Physics 25 Practice Problems Chapter 26

Snell's Law

1. What is the speed of light in water?

2. In traveling from air into water, (a) what angle of incidence at the interface will cause the internally *reflected* ray to make an angle of 34 degrees with respect to the normal line? (b) What angle of incidence will cause the angle of *refraction* to be 22 degrees?

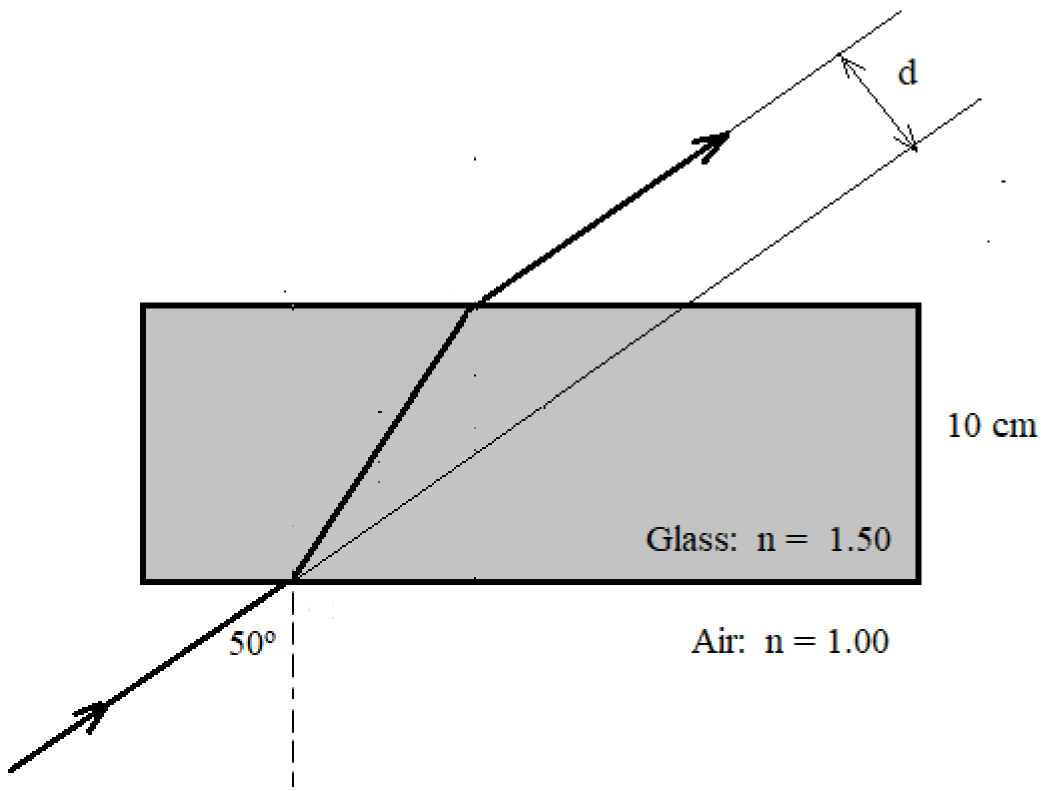
3. In traveling from water to glass, at what angle of incidence--if any--will the angle of refraction be 80 degrees?

4. What is the critical angle for total internal reflection for light traveling from glass into water?

5. The critical angle for total internal reflection when light travels out of a certain transparent substance into water is 36 degrees. What is the index of refraction of that substance?

6. [SKIP THIS PROBLEM] A point source of light located 2.2 meters below the surface of a lake and emits light in all directions. On the surface of the lake directly above the point source, the area illuminated is circular. What is the maximum radius r this disk could have?

7. [SKIP THIS PROBLEM] Determine the "deviation distance," d, the separation between the parallel incident ray entering the glass block from air, and the refracted ray exiting the glass into air.



Convex Lenses

1. The focal length of a convex lens is 60 cm. An 8-cm tall object is placed 120 cm from the lens. What are the image properties?

2. The focal length of a convex lens is 60 cm. A 3-cm tall object is placed 30 cm from the lens. What are the image properties?

3. A convex lens has a focal length of 50 cm. How far from the lens must an object be placed to create an image that is one-third the height of the object, and inverted?

4. A convex lens (f =12.0 cm) is held 8.00 cm in front of newspaper that has a print size with a height of 2.0 mm. What are the image properties?

5. A person has a "near-point" of 138 cm, and she wears contact lenses that have a focal length of 35 cm. How close can she hold a magazine and still read it clearly?

6. A person has a near-point of 100 cm, and she wishes to obtain glasses that will allow her to see clearly her iPhone screen 25 cm away. What must be the refractive power (diopter power, lens power) of glasses that will help her?

7. Prove that upright images cannot be formed with convex lenses if the object is outside the focal point, i.e., the object is farther from the lens than is the focal point.

8. The distance between the objective and the eyepiece of a compound microscope is 220 mm. The focal length of the objective is 12 mm, and the object distance is 16 mm. The overall magnification is 64. What is the focal length of the eyepiece?

Snell's Law Practice Problems Solutions

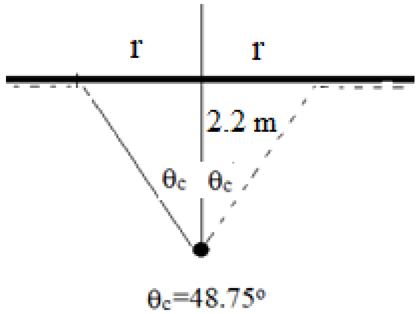
MODE: Degree

1. The index of refraction of water is 1.33. $v = c/n$ $= 3.0 \times 10^8/1.33$ $= 2.26 \times 10^8$ m/s	**2.** (a) 34^o (The angle of reflection equals the angle of incidence.) (b) $1.00 \sin\theta = 1.33 \sin 22$ $\theta = 29.9^o$	3. water: $n = 1.33$ glass: $n = 1.50$ $1.33 \sin\theta = 1.50 \sin 80$ $\sin\theta = 1.11$ (Not possible: $\sin\theta$ cannot be greater than 1.)
4. $1.50 \sin\theta_c = 1.33 \sin 90$ $\theta_c = 62.46^o$	**5.** $n_1 \sin 36 = 1.33 \sin 90$ $n_1 = 2.26$	

6.

Below we use the fact that the critical angle for total internal reflection at a water-air interface is 48.75°.

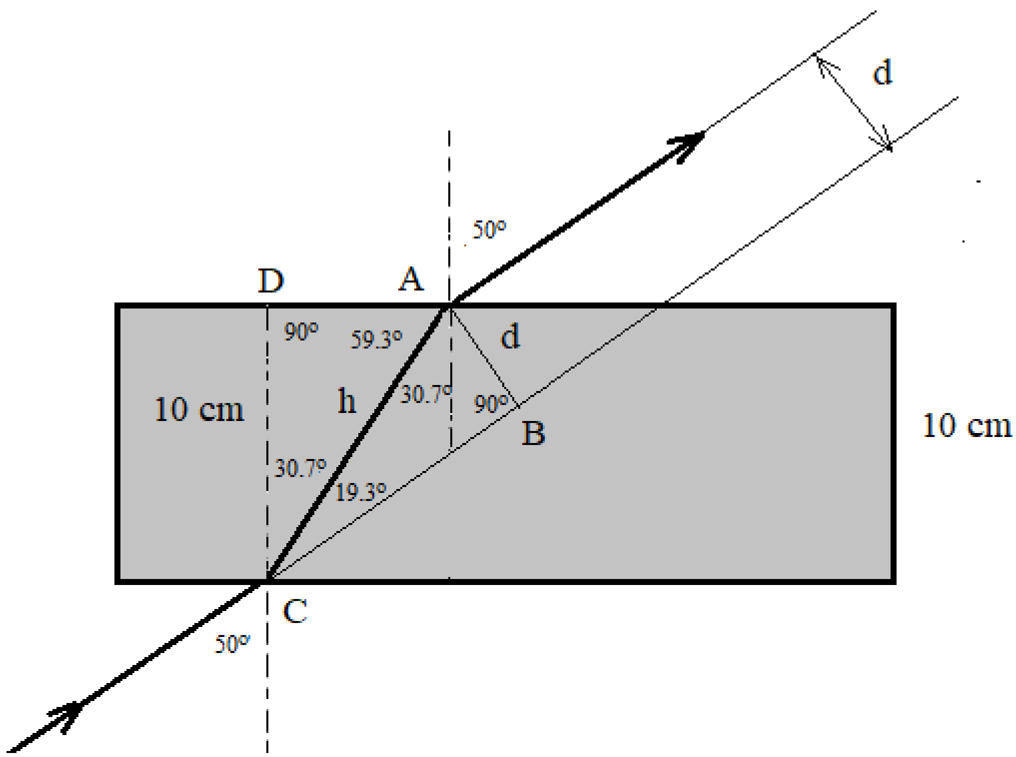
Light incident at the water-air interface at angles greater than the critical angle will be reflected back into the water, and thus will not be visible to viewers above.



$r = 2.2 \tan 48.75$

$= 2.51$ m

7.



$1.00 \sin 50 = 1.50 \sin \theta$
$\theta = 30.7^{o}$

Triangle ACD hypotenuse: h
$10/h = \cos 30.7^{o}$
$h = 11.6$ cm

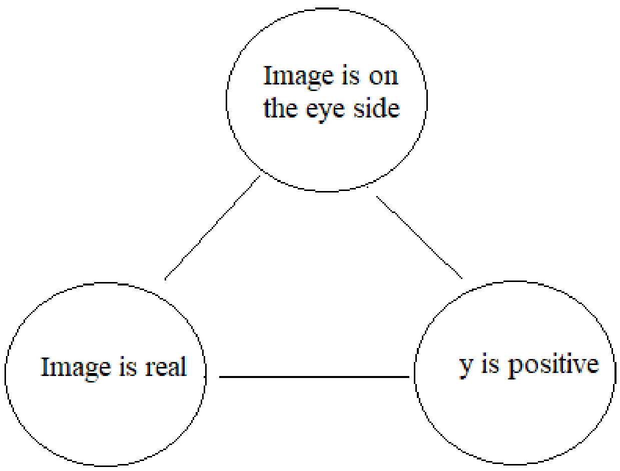
Triangle ABC hypotenuse: h = 11.6 cm
$\sin 19.3^{o} = d/11.6$
$d = 3.83$ cm

Convex Lenses Problem Solutions

Important facts about lenses:

(a) If y is not positive, the image is not on the eye-side
(b) If y is not positive, the image is not real.

If any of the statements below is true, the other two are also true; if any one of the statements is false, the other two are likewise false.



1. 1/120 + 1/y = 1/60 y =120 cm The image distance is positive, so he image is on the eye side, and is real. M = -y/x = -120/120 = -1 The magnification is negative, so the image is inverted. The image height is H_I = (-1) 8 = -8 cm	**2.** 1/30 + 1/y = 1/60 y = -60 cm Image distance is negative, so the image is not on the eye side, and is virtual. M = -y/x = 6030 = 2 The magnification is positive, so the image is upright. The image height is H_I = 2 (3) = 6 cm

<table>
<tr>
<td>3.

$-y/x = -1/3$
$y = x/3$
$1/x + 3/x = 1/50$
$x = 200$ cm</td>
<td>4.

$1/8 + 1/y = 1/12$
$y = -24$ cm
The image distance is negative, so the image is not on the eye side, and is virtual.

$M = -(-24)/8$
$= 3$
The magnification is positive, so the image is upright.

Image Height $= MH_o$
$= 3\ (2)$
$= 6$ mm</td>
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<tr>
<td>5.
$y = -138$ cm
$1/x - 1/138 = 1/35$
$x = 27.9$ cm</td>
<td>6.

$1/f = 1/25 - 1/100$
$f = 33.33$ cm
$= 0.3333$ m
$D = 1/0.3333$
$= 3.00\ m^{-1}$
$= 3.00$ Dp</td>
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7.

$1/x + 1/y = 1/f$
$1/y = 1/f - 1/x$
$= x/fx - f/fx$
$= (x - f)/fx$
$y = fx/(x - f)$
$M = -y/x$
$= f/(f - x)$

If $x > f$, the denominator $(f - x)$ is negative. The numerator f is positive, so M is negative.

Therefore, if the object is outside the focal point, the image is inverted, not upright.

8.

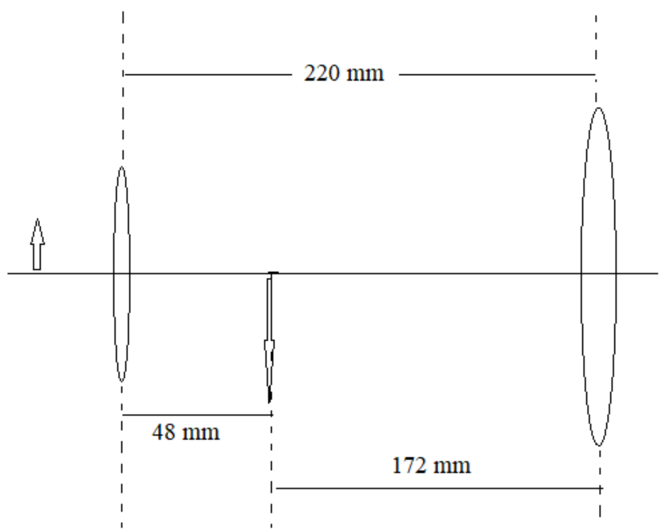
$1/16 + 1/y = 1/12$

$y = 48$ mm

$M_o = -y/x$

$= -48/16$

$= -3$ (Objective's Magnification)



The image thus formed is located 48 mm from the objective, which places it 172 mm from the eyepiece

$M_E = f_E / (f_E - 172)$ Eyepiece Magnification

$M_o M_E = 64$

$(-3) [f_E / (f_E - 172)] = 64$

$f = 164.30$ mm