Name: _____ **Class:** _____ **Date:** _____ **ID: A**

Mirrors and Lenses - Ch 23 websheet 23.1

Multiple Choice

Identify the choice that best completes the statement or answers the question.

____ 1. What type of mirror is used whenever a magnified image of an object is needed?
a. flat mirror
b. concave mirror
c. convex mirror
d. two-way mirror

____ 2. For a spherical mirror, the focal length is equal to ____ the radius of curvature of the mirror.
a. one-fourth
b. one-third
c. one-half
d. the square of

____ 3. A concave mirror with a focal length of 10.0 cm creates a real image 30.0 cm away on its principal axis. How far from the mirror is the corresponding object?
a. 20 cm
b. 15 cm
c. 7.5 cm
d. 5.0 cm

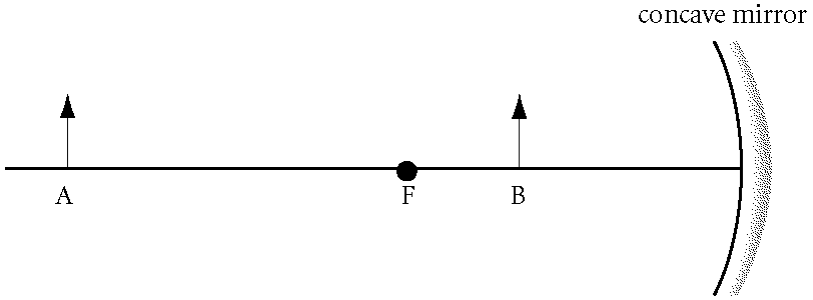
____ 4. A concave mirror forms a real image at 25.0 cm from the mirror surface along the principal axis. If the corresponding object is at a 10.0 cm distance, what is the mirror's focal length?
a. 1.40 cm
b. 7.14 cm
c. 12.0 cm
d. 17.0 cm

____ 5. An object is 29 cm away from a concave mirror's surface along the principal axis. If the mirror's focal length is 9.50 cm, how far away is the corresponding image?
a. 12 cm
b. 14 cm
c. 29 cm
d. 36 cm

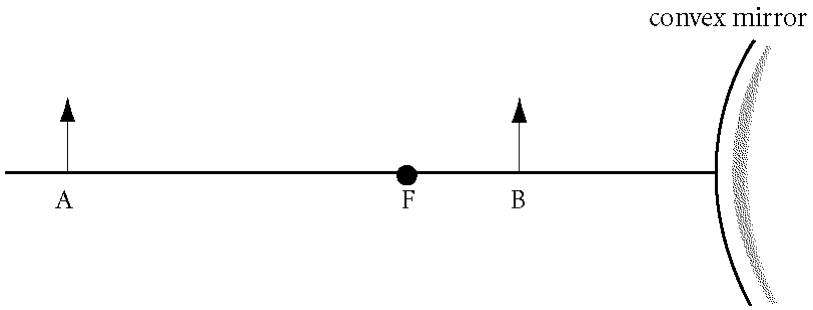
____ 6. If a virtual image is formed 10.0 cm along the principal axis from a convex mirror with a focal length of –15.0 cm, what is the object's distance from the mirror?
a. 30 cm
b. 12 cm
c. 6.0 cm
d. 3.0 cm

____ 7. A convex mirror with a focal length of –20.0 cm has an object 30.0 cm in front of the mirror. What is the value of q for the corresponding image?
a. −60 cm
b. −12 cm
c. 12 cm
d. 60 cm

____ 8. A mirror has an object located on its principal axis 40.0 cm from the mirror's surface. A virtual image is formed 15.0 cm behind the mirror. What is the mirror's focal length?
a. −24.0 cm
b. −10.9 cm
c. 2.38 cm
d. 13 cm



____ 9. In the diagram shown above, the image of object *B* would be
a. virtual, enlarged, and inverted.
b. real, enlarged, and upright.
c. virtual, reduced, and upright.
d. virtual, enlarged, and upright.



____ 10. In the diagram shown above, the image of object *B* would be
a. real, reduced, and upright.
b. virtual, enlarged, and upright.
c. virtual, reduced, and inverted.
d. virtual, reduced, and upright.

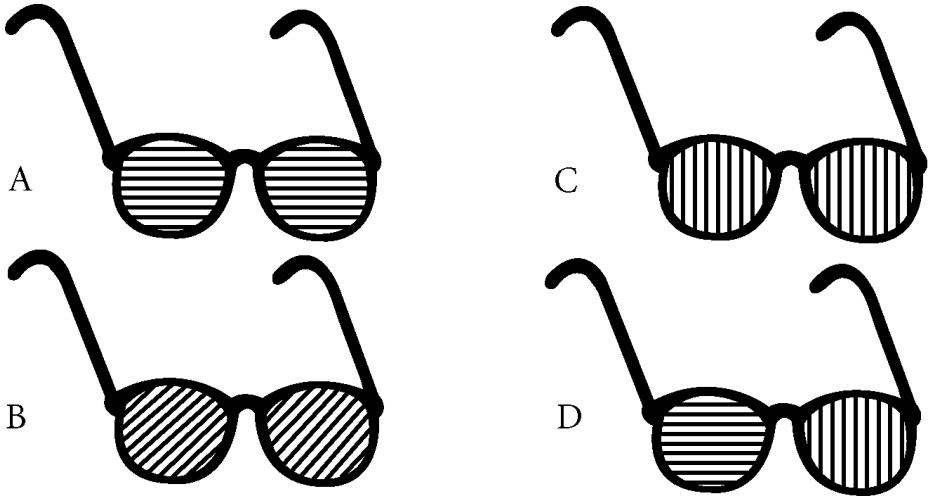
____ 11. Which best describes the image of a concave mirror when the object is located somewhere between the focal point and twice the focal-point distance from the mirror?
a. virtual, upright, and magnification greater than one
b. real, inverted, and magnification less than one
c. virtual, upright, and magnification less than one
d. real, inverted, and magnification greater than one

____ 12. Which best describes the image of a concave mirror when the object is at a distance greater than twice the focal-point distance from the mirror?
a. virtual, upright, and magnification greater than one
b. real, inverted, and magnification less than one
c. virtual, upright, and magnification less than one
d. real, inverted, and magnification greater than one

____ 13. Which best describes the image of a concave mirror when the object's distance from the mirror is less than the focal-point distance?
a. virtual, upright, and magnification greater than one
b. real, inverted, and magnification less than one
c. virtual, upright, and magnification less than one
d. real, inverted, and magnification greater than one

____ 14. A parabolic mirror, instead of a spherical mirror, can be used to reduce the occurrence of which effect?
a. spherical aberration
b. mirages
c. chromatic aberration
d. light scattering

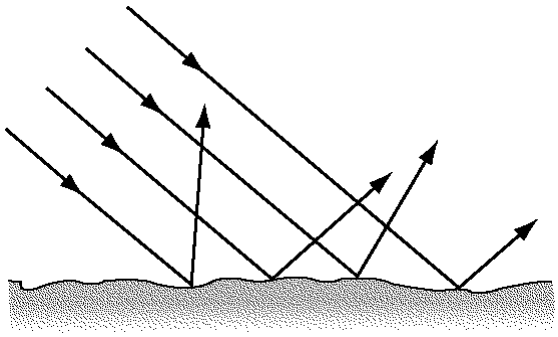
____ 15. When parallel rays that are also parallel to the principal axis strike a spherical mirror, rays that strike the mirror ____ the principal axis are focused at the focal point. Those rays that strike the mirror ____ the principal axis are focused at points between the mirror and the focal point.
a. perpendicular to, far from
b. close to, perpendicular to
c. close to, far from
d. far from, close to



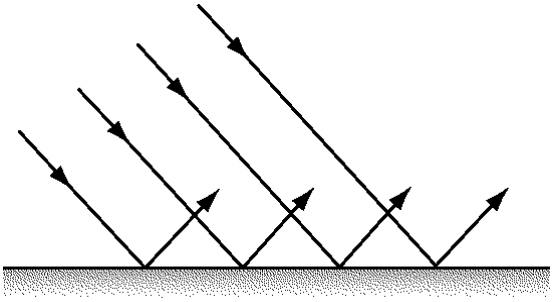
____ 16. Which pair of glasses shown above is best suited for automobile drivers? The transmission axes are shown by straight lines on the lenses. (Hint: The light reflects off the hood of the car.)
a. A
b. B
c. C
d. D

____ 17. If you looked at a light through the lenses from two polarizing sunglasses that were overlapped at right angles to each other,
a. all of the light would pass through.
b. most of the light would pass through.
c. little of the light would pass through.
d. none of the light would pass through.

Short Answer



18. What type of reflection is illustrated in the figure shown above?



19. What type of reflection is illustrated in the figure shown above?
20. If a light ray strikes a flat mirror with an angle of incidence equal to 52°, what is the angle of reflection? Explain.
21. If a light ray strikes a flat mirror at an angle of 61° above the mirror's surface, what is the angle of reflection in relation to the normal?
22. The height of an object is 4.0 cm. Its image height is 12.0 cm. What is the magnification? Is the image upright or inverted? Is the image real or virtual?
23. An object's distance (p) is 20.0 cm, and its image distance (q) is 10.0 cm. What is the magnification of the image? Is the image upright or inverted? Is the image real or virtual?
24. An object's distance is 15.0 cm, and its image distance is 25.0 cm behind the mirror. If the height of the object is 10.0 cm, what is the height of the image? Is the image upright or inverted? Is the image real or inverted?
25. What type of image do flat mirrors always form?
26. What is the chief difference between real and virtual images?

Problem

27. A concave mirror forms a real image at 17.0 cm from the mirror surface along the principal axis. If the corresponding object is at a distance of 36.0 cm, what is the mirror's focal length?
28. A concave mirror with a focal length of 18.0 cm forms a real image at 26.0 cm from the mirror's surface along the principal axis. How far is the corresponding object located from the mirror's surface?
29. A pencil is located 16.0 cm in front of a convex mirror whose focal length is 11.0 cm. In relation to the mirror's surface, where and how far away is the corresponding image located?
30. A candle 15 cm high is placed in front of a concave mirror at the focal point. The radius of curvature is 60 cm. Draw a ray diagram to determine the position and magnification of the image.
31. An object that is 2.00 cm high is placed 10.0 cm in front of a concave mirror with a radius of curvature of 40.0 cm. Find the magnification and location of the corresponding image in relation to the mirror's surface. Draw a ray diagram to confirm the position and magnification of the image.
32. An object is 15 cm from the surface of a spherical glass tree ornament that is 5.00 cm in diameter. Find the magnification and location of the corresponding image in relation to the mirror's surface. Draw a ray diagram to confirm the position and magnification of the image.
33. A concave spherical mirror has a radius of curvature of 10.0 cm. A candle that is 5.0 cm tall is placed 15 cm in front of the mirror. Draw a ray diagram to find the image distance and height. Confirm the results of your diagram with the mirror equation and the equation for magnification.
34. A 1.5 cm high image of a candle is formed by a convex mirror whose focal length is 8.0 cm. The virtual image is 3.00 cm from the mirror's surface. The image's magnification is +0.25. Draw a ray diagram to determine the position and height of the corresponding object. Use the equation for magnification to confirm the results of your diagram.

Mirrors and Lenses - Ch 23 websheet 23.1
Answer Section

MULTIPLE CHOICE

1. C
2. C
3. B
4. B
5. B
6. A
7. B
8. A
9. D
10. D
11. D
12. B
13. A
14. A
15. C
16. C
17. D

SHORT ANSWER

18. diffuse
19. specular
20. 52°; According to the law of reflection, the angle of incidence is equal to the angle of reflection.
21. 29º from the normal

    Given

    $\theta_{mirror's\ surface} = 61°$

    Solution

    Rearrange the equation, $\theta_{mirror's\ surface} = 90° - \theta$, solve for θ, and substitute values.

    $\theta = 90° - \theta_{mirror's\ surface} = 90° - 61° = 29°$.

    According to the law of reflection, the angle of incidence (θ) is equal to the angle of reflection (θ').

    Therefore, $\theta' = \theta = 29°$ from the normal.

22. *Given*

$h = 4.0\text{ cm}$

$h' = 12.0\text{ cm}$

Solution

Substitute values into the equation for magnification, $M = \frac{h'}{h}$, and solve.

$$M = \frac{h}{h'} = \frac{12.0\text{ cm}}{4.0\text{ cm}} = 3.0$$

Since M is positive, the image is upright and virtual.

23. *Given*

$p = 20.0\text{ cm}$

$q = 10.0\text{ cm}$

Solution

Use the equation for magnification, $M = -\frac{q}{p}$, to find M.

$$M = -\frac{q}{p} = -\frac{10.0\text{ cm}}{20.0\text{ cm}} = -0.500$$

Since M is negative, the image is inverted and real.

24. *Given*

$p = 15.0\text{ cm}$

$q = -25.0\text{ cm}$

$h = 10.0\text{ cm}$

Solution

Use the equation for magnification, $M = \frac{h'}{h} = -\frac{q}{p}$, and solve for h'.

$$h' = -\frac{qh}{p} = -\frac{(-25.0\text{ cm})\,(10.0\text{ cm})}{(15.0\text{ cm})} = 16.7\text{ cm}$$

Since M is positive, the image is upright and virtual.

25. virtual
26. Real images can be displayed on a surface; virtual ones cannot.

PROBLEM

27. 11.5 cm

Given

$p = 17.0\text{ cm}$

$q = 36.0\text{ cm}$

Solution

Use the mirror equation, $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$, and solve for f.

$$\frac{1}{f} = \frac{1}{p} + \frac{1}{q} = \frac{1}{17.0\text{ cm}} + \frac{1}{36.0\text{ cm}} = \frac{2.12}{36.0\text{ cm}} + \frac{1}{36.0\text{ cm}} = \frac{3.12}{36.0\text{ cm}}$$

$f = 11.5\text{ cm}$

28. 58.8 cm

Given

$f = 18.0\text{ cm}$

$q = 26.0\text{ cm}$

Solution

Rearrange the mirror equation, $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$, and solve for p.

$$\frac{1}{p} = \frac{1}{f} - \frac{1}{q} = \frac{1}{18.0\text{ cm}} - \frac{1}{26.0\text{ cm}} = \frac{0.0555}{1\text{ cm}} - \frac{0.0385}{1\text{ cm}} = \frac{0.0170}{1\text{ cm}}$$

$p = 58.8\text{ cm}$

29. -6.52 cm

Given

$f = -11.0\text{ cm}$

$p = 16.0\text{ cm}$

Solution

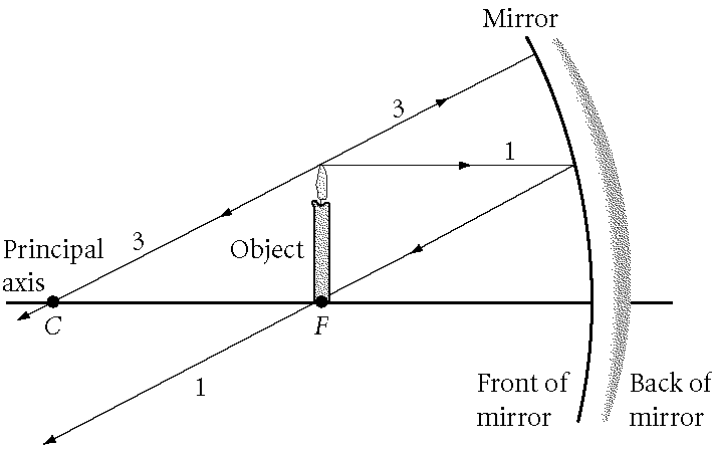
Rearrange the mirror equation, $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$, and solve for q.

$$\frac{1}{q} = \frac{1}{f} - \frac{1}{p} = \frac{1}{-11.0\text{ cm}} - \frac{1}{16.0\text{ cm}} = -\frac{0.0909}{1\text{ cm}} - \frac{0.0625}{1\text{ cm}} = -\frac{0.1534}{1\text{ cm}}$$

$q = -6.52\text{ cm}$

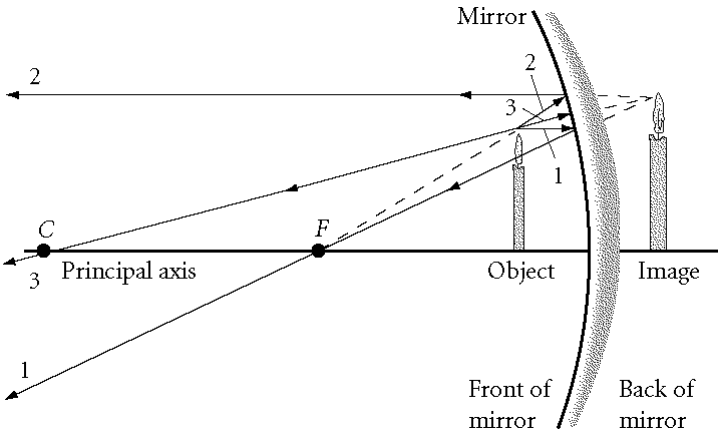
Since q is negative, the image is located 6.52 cm behind the mirror.

30. When the candle is at the focal point, the image is infinitely far to the left and therefore is not seen, as shown in the answer diagram.



31. $q = -20.0\text{ cm}$

$M = +2.00$



Given

$h = 2.00\text{ cm}$

$R = 40.0\text{ cm}$

$p = 10.0\text{ cm}$

Solution

Since $R = 40.0\text{ cm}$, $f = 20.0\text{ cm}$.

Rearrange the mirror equation, $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$, and solve for q.

$$\frac{1}{q} = \frac{1}{f} - \frac{1}{p} = \frac{1}{20.0\text{ cm}} - \frac{1}{10.0\text{ cm}} = \frac{1}{20.0\text{ cm}} - \frac{2}{20.0\text{ cm}} = -\frac{1}{20.0\text{ cm}}$$

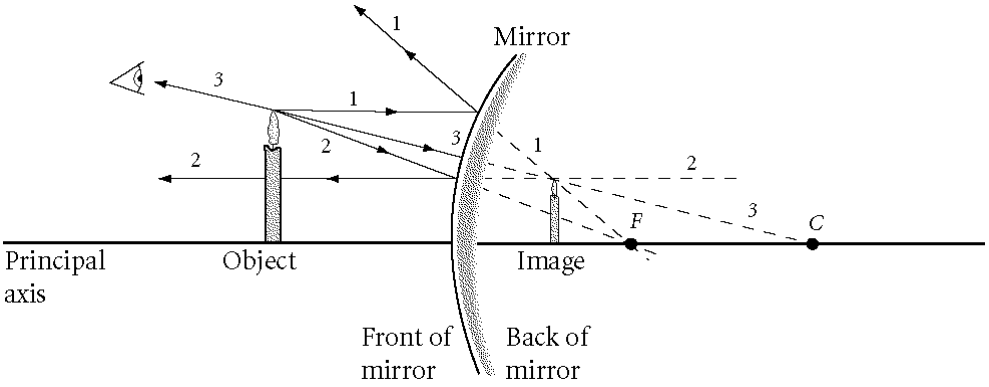
$q = -20.0\text{ cm}$

Since q is negative, the image is located 20.0 cm behind the mirror.

$$M = -\frac{q}{p} = -\frac{(-20.0\text{ cm})}{10.0\text{ cm}} = +2.00$$

32. $q = -1.15\text{ cm}$

$M = +0.077 \text{ or } 7.7 \times 10^{-2}$



Given

$d = 5.00\text{ cm}$

$p = 15\text{ cm}$

Solution

Since $d = 5.00\text{ cm}$, $R = 2.50\text{ cm}$.

Since the ornament acts like a convex mirror, $f = -1.25\text{ cm}$.

Rearrange the mirror equation, $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$, and solve for q.

$$\frac{1}{q} = \frac{1}{f} - \frac{1}{p} = \frac{1}{-1.25\text{ cm}} - \frac{1}{15\text{ cm}} = -\frac{12}{15\text{ cm}} - \frac{1}{15\text{ cm}} = -\frac{13}{15\text{ cm}}$$

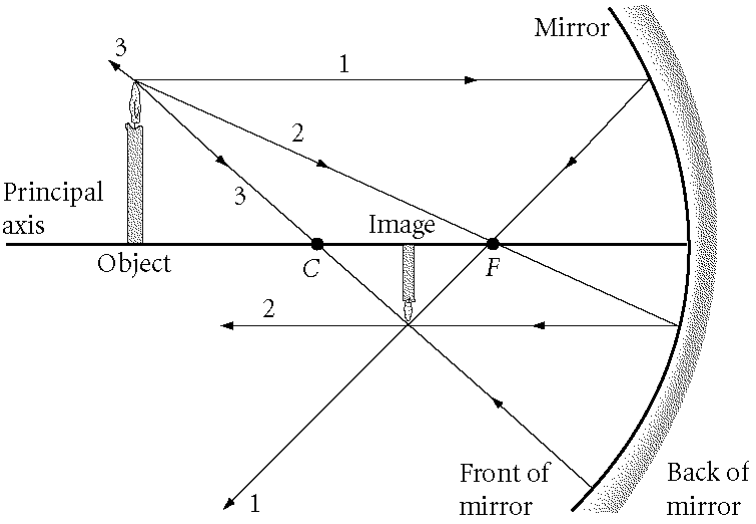
$q = -1.15\text{ cm}$

Since q is negative, the image is located 1.15 cm behind the mirror (or inside the ornament).

$$M = -\frac{q}{p} = -\frac{(-1.15\text{ cm})}{15\text{ cm}} = +0.077 \text{ or } 7.7 \times 10^{-2}$$

33. $q = 7.50\text{ cm}$

$h' = -2.5\text{ cm}$



Given

$h = 5.0\text{ cm}$

$R = 10.0\text{ cm}$

$p = 15\text{ cm}$

Solution

Since $R = 10.0\text{ cm}$, $f = 5.00\text{ cm}$.

Rearrange the mirror equation, $\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$, and solve for q.

$$\frac{1}{q} = \frac{1}{f} - \frac{1}{p} = \frac{1}{5.00\text{ cm}} - \frac{1}{15\text{ cm}} = \frac{3}{15\text{ cm}} - \frac{1}{15\text{ cm}} = \frac{2}{15\text{ cm}}$$

$q = 7.50\text{ cm}$

Since q is positive, the image is located 7.50 cm in front of the mirror.

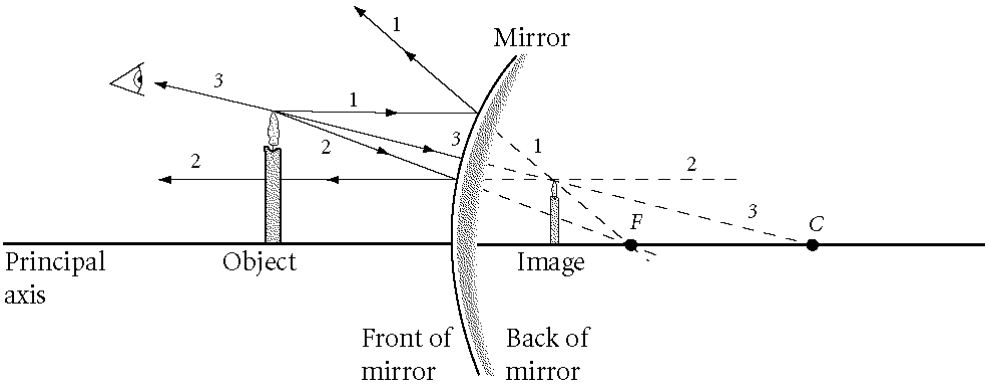
Solve the equation for magnification, $M = \frac{h'}{h} = -\frac{q}{p}$, for h'.

$$h' = -\frac{qh}{p} = -\frac{(7.50\text{ cm})(5.0\text{ cm})}{(15\text{ cm})} = -2.5\text{ cm}$$

Since h' is negative, the image is located below the principal axis.

34. $p = 12\text{ cm}$

$h = 6.0\text{ cm}$



Given

$h' = 1.5\text{ cm}$

$M = +0.25$

$f = -8.0\text{ cm}$

$q = -3.00\text{ cm}$

Solution

Use the equation for magnification, $M = \dfrac{h'}{h}$, and solve for h.

$$h = \frac{h'}{M} = \frac{(1.5\text{ cm})}{(+0.25)} = 6.0\text{ cm}$$

Since h is positive, the object is located above the principal axis.

Use the equation for magnification, $M = -\dfrac{q}{p}$, and solve for p.

$$p = -\frac{q}{M} = -\frac{(-3.00\text{ cm})}{(0.25)} = 12\text{ cm}$$

Since q is positive, the object is located 12 cm in front of the mirror.