

## ✔ Congratulations! You passed!

Grade received 72.22%

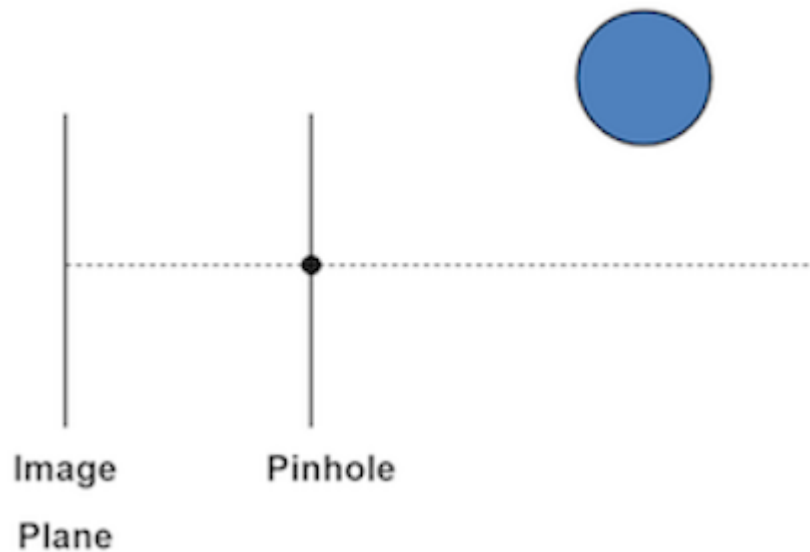
Latest Submission Grade 72.22%

To pass 70% or higher

**Go to next item**

1.

1 / 1 point



The shape of the image of the off-axis sphere imaged by a pinhole camera is:

**Hint: Try to find the points in the sphere which will be visible from the pin hole. What 2D shape will it be? (Refer to the geometry of a circle's tangent.)**

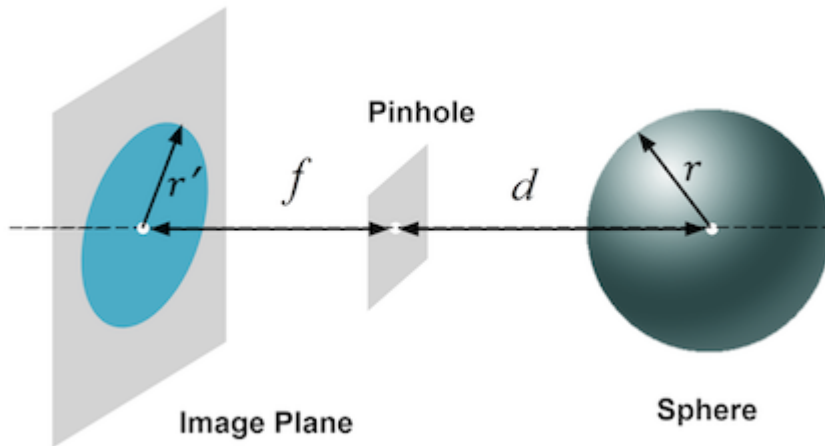
- ☐ A circle
- ☐ A square
- ☐ A point
- ☒ An ellipse

✔ **Correct**

The boundary of the sphere as seen from the pinhole is a circle. This circle produces a cone of rays that passes through the pinhole. Since the cone is tilted (off-axis), its intersection with the image plane is an ellipse.

2.

0 / 2 points



The image of a sphere of radius  $r$  placed on the optical axis of a pinhole camera is a circle with radius  $r'$ . If the distance  $d$  of the center of the sphere from the pinhole is doubled, the radius  $r'$  of the image of the sphere is:

- ☐ Exactly doubled
- ☒ Exactly halved
- ☐ Unchanged
- ☐ None of the above.

⊗ **Incorrect**

3. Consider a pinhole camera with an effective focal length of 2. If the pinhole is located at the origin and the image plane is given by  $z = 2$ , then the 3D image coordinates of the scene point  $(-4, 4, -2)$  are:

2 / 2 points

- ☐ (4, 2, 1)
- ☐ (1, -1, 2)
- ☒ (4, -4, 2)

☐ (2, 2, 2)☒ **Correct**

Direct application of perspective projection equations to the scene point coordinates.

$$(x, y, z) \rightarrow \left( \frac{f}{z}x, \frac{f}{z}y, f \right)$$

**4.****2 / 2 points**

How many vanishing points are produced by the edges of this opaque cube from a fixed viewpoint?

☐ 1☐ 2☒ 3☐  $\infty$ ☒ **Correct**

The cube has three sets of parallel lines in the 3D world. Each of these produces a vanishing point.

5. A focused imaging system has a magnification  $m$  and uses a lens with focal length  $f$ .  
The distance between the image plane and the object plane is:

3 / 3 points

- ☐  $\frac{m-f}{f}$
- ☒  $(m + 2 + \frac{1}{m})f$
- ☐  $\frac{1+m}{f}$
- ☐  $m \cdot f$

☒ **Correct**

This is directly obtained from the expressions for the Gaussian Lens Law and magnification.

$$\begin{aligned}\frac{1}{f} &= \frac{1}{i} + \frac{1}{o} \\ \Rightarrow \frac{i}{f} &= 1 + \frac{i}{o} = 1 + m \\ \Rightarrow \frac{o}{f} &= \frac{o}{i} + 1 = \frac{1}{m} + 1 \\ \Rightarrow i + o &= (m + 2 + \frac{1}{m})f\end{aligned}$$

6. Consider a camera with a single lens with focal length  $f$ . If the object distance is  $o$  and the image distance is  $i$ , the magnification is:

1 / 1 point

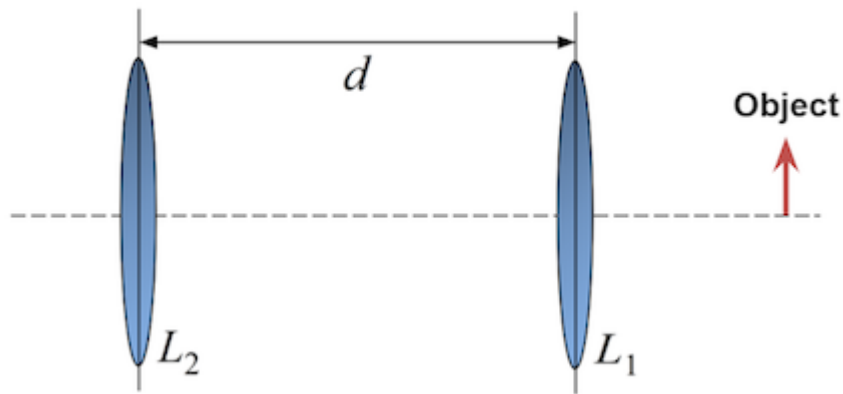
- ☐  $m = \frac{1}{i} + \frac{1}{o}$
- ☐  $m = \frac{i-o}{i+o}$
- ☐  $m = 2f$
- ☒  $m = \frac{i}{o}$

☒ **Correct**

See derivation of magnification for a lens camera.

7.

2 / 2 points

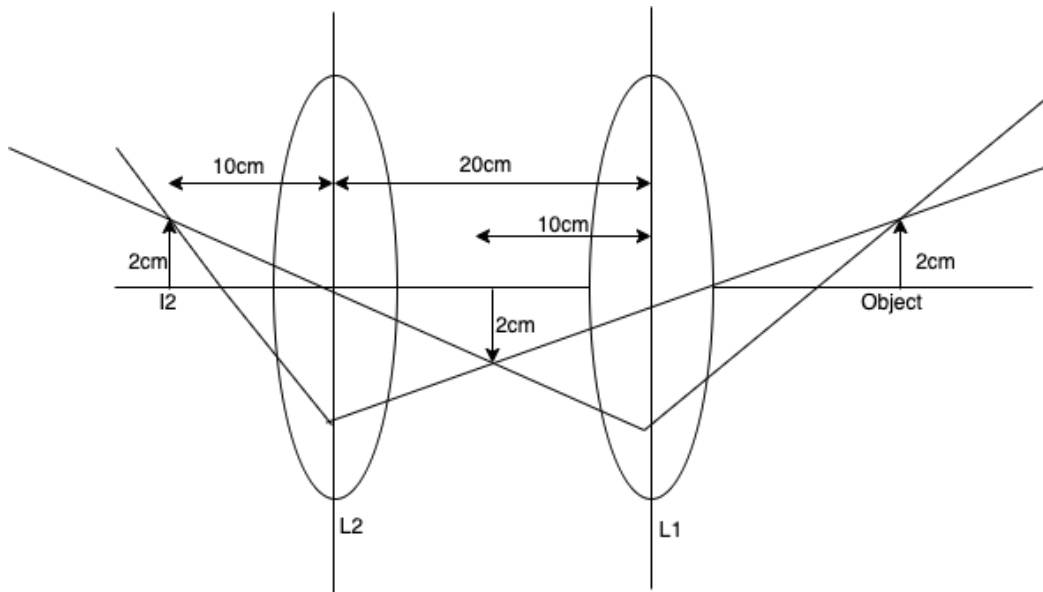


In this two-lens system, both lenses have the same focal length  $f = 5 \text{ cm}$  and are separated by  $d = 20 \text{ cm}$ . If the object is  $2 \text{ cm}$  tall and placed  $10 \text{ cm}$  away from lens  $L_1$ , how tall would its image behind lens  $L_2$  be?

- ☐  $5 \text{ cm}$
- ☐  $4 \text{ cm}$
- ☐  $3 \text{ cm}$
- ☒  $2 \text{ cm}$

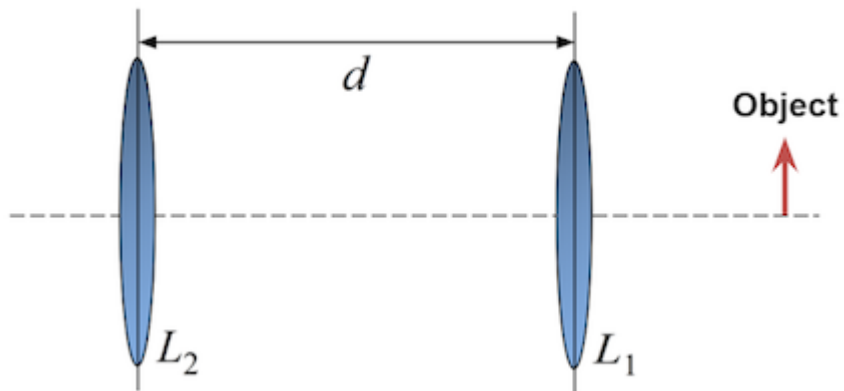
✓ **Correct**

Lens  $L_1$  forms an inverted image of the object behind it. Using the Gaussian Lens Law, we find that this inverted image is  $2 \text{ cm}$  tall and  $10 \text{ cm}$  behind  $L_1$ . Since the two lenses are separated by  $20 \text{ cm}$ , the inverted image acts like an object that is  $10 \text{ cm}$  in front of lens  $L_2$ . The final (upright) image is therefore formed  $10 \text{ cm}$  behind  $L_2$  and is  $2 \text{ cm}$  tall. The total magnification of the two-lens system is therefore 1, and the height of the final image is  $2 \text{ cm}$ .



8.

0 / 3 points



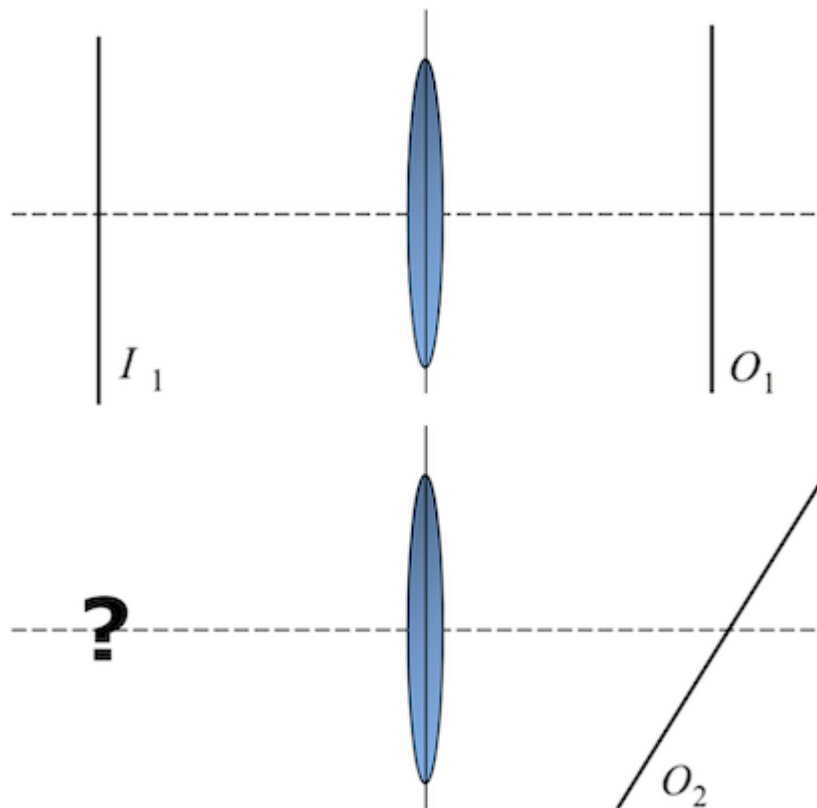
In this two-lens system, lens  $L_1$  with focal length  $f_1$  and lens  $L_2$  with focal length  $f_2$  are separated by  $d = 2f_1$ . What is the focal length  $f$  of the system?

- ☐  $\frac{f_1 f_2}{f_1 + f_2}$   
☐  $\frac{f_1 f_2}{f_2 - f_1}$   
☒  $\frac{1}{f_2} + \frac{1}{f_1}$   
☐  $\frac{1}{f_2} - \frac{1}{f_1}$

⊗ Incorrect

9.

1 / 1 point



We know the focused image of a vertical line  $O_1$  is a vertical line  $I_1$ . The focused image of the tilted line  $O_2$  is a:

- ☒ Tilted line
- ☐ Curve
- ☐ Point
- ☐ Vertical line

⊙ Correct

Use an equation of the line for the object. Then use the Gaussian Lens Law to find the equation of the focused image of the line. This too turns out to be a line. Additionally, the tilt of the image line is in the opposite direction of the object line. The above phenomenon is called the *Scheimpflug principle*.

10.

1 / 1 point



What is the lens effect you see in this image?

- ☐ Chromatic aberration
- ☐ Radial distortion
- ☒ Vignetting
- ☐ Tangential Distortion

✓ **Correct**

Note that the image gets darker as you move away from the center.