A Lens Is Used To Make An Image Of Magnification -1.50. The Image Is 30.0 Cm From The Lens. What Is The

A Lens Is Used To Make An Image Of Magnification -1.50. The Image Is 30.0 Cm From The Lens. What Is The in the first paragraph sets the stage for understanding a fundamental optical problem involving lenses, magnification, and image formation. If you're studying physics, particularly optics, grasping how to determine the focal length of a lens based on given parameters is essential. This article provides a detailed explanation of how to approach such problems, including the relevant formulas, step-by-step calculations, and practical applications.

Understanding the Basics of Lens Optics

What Is a Lens?

A lens is a transparent optical device that refracts (bends) light to converge or diverge rays to form an image. Lenses are commonly classified as:

- Convex lenses (converging lenses)
- Concave lenses (diverging lenses)

Convex lenses are typically used to magnify images and are the focus of our discussion.

Image Formation in Lenses

When an object is placed in front of a lens, the lens bends light rays to produce an image. The characteristics of this image—such as size, orientation, and position—depend on the object location, the focal length of the lens, and the type of lens.

Key Parameters in Lens Optics

- Object Distance (u): Distance from the object to the lens (measured from the lens along the principal axis).
- Image Distance (v): Distance from the lens to the image.
- Focal Length (f): The distance from the lens to the focal point where parallel rays converge (or appear to

diverge from for a virtual image).
- Magnification (M): The ratio of the image height to the object height, which can also be expressed as $\frac{v}{u}$.

Understanding Magnification and Its Significance

Magnification Definition

Magnification (M) describes how much larger or smaller the image is relative to the object. It is given by:

$$
M = \frac{\text{Image height}}{\object height} = \frac{v}{u}
$$

where:
- v = image distance
- u = object distance

Interpreting a Magnification of -1.50

The negative sign indicates that the image is inverted relative to the object. The magnitude, 1.50, indicates that the image is 1.5 times larger than the object in size.

Implication:
- The image is inverted.
- The image size is 1.5 times the size of the object.

Given Data and What Is Being Asked

- Magnification (M): -1.50
- Image Distance (v): 30.0 cm
- Question: What is the focal length (f) of the lens?

Understanding what is asked is crucial to solving the problem. Since the problem provides the image distance and magnification, our goal is to find the focal length of the lens.

Step-by-Step Solution Approach

Step 1: Use the Magnification Formula

Recall:

$$
M = \frac{v}{u}
$$

Rearranged to find object distance:

$$
u = \frac{v}{M}
$$

Substituting known values:

$$
u = \frac{30.0\, \text{cm}}{-1.50} = -20.0\, \text{cm}
$$

Note: The negative object distance indicates the object is on the same side as the incoming light (real object in front of the lens).

Step 2: Apply Lens Formula

The lens formula relates object distance (u), image distance (v), and focal length (f):

$$
\frac{1}{f} = \frac{1}{v} + \frac{1}{u}
$$

Plugging in known values:

$$
\frac{1}{f} = \frac{1}{30.0\, \text{cm}} + \frac{1}{-20.0\, \text{cm}}
$$

Calculating:

$$
\frac{1}{f} = \frac{1}{30} - \frac{1}{20} = \frac{2}{60} - \frac{3}{60} = -\frac{1}{60}
$$

Thus:

$$
f = -60\, \text{cm}
$$

The negative focal length indicates that the lens is a diverging lens (concave).

Interpreting the Results

Focal Length of the Lens

The focal length is -60 cm. This negative value confirms that the lens is diverging (concave), which makes sense given the negative magnification and the virtual nature of the image.

Summary of Key Findings

- Object Distance (\(u \)): -20.0 cm
- Image Distance (\(v \)): 30.0 cm (positive, real image side)
- Focal Length (\(f \)): -60.0 cm

Practical Applications of Lens Calculations

Optical Devices

Understanding lens parameters is crucial in designing optical devices such as:

- Eyeglasses and contact lenses
- Microscopes and telescopes
- Camera lenses

Medical Imaging

Accurate calculations of focal lengths facilitate the development of medical imaging equipment like endoscopes and ophthalmoscopes.

Additional Considerations and Tips

Sign Conventions in Lens Formula

- For a converging lens (convex): $f > 0$.
- For a diverging lens (concave): $f < 0$.
- Object distances u are negative if the object is in front of the lens (real object).
- Image distances v are positive if the image is real (on the opposite side of the object), and negative if virtual.

Common Mistakes to Avoid

- Forgetting to apply the correct sign conventions.
- Confusing magnification sign with image orientation.
- Not verifying if the calculated object and image distances make physical sense.

Summary

In this article, we explored how to determine the focal length of a lens given the magnification and image distance. Starting with the magnification formula and the lens equation, we calculated the object distance and then derived the focal length. The negative focal length indicates a diverging lens, which aligns with the inverted, magnified virtual image.

Understanding these fundamental concepts is essential for students and professionals working with optical systems. Mastery of the relationships between object distance, image distance, magnification, and focal length enables accurate design and analysis of various optical devices.

Whether you're solving physics problems or designing optical equipment, the principles and methods outlined here will serve as a reliable guide.

Frequently Asked Questions

What is the focal length of a lens that produces a magnification of -1.50 with the image 30.0 cm from the lens?

The focal length can be calculated using the lens formula and magnification. Given magnification (M) = -1.50 and image distance (v) = 30.0 cm, the focal length (f) is approximately 20.0 cm.

How does the negative magnification value affect the image in this lens

system?

A negative magnification indicates that the image is inverted relative to the object. In this case, with M = -1.50, the image is upside down and magnified 1.5 times.

If the magnification is -1.50 and the image is 30.0 cm from the lens, what is the object distance?

Using the magnification formula M = v/u, where v = 30.0 cm, u = object distance, and M = -1.50, the object distance u is approximately -20.0 cm (on the same side as the object).

What type of lens is used if the magnification is negative and the image is real?

A converging (convex) lens is typically used to produce real, inverted images with negative magnification.

How can the focal length of the lens be determined using the given data?

Using the lens formula 1/f = 1/v + 1/u and the known magnification, you can first find the object distance u, then calculate the focal length f. In this scenario, the focal length is approximately 20.0 cm.

Additional Resources

Magnification: Unlocking the Secrets of Image Formation and Lens Functionality

---

Introduction

In the fascinating world of optics, understanding how lenses work to produce clear images is fundamental. Whether you're a student delving into physics, a professional in optical engineering, or an enthusiast exploring the science behind everyday devices like cameras and microscopes, grasping the concepts of magnification and image formation is essential. Today, we explore a specific optical scenario: a lens used to produce an image with a magnification of -1.50, where the image is located 30.0 cm from the lens. This case provides an excellent opportunity to analyze the various parameters involved and understand the underlying physics in detail.

The Significance of Magnification in Lens Systems

What Is Magnification?

Magnification (denoted as M) in optics describes how much larger or smaller an image is compared to the object. It is a dimensionless ratio, often expressed as a positive or negative number:

- Positive magnification: The image is upright relative to the object.
- Negative magnification: The image is inverted relative to the object.

In our case, the magnification is -1.50, indicating that the image is inverted and 1.5 times larger than the object.

Why Is Magnification Important?

Magnification determines the usefulness of an optical device for various applications:

- Magnifying glasses and microscopes: Require high magnification.
- Cameras: Use lenses to produce images of specific magnifications for clear photographs.
- Telescopes: Maximize distant object visibility through high magnification.

Understanding how to manipulate magnification involves analyzing the interplay between the lens's focal length, object distance, and image distance.

Fundamental Concepts and Formulas

The Lens Formula

The primary relation governing lens image formation is the lens formula:

$$
\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}
$$

where:

- f = focal length of the lens (positive for converging lenses, negative for diverging)
- d_o = object distance from the lens
- d_i = image distance from the lens

The Magnification Formula

Magnification relates to the distances as:

$$
M = -\frac{d_i}{d_o}
$$

The negative sign indicates that a positive d_i with a negative d_o or vice versa results in an inverted image.

Analyzing the Given Scenario

Let's summarize the known data:

- Magnification, M = -1.50
- Image distance, d_i = 30.0 cm

Our goal is to determine the focal length f of the lens, or equivalently, other parameters such as object distance d_o.

Step-by-Step Solution

Step 1: Find the Object Distance d_o

Using the magnification formula:

$$
M = -\frac{d_i}{d_o}
$$
$$
-1.50 = -\frac{30.0\, \text{cm}}{d_o}
$$

Solving for d_o:

$$
d_o = \frac{30.0\, \text{cm}}{1.50} = 20.0\, \text{cm}
$$

Interpretation: The object is located 20.0 cm from the lens.

Step 2: Determine the Focal Length f

Using the lens formula:

$$
\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}
$$

Substitute the known values:

$$
\frac{1}{f} = \frac{1}{20.0\, \text{cm}} + \frac{1}{30.0\, \text{cm}}
$$

Calculating:

$$
\frac{1}{f} = \frac{3}{60} + \frac{2}{60} = \frac{5}{60} = \frac{1}{12}
$$

Therefore,

$$
f = 12\, \text{cm}
$$

Conclusion: The lens has a focal length of +12.0 cm, indicating a converging lens.

Interpreting the Results: A Complete Picture

Lens Characteristics

- Type: Converging lens (since focal length is positive)
- Focal Length: 12.0 cm
- Object Distance: 20.0 cm in front of the lens
- Image Distance: 30.0 cm behind the lens

Image Attributes

- Magnification: -1.50
- Image orientation: inverted
- Image size: 1.5 times larger than the object

This setup resembles a typical magnifying system, such as a camera lens or a microscope, where the object is within the focal length to produce a real, inverted, magnified image.

Broader Implications and Applications

Practical Significance

Understanding these parameters enables the design of optical systems with precise image characteristics:

- Cameras: Selecting lenses with specific focal lengths to achieve desired magnification and focus.
- Microscopes: Using converging lenses to produce larger, detailed images of small objects.
- Eyeglasses: Correcting vision by manipulating focal length to compensate for eye defects.

Design Considerations

When designing optical devices, engineers consider:

- Focal length: Determines the lens's converging or diverging power.
- Object placement: Influences the size and orientation of the image.
- Image position: Affects the magnification and whether the image is real or virtual.

Additional Factors Influencing Lens Image Formation

While the above calculations assume ideal conditions, real-world scenarios involve additional considerations:

- Lens aberrations: Imperfections causing distortions.
- Material properties: Refractive index affects focal length.
- Aperture size: Determines image brightness and depth of field.
- Alignment: Precise positioning is essential for optimal image quality.

Summary: Bringing It All Together

In conclusion, analyzing a lens that produces an image with a magnification of -1.50 at 30.0 cm from the lens reveals crucial insights:

- The object is located 20.0 cm from the lens.
- The lens has a focal length of 12.0 cm.

- The image is real, inverted, and magnified.

Understanding these relationships empowers optical engineers, photographers, and students to manipulate and optimize lenses for their specific needs. Whether creating high-precision microscopes or capturing stunning photographs, mastery of magnification and image formation principles is fundamental to advancing optical technology.

Final Thoughts

Optics remains a vibrant field where theoretical principles directly translate into practical innovations. By dissecting specific scenarios like this one, we deepen our understanding and expand our capacity to develop sophisticated optical systems. Whether you're designing a new lens or simply exploring the beauty of how light creates images, the principles of magnification and image formation serve as the foundation for countless technological marvels.

A Lens Is Used To Make An Image Of Magnification 1 50 The Image Is 30 0 Cm From The Lens What Is The

A Lens Is Used To Make An Image Of Magnification 1 50 The Image Is 30 0 Cm From The Lens What Is The

Related Articles

- A Client Telephones The Medical Clinic To Ask For Help With Pruritus And A Change In Stool Color. Which
- At The Museum, You See This Greek Sculpture That Was Influenced By The Conquests Of Alexander The Great
- American Planes Dropped More Tons Of Bombs On Vietnam Than Were Used In All Of World War Ii. TRUE/FALSE

Back to Home