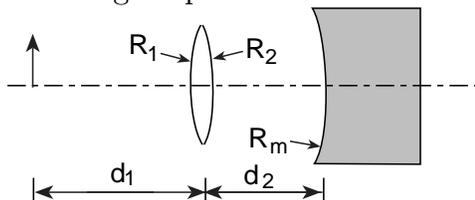


This print-out should have 20 questions. Multiple-choice questions may continue on the next column or page – find all choices before answering.

---

**001** (part 1 of 6) 10.0 points

An object, a lens, and a mirror are placed in air as shown in the figure below, which applies to the following six problems.



If the magnitude of the radius of curvature of the mirror is  $R_m = 3.764$  cm, what is its focal length?

Answer in units of cm.

---

**002** (part 2 of 6) 10.0 points

The magnitude of the lens' radii of curvature are  $R_1 = 3.764$  cm and  $R_2 = 2.823$  cm.

*Assume:* The lens is made of glass whose index of refraction is 1.51.

*Note:* This is the same lens that is shown in the figure above.

What is the focal length of this lens?

Answer in units of cm.

---

**003** (part 3 of 6) 10.0 points

*Hint:* First determine position of image relative to the lens, and then find this position relative to the mirror.

If  $d_1 = 5.88125$  cm and  $d_2 = 9.41$  cm and the light from the object passes through the lens, where is the position  $s_2$  of the image, where  $s_2$  is measured relative to the mirror and is taken as positive if it is to the left of the mirror?

Answer in units of cm.

---

**004** (part 4 of 6) 10.0 points

Now treat the image at  $s_2$  as the object for the mirror to produce an image of. Find the position  $s'_2$  of this image. Let the distance of  $s'_2$  be measured from the mirror where positive distances are to the left of the mirror.

Answer in units of cm.

---

**005** (part 5 of 6) 10.0 points

Now treat the image at  $s'_2$  as the object which the lens produces an image of. Find the position  $s'_3$  of this image relative to the lens with the positive direction taken to the left of the lens.

Answer in units of cm.

---

**006** (part 6 of 6) 10.0 points

*Hint:* A minus sign indicates an inverted image.

What is the total magnification of the final image?

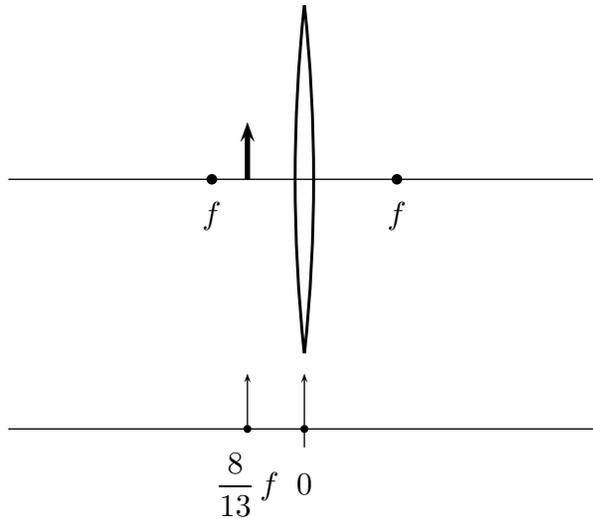
1.  $M = 14.9817$
2.  $M = 8.3562$
3.  $M = -12.9684$
4.  $M = 12.4878$
5.  $M = 9.8216$
6.  $M = -18.1936$
7.  $M = 11.2169$
8.  $M = -8.7321$
9.  $M = 13.1322$
10.  $M = -6.3831$

---

**007** (part 1 of 6) 10.0 points

*Hint:* Construct a ray diagram.

*Given:* A real object is located to the left of a convergent lens. The object's distance from the lens and its focal length are shown in the figure below.



The image is

1. real, inverted, and smaller.  
A ray diagram could be helpful.
2. virtual, inverted, and smaller.
3. virtual, erect, and larger.
4. virtual, inverted, and larger.
5. real, inverted, and larger.
6. virtual, erect, and smaller.
7. real, erect, and smaller.
8. real, erect, and larger.

---

**008** (part 2 of 6) 10.0 points

The image distance is

1.  $\frac{18}{11} f$ .
2.  $\frac{8}{5} f$ .
3.  $\frac{-9}{4} f$ .
4.  $\frac{-8}{5} f$ .
5.  $\frac{-19}{7} f$ .
6.  $\frac{-12}{5} f$ .

7.  $\frac{-19}{6} f$ .

8.  $\frac{-5}{2} f$ .

9.  $\frac{-3}{2} f$ .

10.  $\frac{-17}{7} f$ .

---

**009** (part 3 of 6) 10.0 points

The magnification is

1.  $\frac{-4}{7}$ .

2.  $\frac{7}{2}$ .

3.  $\frac{-7}{9}$ .

4.  $\frac{13}{5}$ .

5.  $\frac{-3}{2}$ .

6.  $\frac{25}{8}$ .

7.  $\frac{17}{6}$ .

8.  $\frac{24}{5}$ .

9.  $\frac{23}{6}$ .

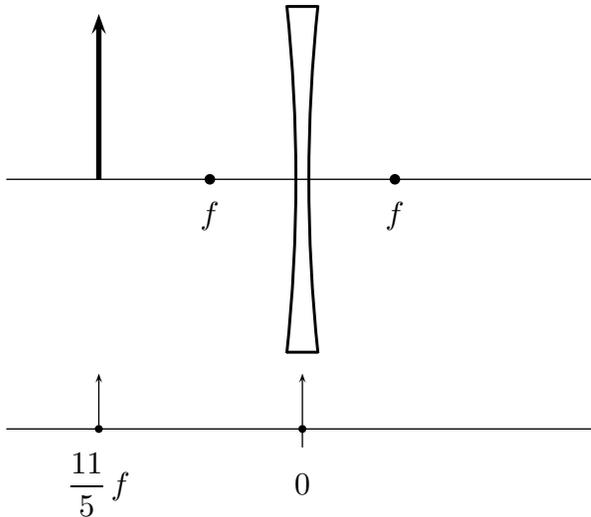
10.  $\frac{18}{7}$ .

---

**010** (part 4 of 6) 10.0 points

*Hint:* The convergent lens in this problem is a part of a lens system so the object in this problem may be either real or virtual. Construct a ray diagram.

*Given:* A real object is located to the left of a divergent lens. The object's distance from the lens and its focal length are shown in the figure below.



The image is

1. virtual, erect, and larger.
2. virtual, inverted, and larger.
3. real, inverted, and larger.
4. virtual, inverted, and smaller.
5. real, inverted, and smaller.
6. virtual, erect, and smaller.
7. real, erect, and larger.
8. real, erect, and smaller.

---

**011** (part 5 of 6) 10.0 points

The image distance is

1.  $\frac{-14}{19}f$ .
2.  $\frac{-15}{23}f$ .
3.  $\frac{-16}{25}f$ .
4.  $\frac{-13}{19}f$ .
5.  $\frac{-11}{16}f$ .
6.  $\frac{-13}{21}f$ .

7.  $\frac{-12}{17}f$ .

8.  $\frac{-13}{18}f$ .

9.  $\frac{-17}{26}f$ .

10.  $\frac{-17}{23}f$ .

---

**012** (part 6 of 6) 10.0 points

The magnification is

1.  $\frac{10}{29}$ .

2.  $\frac{7}{24}$ .

3.  $\frac{6}{17}$ .

4.  $\frac{8}{23}$ .

5.  $\frac{5}{16}$ .

6.  $\frac{7}{22}$ .

7.  $\frac{7}{19}$ .

8.  $\frac{4}{13}$ .

9.  $\frac{10}{27}$ .

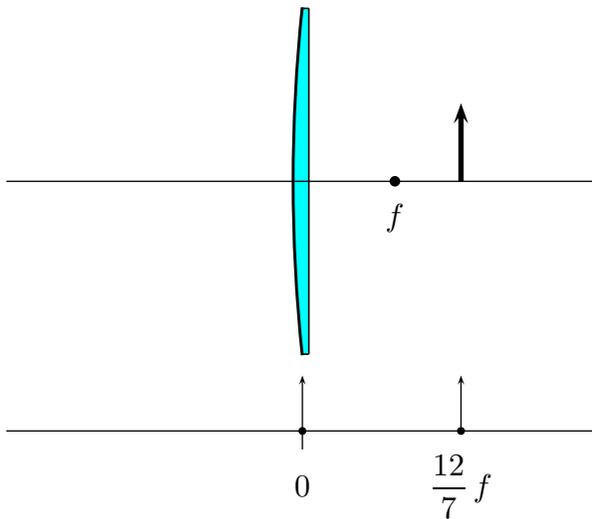
10.  $\frac{7}{25}$ .

---

**013** (part 1 of 3) 10.0 points

*Hint:* The divergent mirror in this problem is a part of a lens/mirror system so the object in this problem may be either real or virtual. Construct a ray diagram.

*Given:* A virtual object is located to the right of a divergent mirror. The object's distance from the mirror and its focal length are shown in the figure below.



The image is

1. real, inverted, and smaller.
2. real, erect, and larger.
3. real, inverted, and larger.
4. virtual, erect, and larger.
5. virtual, inverted, and larger.
6. real, erect, and smaller.
7. virtual, erect, and smaller.
8. virtual, inverted, and smaller.

---

**014** (part 2 of 3) 10.0 points

The image distance is

1.  $\frac{18}{11} f$ .
2.  $\frac{19}{6} f$ .
3.  $\frac{12}{5} f$ .
4.  $\frac{-15}{23} f$ .
5.  $\frac{-13}{6} f$ .
6.  $\frac{-14}{9} f$ .

7.  $\frac{17}{6} f$ .

8.  $\frac{-11}{7} f$ .

9.  $\frac{-12}{5} f$ .

10.  $\frac{-13}{20} f$ .

---

**015** (part 3 of 3) 10.0 points

The magnification is

1.  $\frac{11}{3}$ .

2.  $\frac{6}{23}$ .

3.  $\frac{-2}{3}$ .

4.  $\frac{-10}{7}$ .

5.  $\frac{17}{5}$ .

6.  $\frac{-7}{8}$ .

7.  $\frac{23}{6}$ .

8.  $\frac{-7}{5}$ .

9.  $\frac{-11}{6}$ .

10.  $\frac{7}{22}$ .

---

**016** (part 1 of 5) 10.0 points

A concave spherical mirror has a radius of curvature of 22.6 cm.

Locate the image for an object distance of 37 cm. (Answer with  $-1000$  if no image is formed.)

Answer in units of cm.

---

**017** (part 2 of 5) 10.0 points

Find the magnification.

---

**018** (part 3 of 5) 10.0 points

Describe the image.

1. real, upright, smaller

2. None of these
3. virtual, upright, larger
4. real, inverted, larger
5. real, inverted, smaller
6. virtual, inverted, larger
7. virtual, inverted, smaller
8. real, upright, larger
9. virtual, upright, smaller

---

**019** (part 4 of 5) 10.0 points

Locate the image for an object distance of 11.3 cm. (Answer with  $-1000$  if no image is formed.)

---

**020** (part 5 of 5) 10.0 points

Describe the image.

1. real, upright, smaller
2. virtual, upright, larger
3. virtual, upright, smaller
4. real, inverted, larger
5. virtual, inverted, larger
6. virtual, inverted, smaller
7. real, upright, larger
8. real, inverted, smaller
9. None of these