Optics

AP Physics – Mr. Hall

WORKSHEET #2

Name: _____

1. A beam of light, wavelength 625 nm in air, is incident on a block of flint glass at an angle of 31.5°. Find (a) the speed of light in the flint glass (b) the angle of refraction and (c) the wavelength of the light in the glass.

a. $v = c/n = 3.00\times10^8\ m/s / 1.65 = 1.8181818\times10^8\ m/s =$ $\boxed{1.82\times10^8\ m/s}$

b. $\theta_2 = \sin^{-1}(n_1\sin\theta_1 / n_2) = \sin^{-1}(1.0003 \cdot \sin(31.5°) / 1.65) = 18.46714425° =$ $\boxed{18.5°}$

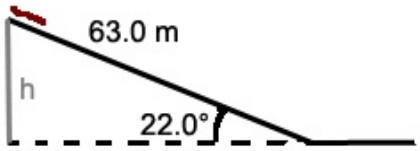
c. $\lambda_2 = n_1\lambda_1 / n_2 = 1.0003 \cdot 625\ nm / 1.65 = 378.9015152\ nm =$ $\boxed{379\ nm}$

2. An FM radio signal is broadcast at a frequency of 107.5 MHz. (a) What is its wavelength? (b) What is the period of the wave?

a. $\lambda = c/f = 3.00\times10^8\ m/s / 107.5\times10^6\ Hz = 2.790697674\ m =$ $\boxed{2.79\ m}$

b. $T = 1/f = 1/(107.5\times10^6\ Hz) = 9.302325581\times10^{-9}\ s =$ $\boxed{9.30\ ns}$

3. A sled rests on a snow slope that is elevated at an angle of 22.0°. The distance along the slope to the bottom of the slope is 63.0 m. (a) Draw a sketch of the sled on the slope (b) How fast will the sled be going when it reaches the bottom of the hill?



a. see image

b. $h = 63.0\ m \cdot \sin(22.0°) = 23.6\ m$

$v = (2gh)^{\frac{1}{2}} = (2 \cdot 9.8\ m/s^2 \cdot 23.60021539\ m)^{\frac{1}{2}} = 21.50730624\ m/s =$ $\boxed{21.5\ m/s}$

4. A beam of light with a wavelength of 471 nm traveling in air is incident on slab of material. The angle of incidence is 38.0°. The refracted beam makes an angle of 25.0°. (a) Find index of refraction for slab. (b) Find wavelength of light in medium. (c) Find the speed of light in the slab.

a. $n_2 = n_1\sin\theta_1 / \sin\theta_2 = 1.0003 \cdot \sin(38.0°) / \sin(25.0°) = 1.457216191 =$ $\boxed{1.46}$

b. $\lambda_2 = n_1\lambda_1 / n_2 = 1.0003 \cdot 471\ nm / 1.457216191 = 323.3159931\ nm =$ $\boxed{323\ nm}$

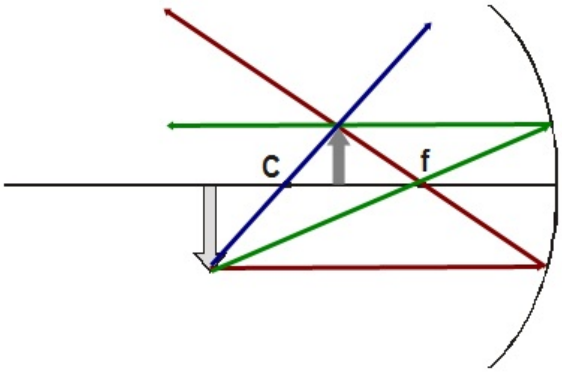
c. $v = c/n = 3.00\times10^8\ m/s / 1.457216191 = 2.05871992\times10^8\ m/s =$ $\boxed{2.06\times10^8\ m/s}$

5. What is the critical angle for light in water? Assume that air is on the other side of the water.

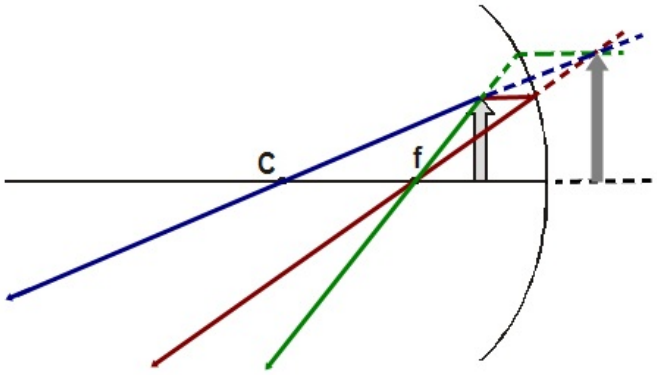
$n_1 \sin\theta_1 = n_2 \sin\theta_2$

$\theta_1 = \sin^{-1}(n_2 \sin\theta_2 / n_1) = \sin^{-1}(1.0003 \cdot \sin(90°) / 1.33) = 48.77307284° =$ $\boxed{48.8°}$

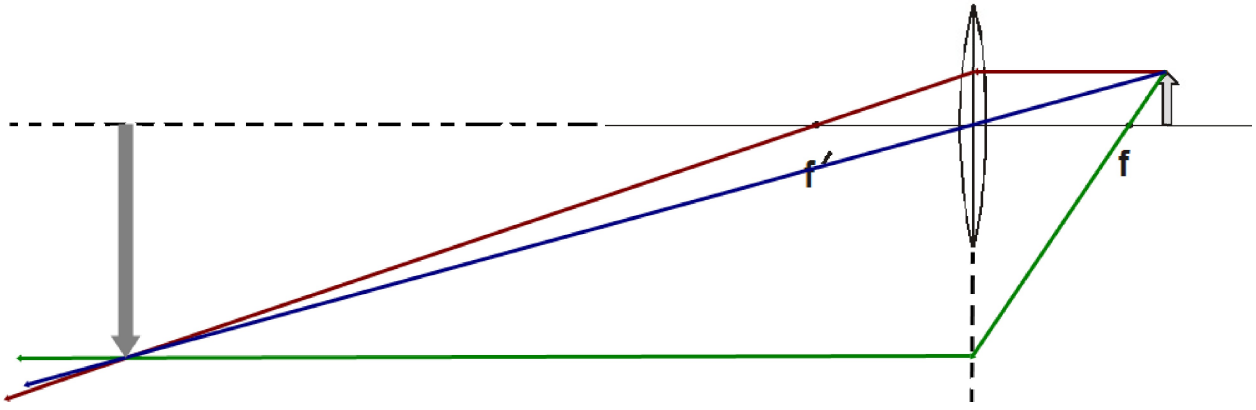
6. Construct the image on the drawing below via ray tracing.



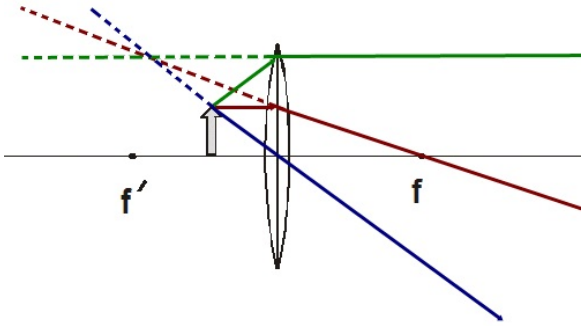
7. Construct the image on the drawing below via ray tracing.



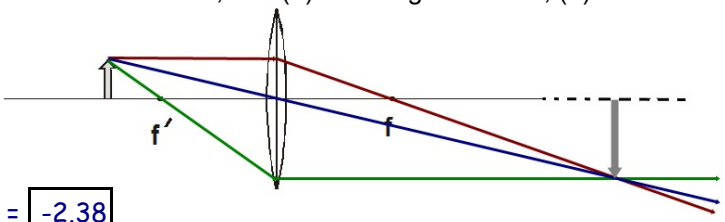
8. Construct the image for an object placed as shown below.



9. Construct the image for an object placed as shown below.



10. Construct the image formed by the object as shown below. If the focal length of the lens is 15.5 cm and the 3.20 cm (in height) object is placed 22.0 cm from the lens, find (a) the image distance, (b) the magnification, (c) the image height.



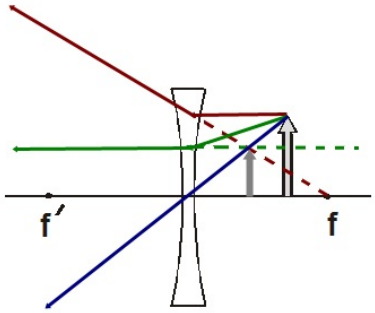
a. $1/f = 1/d_i + 1/d_o$
$1/(0.155\ m) = 1/d_i + 1/(0.22\ m)$
$d_i = (1/(0.155\ m) - 1/0.22\ m)^{-1} =$ **52.5 cm**

b. $M = -d_o/d_i = 52.5\ cm/22.0\ cm = -2.384615 =$ **-2.38**

c. $h_i = M \cdot h_o = -2.384615 \cdot 3.20\ cm = -7.630769\ cm =$ **-7.63 cm**

11. (a) Draw in the rays and the image for this lens set up. (b) What kind of image is it?

a. see image
b. virtual image



12. Construct the image for this spherical convex mirror.