Physics 152 Roster No.:________________________

Score:________16 pts. possible______

FALL 2003 Midterm Exam #3, Part A

Exam time limit: 50 minutes. You may use a calculator and both sides of TWO sheets of notes, *handwritten only*. Closed book; no collaboration. For multiple choice questions, circle the letter of the one best answer (unless more than one answer is asked for). Ignore gravity in all problems unless told otherwise, and ignore relativistic effects in non-relativistic problems.

$$c = 2.998 \times 10^8 \text{ m/s}$$

(1 point each, unless otherwise specified)

1. (4 pts.) **Match** each of the following descriptions to one term from the list at left (*use each term NO MORE than ONCE or not at all*):

A. birefringence
B. Brewster's angle
C. dispersion
D. diffraction
E. Huygens's principle
F. interference
G. Malus's Law
H. monochromatic
I. polarization
J. reflection
K. refraction

_______ differing index of refraction for different wavelengths of light

_______ differing index of refraction for different polarization orientations

_______ the destructive or constructive addition of waves at the same point in space

_______ the orientation direction of the **E**-field of an electromagnetic wave

_______ reflected light is polarized parallel to the surface of reflection

_______ the slowing of the speed of light in materials with $n > 1$

_______ any point on a propagating wavefront acts as the source of new "wavelets"

_______ the "spreading" of a wave around a corner or an obstacle

2. Which one of the following statements is **TRUE**?

A. Sunlight is plane-polarized.
B. Sunlight is monochromatic.
C. Rainbows are possible because water is dispersive.
D. Sunlight reflected from the surface of water at Brewster's angle is completely unpolarized.

3. (2 pts.) If the index of refraction of visible light in diamond is 2.42, what is the **speed** of visible light in diamond?

A. 7.26×10^7 m/s
B. 1.24×10^8 m/s
C. 1.76×10^8 m/s
D. 2.27×10^8 m/s
E. 3.00×10^8 m/s (equal to c)
F. 7.26×10^8 m/s

4. You are using a big magnifying glass to enlarge a tiny classified ad in the newspaper. Any one of the following would change the **magnification** of the ad **EXCEPT**:

A. changing the distance from the ad to the lens
B. changing the curvature of the side of the lens nearest to you
C. changing the curvature of the side of the lens nearest to the newspaper
D. removing 1 cm of glass from around the edge of the lens
E. changing the lens from glass to diamond
F. filling the room with water

5. (2 pts.) You see your reflection on the outside of a shiny spherical (convex) Christmas tree ornament. Your **reflection** appears:

A. upright and enlarged
B. upright and shrunken
C. inverted and enlarged
D. inverted and shrunken

6. All of the following are true **EXCEPT**:

A. The faster an object's speed is relative to yours, the smaller its mass becomes.
B. No mass can move at the speed of light.
C. No mass can move faster than the speed of light.
D. Anything that moves at the speed of light must have zero mass.

7. Your friend is riding on a *very* fast train, moving at 80.0% of *c*. You are standing at rest on the ground right next to the train tracks as it passes by, and you can see each other through the train's window.

a. (2 pts.) During the time that it takes 10.0 seconds to elapse on the clock next to your friend inside the train, **how many seconds** do you see elapse on your own watch?

A. 10.0 s
B. 12.5 s
C. 14.1 s
D. 16.7 s
E. 18.0 s
F. 28.2 s

b. (2 pts.) You and your friend both have meter-sticks which you measured to be 1.00 meter long before he got on the train. Now, you both hold up your sticks in the direction that the train is moving. What **length** would you measure your train-riding friend's stick to have?

A. 0.600 m
B. 0.667 m
C. 0.750 m
D. 0.800 m
E. 0.886 m
F. 0.993 m

c. At the same exact time, what **length** would your train-riding friend measure *your* stick to have?

A. shorter than your answer to part (b)
B. the same as your answer to part (b)
C. longer than your answer to part (b), but still shorter than 1.00 meter
D. 1.00 meter
E. longer than 1.00 meter

Physics 152 Roster No.:_______________

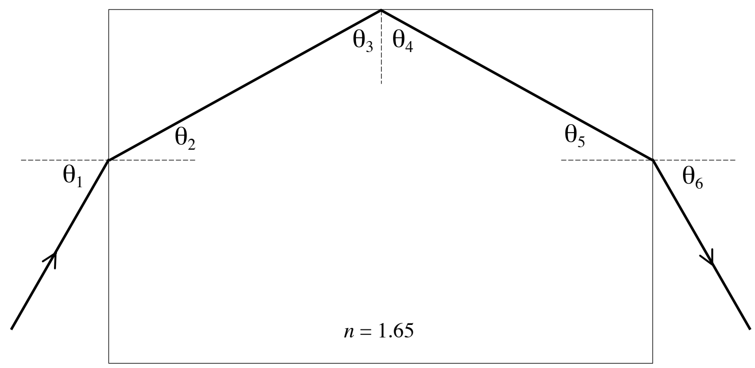
Score: **34 pts. possible**

FALL 2003 Midterm Exam #3, Part B

Show your work on all free-response questions. Be sure to use **proper units** and **significant figures** in your final answers. Ignore gravity in all problems unless told otherwise, and ignore relativistic effects in non-relativistic problems.

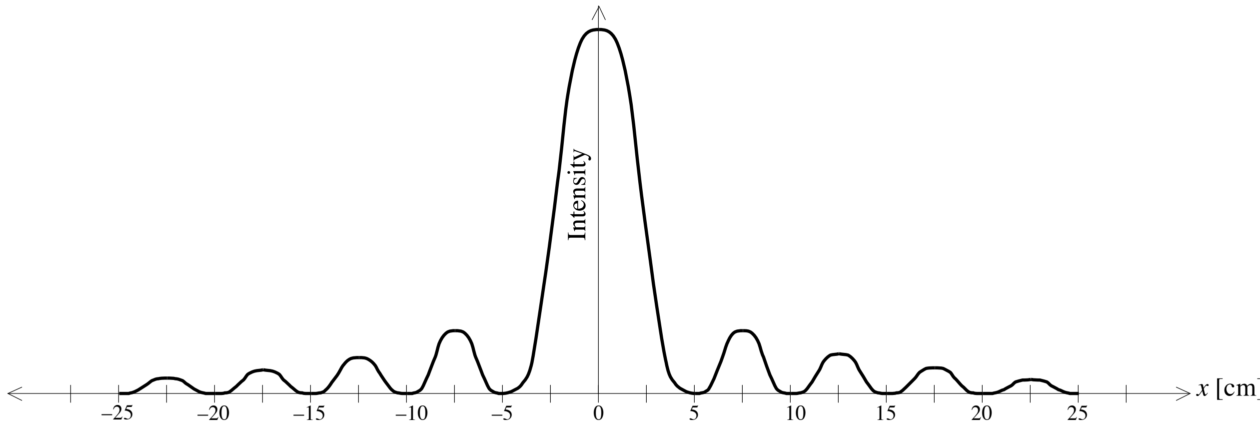
1. You have a rectangular prism of glass ($n = 1.65$; all corners exactly 90˚). You shine a red laser (λ_{air} = 632.8 nm) from air ($n = 1.00$) into the left side of the glass at an incident angle $\theta_1 = 60.0˚$.

a. (8 pts.) Calculate all five of the **angles θ_2 through θ_6**. Show your work! (You will find that some of the angles require little or no new calculation; use very brief explanations in those cases.)



b. (5 pts.) Calculate the **critical angle** between the prism and air. Show your work! Relatedly, briefly **explain what happens** when the ray hits the top side of the prism, resulting in θ_3 and θ_4… what is this phenomenon **called**?

2. Suppose that monochromatic light from a green laser (λ_{air} = 555.0 nm) is incident on a single narrow slit, and forms an interference pattern on a white wall 15.0 m away from the slit. You use a light meter and find that the resulting pattern has the following intensity as a function of distance (in *centimeters*) from the center of the pattern:



a. (2 pts.) **Label** the m = 0, 1, 2, and 3 **maxima** and the m = 1, 2, and 3 **minima** on the above graph. (You do not need to label both sides; just the right or left side is fine.)
b. (6 pts.) Calculate the **width of the slit** being illuminated. Show your work clearly.

3. Have you ever wondered what happens when you turn the "focus" knob on a conventional camera? You are adjusting the distance between the lens to the film, so that you can position the film exactly at the image plane for your desired object. Light from an object at a distance d_o "in front of" the lens will form a real image at distance d_i "behind" the lens. So, by turning the focus knob, you are adjusting the lens-film distance until the film is located at exactly d_i from the lens — then the image on the film will be nice and sharp.

a. (3 pts.) Suppose that your camera lens has a focal length of 28.0 mm. You want to focus on a flower 100.0 mm in front of the lens. At what **distance d_i** behind the lens will the image form? (This is the distance where we want to position the film inside the camera.) Show your work.

b. (3 pts.) What will be the **magnification** of the flower's image compared the actual flower? (Watch your signs!)

c. (3 pts.) If the actual flower is 75 mm across, **will its entire image fit** within a 35-mm tall piece of film? Show your work.

d. (4 pts.) On the diagram below, show than an object located 100 mm to the left of the lens will form a real image at the position you calculated in part (a). Trace at least **two** of its **principal rays**. **LABEL** the **object and image**. Use an object of any height you wish, and observe the scale of 10 mm per division. (Does your resulting magnification agree with your answer to part (b)? It should.)