Name: ________________________

1. A beam of light, wavelength 615 nm in water, is incident on the side of a tank the sides of which are made of flint glass. The angle of incidence is 41.0°. Find (a) the speed of light in the glass (b) the angle of refraction (c) the wavelength of the light in the glass, and (d) the critical angle for the glass.

   a. $v = c/n = 3.00\times10^8$ m/s / 1.65 = 1.8181818×10^8 m/s = $\boxed{1.82\times10^8 \text{ m/s}}$

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

      $\theta_2 = \sin^{-1}(n_1\sin\theta_1/n_2) = \sin^{-1}(1.33 \cdot \sin(41.0°)/1.65) = 31.925987° = \boxed{31.9°}$

   c. $\lambda_1 n_1 = \lambda_2 n_2$

      $\lambda_2 = \lambda_1 n_1/n_2$ = 615 nm · 1.33/1.65 = 495.727272 nm = $\boxed{496 \text{ nm}}$

   d. $\theta_1 = \sin^{-1}(n_2\sin\theta_2/n_1) = \sin^{-1}(1.33 \cdot \sin(90°)/1.65) = 53.7128° = \boxed{53.7°}$

      (from glass to water, not possible the other way)

2. In a double slit experiment, the slits are separated by 0.100 mm. The slits are illuminated by 585 nm light. The screen is 4.00 m from the slits. Find the difference in path lengths for waves coming through the slits for a second order bright fringe.

   diff = $m\lambda$ = 2 · 585 nm = $\boxed{1170 \text{ nm or } 1.17\ \mu\text{m}}$

3. The distance between two slits is 0.0500 mm and the distance to the screen is 2.50 m, find the spacing between the first-order and second-order bright fringes for yellow light with a wavelength of 580.0 nm wavelength.

   Since the fringes are equidistant, the distance will be the same as to the first fringe.

   $x_m = m\lambda L/d = 1 \cdot 580.0\times10^{-9}$ m · 2.50 m / 5.00×10^{-5} m = 0.029 m = $\boxed{2.90 \text{ cm}}$

4. A thin layer of oil (*n* = 1.28) spills onto the surface of a nearby lake. It produces maximum reflection for orange light (600.0 nm wavelength in air). Assuming the maximum occurs in the first order, determine the thickness of the oil slick.

   $n_1\lambda_1 = n_2\lambda_2$

   $\lambda_2 = (n_1/n_2)\lambda_1$ = (1.0003/1.28) · 600.0 nm = 468.890625 nm

   d = 468.890625 nm / 2 = 234.4453125 nm = $\boxed{234 \text{ nm}}$

5. Find the minimum film thickness for destructive interference in reflected light for a thin film. Figure on a first minima deal. The film's index of refraction is 1.25. It is illuminated by light that has wavelength of 625 nm.

$n_1\lambda_1 = n_2\lambda_2$

$\lambda_2 = (n_1/n_2)\lambda_1 = (1.0003/1.25) \cdot 625\ \text{nm} = 500.15\ \text{nm}$

$d = 500.15\ \text{nm} / 4 = 125.0375\ \text{nm} = \boxed{125\ \text{nm}}$

6. 585 nm light hits a slit (note, just the one slit) that is 0.300 mm in width. The observing screen is 2.50 m away. Find (a) the position of the first dark fringe and (b) the width of the central bright fringe.

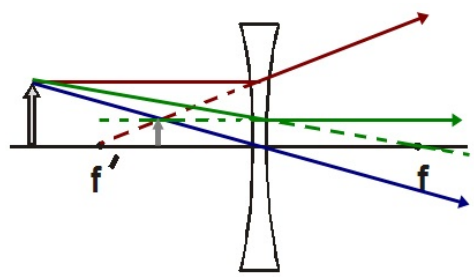
a. $D\sin\theta = m\lambda$

$\theta = \sin^{-1}(m\lambda/D) = \sin^{-1}(1 \cdot 585\times10^{-9}\ \text{m}/0.300\times10^{-3}\ \text{m}) = 0.11172684°$

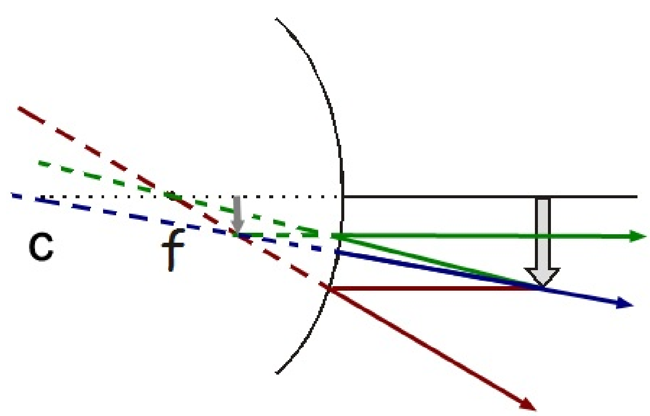
$x = y\tan\theta = 2.50\ \text{m} \cdot \tan(0.11172684°) = 0.004875\ \text{m} = 4.875\ \text{mm} = \boxed{4.88\ \text{mm}}$

b. $d = 2 \cdot 4.875\ \text{mm} = \boxed{9.75\ \text{mm}}$

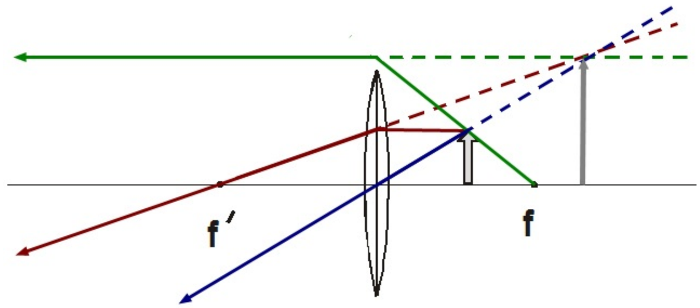
7. Construct the image on the drawing below via ray tracing.



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



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



10. A double convex thin lens has a focal length of 35.0 cm. A 2.15 cm tall object is placed 10.0 cm from the lens, find (a) the type of image, (b) the image distance, (c) the magnification, (d) the image height.

b. $i^{-1} + o^{-1} = f^{-1}$

$i = (f^{-1} - o^{-1})^{-1} = ((1/35) - (1/10))^{-1} =$ **-14.0 cm**

a. **virtual image** (negative image distance value)

c. $m = -i/o = -(-14.0\text{ cm})/10.0\text{ cm} =$ **1.40**

d. $h_i = h_o \cdot m = 2.15\text{ cm} \cdot 1.40 =$ **3.01 cm**

11. A rock is thrown at an angle of 25° and hits the ground at the same height as it started with. It is in the air for 3.2 seconds. How far did it travel in the horizontal direction?

$v = v_i + at$

$v_i = v - at = 0\text{ m/s} - (-9.8\text{ m/s}^2) \cdot 1.6\text{ s} = 15.68\text{ m/s}$

$v_x = v_y/\tan\theta = 15.68\text{ m/s} / \tan(25°) = 33.6259\text{ m/s}$

$d_x = v_x \cdot t = 33.6259\text{ m/s} \cdot 3.2\text{ s} = 107.60278\text{ m} =$ **110 m**