

# Light Rays and Reflection : Notes/W.S.-10

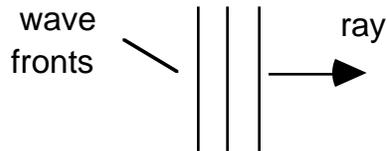
Light is an electromagnetic wave. It is composed of electric and magnetic fields. In general, light travels in straight lines, and moves with a velocity of  $3.0 \times 10^8$  m/s.

Light waves have a frequency and a wavelength. Blue light has a shorter wavelength than red light. The speed of light does not depend on its wavelength.

Light can be reflected, diffracted and refracted. Light can be reflected by a flat shiny metal surface such as a mirror. Diffraction (bending) effects are hard to observe because the frequency of light is so high. Remember, high frequency waves diffract less than low frequency waves. Light can be refracted by water or glass because it slows down in those media.

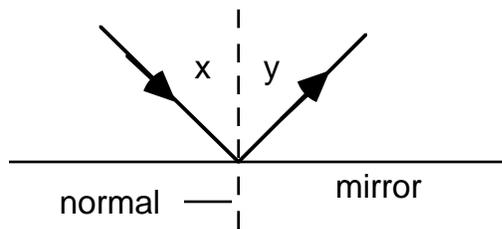
## Rays

When solving reflection and refraction problems, it is useful to represent the waves with an arrow. The arrow is perpendicular to the wave front as shown below.



## Reflection

We can show light waves being reflected by a mirror. The wave fronts are not shown.

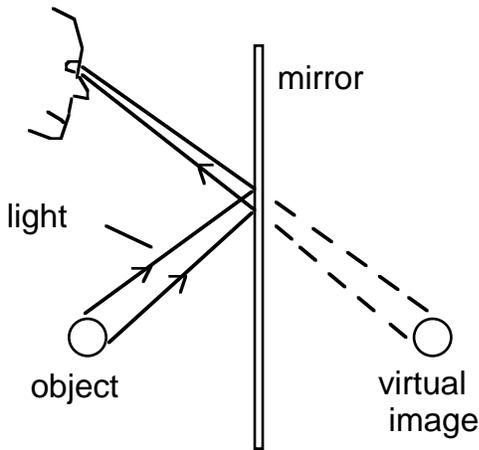


Light obeys two simple laws.

- Light travels in straight lines.
- The angle of incidence  $x$  is equal to the angle of reflection  $y$ .

### Images

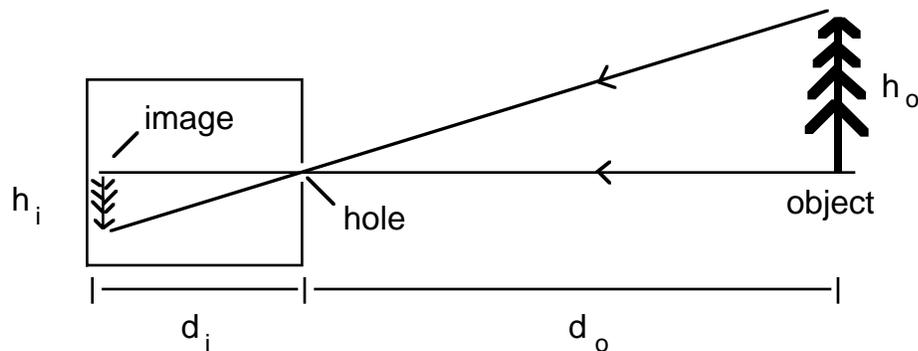
We can find images in plane mirrors by using the above two laws.



Light from the object travels to the eye after being reflected by the mirror. The light appears to come from the image, which is located behind the mirror. The image is the same size as the object and appears to be the same distance behind the mirror as the object is in front.

### The Pinhole Camera

It was discovered in the 16th century that light from a distant object will form an image of the distant object on the inside of a box with a small hole in it. This simple box was called a "camera obscura".



From the geometry above, we have the equation:

$$\frac{h_i}{h_o} = \frac{d_i}{d_o}$$

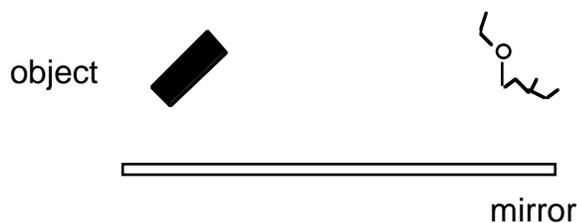
Pictures can be taken with this pinhole camera, but a long exposure time is needed as the hole must be small.

Questions:

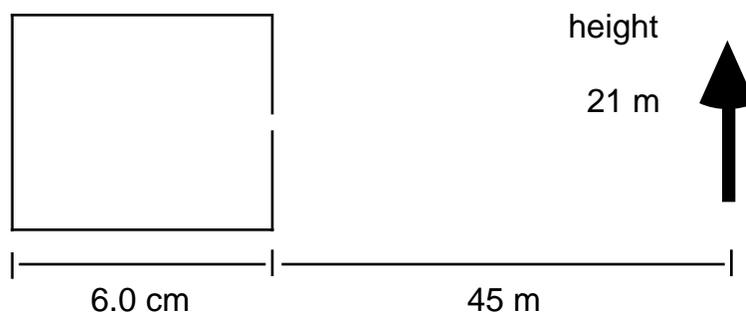
- 1)a) What is the speed of light?
  - b) How many minutes does it take for light from the sun to reach the Earth? (distance to Sun equals  $1.5 \times 10^{11} \text{m}$ )
  - c) Which has a higher frequency; blue light or red light?
  - d) Yellow light has a wavelength of  $6.0 \times 10^{-7} \text{ m}$ . Find it's frequency. (use velocity = frequency x wavelength)
- 2) Explain why light does not diffract very much and is therefore seen to travel in straight lines.
- 3)a) What are the two laws of reflection?
  - b) Draw a ray diagram to show what happens to the light wave fronts shown below when they are reflected. Draw the normal.



c) Draw a ray diagram to find the image of the object. Use a ruler and a pencil. Be neat.

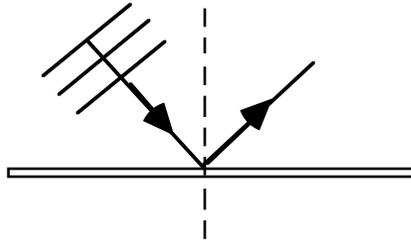


4)a) For the pinhole camera below, draw the image inside. (distances not shown to scale)

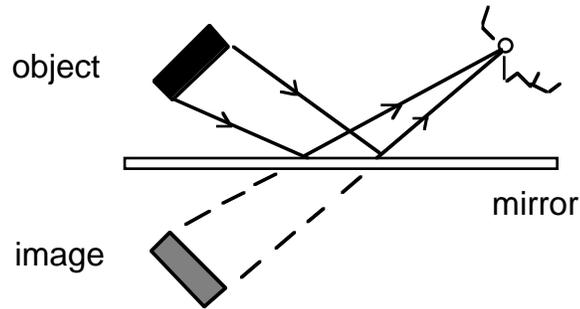


b) Find the height of the image.

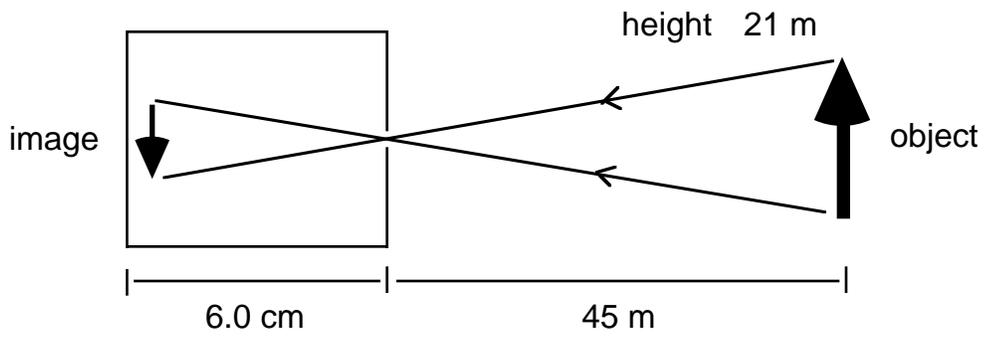
Answers: 1)a)  $3.0 \times 10^8$  m/s, b) 8.3 minutes, c) blue, d)  $5.0 \times 10^{14}$  Hz, 2) Light has a high frequency. High frequency waves do not diffract much., 3)a) Light travels in straight lines and the angle of incidence equals the angle of reflection., b)



c)



4)a)



b) 2.8 cm.