

Physics 133  
Final Exam  
1:30 - 3:18 PM, Tuesday, June 6

Spring 2000

2:30 Section

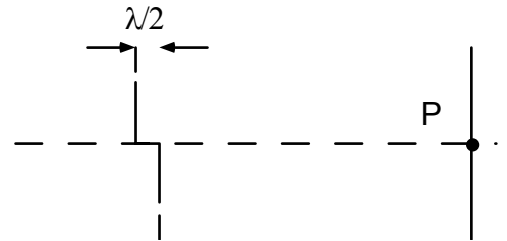
Name (1 pt): \_\_\_\_\_

Recitation Instructor (1 pt): \_\_\_\_\_

This test consists of a total of 9 pages, 7 of problems, an optional question about course format, and an equation sheet.

Section I - short problems/questions

I.1 (10 pts) A double slit experiment is modified as shown in the figure so that one of the slits is  $\lambda/2$  farther to the right than the other. At "P", the central location on the screen, is there a maximum or a minimum? Why?

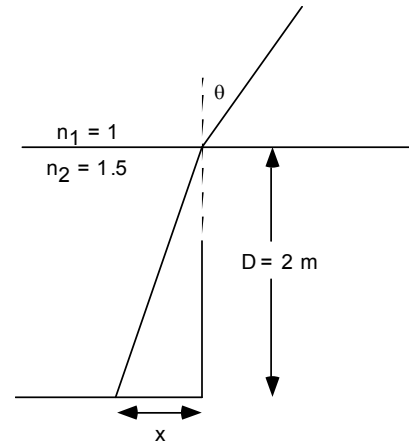


I.2 (10 pts): A stick of length  $l = 15$  m in the  $S'$  frame is moving at  $v = 0.6c$  relative to observers in the  $S$  frame. How long do observers in the  $S$  frame measure the stick to be?

I.3 (10 pts): As measured in parsecs, how far away is a star whose parallax is 0.1 arc sec?

Name (1 pt): \_\_\_\_\_

I.4 (10 pts) A ray of light is incident on a pool of depth 2 m at an angle of  $\theta = 30^\circ$  from the normal. The liquid in the pool has an index of refraction of  $n_2 = 1.5$ . As shown in the figure the ray enters the pool at its edge and hits the bottom a distance  $x$  from the edge of the pool. What is  $x$ ?



In the following two multiple choice questions, circle the best answer.

I.5 (10 pts): Most of the deuterium in the universe was created

- (a) during the first few minutes after the big bang.
- (b) in the era around the time of the launching of the microwave background radiation.
- (c) in the interiors of stars like the sun.
- (d) in supernova collapses

I.6 (10 pts): Which of the following does NOT significantly effect or predict the future of the universe?

- (a) The mass density of the universe
- (b) the ratio of iron to magnesium in the universe
- (c) The size of the Hubble constant
- (d) the abundance of dark matter in the universe

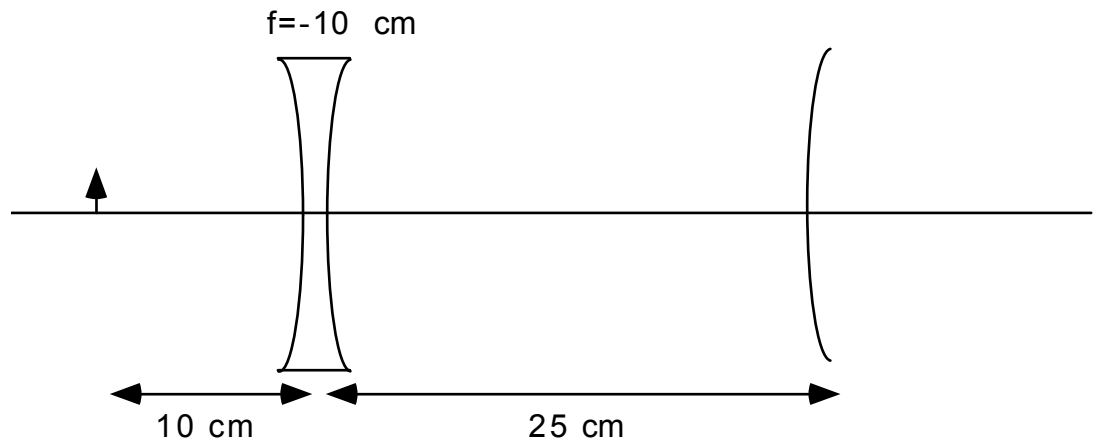


Name (1 pt): \_\_\_\_\_

Part II.

II.1 (30 pts) The optical system below consists of a lens on the left and a mirror on the right. The object is erect and has a height of 2 cm. After the light has passed the lens for the second time and exited the system

- (a) What is the location of the final image? Unambiguously draw and label this location on the diagram.
- (b) How large is the final image and is it erect or inverted?
- (c) Is the final image real or virtual?



Name (1 pt): \_\_\_\_\_

II.2 (25 pts): The reflection of perpendicularly incident white light by a soap film in air has an interference maximum at 600 nm and a minimum at 450 nm, and there are no minimum or maxima between 450 nm and 600 nm. If  $n = 1.33$  for the film, what is the film thickness?

Name (1 pt): \_\_\_\_\_

II.3 (25 pts): It is concluded from measurements of the light emitted by quasar  $Q_1$  that it is moving away from us at a speed of  $0.800c$ . Quasar  $Q_2$ , which lies in the same direction in space but is closer to us, is moving away from us at a speed  $0.400c$ .

- (a) At what velocity would an observer on  $Q_1$  measure us to be receding?
- (b) What velocity for  $Q_2$  would be measured by an observer on  $Q_1$ .

Name (1 pt): \_\_\_\_\_

II.4 (30 pts): A double slit with slit separation  $12\ \mu\text{m}$  and slit width  $6\ \mu\text{m}$  is illuminated with light of wavelength  $\lambda = 600\ \text{nm}$ .

- (a) What is the angular location of the first side maximum in the interference pattern?
- (b) What is the angular location of the third side maximum in the interference pattern?
- (c) What is the ratio of the light intensities for these two maxima?

Name (1 pt): \_\_\_\_\_

II.5 (22 pts): What is the speed of a particle

(a) Whose kinetic energy is equal to three times its rest energy?

(b) Whose total energy is equal to three times its rest energy?  
relate to these questions?