Unit 3: Chapter 5

Reflection

The Law of Reflection

- To show how light is reflected from a solid surface, we can use ray diagrams. A ray diagram has 5 main components:

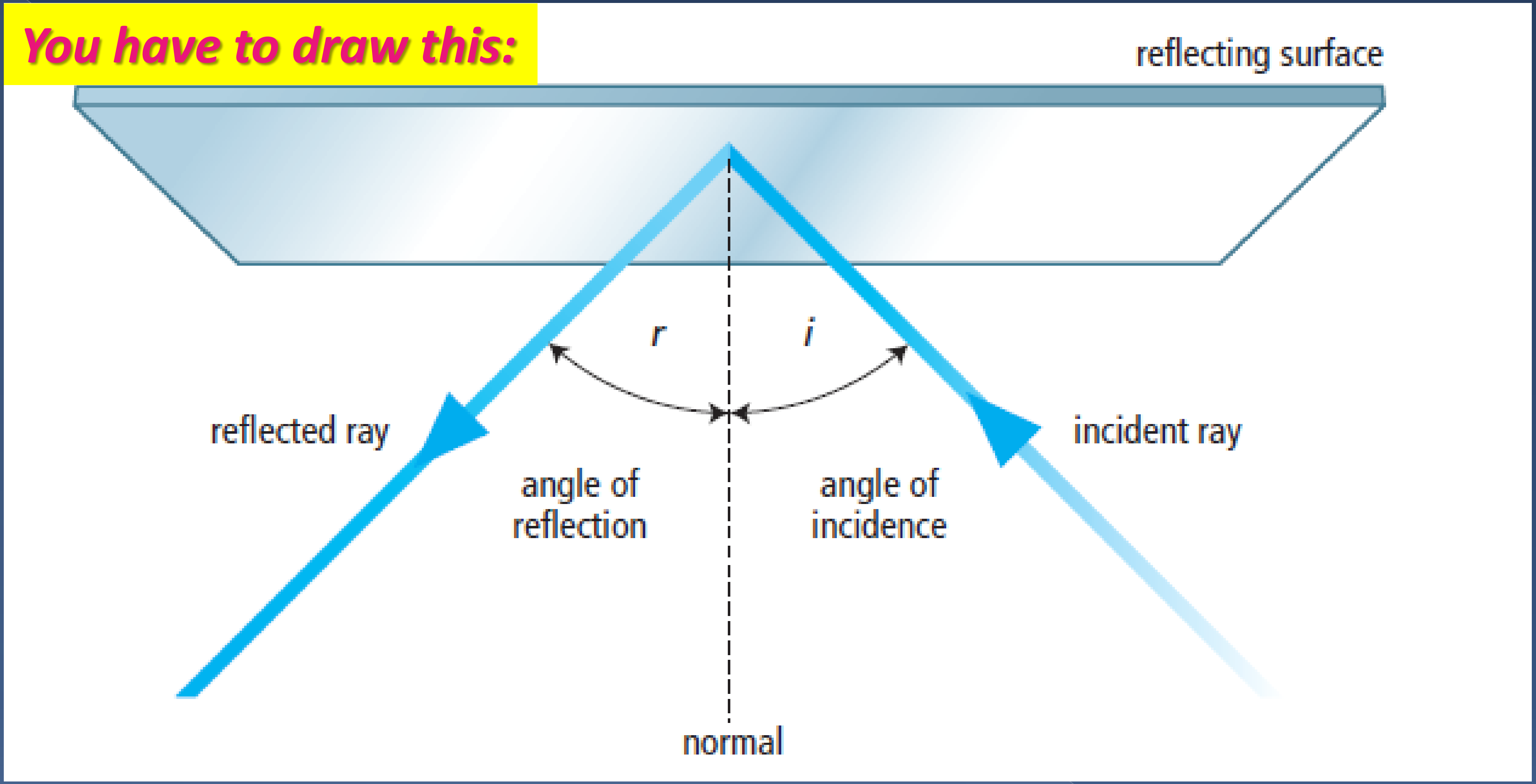
1. ***The incident ray:*** this is the incoming ray that will hit the solid surface/barrier (e.g. a mirror)

2. ***The reflected ray:*** the ray that bounces off the barrier.

3. ***The normal:*** this is the imaginary line that is perpendicular (remember this means *at a right angle to*) to the barrier. We use the normal to explain how the waves reflect

4. ***The angle of incidence:*** the angle between the incident beam and the normal. We always label this angle "i"

5. ***The angle of reflection:*** the angle formed between the reflected beam and the normal. We always label this angle "r".



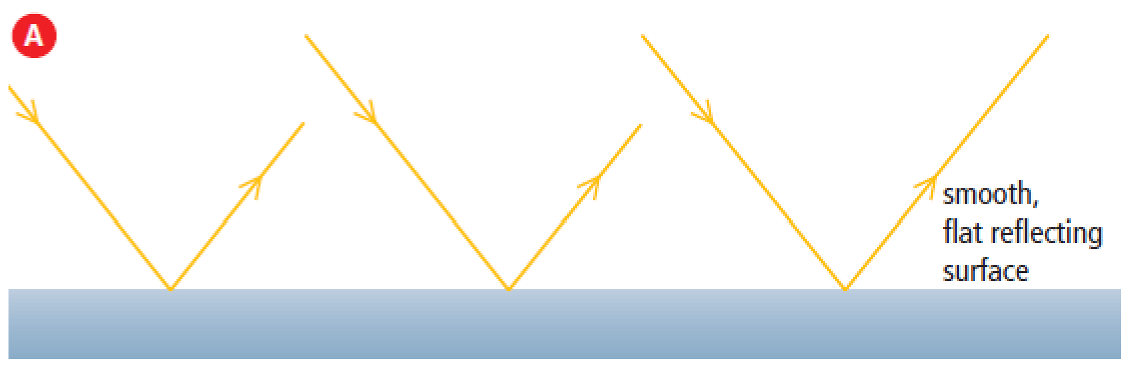
Law of reflection: the angle of reflection equals the angle of incidence.

http://www.freezeray.com/flashFiles/Reflection1.htm

Remember:

- ***Specular reflection*** (reflection from a mirror-like surface)
  - A clear image is produced.
  - For a surface to act as a mirror and produce specular reflection, it must be smooth ***compared to the wavelength of the light striking the surface.***

You have to draw this:

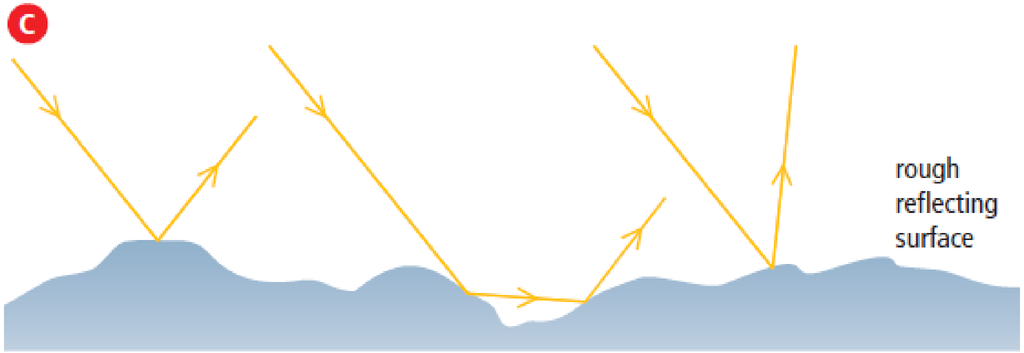


(A) Specular reflection: Smooth surfaces reflect all light uniformly.

- ***Diffuse reflection*** (reflection from a rough surface).
  - No clear image produced, but you can see the surface the light is bouncing off.
  - Light bounces off in random directions
  - Example: A piece of paper (the black ink absorbs all the light and the white paper reflects all the light in random directions)

You have to draw this:

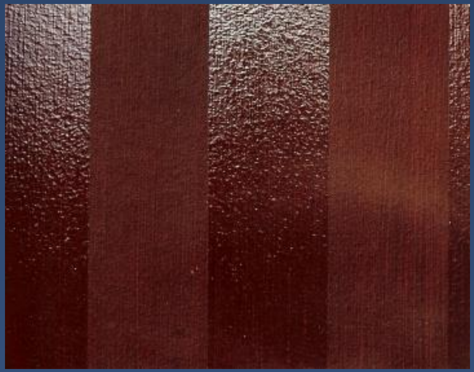
(B) Scanning electron micrograph of the surface of paper



(C) Diffuse reflection: Rough surfaces appear to reflect light randomly.

How Do We Use Specular and Diffuse Reflection Everyday?

- Matte paints (diffuse reflection)
- Glossy paints (specular reflection)



- Countertops

- Furniture or car wax

- Glazed vs. unglazed ceramics

- Matte vs. glossy photographs
- Stealth bombers – made of specular materials so that they reflect their surroundings and are more difficult to see.

Types of Mirrors

1. ***Plane mirrors***: a flat, smooth mirror (specular).

   Ex: a regular bathroom mirror.

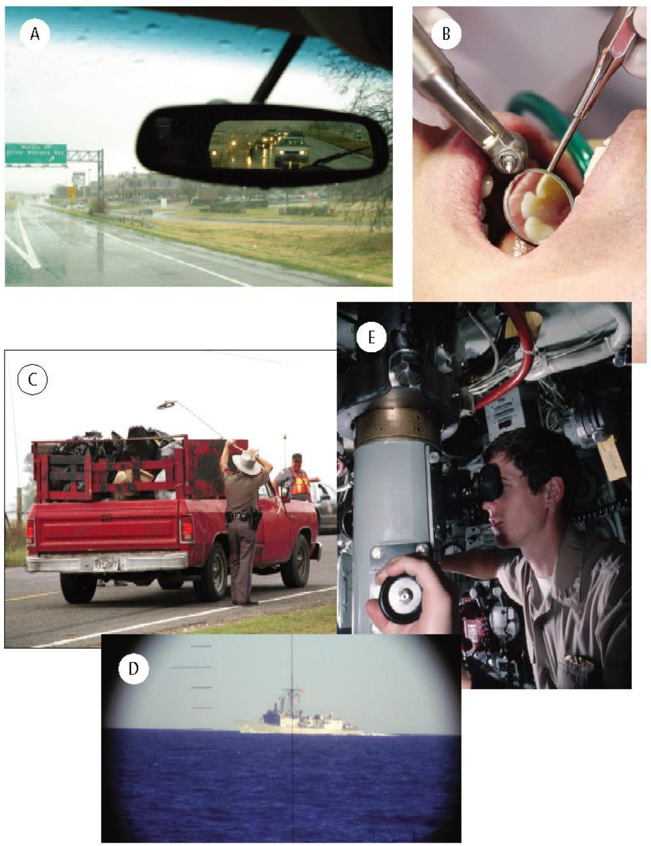
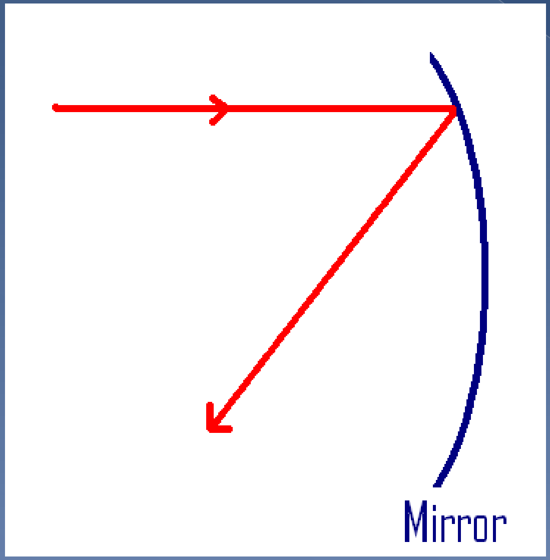


Figure 5.20 Some mirrors are just for convenience. However, many mirrors have a very important function. (A) A driver needs a rear view mirror to see what is behind the car without turning all the way around. (B) The dentist needs a dental mirror to see the inside of your teeth in order to find cavities or other problems. (C) Truck inspectors need a vehicle inspection mirror to see if anything that doesn't belong on the truck is on it. (D) Submarine captains need a small tube containing mirrors, called a periscope, to see if there are any ships nearby. (E) The sailor inside the submarine can see the reflected image of a nearby ship in the periscope, but people in the ship cannot see the submarine.

2. ***Concave mirrors:*** have a reflecting surface that curves inward like the inside of a bowl or sphere. The curved surface of the mirror reflects light in a unique way, creating an image that differs from the object being reflected (a "stretched" image). Ex: the inside of a metal spoon.



3. ***Convex mirrors:*** a mirror that curves outward, like the outside of a bowl or sphere. The images in these mirrors are also distorted. Ex: the safety mirror on the front of a school bus.

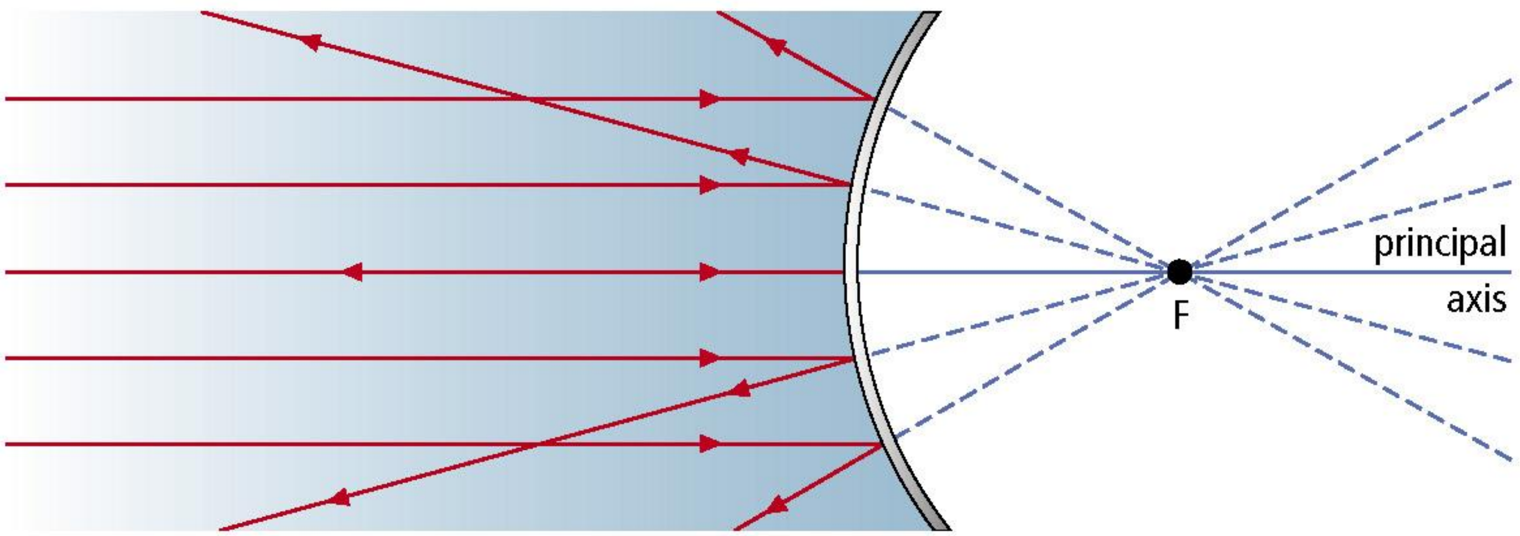
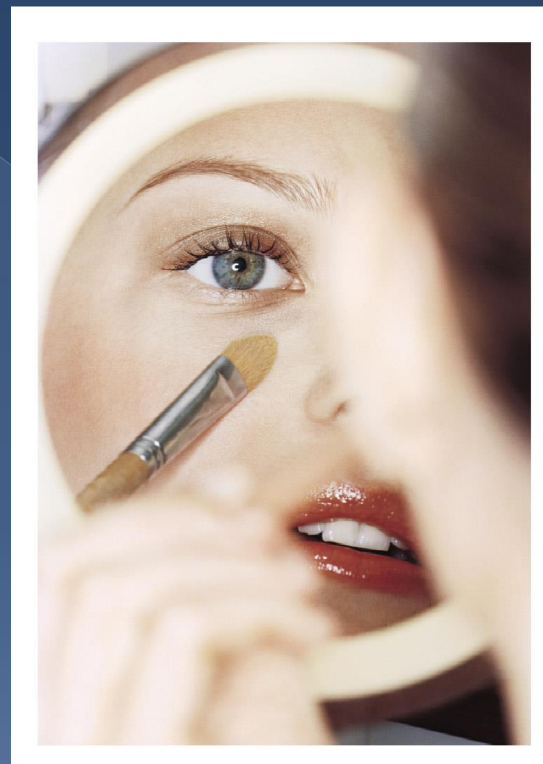
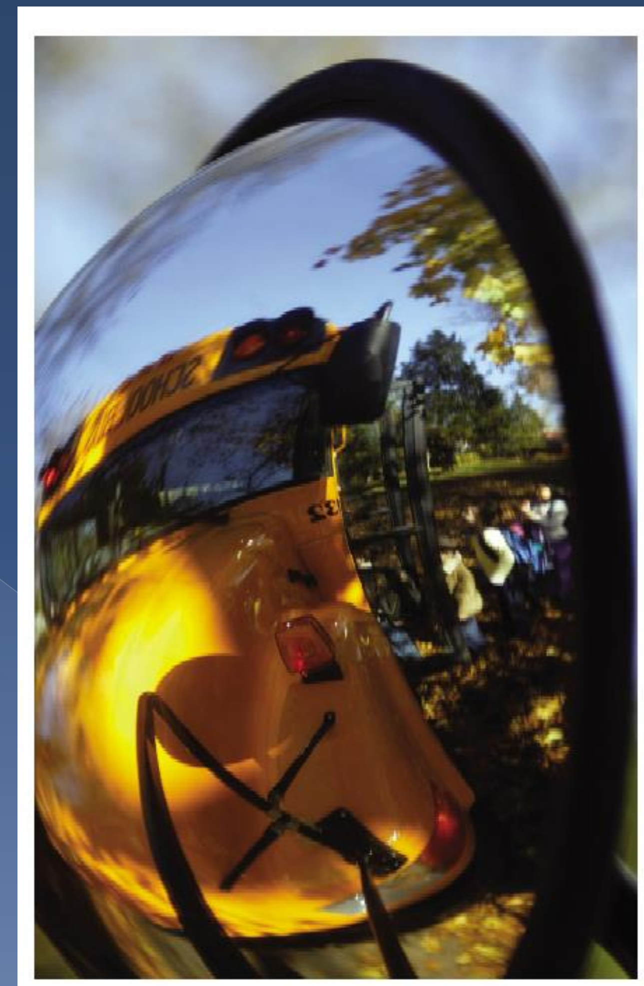


Figure 5.32 The focal point for a convex mirror is always behind the mirror. Nevertheless, you can use it to draw ray diagrams.

Plane Concave Convex






CONVEX MIRROR
PLANE MIRROR
CONCAVE MIRROR


kittehs help wif science
convex kitteh
concave kitteh
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Images in a Plane Mirror

- The angle of incidence and the angle of reflection are always equal (***law of reflection***) http://www.youtube.com/watch?v=2ek0EsEMTBc

- The image and the object distance from the mirror are always equal. http://www.freezeray.com/flashFiles/planeMirror.htm

Ray Diagram of a Plane Mirror

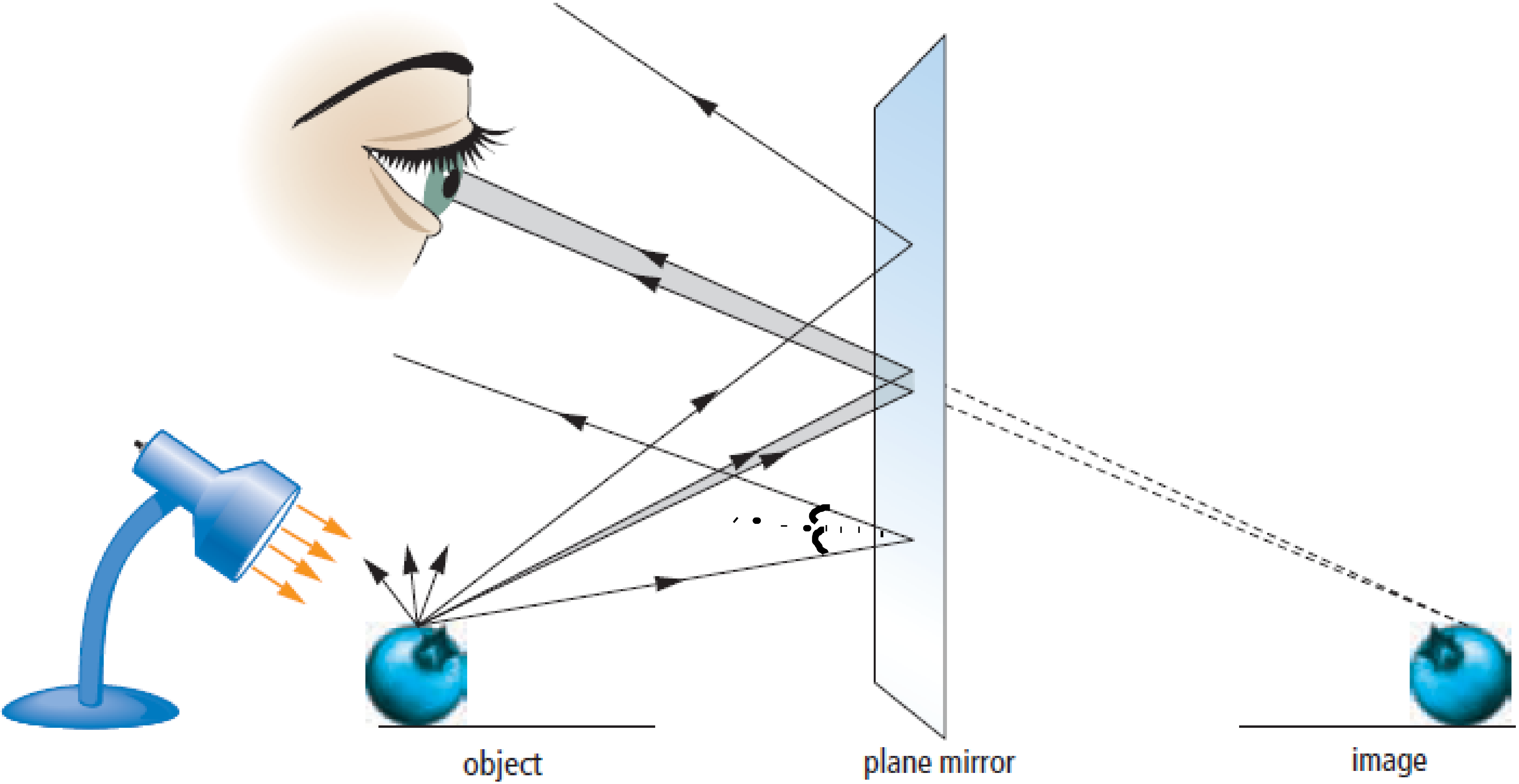


Figure 5.18 Only a small fraction of the light reflecting from an object enters the eye of the observer.

- https://www.youtube.com/watch?v=vt-SG7Pn8UU

- Bookwork: page 195 #'s 1-5

Reflection Lab

- Page 192-193.

Program Video Series on Light

- http://www.infocobuild.com/books-and-films/science/light-fantastic.html

Images in Concave Mirrors

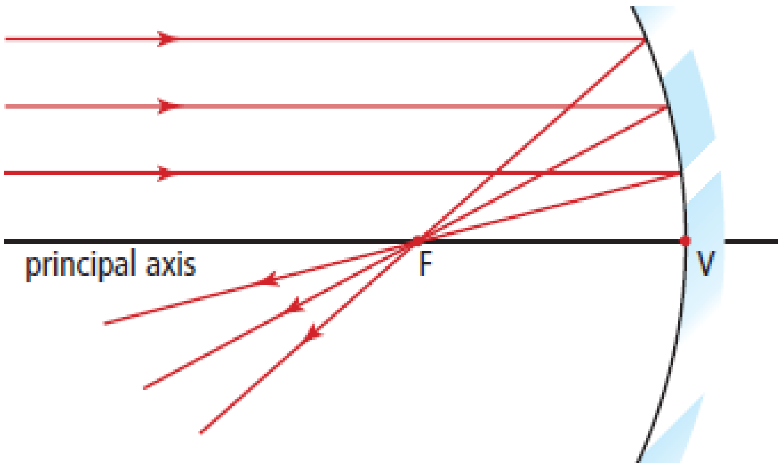
Reflected light rays travel toward each other, or converge.

Principal axis ***– the line normal to the centre of the mirror***

Vertex *– the point at which the principal axis meets the mirror*

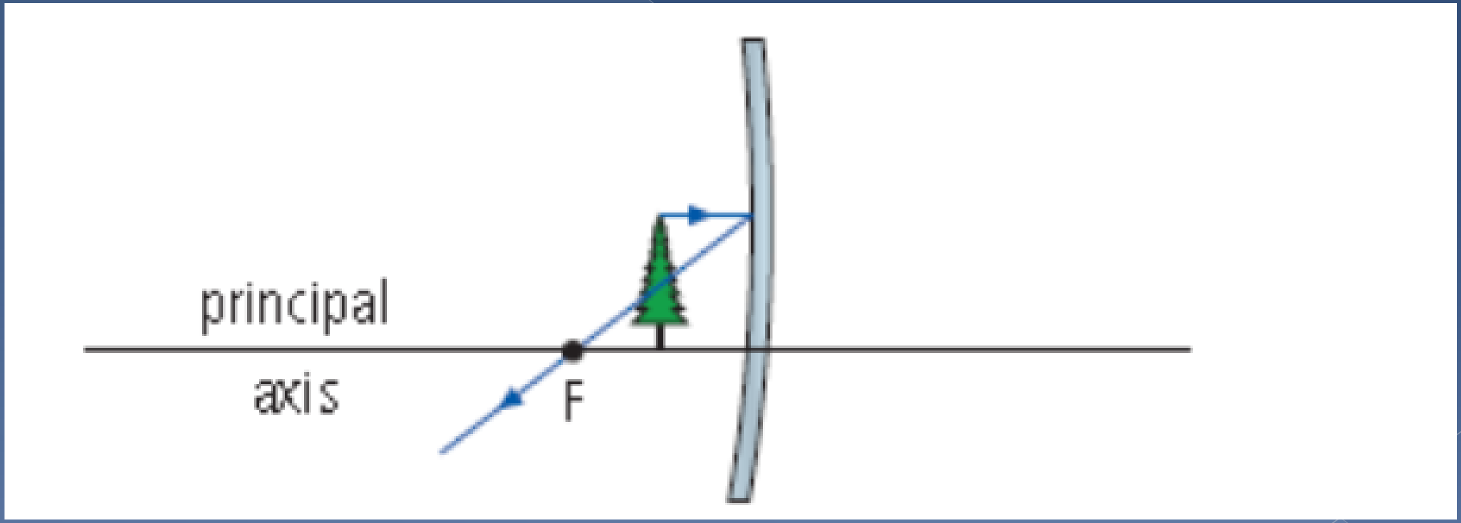
If you then draw rays of light approaching the mirror parallel to the principal axis, you will see that all of the reflected rays intersect at one point. This is the ***focal point*** (F)

Figure 5.23 The principal axis is normal to the centre of the concave mirror. Rays that are parallel to this axis will all reflect through the focal point.

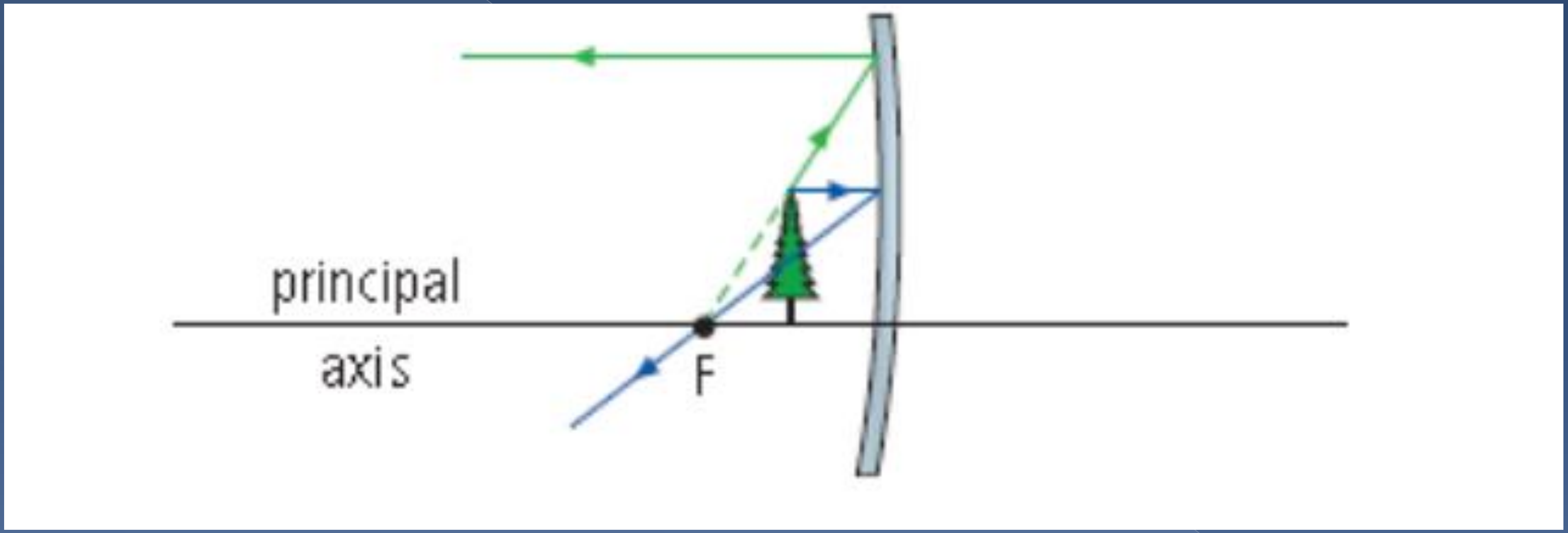


Object is between Focal point and Mirror Page 198

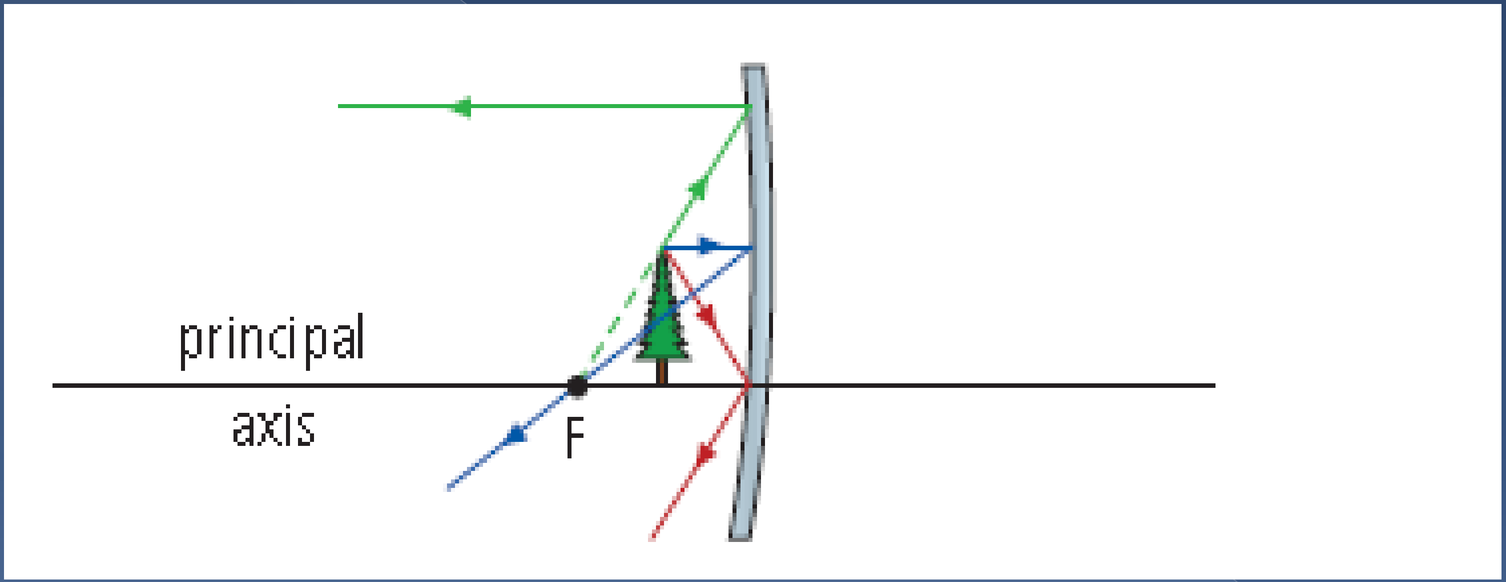
Step 1: Draw a ray parallel to the principal axis, from the top of the object to the mirror, with the reflected ray passing through the focal point.



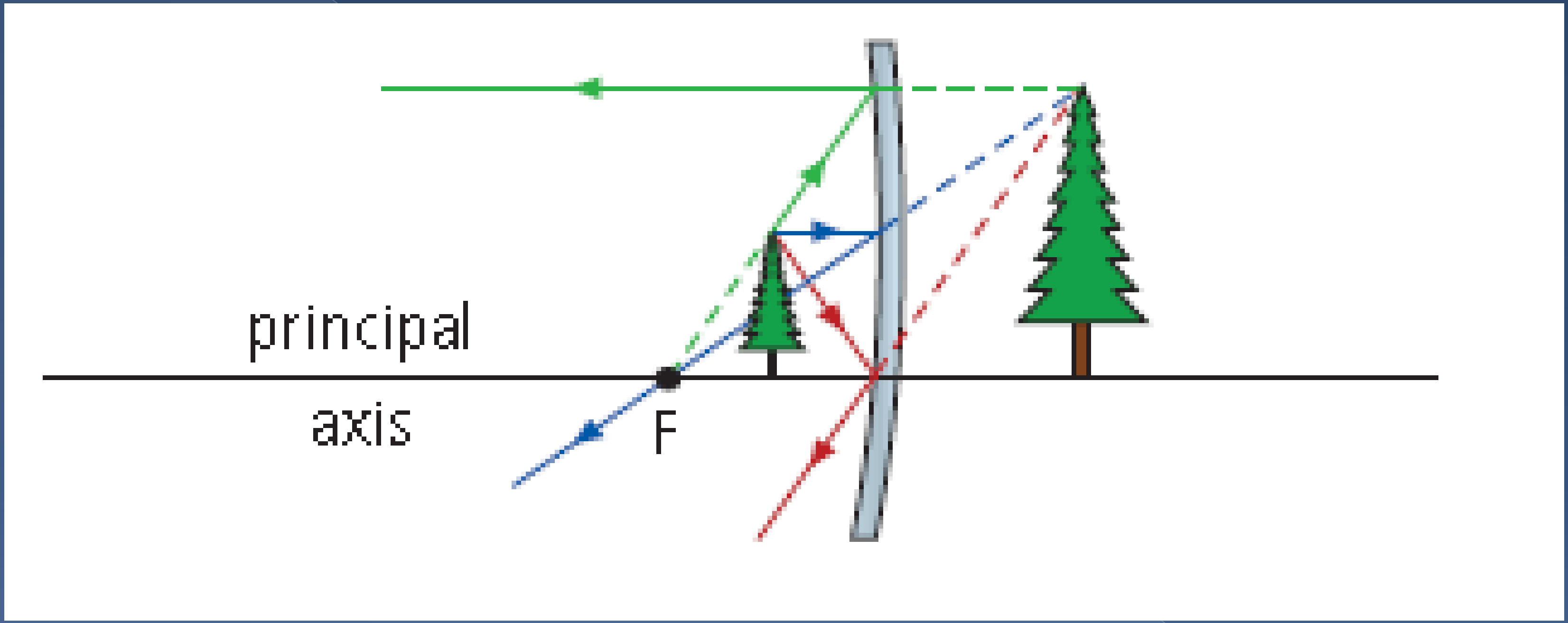
Step 2: Draw a ray from the focal point, to the top of the object then all the way to the mirror, with the reflected ray parallel to the principal axis.



Step 3: Draw a ray from the top of the object travelling to the vertex and reflecting at the same angle.

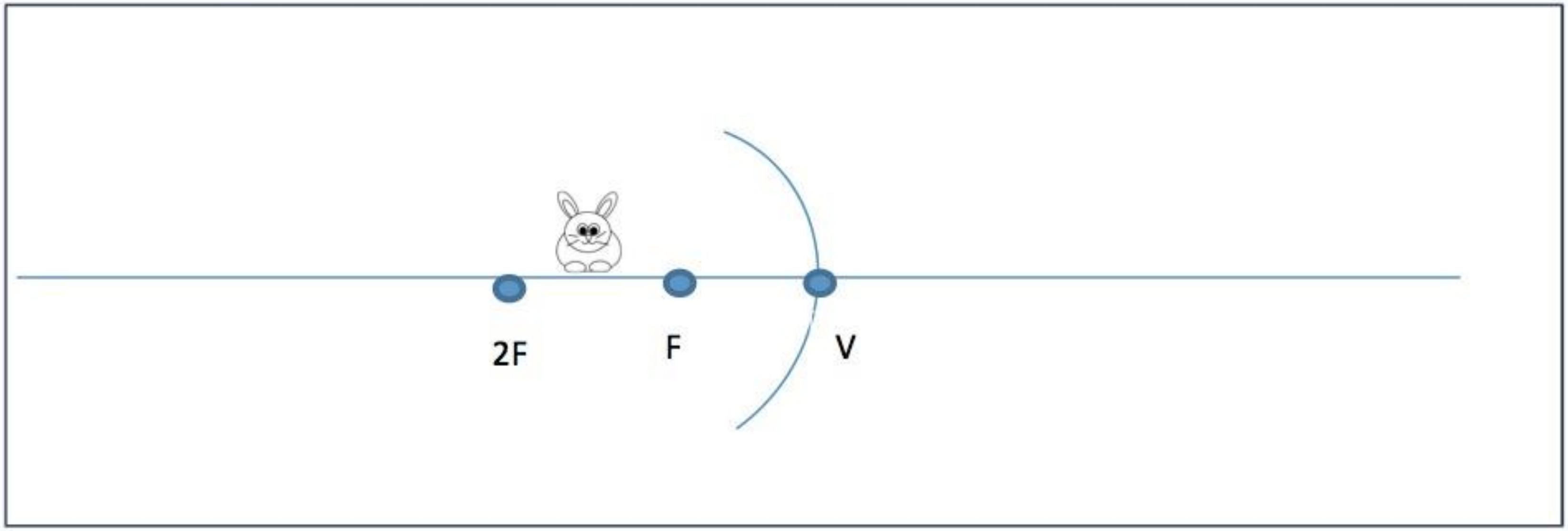


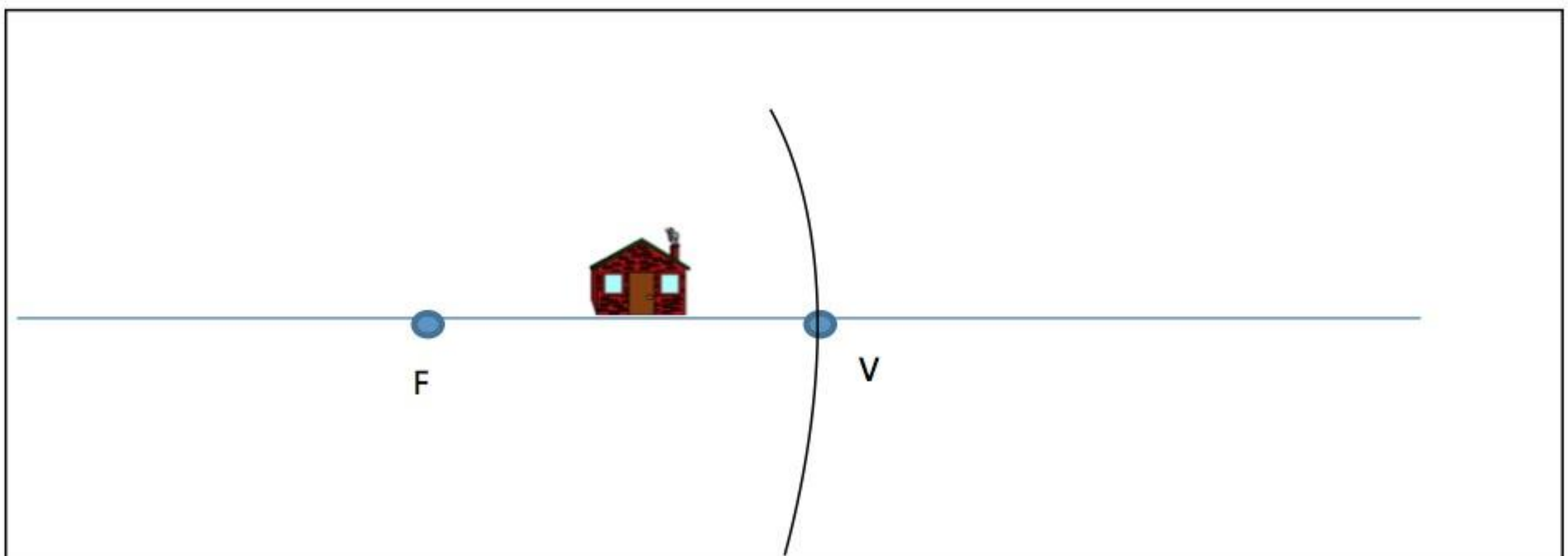
Step 4: Extend all of the ***reflected rays*** behind the mirror. The point where they cross over is the top of your image.

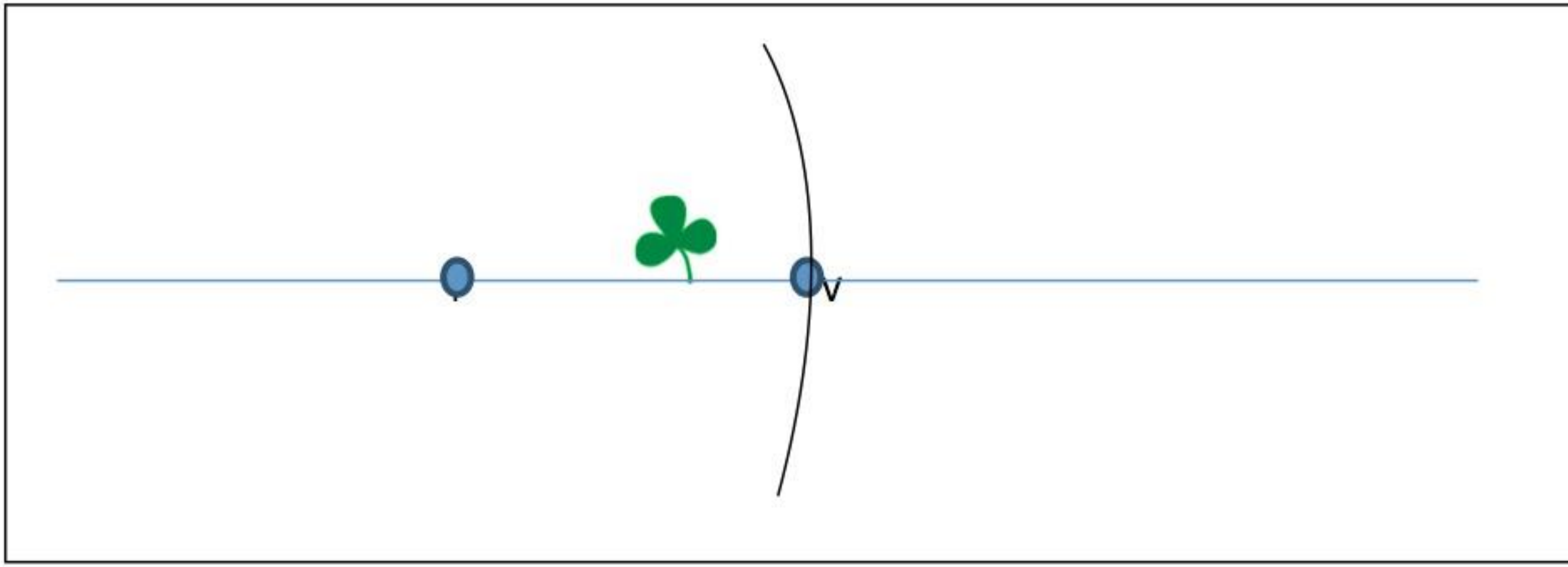


The image will be…	
1. **S**ize	Larger
2. **P**osition	Farther
3. **O**rientation (upright or inverted)	Upright
4. **T**ype of Image (Real or virtual?)	Virtual

YOU TRY IT!



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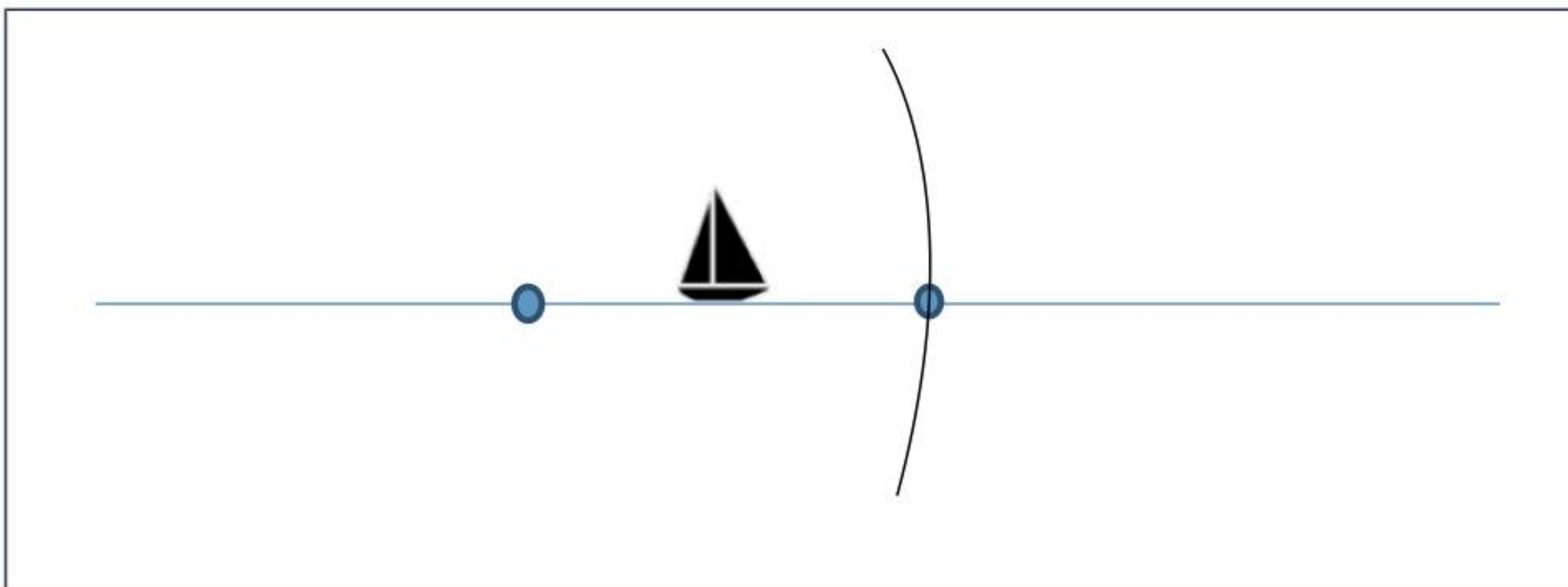
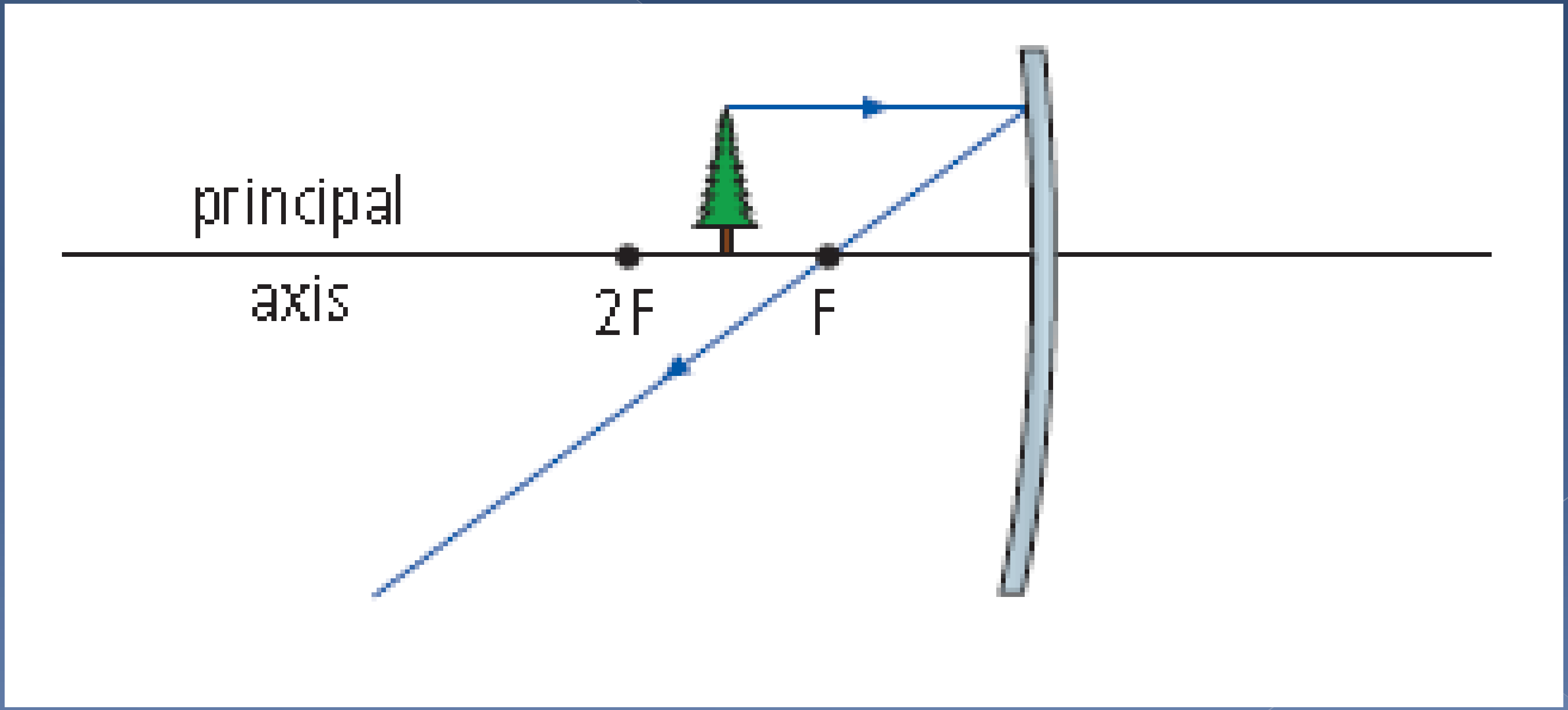
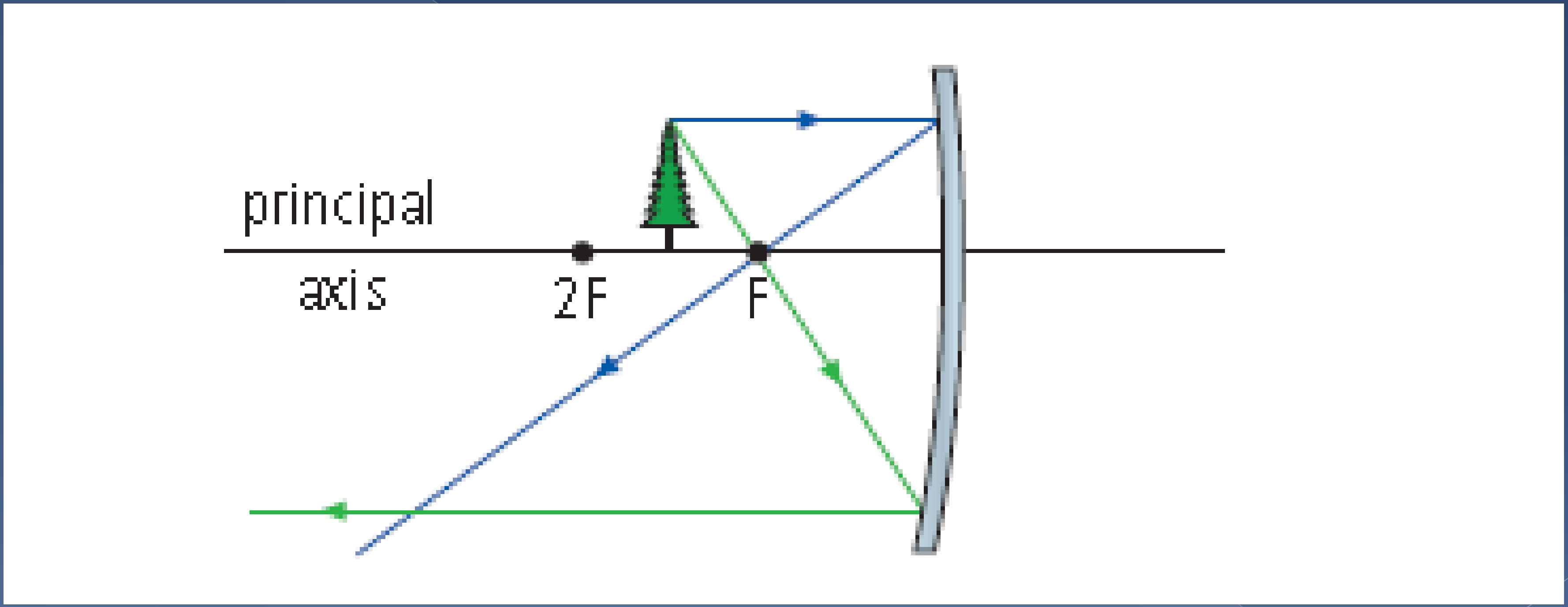


Object is between the focal point and 2X the focal length. Page 200.

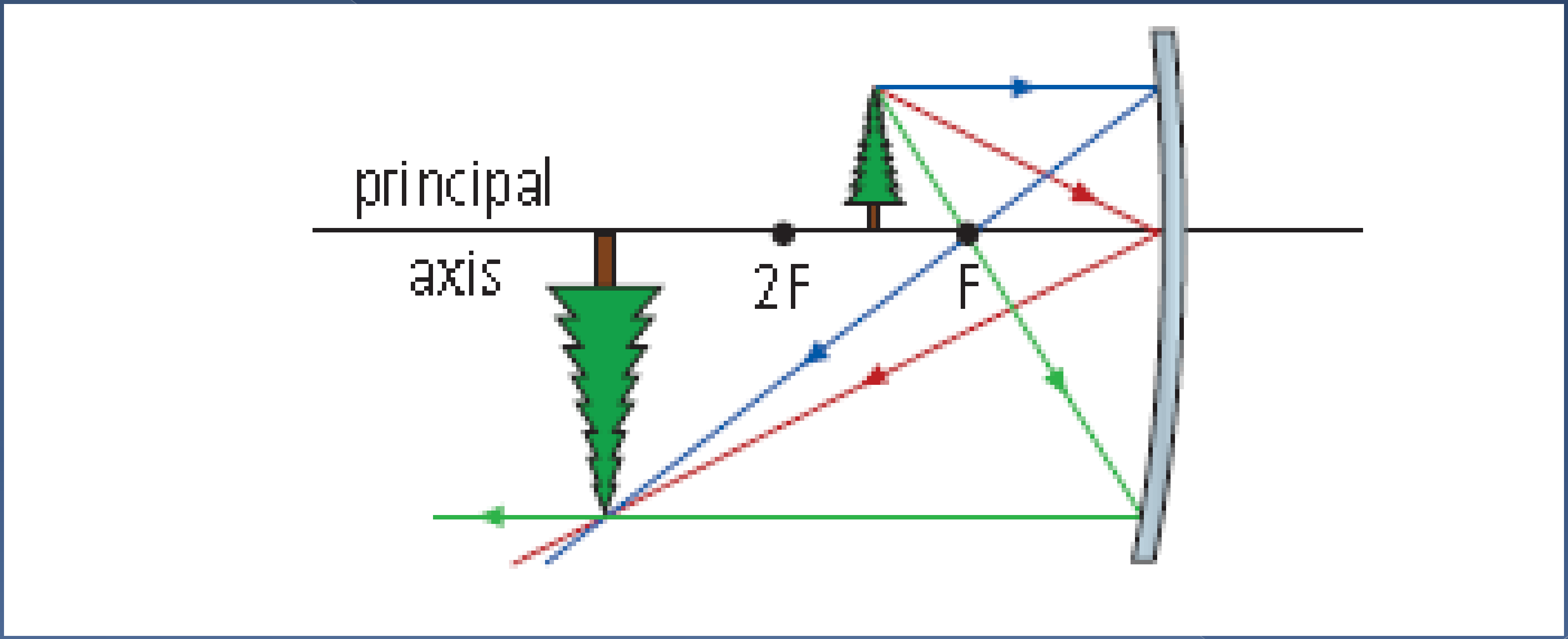
Step 1: Draw a ray parallel to the principal axis, with the reflected ray passing through the focal point.



Step 2: Draw a ray through the focal point, with the reflected ray parallel to the principal axis.



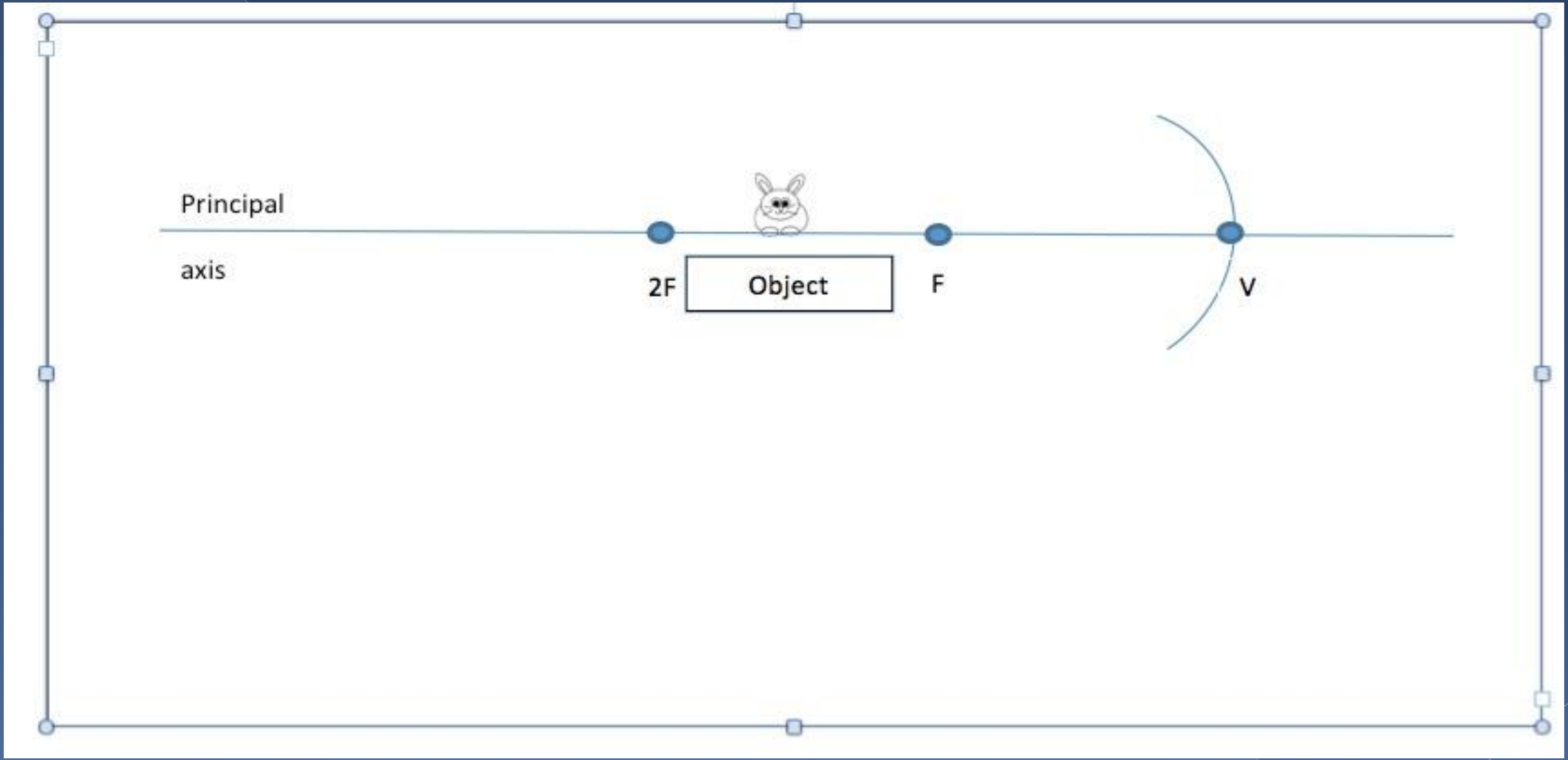
Step 3: Draw a ray travelling to the vertex and reflecting at the same angle.

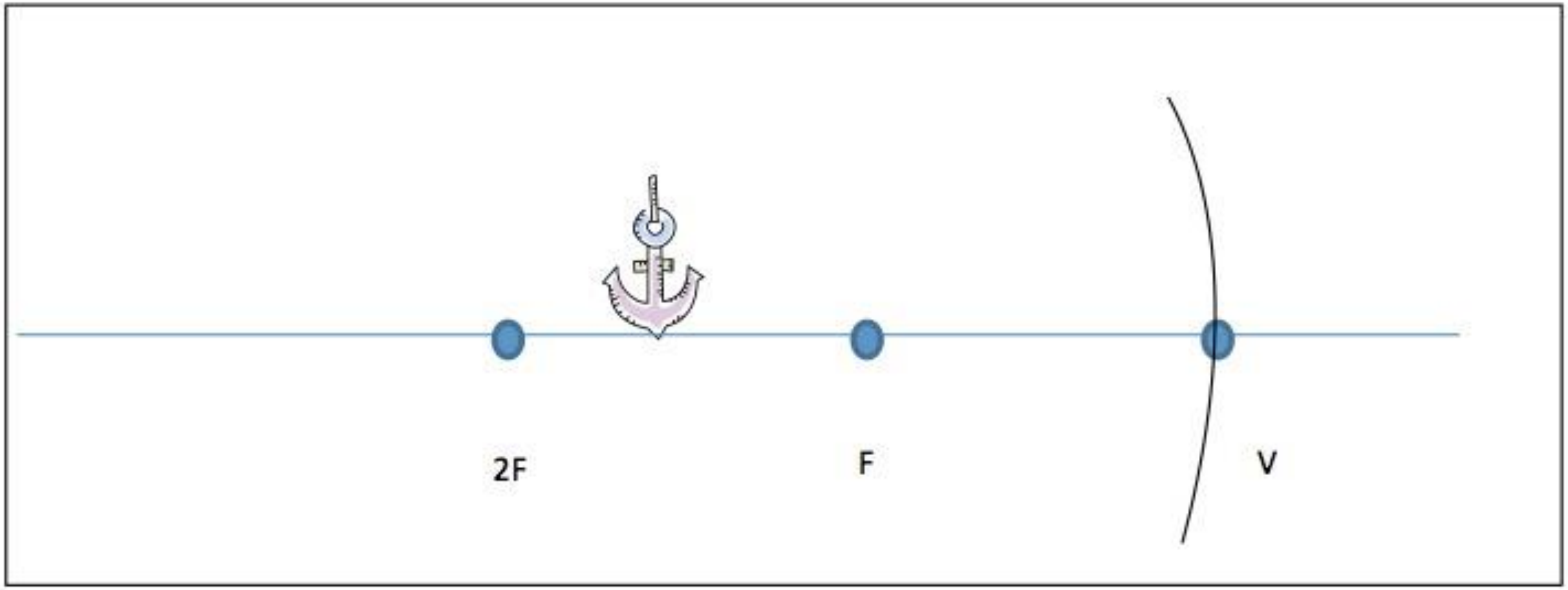


Step 4: You do not have to extend your rays here – the reflected rays all intersect, so the top of your image is the point where the three rays cross.

The image will be…	
1. **S**ize	Larger
2. **P**osition	Farther
3. **O**rientation (upright or inverted)	Inverted
4. **T**ype of Image (Real or virtual?)	Real

YOU TRY IT!

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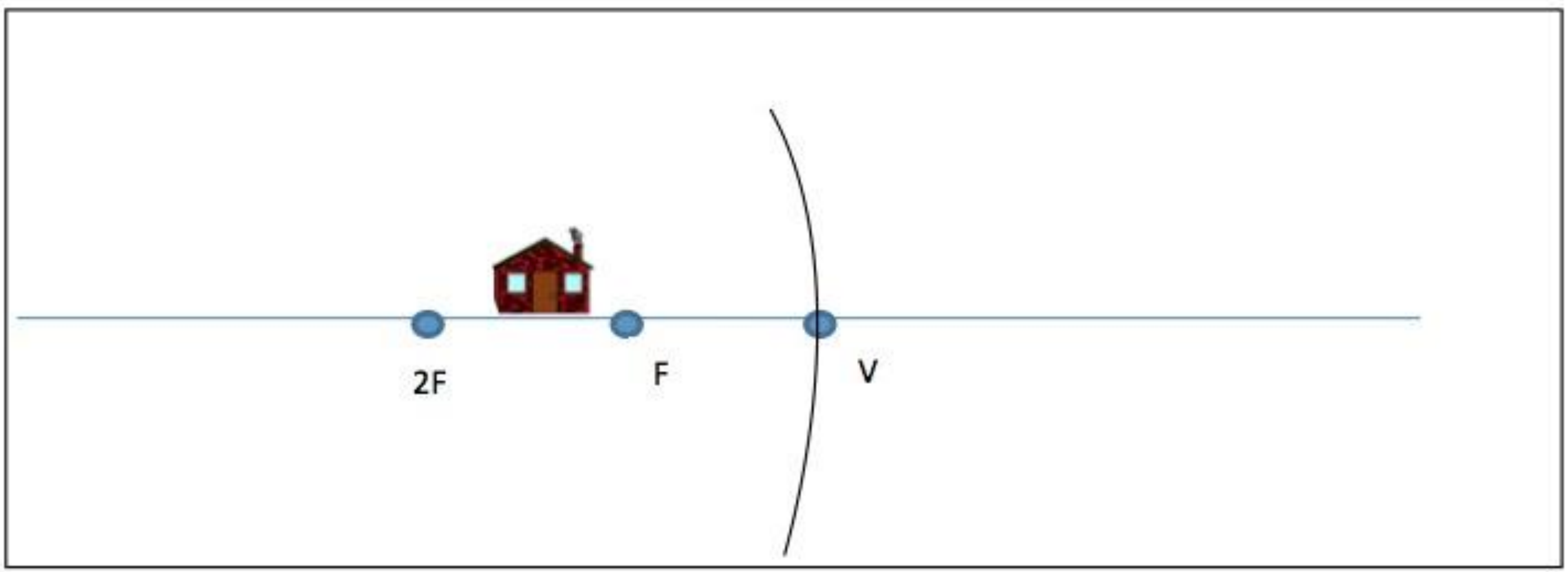
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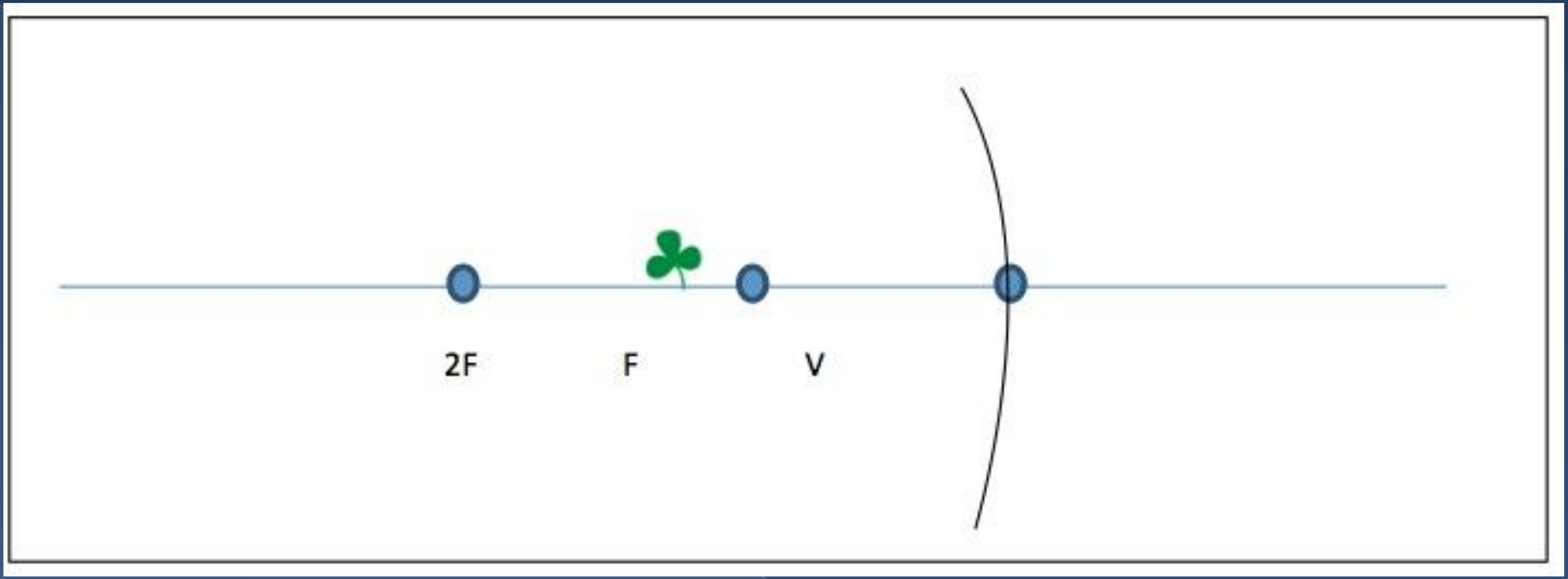
2F
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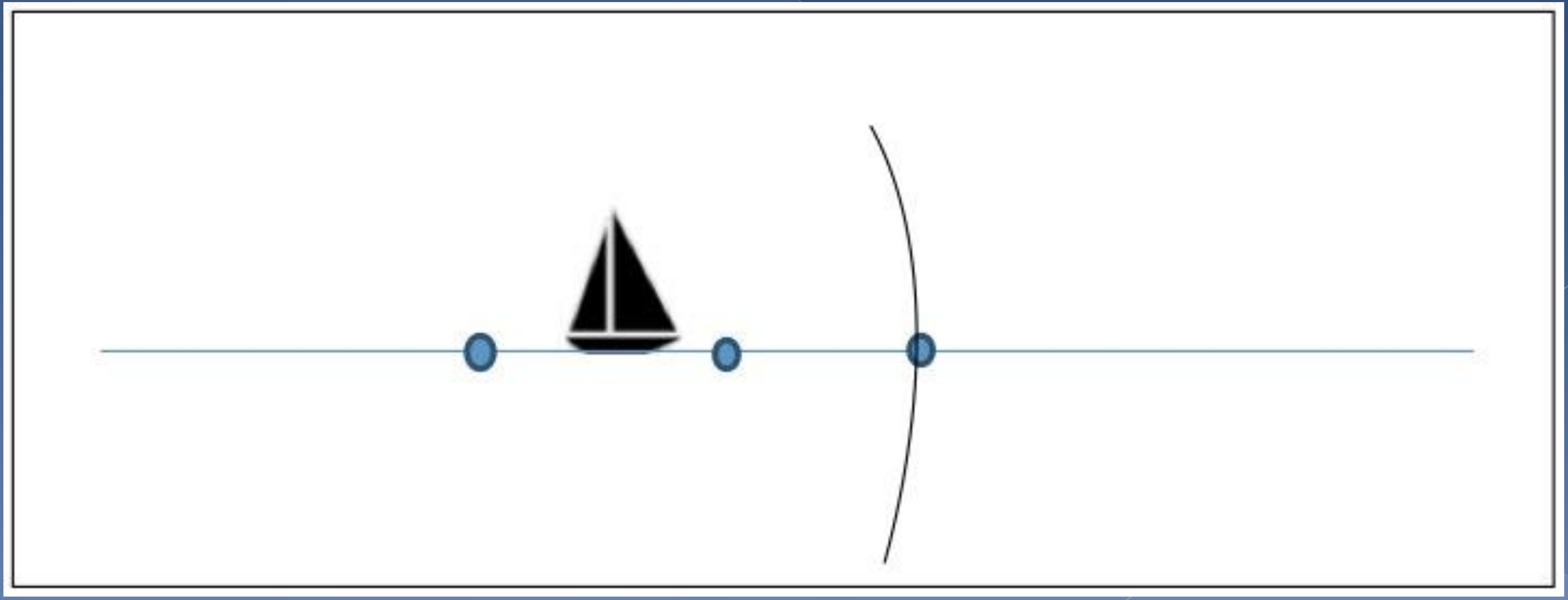


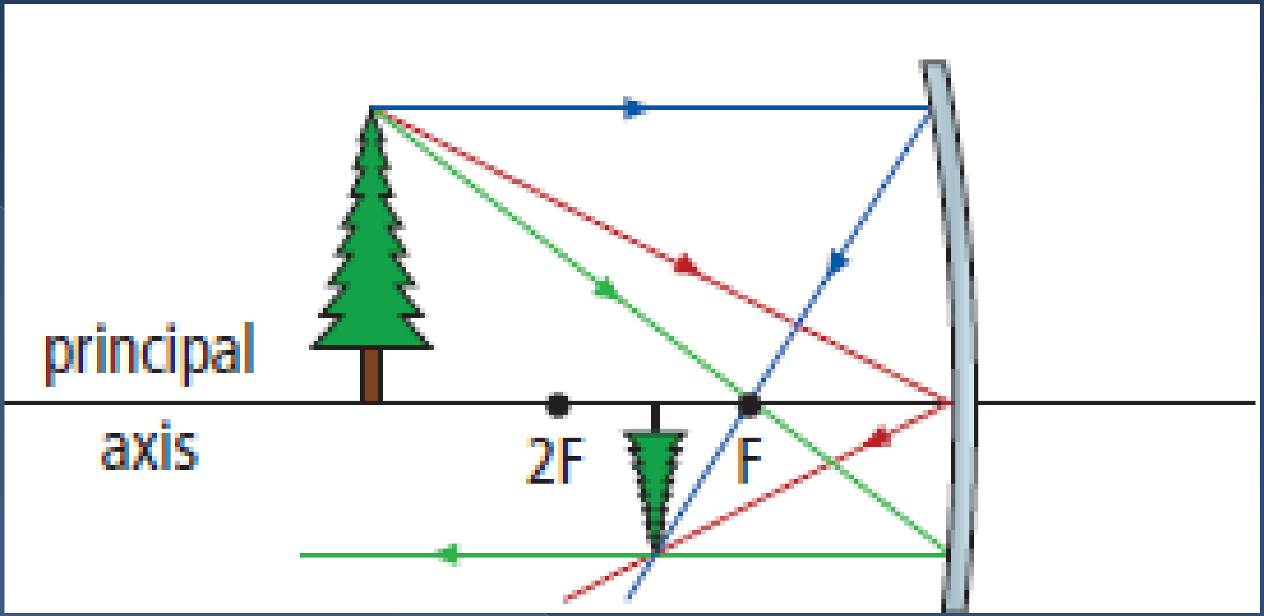
Object is beyond 2X the focal length. P. 202

Step 1: Draw a ray parallel to the principal axis, with the reflected ray passing through the focal point.

Step 2: Draw a ray through the focal point, with the reflected ray parallel to the principal axis.

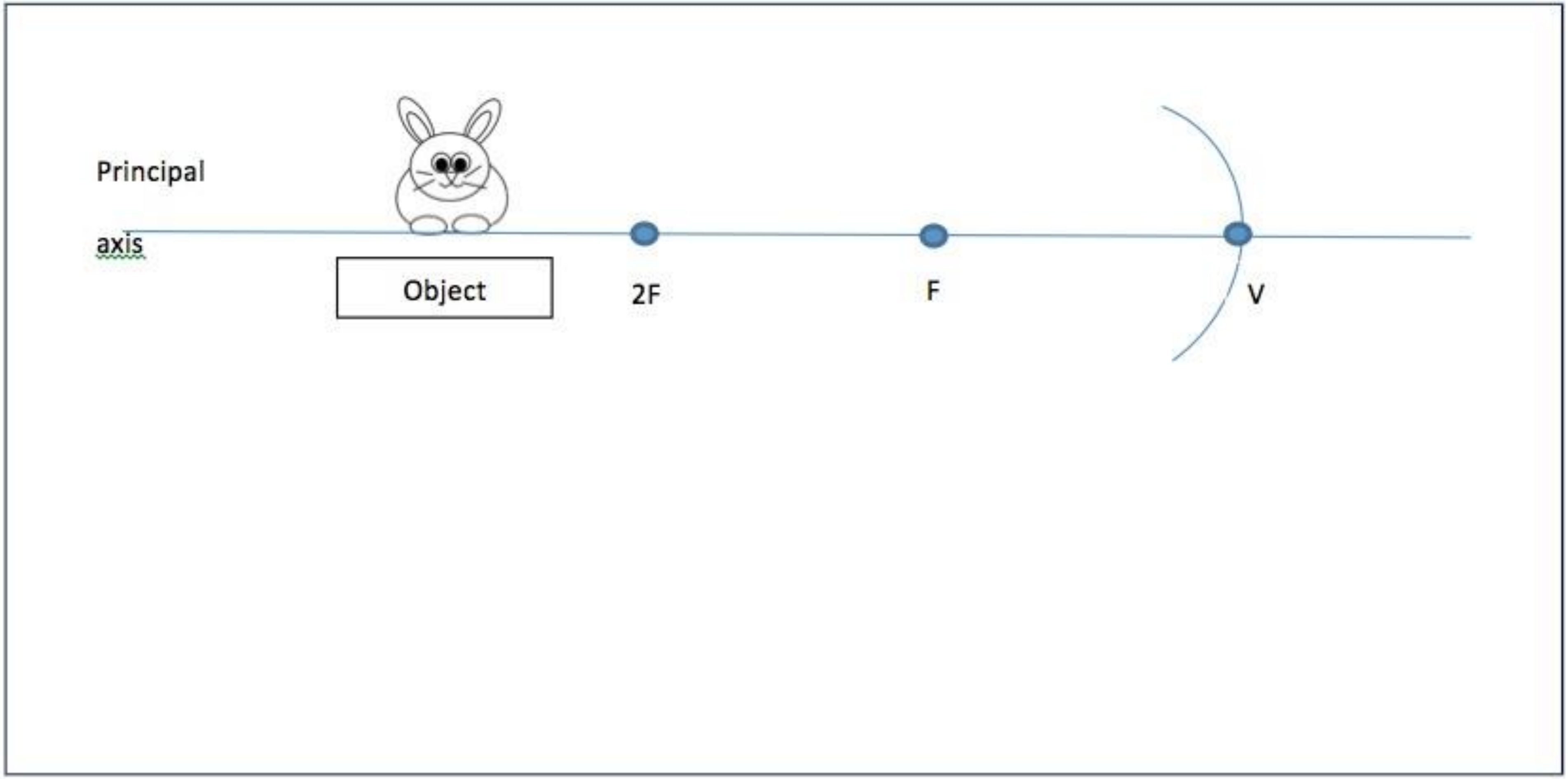
Step 3: Draw a ray travelling to the vertex and reflecting at the same angle.

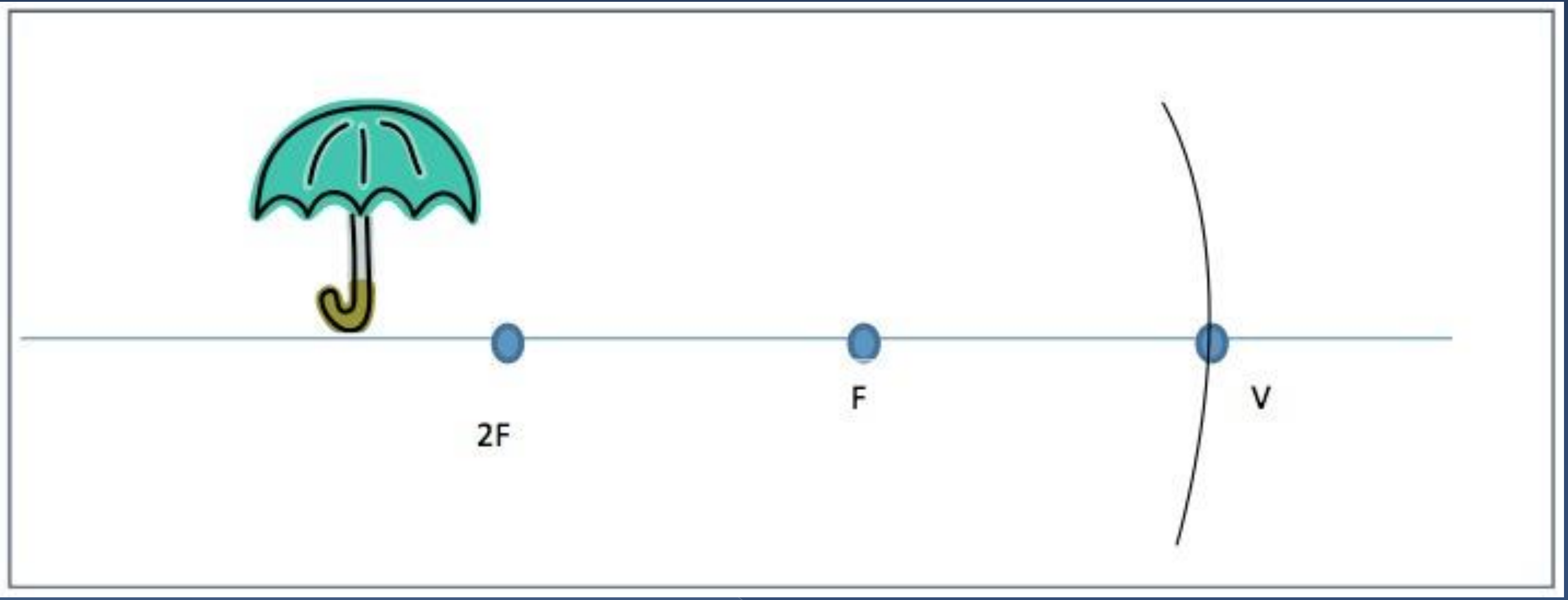
Step 4: You do not have to extend your rays here – the reflected rays all intersect, so the top of your image is the point where the three rays cross.



The image will be…	
1. Size	Smaller
2. Position	Closer
3. Orientation (upright or inverted)	Inverted
4. Type of Image (Real or virtual?)	Real

YOU TRY IT!

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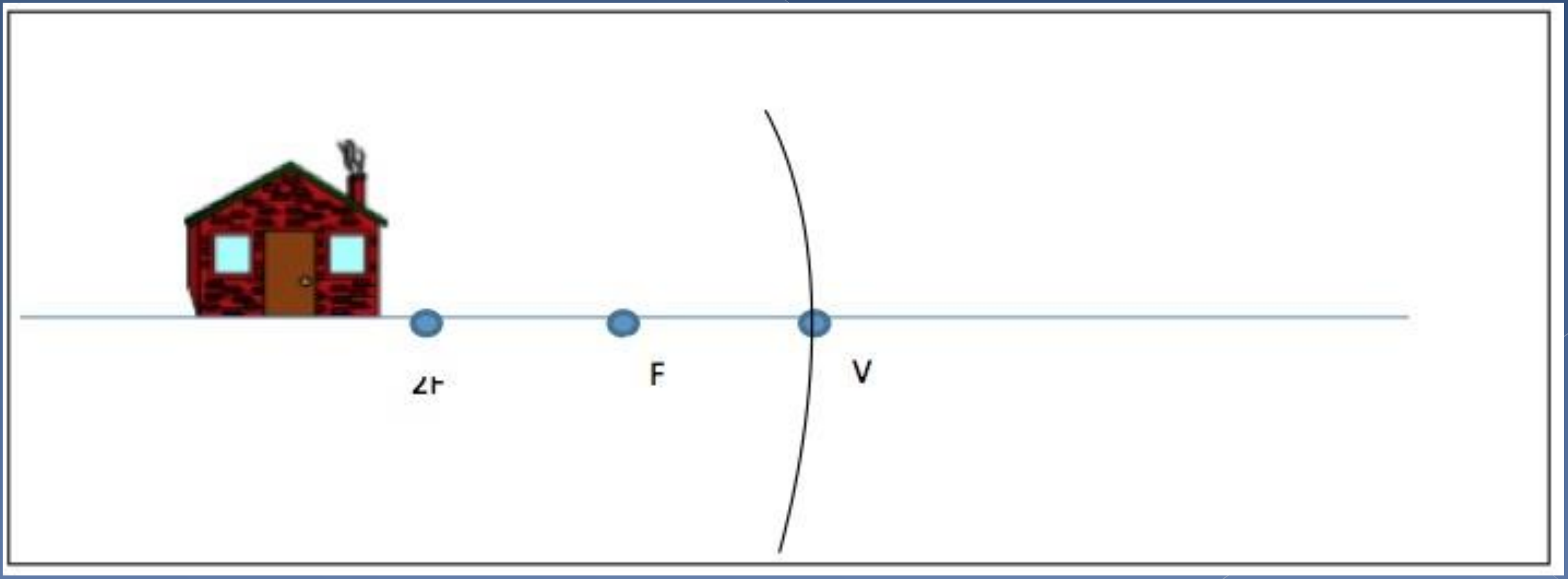
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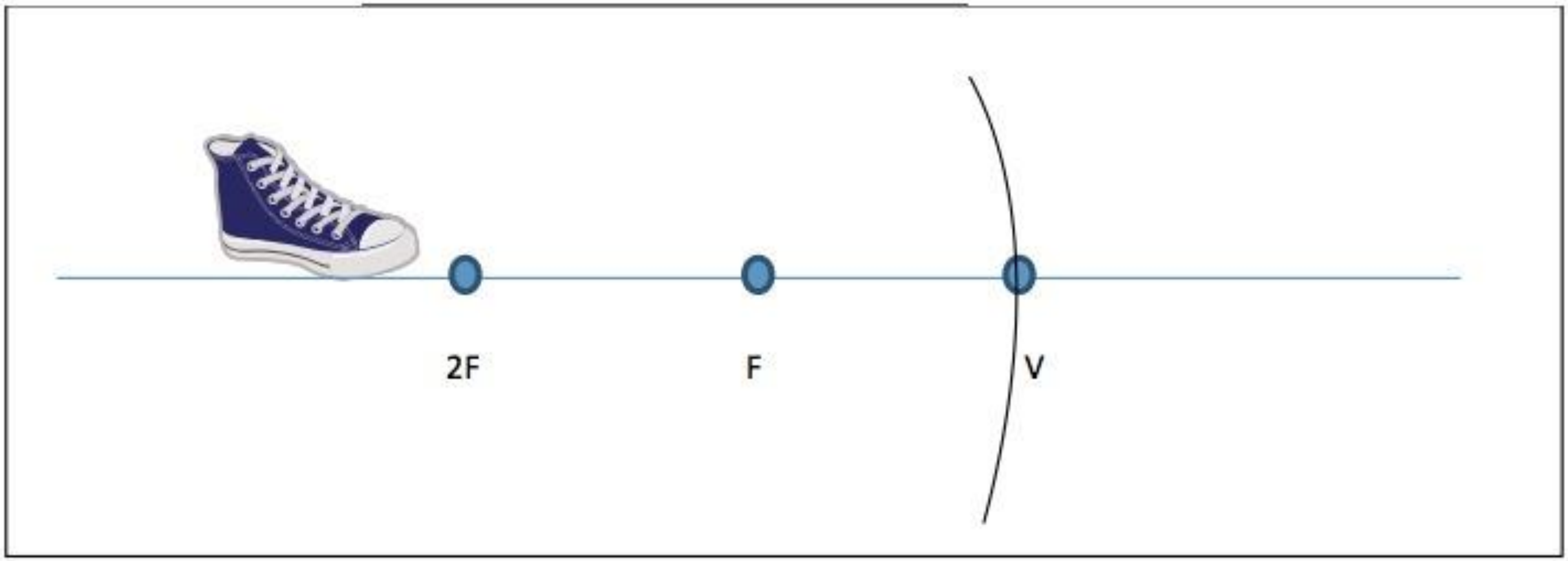
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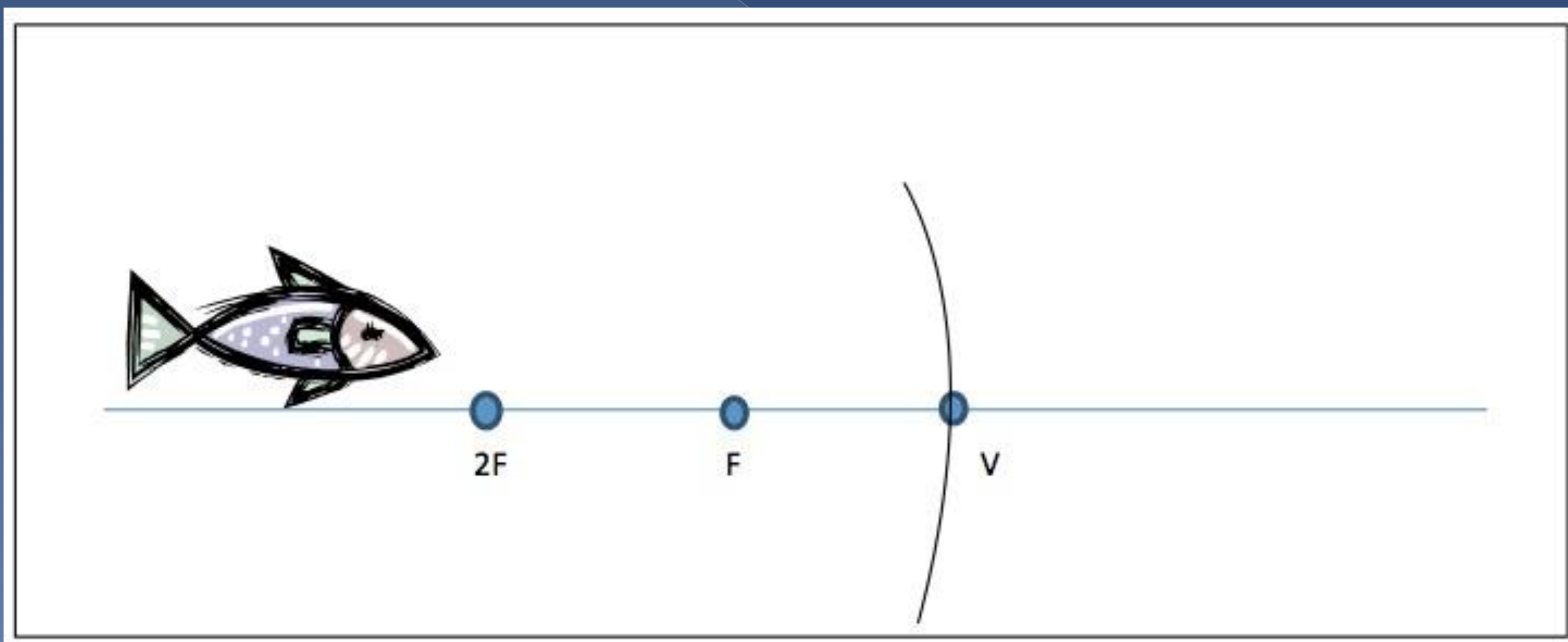

2F
F
V

- Textbook: page 202 #'s 1-2

Images in Convex Mirrors

Reflected rays never meet. But, if you extend the rays ***behind*** the mirror, the extended rays will intersect at the focal point , F.

The focal point for a convex mirror is ***behind the mirror***.

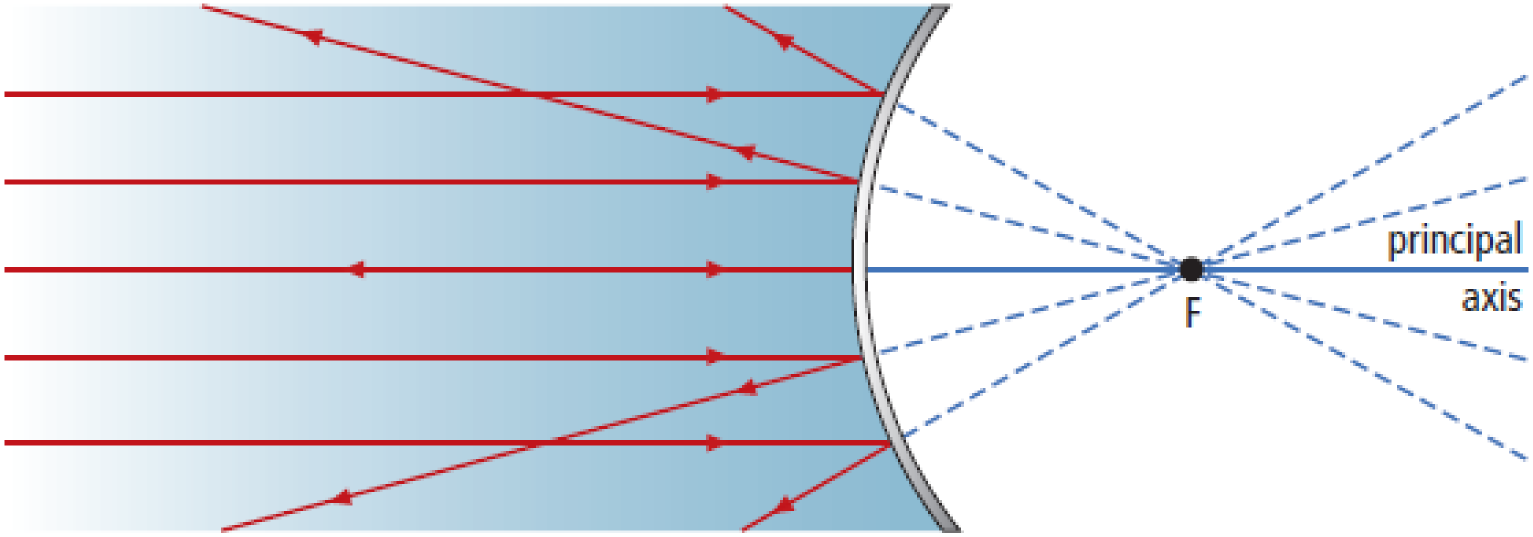


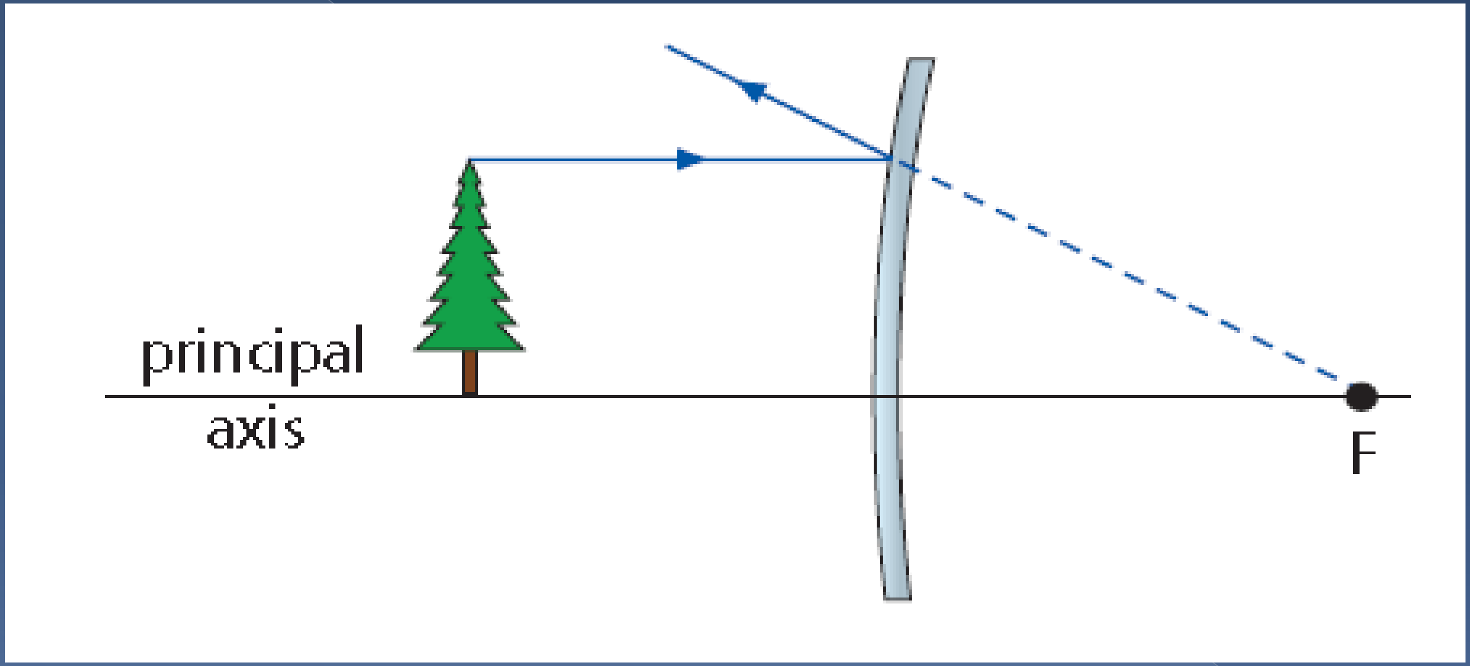
Figure 5.32 The focal point for a convex mirror is always behind the mirror. Nevertheless, you can use it to draw ray diagrams.

Ray diagrams for Convex Mirrors

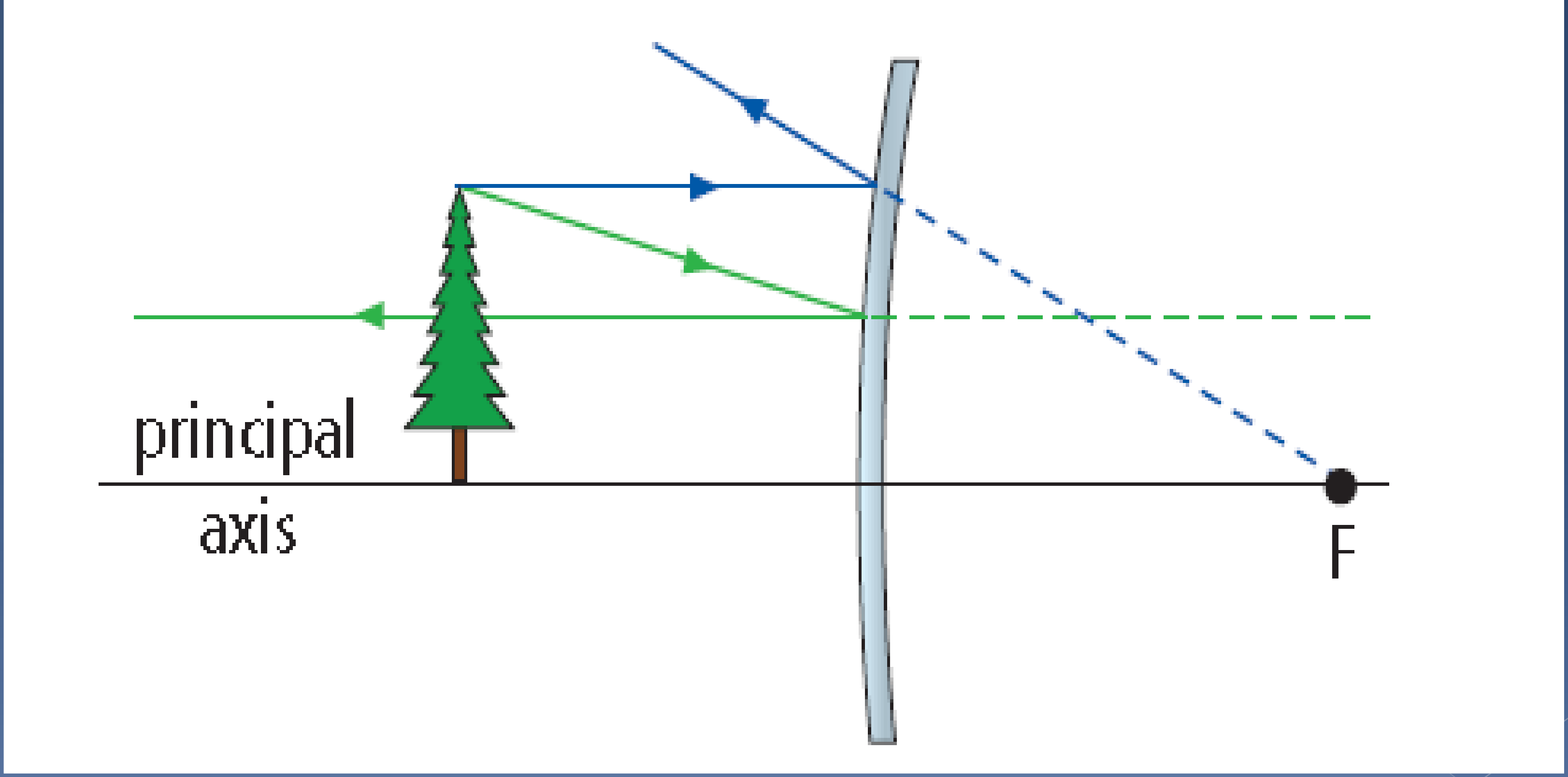
- When drawing ray diagrams for a convex mirror, you follow the same steps no matter where the object is in relation to the mirror (the object distance doesn't matter).

- Remember in convex mirrors the **focal point is always BEHIND THE MIRROR.**

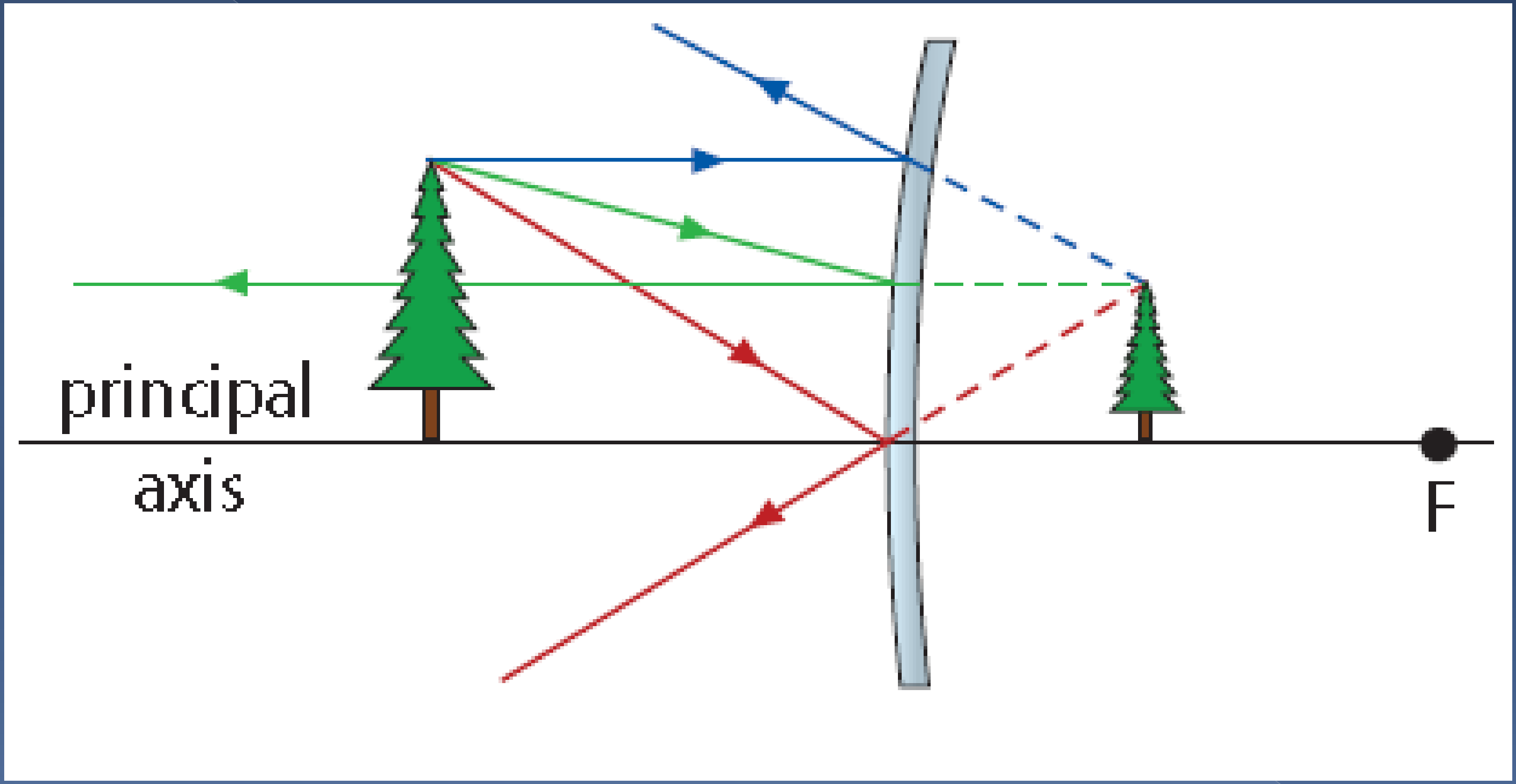
Step 1: Draw a ray parallel to the principal axis, with the reflected ray reflecting in line with the focal point behind the mirror.



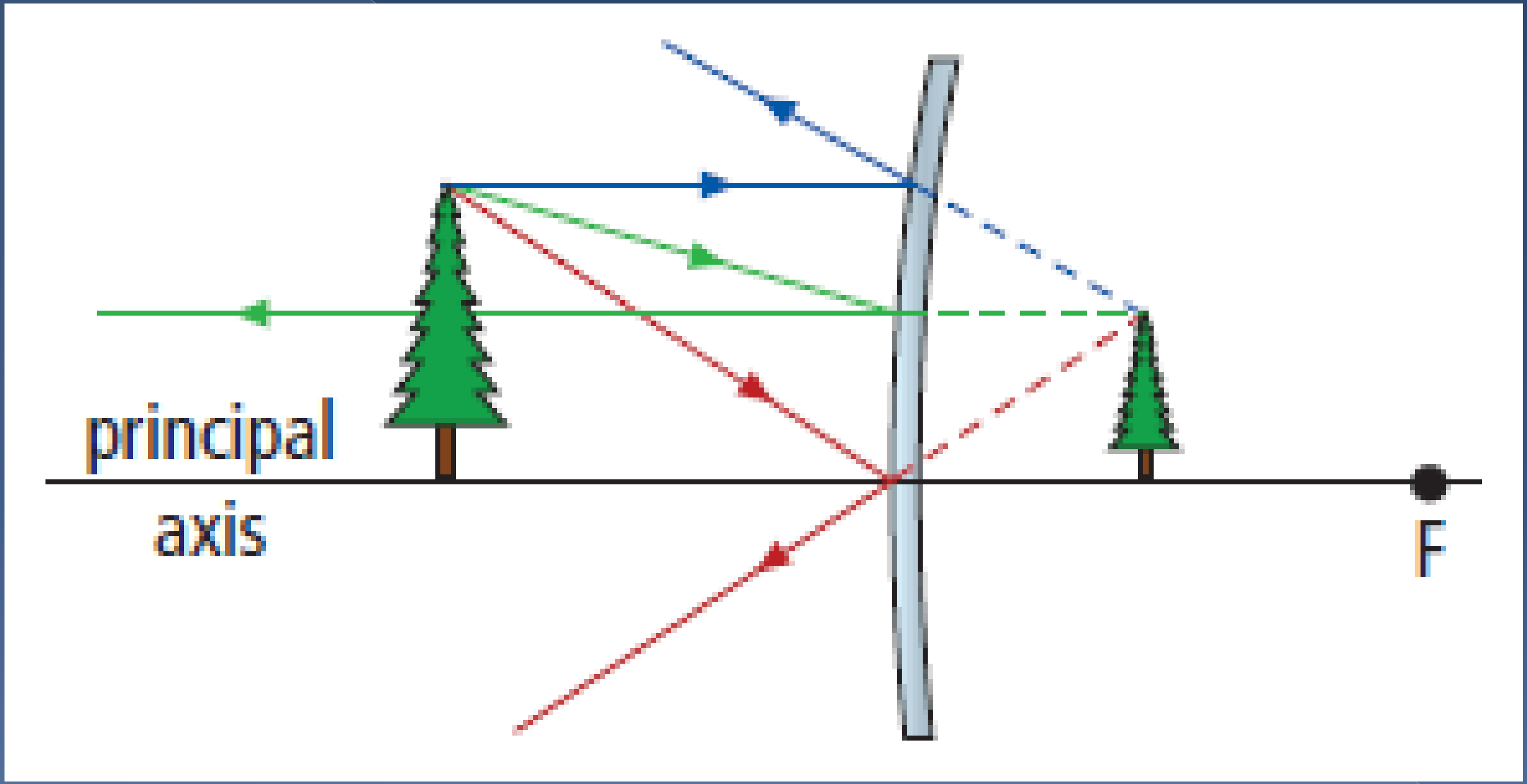
Step 2: Draw a ray in line with the focal point, with the reflected ray parallel to the principal axis.



Step 3: Draw a ray travelling to the vertex and reflecting at the same angle.

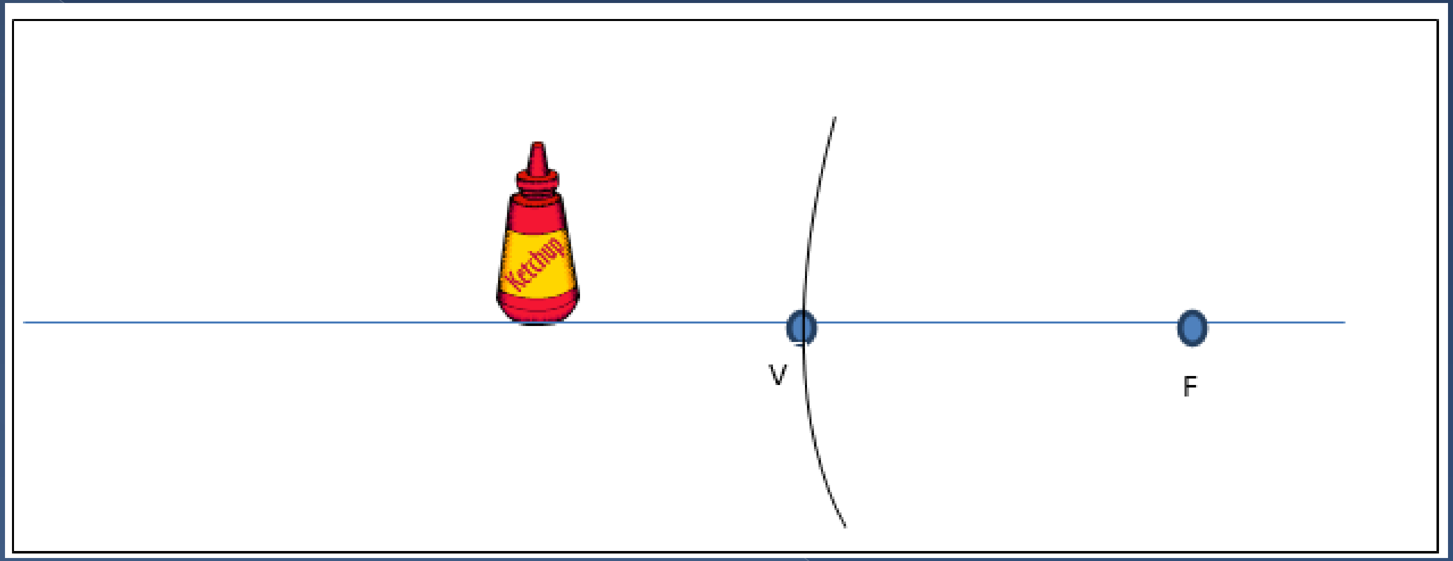


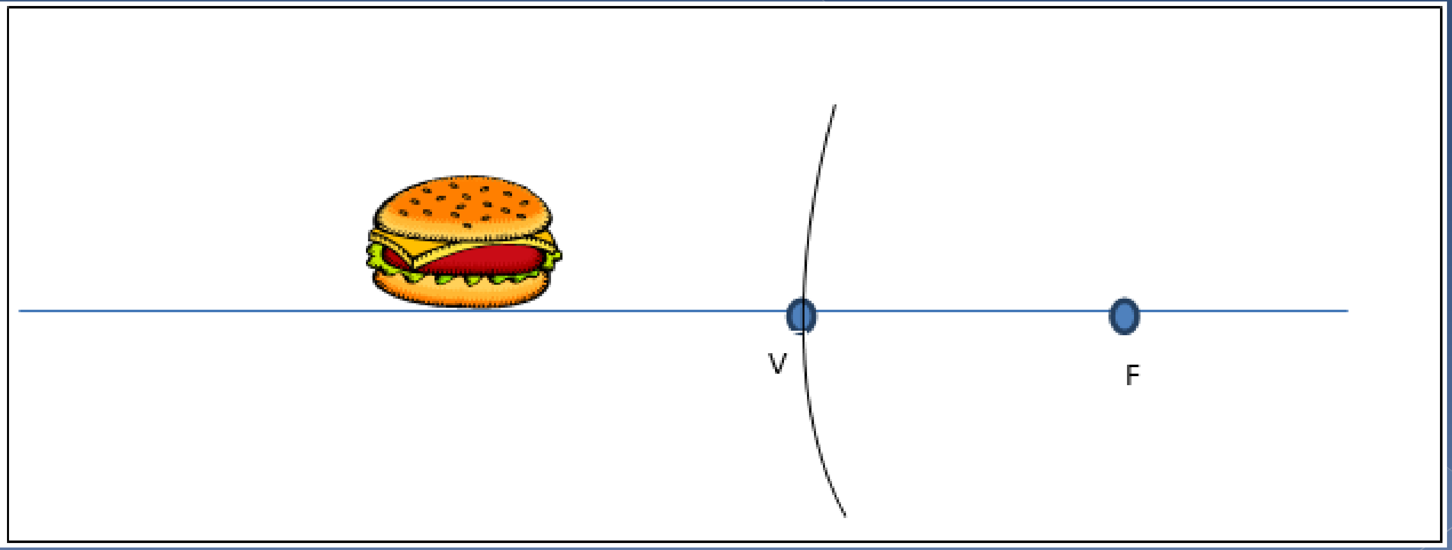
Step 4: Extend all of the ***reflected rays*** behind the mirror. The point where they cross over is the top of your image.

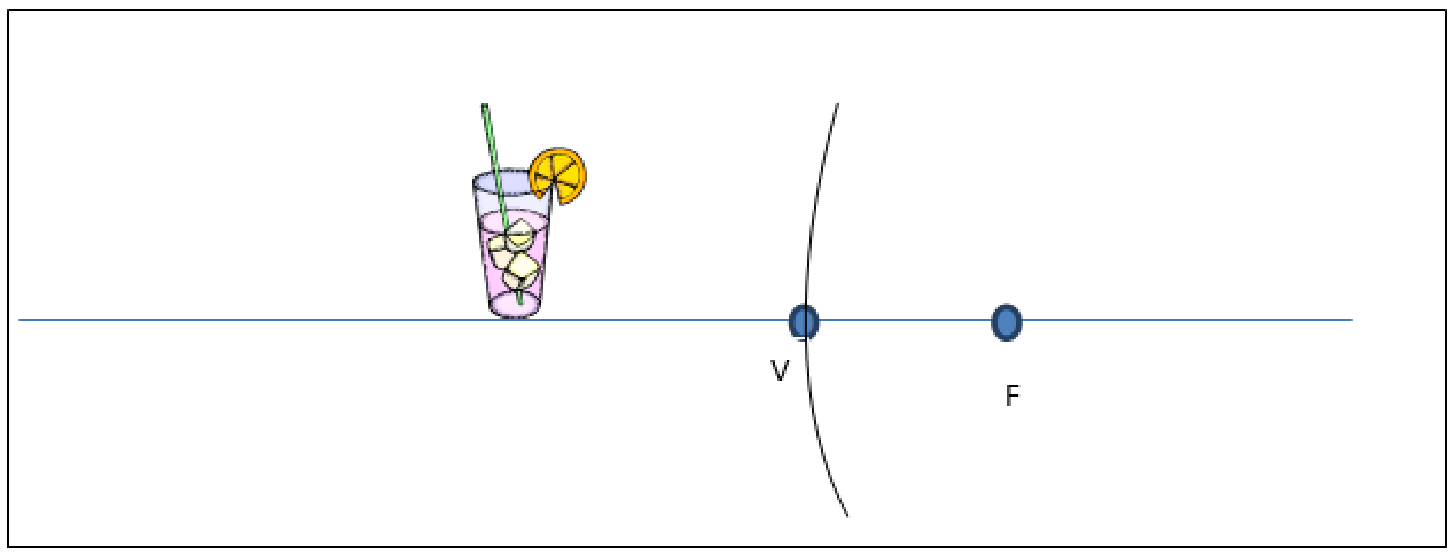


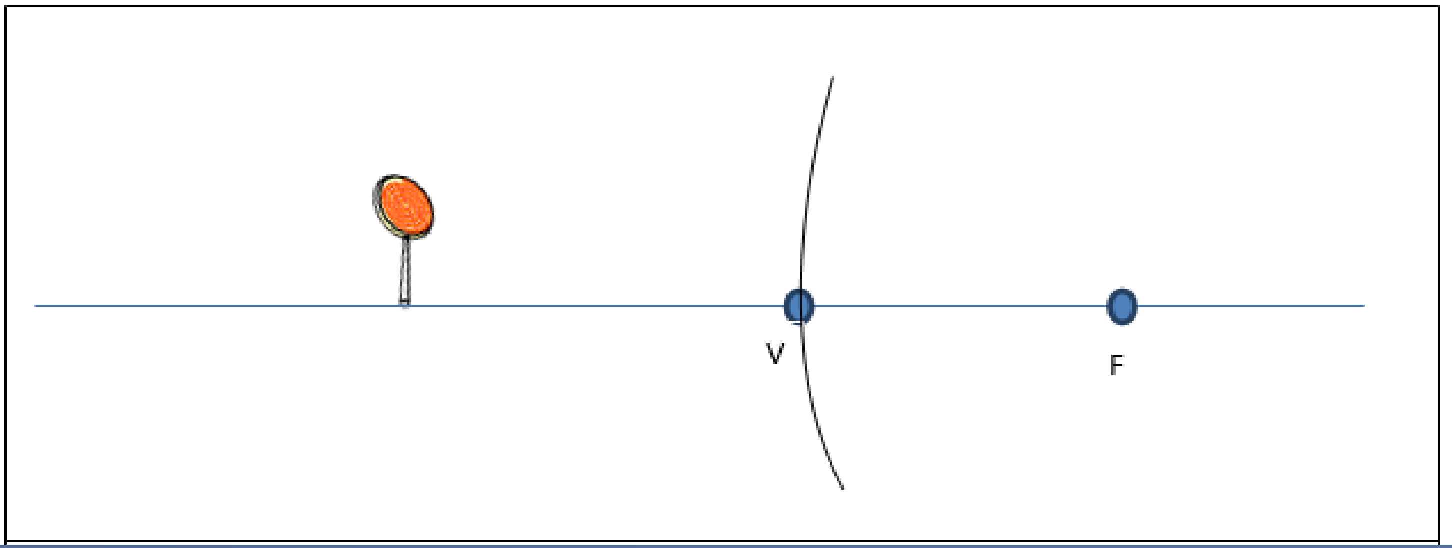
The image will be…	
1. **S**ize	Smaller
2. **P**osition	Closer
3. **O**rientation (upright or inverted)	Upright
4. **T**ype of Image (Real or virtual?)	Virtual

YOU TRY IT!









- Textbook: page 206 #'s 1-3

Summary:

- There are two types of curved mirrors:

1) **Concave mirrors** have a reflective surface that curves inward. Depending on the location of the object relative to the focal point of the mirror, images in these mirrors can be:
    1) Real *or* virtual (***a real image*** is formed when ***reflected rays*** meet).
    2) Upright *or* inverted
    3) Larger *or* smaller than the object

2. **Convex mirrors** have a reflective surface that curves outward. Images in convex mirrors are:
    1) Smaller than the object
    2) Closer to the mirror
    3) Upright
    4) Virtual

What Will It Look Like? **SPOT**

Mirror/Object Type	Size	Position (Distance)	Orientation	Type (Real or Virtual?)
Concave mirror (object between focal point and mirror)	Larger than the object	Further than the object distance	Upright	Virtual
Concave mirror (object between focal point and two times the focal length)	Larger than the object	Further than the object distance	Inverted	Real
Concave mirror (object beyond two times the focal length	Smaller than the object	Closer than the object distance	Inverted	Real
Convex mirror	Smaller than the object	Closer than the object distance	Upright	Virtual

Real VS Virtual Images

- Describe the difference between real and virtual images. Use your notes and your textbook:

Homework

- Ray diagram assignment
- P. 187, #s 2, 7a, 9a&b, and 10.
- P. 209, #s 1-12