

TIME OF COMPLETION _____

NAME SOLUTION

DEPARTMENT OF NATURAL SCIENCES

PHYS 1112, Exam 3
Version 1
Total Weight: 100 points

Section 1
November 29, 2001

1. Check your examination for completeness prior to starting. There are a total of ten (10) problems on nine (9) pages.
2. Authorized references include your calculator with calculator handbook, and the Reference Data Pamphlet (provided by your instructor).
3. You will have 80 minutes to complete the examination.
4. The total weight of the examination is 100 points.
5. There are six (6) multiple choice and four (4) calculation problems. Work all problems. Show all work; partial credit will be given for correct work shown.
6. If you have any questions during the examination, see your instructor who will be located in the classroom.
7. Start: 10:30 a.m.
Stop: 11:50 a.m

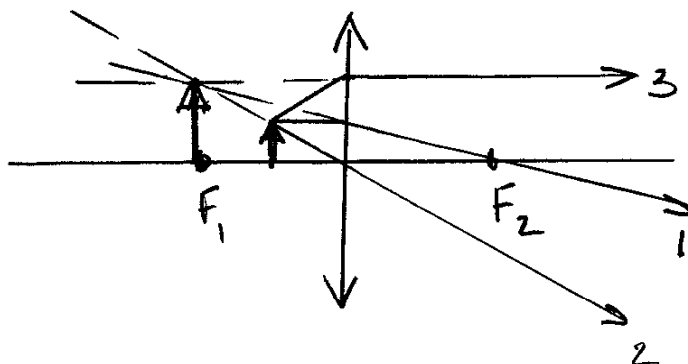
PROBLEM	POINTS	CREDIT
1-6	30	
7	20	
8	20	
9	15	
10	15	
TOTAL	100	
	PERCENTAGE	

CIRCLE THE SINGLE BEST ANSWER FOR ALL MULTIPLE CHOICE QUESTIONS. IN MULTIPLE CHOICE QUESTIONS WHICH REQUIRE A CALCULATION SHOW WORK FOR PARTIAL CREDIT.

1. Compared to an object in front of it, the image in a plane mirror is always
- a. Smaller.
 - (5) b. Virtual.
 - c. Three times as far away.
 - d. None of these.

2. Coherent light waves never arise from
- a. Two lasers.
 - b. Two pinholes.
 - (5) c. Two candles.
 - d. Two slits.

3. Which of the following best describes the image of a thin converging lens that forms whenever the object is at a distance less than one focal length from the lens?
- a. Inverted, enlarged, and real.
 - (5) b. Upright, enlarged, and virtual.
 - c. Upright, diminished, and virtual.
 - d. Inverted, diminished, and real.



4. When light passes from a material with a high index of refraction into material with a low index of refraction:

- a. None of the light is reflected.
- (5) b. Some light is reflected without a change in phase.
- c. Some light is reflected with a 180° change in phase.
- d. The light which is not reflected has a 108° change in phase.

5. If the polarizing angle for diamond is 67.5° , what is the index of refraction of this material?

- a. 2.00.
- b. 2.20.
- (5) c. 2.42.
- (5) d. 2.65.

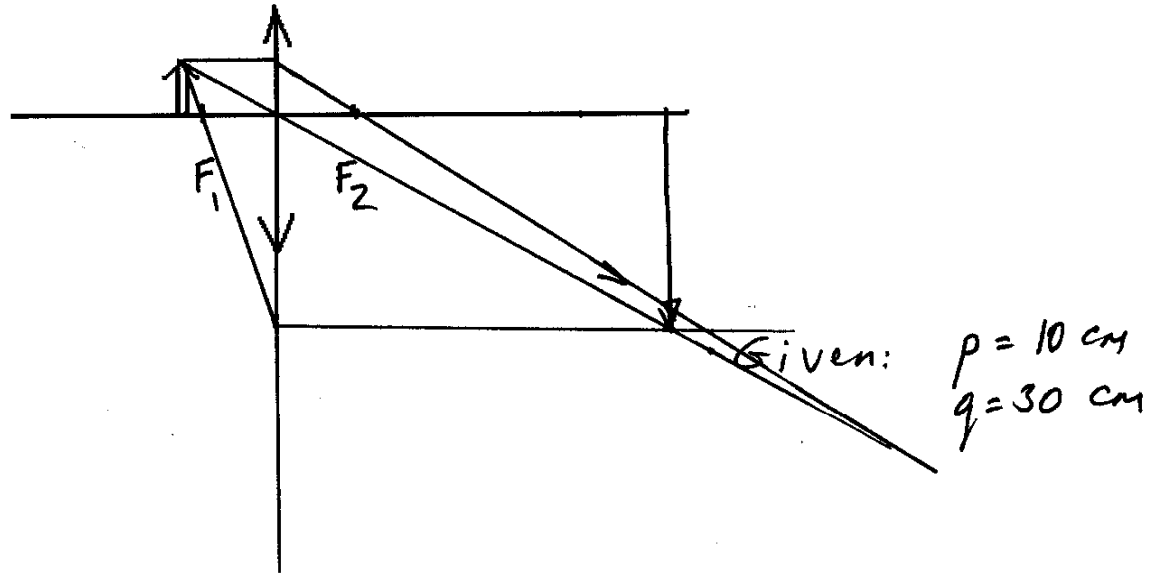
$$n = \tan \theta_p$$
$$n = \tan 67.5^\circ$$
$$n = 2.414$$

6. A light ray in air is incident on an air-to-glass boundary at an angle of 45° and is refracted in the glass at 30° with the normal. Find the index of refraction of the glass.

- a. 2.13.
- b. 1.74.
- (5) c. 1.23.
- d. 1.41.

$$n_1 \sin \theta_1 = n_2 \sin \theta_2$$
$$n_1 = 1 \quad \sin \theta_1 = \sin 45^\circ = 0.707$$
$$0.707 = n_2 \cdot \sin(30^\circ)$$
$$0.707 = n_2 \cdot 0.5$$
$$n_2 = 1.414$$

7. A grasshopper sitting 10 cm to the left of a converging lens sees its image on a screen 30 cm to the right of the lens.



- a. What is the focal length of the lens?

(20)

$$\frac{1}{p} + \frac{1}{q} = \frac{1}{f}$$

$$\frac{1}{10.0} + \frac{1}{30.0} = \frac{1}{f}$$

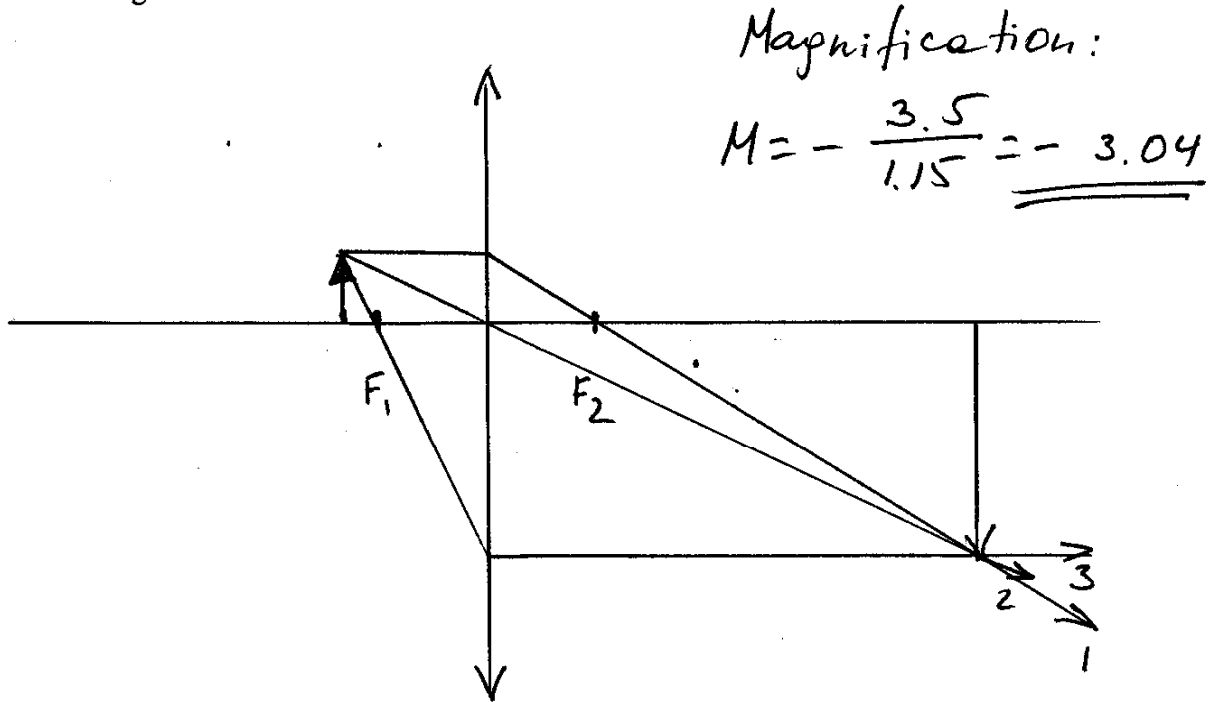
$$0.100 + 0.03333 = \frac{1}{f}$$

$$\underline{\underline{f = 7.5 \text{ cm}}}$$

- b. Calculate the magnification of the lens.

$$M = -\frac{q}{p} = -\frac{30.0 \text{ cm}}{10.0 \text{ cm}} = \underline{\underline{-3.00}}$$

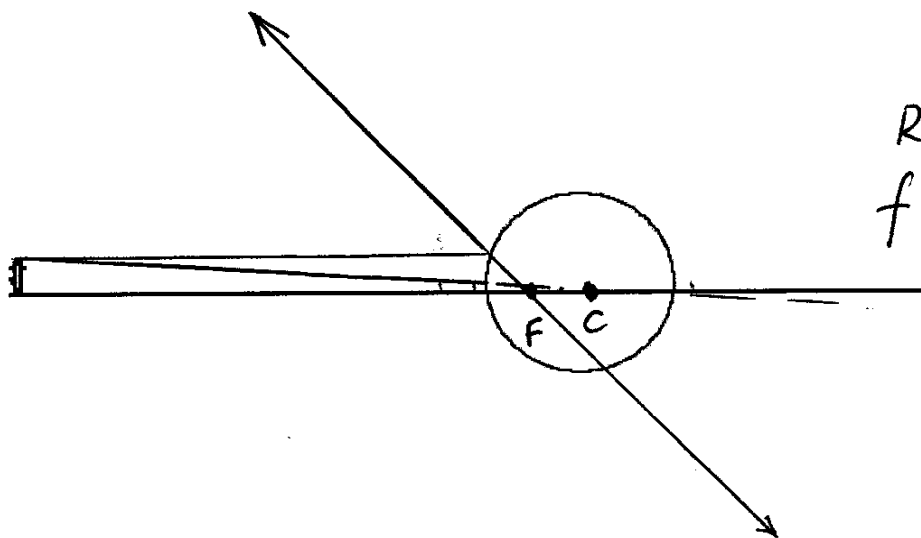
- c. Draw a ray diagram of the situation and find the magnification of the lens from the diagram.



- d. Describe the image (real or virtual, upright or inverted, enlarged or reduced?).

Image is real, inverted, and enlarged

8. A polished metal sphere has a diameter of 80.0 cm. A mouse, whose face is 100 cm from the vertex of the spherical surface looks directly at it. (*Hint: A convex mirror has a negative focal length.*)



$$R = 40 \text{ cm} = 0.400 \text{ m}$$

$$f = \frac{R}{2} = 0.200 \text{ m}$$

$$= 20 \text{ cm}$$

add " " sign:

$$f = -20.0 \text{ cm}$$

- a. Locate the mouse's image.

$$\frac{1}{100.0} + \frac{1}{q} = -\frac{1}{20.0}$$

$$0.01 + \frac{1}{q} = -0.05$$

$$\frac{1}{q} = -0.06 \quad \underline{\underline{q = -16.7 \text{ cm}}}$$

- b. Find the magnification.

$$M = -\frac{q}{p} = -\frac{16.7}{100.0} = \underline{\underline{0.167}}$$

(20)

c. Draw a ray diagram.

d. Describe the mouse's image (real or virtual, upright or inverted, enlarged or reduced?)

Virtual, upright, and reduced

9. Sunlight incident on a screen containing two long, narrow slits 0.200 mm apart casts a pattern on a white sheet of paper 2.00 m beyond.

a. What is the distance from the central maximum to the first violet ($\lambda = 400 \text{ nm}$) fringe?

(15)

$$y_{\text{bright}} = \frac{\lambda L}{d} \text{ m} \quad m = 1$$

$$y_{\text{BRIGHT}} = \frac{400.0 \times 10^{-9} \text{ m} \cdot 2.00 \text{ m}}{0.200 \times 10^{-3} \text{ m}} = 4000.0 \times 10^{-6} \text{ m}$$

$$= 4.00 \times 10^{-3} \text{ m} = \underline{\underline{4.00 \text{ mm}}}$$

b. What is the distance from the central maximum to the second red ($\lambda = 600 \text{ nm}$) fringe?

FIRST RED: $y'_{\text{BRIGHT}} = \frac{\lambda L}{d} \text{ m} \quad m = 1$

$$y = \frac{600 \cdot 2.00 \text{ m} \times 10^{-9} \text{ m}}{0.200 \times 10^{-3} \text{ m}} = 6000 \times 10^{-6} \text{ m}$$

$$= 6.00 \times 10^{-3} \text{ m}$$

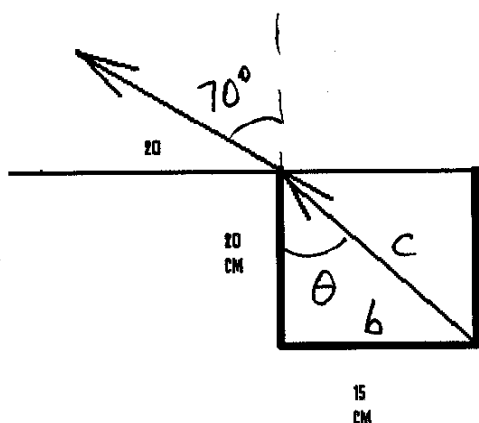
SECOND RED: $m = 2$

$$y_{\text{BRIGHT}}^2 = 2 \cdot y_{\text{BRIGHT}}^1 = \underline{\underline{6.00 \text{ mm}}}$$

$$y_{\text{BRIGHT}}^2 = \underline{\underline{12.00 \text{ mm}}}$$

10. We wish to determine the index of refraction of a liquid filling a small tank as shown below. By moving up and down, it is found that the back edge of the container is just visible at an angle of 20.0° above the horizontal. Find the index of refraction.

(15)



$$\theta_1 = 70^\circ$$

$$n_1 = 1.00$$

$$\sin \theta_2 = \frac{b}{c}$$

$$c = \sqrt{(20 \text{ cm})^2 + (15 \text{ cm})^2}$$

$$= 25 \text{ cm}$$

$$\sin \theta_2 = \frac{b}{c} = \frac{15}{25} = 0.6$$

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

$$\sin(70^\circ) = n_2 \cdot 0.6$$

$$n_2 = \frac{\sin 70^\circ}{0.6} = \frac{0.9396}{0.6}$$

$$\underline{\underline{n_2 = 1.566}}$$