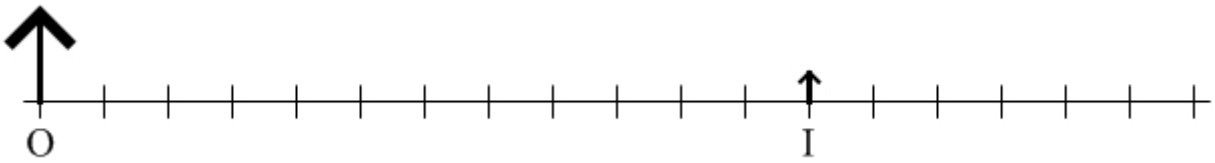
PROBLEM 1 – 10 points

When an object is placed at the position O in the diagram, a single mirror creates an upright virtual image at position I. The image is exactly 1/3 the size of the object, and the image is located 12 cm from the object (the tick marks in the diagram are 1 cm apart).



Your job is to determine the location and the type of mirror being used.

[3 points] (a) Determine the focal length of the mirror.

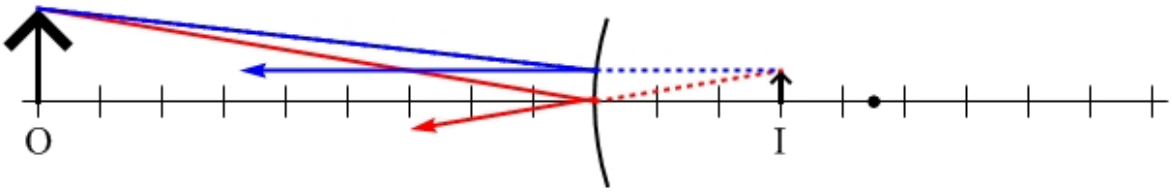
The image is upright, so it must be virtual, which means the mirror is between the object and image. To get a 3:1 ratio with the heights, we need a 3:1 ratio in the distances. Thus, the mirror must be 9 cm from the object (d_i = 9 cm) and 3 cm from the image (d_i = –3 cm, negative because the image is virtual).

$$\frac{1}{f}=\frac{1}{d_o}+\frac{1}{d_i}=\frac{1}{9\text{ cm}}-\frac{1}{3\text{ cm}}=\frac{1}{9\text{ cm}}-\frac{3}{9\text{ cm}}=-\frac{2}{9\text{ cm}}$$

This gives f = –4.5 cm

[3 points] (b) Show, as accurately as possible, both the position of the mirror, and its shape, on the diagram, and sketch a ray diagram that shows how the mirror creates the image.

Here's a second copy of the diagram just in case you'd like to re-draw your diagram neatly.



[4 points] (b) If the object is moved a little bit closer to the mirror, what will the image do? **Select the two true statements** from the list below.

[**X**] The image will increase in size.

[ ] The image will decrease in size.

[ ] The image will remain the same size.

[**X**] The position of the image will shift toward the mirror.

[ ] The position of the image will shift away from the mirror.

[ ] The position of the image will remain the same.

The closer the object gets to the mirror, the closer the image gets to the mirror, and the larger the image is. The image goes to the focal point, when the object moves far away, and the object and image meet at the mirror as the object moves closer.

PROBLEM 2 – 10 points

You have a mirror, and you are trying to determine what kind of mirror it is. You make the following observations, about the image created when an object is placed at a particular point in front of the mirror.

[2 points] (a) The mirror creates a virtual image of the object. Based on this observation, what kind of mirror could this be? **Select all that apply**.

[**X**] a concave (converging) mirror [**X**] a convex (diverging) mirror [**X**] a plane mirror
Plane and diverging mirrors only create virtual images, while a converging mirror can create a virtual image – it could be any one of the three.

[2 points] (b) The mirror creates an upright image of the object. Based on this, and the previous observation, what kind of mirror could this be? **Select all that apply**.

[**X**] a concave (converging) mirror [**X**] a convex (diverging) mirror [**X**] a plane mirror
Virtual and upright go together, so this really gives no additional information.

[2 points] (c) The image created by the mirror is larger than the object. Based on this observation, and the previous observations, what kind of mirror could this be? **Select all that apply**.

[**X**] a concave (converging) mirror [ ] a convex (diverging) mirror [ ] a plane mirror
Only a converging mirror can create a virtual image larger than the object.

[2 points] (d) If the object distance is 15 cm, and the image is twice as large as the object, find the image distance and the mirror's focal length.

The ratio of the distances, with a minus sign, is equal to the ratio of the heights. So, the image distance must be –30 cm. Knowing that, we can determine the focal length:

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i} = \frac{1}{15\text{ cm}} - \frac{1}{30\text{ cm}} = \frac{2}{30\text{ cm}} - \frac{1}{30\text{ cm}} = \frac{1}{30\text{ cm}}$$

The focal length is +30 cm.

[2 points] (e) Sketch a ray diagram for the situation described in part (d). The tick marks on the diagram are 5 cm apart.