# 6. A Mirror Shows An Upright Image Four Times As Large As The Object When The Object Is 50 Cm Away From

**6. A Mirror Shows An Upright Image Four Times As Large As The Object When The Object Is 50 Cm Away From** - this intriguing phenomenon in optics highlights how mirrors can manipulate the size and orientation of images based on their position relative to the object. Understanding this concept is essential for students, educators, and enthusiasts interested in optics and reflection principles. In this comprehensive article, we delve into the physics behind this specific mirror behavior, exploring the factors that influence image size, types of mirrors involved, and practical applications. Whether you are studying for an exam or simply curious about how mirrors work, this article aims to provide in-depth insights into the fascinating world of optical reflection.

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## Understanding the Basics of Mirror Reflection

### Types of Mirrors

Mirrors are broadly classified into two main types based on their surface shape:

- **Plane Mirrors**: Flat mirrors that produce virtual, upright, and same-sized images as the object.
- **Curved Mirrors**: Include concave and convex mirrors that can magnify or diminish images depending on their shape and the object's position.

### Image Formation in Mirrors

The formation and size of images in mirrors depend on:

1. The shape of the mirror (plane, concave, convex)
2. The position of the object relative to the mirror's focal point and center of curvature
3. The distance between the object and the mirror

In particular, curved mirrors, such as concave mirrors, are capable of producing magnified images, which is central to the scenario discussed in this article.

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# Concave Mirrors and Magnification

## How Concave Mirrors Work

Concave mirrors have a reflective surface that curves inward, resembling the interior of a sphere. When an object is placed in front of a concave mirror, the mirror can produce real or virtual images depending on the object's position:

- Object beyond the focal point: real, inverted, and magnified or diminished depending on distance.
- Object at the focal point: no image is formed (parallel rays).
- Object between the focal point and mirror: virtual, upright, and magnified.

## Magnification in Concave Mirrors

Magnification ($M$) is the ratio of image height to object height and is given by:

$$
M = \frac{\text{Image Height}}{\text{Object Height}} = \frac{v}{u}
$$

where:
- $v$ = image distance from the mirror
- $u$ = object distance from the mirror (negative if measured against the direction of incident rays)

When the mirror produces an image four times as large as the object, $M = 4$.

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# Analyzing the Scenario: Object 50 Cm Away

## Given Data

- Object distance, $u = -50\, \text{cm}$ (negative sign conventionally used)
- Image is upright and four times as large as the object, so $M = +4$

## Calculating Image Distance

Using the magnification formula:

\[

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

which leads to:

$$
v = M \times u = 4 \times (-50\, \text{cm}) = -200\, \text{cm}
$$

The negative sign indicates that the image is virtual and located on the same side as the object, typical for magnified, upright images in concave mirrors when the object is between the focal point and the mirror.

## Applying the Mirror Equation

The mirror equation relates the focal length ($f$), object distance ($u$), and image distance ($v$):

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

Substituting the known values:

$$
\frac{1}{f} = \frac{1}{-200} + \frac{1}{-50} = -\frac{1}{200} - \frac{1}{50}
$$

Converting to a common denominator:

$$
-\frac{1}{200} - \frac{4}{200} = -\frac{5}{200} = -\frac{1}{40}
$$

Thus,

$$
f = -40\, \text{cm}
$$

The negative focal length confirms that the mirror is concave.

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# Implications of the Focal Length and Object Distance

## Position of the Object

Since the object is at 50 cm from the mirror and the focal length is -40 cm, the object is located beyond the focal point, but close enough to produce a magnified, upright virtual image.

### Magnification Conditions

- The magnification of 4 indicates a significant magnification, typical of the object being between the focal point and the mirror.
- This scenario aligns with the principle that when the object is between the focal point and the mirror, the mirror produces an upright, virtual, and magnified image.

### Key Points to Remember

- The image size is four times the object size when the object is placed between the focal point and the mirror.
- The virtual image appears behind the mirror.
- The mirror's focal length influences the degree of magnification.

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## Practical Applications of Magnified Virtual Images in Mirrors

### Use in Magnifying Devices

Concave mirrors are commonly used in:

- Makeup mirrors
- Shaving mirrors
- Microscopes and telescopes

to produce highly magnified, upright virtual images that assist in detailed work.

### Medical and Scientific Uses

- Dental mirrors utilize concave mirrors to magnify the view of the oral cavity.
- Optical instruments depend on precise image formation for accuracy and clarity.

### Decorative and Architectural Uses

- Concave mirrors can be used to create visual effects through magnification and reflection, enhancing aesthetic appeal.

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## Summary and Key Takeaways

- When an object is 50 cm away from a concave mirror with a focal length of –40 cm, it produces an upright, virtual image four times as large as the object.
- The image's position is approximately 200 cm behind the mirror, confirming the virtual nature.
- The magnification formula and mirror equation are essential tools to analyze and predict image characteristics.
- Understanding the physics of mirror reflection helps in designing practical optical devices and appreciating everyday objects like magnifying mirrors.

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## Conclusion

The phenomenon where a mirror shows an upright image four times as large as the object at a 50 cm distance exemplifies the fascinating principles of optics. It underscores the significance of the mirror's curvature, focal length, and object position in determining the nature and size of the resulting image. Recognizing how concave mirrors can produce magnified, virtual images is crucial for various technological and daily applications, from cosmetic mirrors to scientific instruments. By mastering these concepts, students and enthusiasts can deepen their understanding of optical physics and appreciate the remarkable capabilities of simple reflective surfaces.

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## SEO Keywords for Optimization

- Mirror image magnification
- Concave mirror optics
- Virtual image formation
- Magnified upright images
- Mirror physics tutorial
- Focal length and image size
- Object distance and mirror image
- Optical reflection principles
- How mirrors produce enlarged images
- Applications of concave mirrors

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This detailed exploration provides a comprehensive understanding of how a mirror can produce an image four times larger than the object when the object is 50 cm away, illustrating core concepts in optics and reflection. Whether for academic purposes or practical applications, grasping these principles enhances one's appreciation of the physics behind everyday reflective devices.

## Frequently Asked Questions

## What type of mirror produces an upright image four times larger than the object when the object is 50 cm away?

A concave mirror positioned within its focal length can produce an upright, magnified image four times larger than the object.

## How can I determine the focal length of the mirror given that the image is four times the size of the object at 50 cm distance?

Using the magnification formula (magnification = image size / object size) and mirror equation, you can calculate the focal length based on the given magnification (4) and object distance (50 cm).

## What is the approximate focal length of the mirror in this scenario?

The focal length of the mirror is approximately 16.7 cm, assuming the mirror produces an upright, magnified image at the given object distance.

## Why does the mirror produce an upright and magnified image at this distance?

Because the object is placed between the focal point and the mirror in a concave mirror, resulting in an upright, magnified virtual image.

## Can a convex mirror produce a similar image size and orientation at 50 cm object distance?

No, convex mirrors always produce virtual, upright, and diminished images; they cannot produce an upright image four times larger than the object at that distance.

## How does the distance of the object from the mirror affect the size and nature of the image?

As the object moves closer to the mirror within the focal length, the image becomes larger and upright; moving farther away reduces magnification and can produce real or virtual images depending on the position.

## What practical applications utilize the principle of magnified upright images formed by concave mirrors?

Applications include makeup mirrors, telescopes, shaving mirrors, and certain microscopy devices where magnification and upright images are desired.

## What safety precautions should be taken when working with concave mirrors to observe image formation?

Avoid looking directly into the mirror when a bright light source is reflected, handle the mirror carefully to prevent damage, and ensure proper distance to avoid eye strain or injury.

## Additional Resources

A Mirror Shows An Upright Image Four Times As Large As The Object When The Object Is 50 Cm Away From—this intriguing statement invites us to explore the fascinating world of optical physics, particularly the behavior of images formed by mirrors. Understanding the conditions under which a mirror produces an image four times as large and upright as the object at a specific distance can deepen our grasp of concepts like magnification, mirror types, and image formation principles. In this comprehensive guide, we will delve into the physics behind this phenomenon, analyze the possible mirror configurations, and provide practical insights into how these principles apply in real-world scenarios.

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Understanding the Fundamentals of Mirrors and Image Formation

Before we analyze the specific case where a mirror produces an upright, magnified image, it's essential to revisit some foundational concepts in optics.

Types of Mirrors and Their Characteristics

- Plane Mirrors: Flat surfaces that produce images that are virtual, erect, and of the same size as the object, with no magnification or reduction.
- Concave Mirrors: Spherical mirrors with a reflective surface that curves inward. They can produce real or virtual images depending on the object's position relative to the focal point.
- Convex Mirrors: Spherical mirrors with a reflective surface that curves outward, always forming virtual, erect, and diminished images.

Image Formation Principles

- Ray Diagrams: Visual tools that help us understand how light rays reflect off a mirror and where the image forms.
- Magnification (M): Defined as the ratio of the height of the image to the height of the object ($M = h_i / h_o$). It can also be calculated as the ratio of the image distance to the object distance ($M = v / u$).

Mirror Equation and Magnification Formula

The primary equations governing mirror behavior are:

- Mirror Equation:

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

where
$f$ = focal length,
$v$ = image distance,
$u$ = object distance (measured from the mirror).

- Magnification:

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

\]

For upright images, the magnification is positive, and for real images, the image distance v is positive in the mirror sign convention.

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Interpreting the Key Statement

"A mirror shows an upright image four times as large as the object when the object is 50 cm away from"—this statement indicates a specific scenario involving:

- An object located 50 cm from the mirror.
- An image that is upright and four times larger than the object.

Our goal is to analyze what type of mirror produces such an image under these conditions, and how the position of the object relates to the mirror’s focal length and image formation.

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Step-by-Step Analysis of the Scenario

1. Establish Known Data

- Object distance, $u = -50\,cm$ (assuming mirror sign convention where object distances in front of the mirror are negative).
- Magnification, $M = +4$ (positive sign indicates an upright image).

2. Determine Image Distance

Using the magnification formula:

$$
M = \frac{v}{u}
$$
$$
v = M \times u = 4 \times (-50\,cm) = -200\,cm
$$

The negative sign of v indicates that the image is virtual and located behind the mirror. This suggests that the mirror produces an upright, magnified virtual image.

3. Find the Focal Length

Applying the mirror equation:

$$
\frac{1}{f} = \frac{1}{v} + \frac{1}{u}
$$
$$
\frac{1}{f} = \frac{1}{-200\,cm} + \frac{1}{-50\,cm} = -\frac{1}{200} - \frac{1}{50}
$$
$$
\frac{1}{f} = -\frac{1}{200} - \frac{4}{200} = -\frac{5}{200} = -\frac{1}{40}
$$

$$
f = -40\,cm
$$

The negative focal length confirms that the mirror is convex, as convex mirrors have negative focal lengths.

4. Summary of Findings

- The mirror is convex with a focal length of −40 cm.
- The object is placed 50 cm in front of the mirror.
- The virtual, upright, magnified image forms 200 cm behind the mirror, with a magnification of +4.

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Practical Implications and Applications

Understanding this scenario offers insights into several real-world applications:

a. Convex Mirrors in Vehicles

Convex mirrors are commonly used as side and rear-view mirrors because they produce upright, magnified, virtual images, providing a wider field of view. The fact that these mirrors create images multiple times larger and upright of objects at close distances is instrumental in reducing blind spots.

b. Security and Surveillance

Convex mirrors are often installed in stores and hallways to give a broader view of the surroundings, allowing for better surveillance due to the magnified and upright images.

c. Optical Instruments and Devices

The principles of magnification and image formation are crucial in designing devices like periscopes, microscopes, and telescopes, where virtual images and magnification are essential.

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Exploring the Relationship Between Object Distance and Image Size

The scenario shows that the object is 50 cm away from the mirror, and the image is 4 times larger and upright. Now, let's explore some general principles:

a. For Convex Mirrors

- The images are always virtual, erect, and diminished or magnified depending on the object distance.
- The magnification is positive, and image size decreases as the object moves farther away.
- Closer objects (within the focal length) produce larger, virtual images.

b. For Concave Mirrors

- When the object is within the focal length, the images are virtual, erect,

and magnified.
- When the object moves beyond the focal point, the images tend to be real, inverted, and can be magnified or diminished depending on the position.

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Practical Calculations for Different Object Positions

Suppose we want to find out how the image size changes if the object is moved to other distances from the mirror. Using the derived focal length f = -40 cm, here are some scenarios:

| Object Distance $u$ (cm) | Image Distance $v$ (cm) | Magnification $M$ | Image Type |
|---|---|---|---|
| -50 (initial) | -200 | +4 | Virtual, upright, magnified |
| -30 | ? | ? | Virtual, upright |
| -100 | ? | ? | Virtual, upright |

Calculate for $u = -30\,cm$:

$$
\frac{1}{f} = \frac{1}{v} + \frac{1}{u}
$$
$$
-\frac{1}{40} = \frac{1}{v} + \frac{1}{-30}
$$
$$
\frac{1}{v} = -\frac{1}{40} + \frac{1}{30} = -\frac{3}{120} + \frac{4}{120} = \frac{1}{120}
$$
$$
v = 120\,cm
$$

Magnification:

$$
M = \frac{v}{u} = \frac{120}{-30} = -4
$$

The negative sign indicates an inverted image. Since the magnitude is 4, the image is 4 times larger but inverted at 120 cm behind the mirror.

Similarly, for $u = -100\,cm$:

$$
\frac{1}{v} = -\frac{1}{40} + \frac{1}{-100} = -\frac{1}{40} - \frac{1}{100} = -\frac{5}{200} - \frac{2}{200} = -\frac{7}{200}
$$
$$
v = -\frac{200}{7} \approx -28.57\,cm
$$

Magnification:

$$
M = \frac{-28.57}{-100} \approx +0.2857
$$

\]

This indicates a virtual, upright, and smaller image.

Key insight: As the object moves closer to the convex mirror (from 100 cm to 50 cm), the image becomes larger and more magnified, consistent with the properties of convex mirrors.

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Summary and Final Remarks

The statement that "A mirror shows an upright image four times as large as the object when the object is 50 cm away" can be fully explained by the physics of convex mirrors with a focal length of -40 cm. The virtual image forms behind the mirror at 200 cm and is upright and magnified due to the mirror's shape and the object's proximity.

Key Takeaways:

- Convex mirrors produce virtual, upright, and diminished or magnified images depending on the object's position.
- Magnification depends on the ratio of image distance to object distance

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