl (be careful if it is your parents').

Curved mirrors come in two "types":



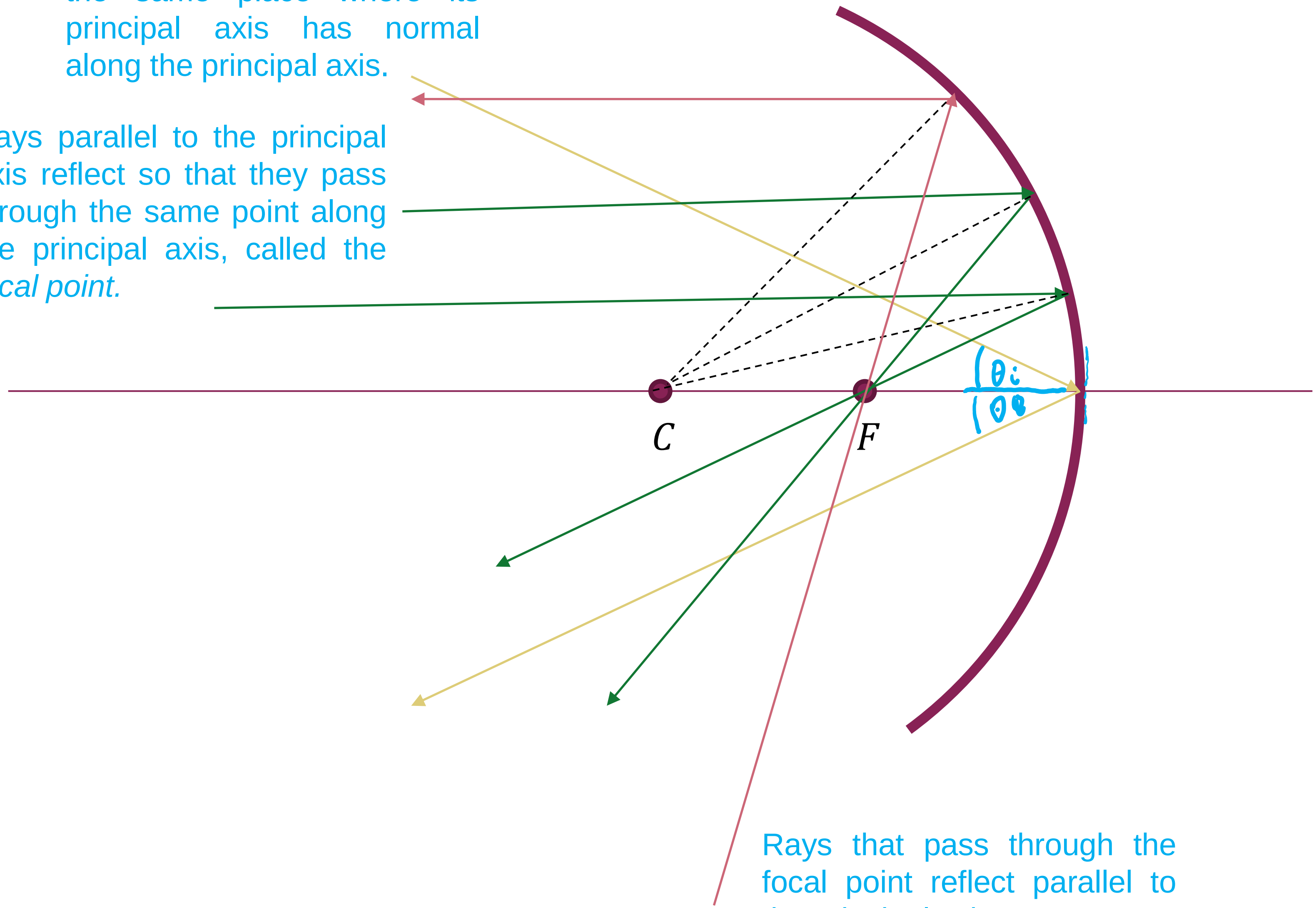



# 23.2 CONCAVE MIRRORS

Law of reflection always applies, but the normal to the surface is always in the radial direction, which is different at each point

Ray that reaches the mirror at the same place where its principal axis has normal along the principal axis.

Rays parallel to the principal axis reflect so that they pass through the same point along the principal axis, called the *focal point.*

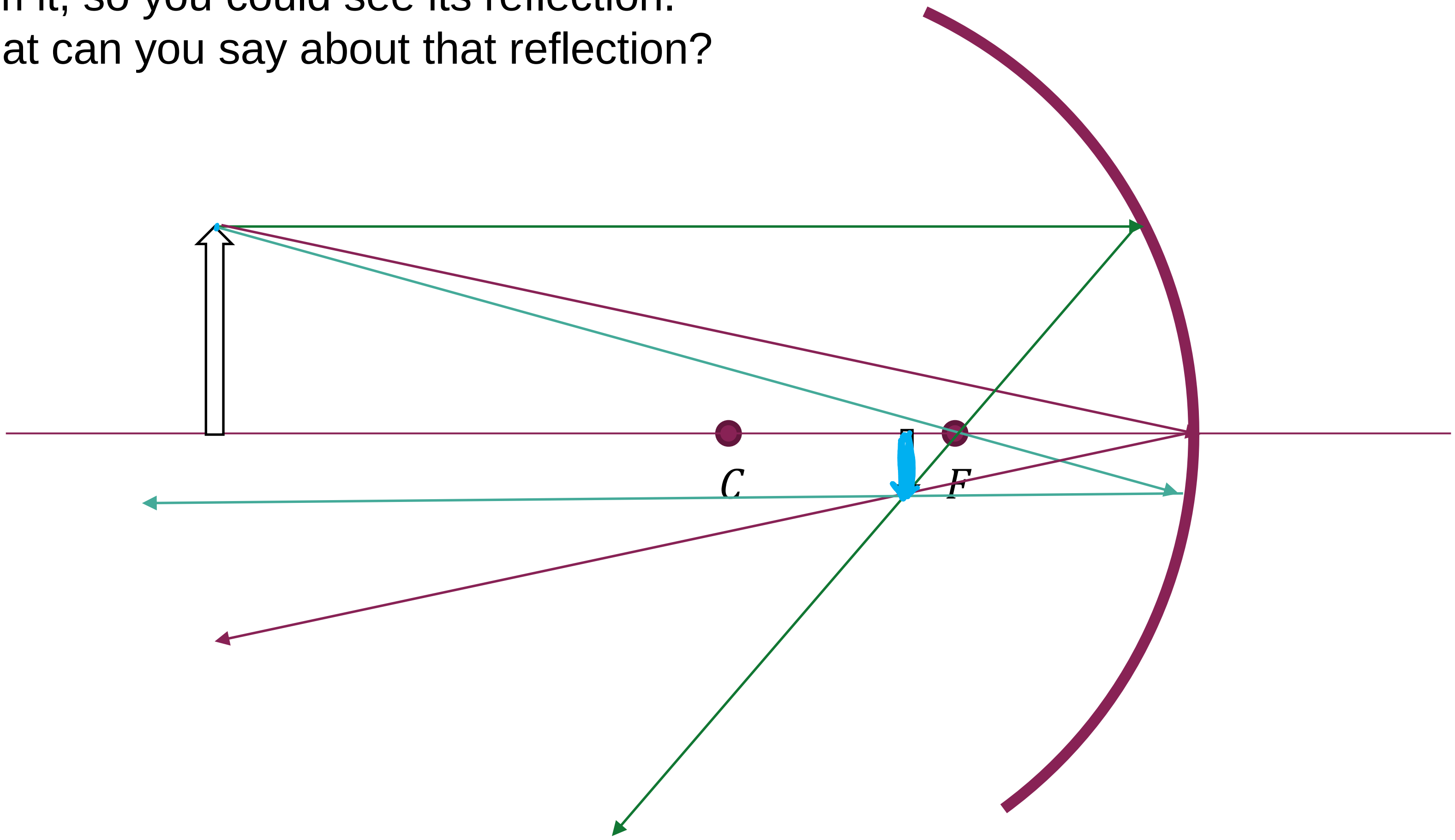



Rays that pass through the focal point reflect parallel to the principal axis.

# 23.2 WHAT DO YOU SEE?

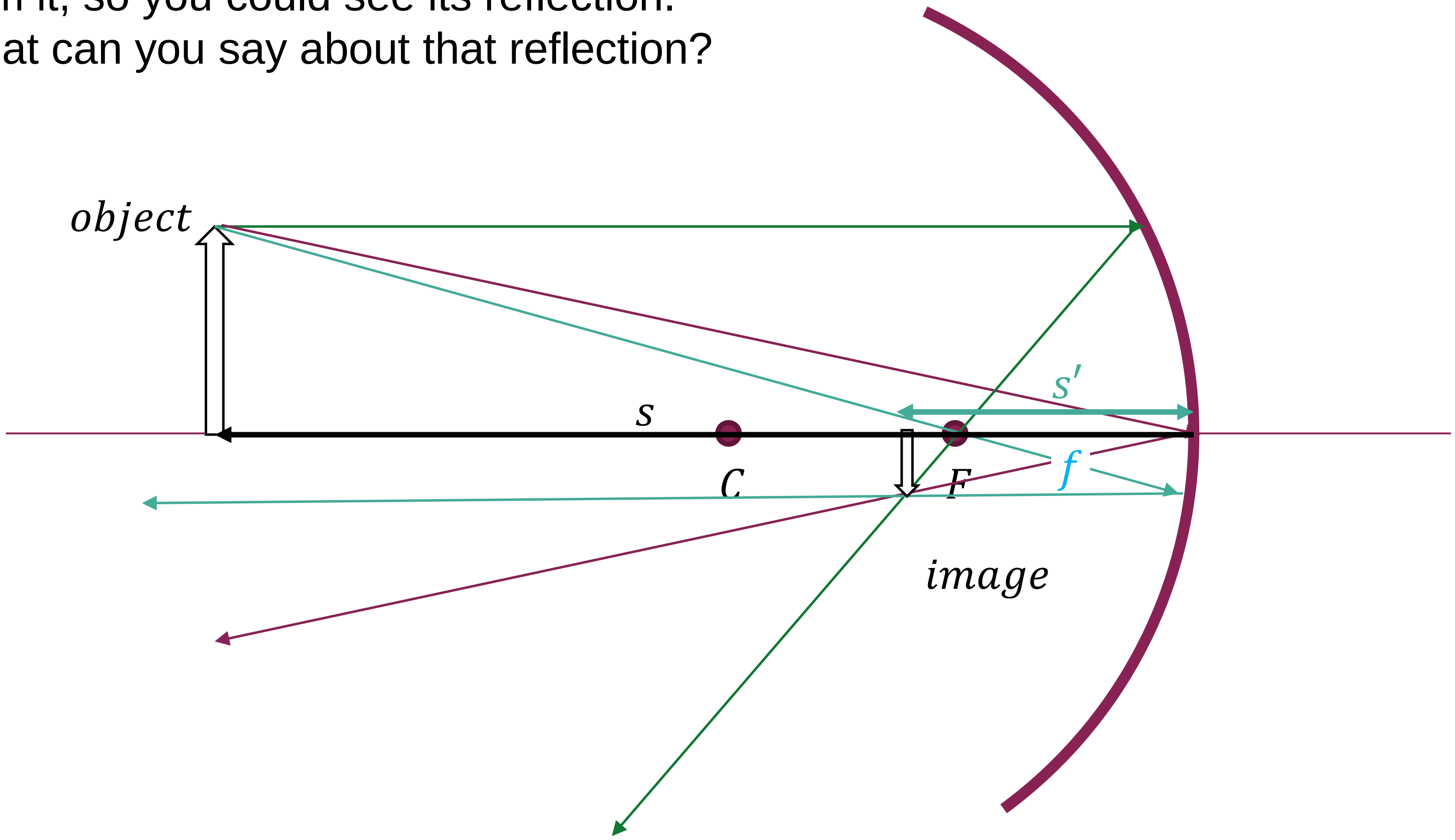
Take your spoon and look into the concave side of it. Position your finger far away from it, so you could see its reflection.

What can you say about that reflection?



# 23.2 CREATING AN IMAGE - $s > R$

Take your spoon and look into the concave side of it. Position your finger far away from it, so you could see its reflection.
What can you say about that reflection?

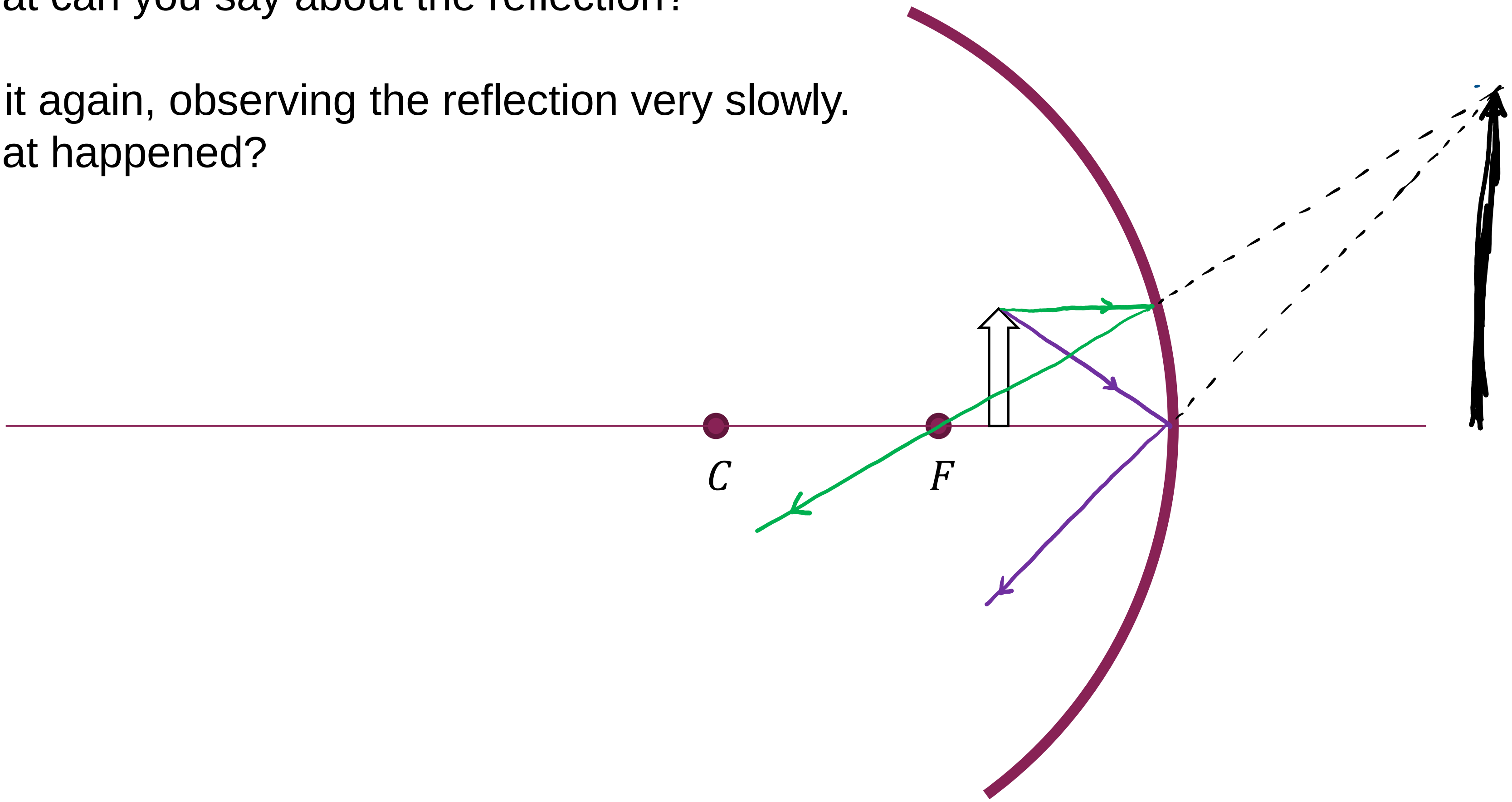



$s$ – distance between the object and the mirror
$s'$ – distance between the image and the mirror
(*convention: positive for **real** image, negative for **virtual** image*)
$f$ – focal length

# 23.2 CREATING AN IMAGE - $s < f$

Now move your finger closer, so you can almost touch the surface (but not quite).
What can you say about the reflection?

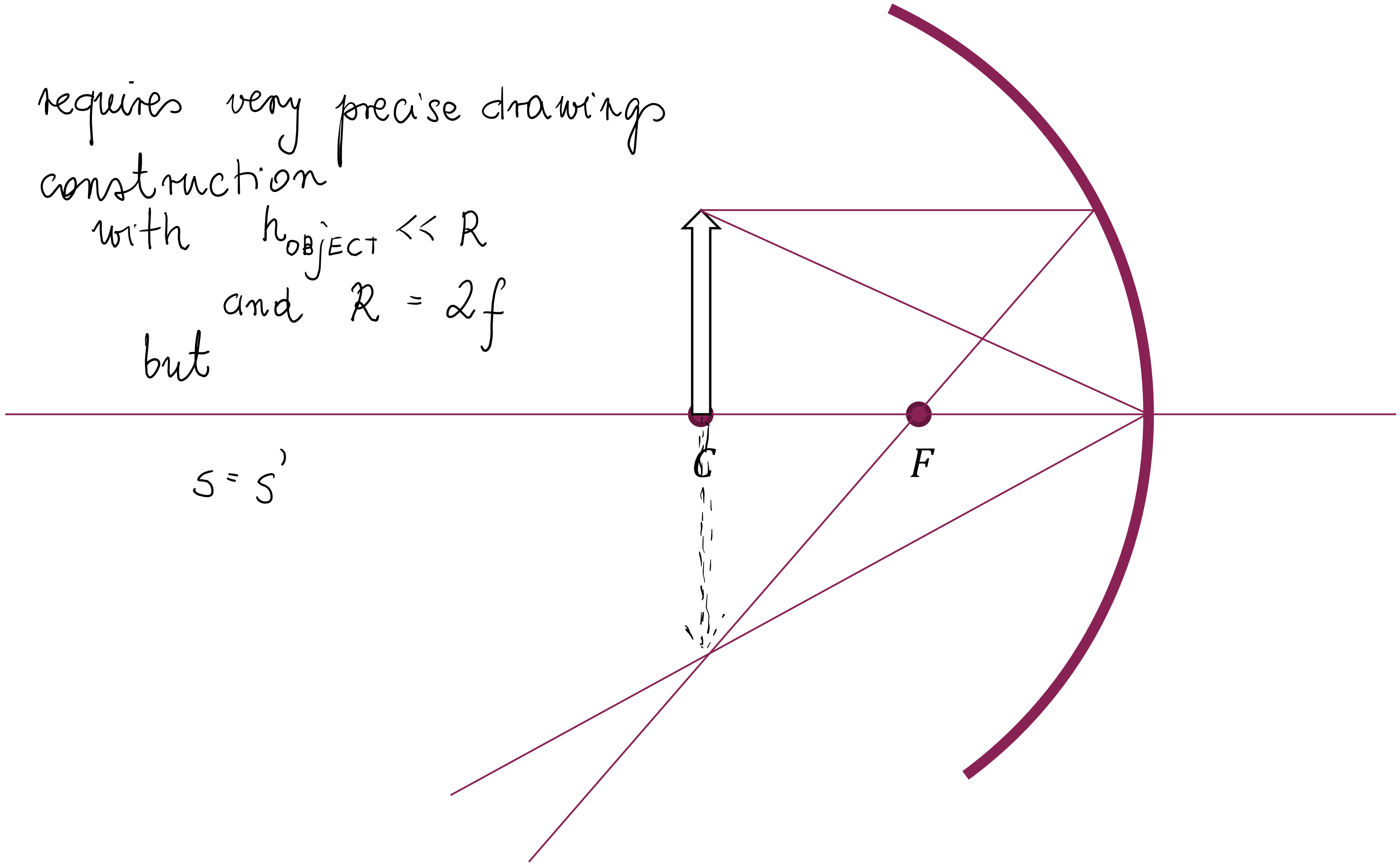
Do it again, observing the reflection very slowly.
What happened?



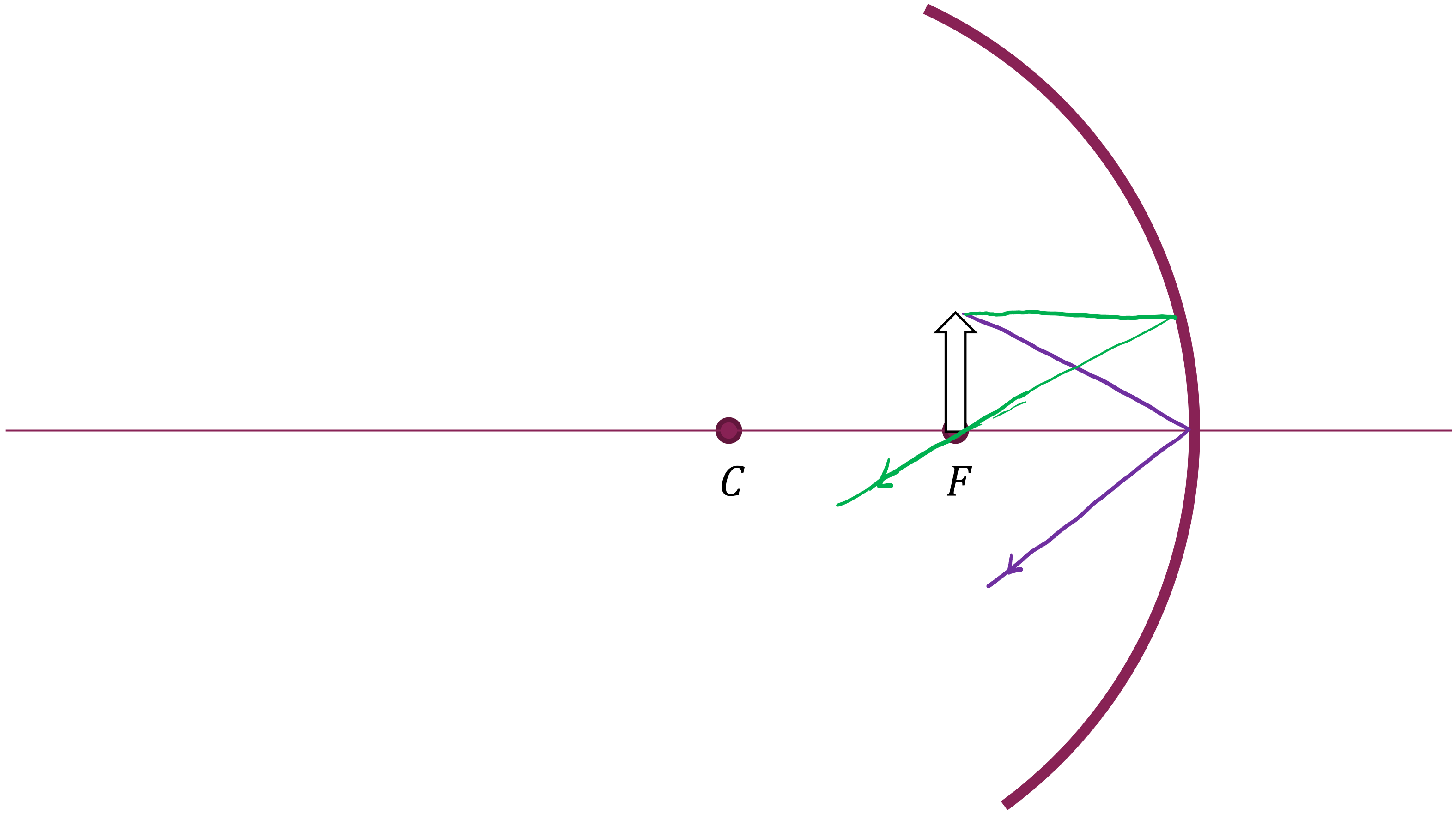
# 23.2 CREATING AN IMAGE - $s = R$ → try it yourself

It requires very precise drawings
& construction
with $h_{OBJECT} << R$
but and $R = 2f$

$s = s'$



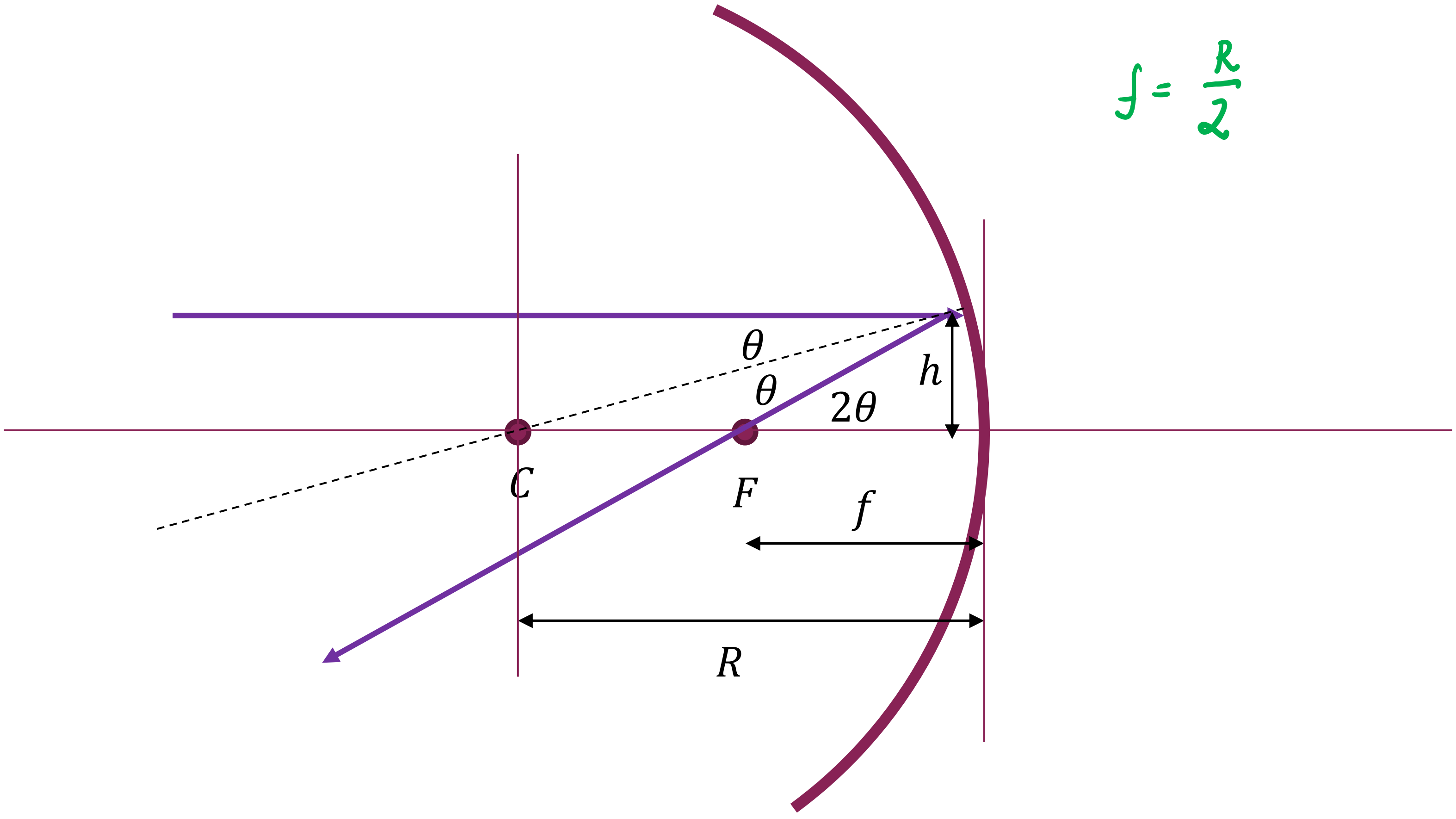
# 23.2 Creating an Image - $s = f$



# 23.2 FOCAL LENGTH

Assumptions:

1. The curvature of the mirror is large comparing to its size ($R \gg h$)
2. The incident rays are close to the principal axis.

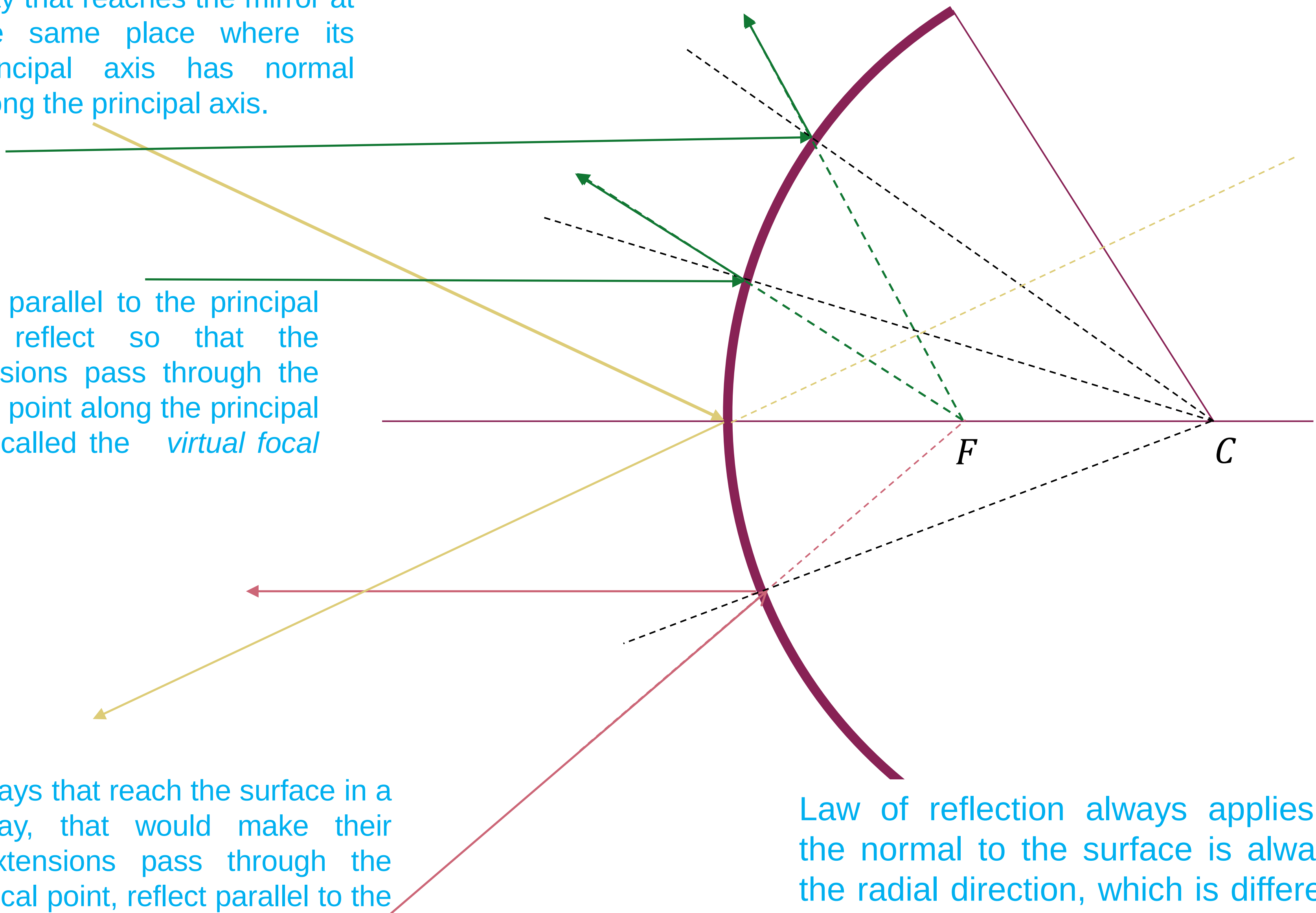



$f = \frac{R}{2}$

# 23.2 Convex Mirrors

Ray that reaches the mirror at the same place where its principal axis has normal along the principal axis.

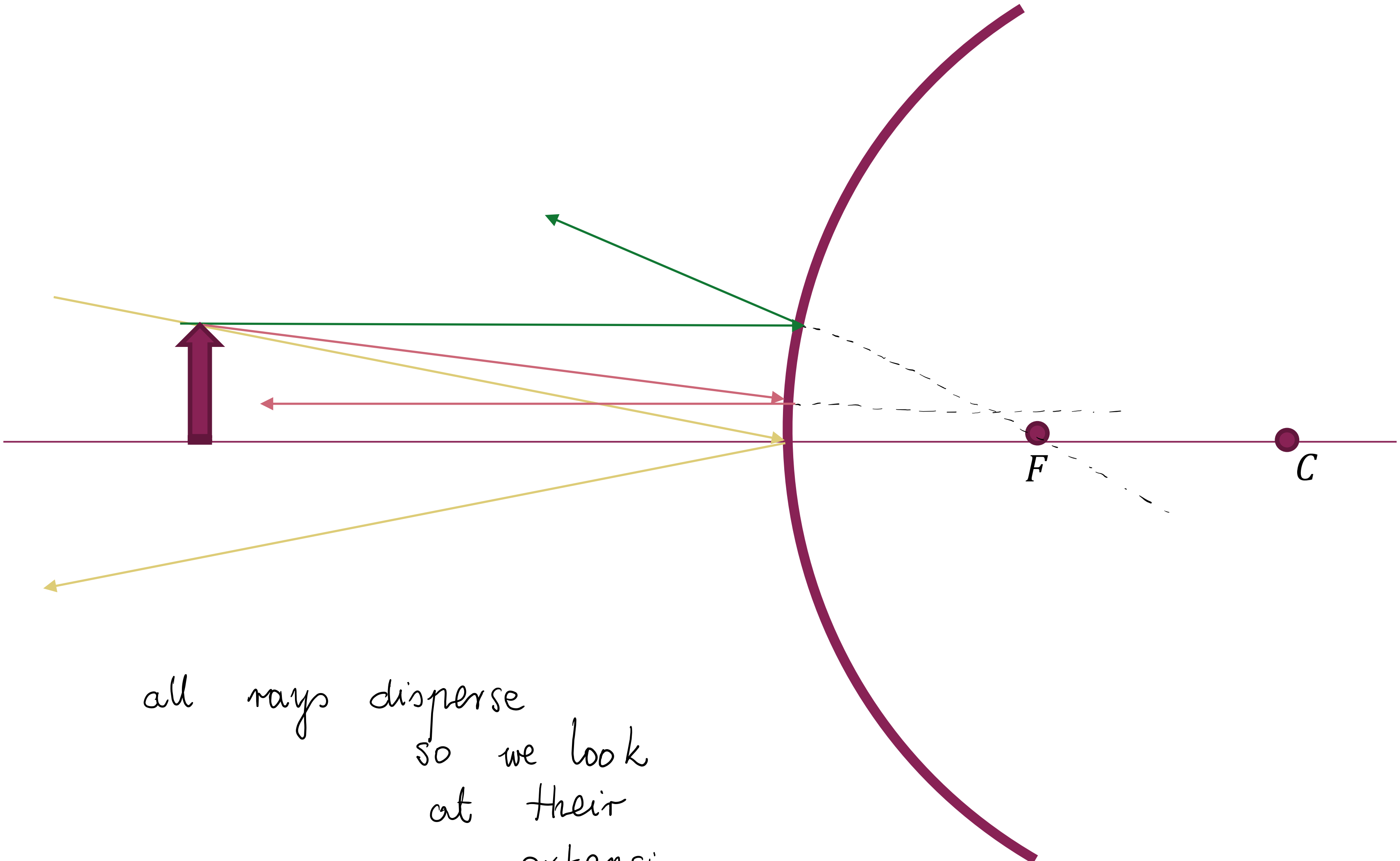
Rays parallel to the principal axis reflect so that the extensions pass through the same point along the principal axis, called the *virtual focal point.*




Rays that reach the surface in a way, that would make their extensions pass through the focal point, reflect parallel to the surface

Law of reflection always applies, but the normal to the surface is always in the radial direction, which is different at each point

# 23.2 WHAT DO YOU SEE?




all rays disperse so we look at their extensions

# 23.2 Creating an Image