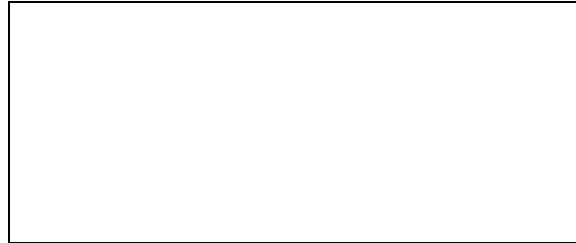


Physics 228– Exam I
February 21, 2008
Profs. Coleman and Andrei

Your name sticker
with exam code



SIGNATURE: _____

1. The exam will last from 9:40 p.m. to 11:20 p.m. Use a #2 pencil to make entries on the answer sheet. Enter the following ID information now, before the exam starts.
2. In the section labelled NAME (Last, First, M.I.) enter your last name, then fill in the empty circle for a blank, then enter your first name, another blank, and finally your middle initial.
3. Under STUDENT # enter your 9-digit Identification Number.
4. Enter 228 under COURSE, and your section number (see label above) under SEC.
5. Under CODE enter the exam code given above.
6. During the exam, you may use pencils, a calculator, and one **handwritten** 8.5 x 11 inch sheet with formulas and notes, without attachments.
7. There are 15 multiple-choice questions on the exam. For each question, mark only one answer on the answer sheet. There is no deduction of points for an incorrect answer, so even if you cannot work out the answer to a question, you should make an educated guess. At the end of the exam, **hand in the answer sheet and**

the cover page. Retain this question paper for future reference and study.

8. When you are asked to open the exam, make sure that your copy contains all 15 questions. Raise your hand if this is not the case, and a proctor will help you. Also raise your hand during the exam if you have a question.
9. Please **SIGN the cover sheet under your name sticker.** A proctor will check your name sticker and your student ID sometime during the exam. Please have them ready.
10. Good luck!

Useful Information

speed of light: $c = 3.00 \times 10^8$ m/s

1 nm = 10^{-9} m

**Answer key is:
55243 12141 53111**

1. A spherical mirror forms an image that is virtual, one-quarter of the size of the object, and is 3 cm from the mirror. What is the focal length of the mirror?

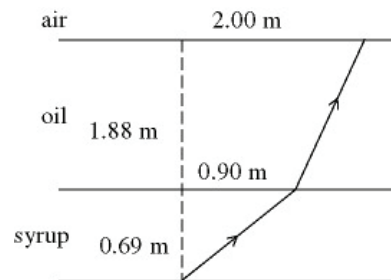
- a) +2.4 cm
- b) -0.25 cm
- c) +1.0 cm
- d) +0.6 cm
- e) -4.0 cm

2. X-rays of wavelength 0.129 nm are incident on a crystal, and a first-order maximum is observed at an angle of 8.15° to the plane of atoms. What is the interplanar spacing?

- a) About 0.40 nm
- b) About 0.35 nm
- c) About 0.25 nm
- d) About 0.30 nm
- e) About 0.45 nm

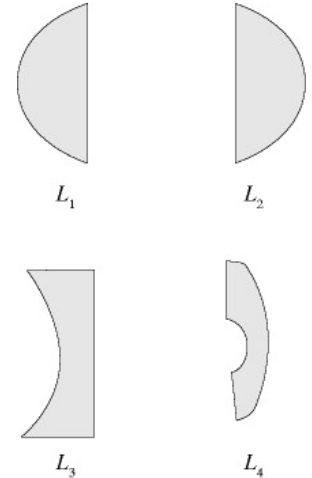
3. The tank shown in the figure holds a layer of oil, 1.88 m thick, which floats on a layer of syrup that is 0.69 m thick. Both liquids are clear and do not intermix. A ray, which originates at the bottom of the tank on a vertical axis, crosses the oil-syrup interface at a point 0.90 m from the axis. The ray continues and arrives at the oil-air interface, 2.00 m from the axis and at the critical angle. The index of refraction of the oil is closest to:

- a) 2.00
- b) 1.98
- c) 2.02
- d) 1.96
- e) 1.94



4. The radius of the curved part of lens L_3 in the figure is 35.0 cm, and the refractive index of the lens material is 1.62. The focal length of L_3 is closest to:

- a) +21.6 cm
- b) +56.5 cm
- c) -21.6 cm
- d) -56.5 cm
- e) +28.2 cm



5. Coherent monochromatic light of wavelength 625 nm passes through a pair of thin parallel slits whose spacing is $2.81 \times 10^{-6} m$. At most, how many bright fringes can be formed on one side of the central bright fringe (not counting the central bright fringe)?

- a) 2
- b) 3
- c) 4
- d) 5
- e) 6

6. A single slit forms a diffraction pattern, with the first minimum at an angle of 40° from central maximum. Monochromatic light of wavelength 640-nm is used. The width of the slit, in nm, is closest to:

- a) 996
- b) 955
- c) 873
- d) 832
- e) 914

7. A metallic sheet has a large number of slits, 5.0 mm wide and 20 cm apart, and is used as a diffraction grating for microwaves. A wide parallel beam of microwaves is incident normally on the grating. The microwave wavelength is 6.0 cm. The largest angle from the normal, at which an intensity maximum occurs, is closest to:

- a) 74°
- b) 64°
- c) 84°
- d) 69°
- e) 79°

8. Light of wavelength 425.0 nm in air falls at normal incidence on an oil film that is 850.0 nm thick. The oil is floating on a water layer 1500 nm thick. The refractive index of water is 1.33, and that of the oil is 1.40. The number of wavelengths of light that fit in the oil film is closest to:

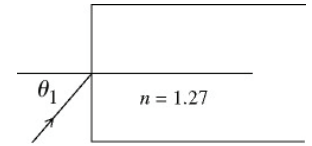
- a) 2.80
- b) 4.69
- c) 2.66
- d) 2.00
- e) 3.53

9. When an object is placed 30 cm from a converging lens, the image formed is positioned 60 cm from the lens. If the object is moved 5 cm closer to the lens, the position of the image changes by 40 cm. What is the focal length of the lens?

- a) 16 cm
- b) 25 cm
- c) 36 cm
- d) 20 cm
- e) 32 cm

10. In the investigation of a new type of optical fiber (index of refraction $n=1.270$) a laser beam is incident on the flat end of a straight fiber in air. What is the maximum angle of incidence θ_1 if the beam is not to escape from the fiber?

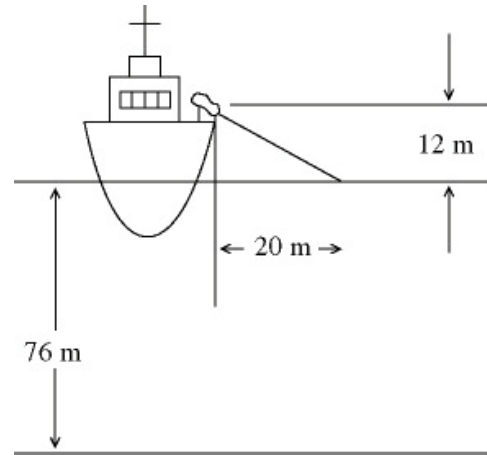
- a) 51.5°
- b) 42.2°
- c) 45.3°
- d) 39.1°
- e) 48.4°



11. A beam of light is linearly polarized in a vertical plane and has an intensity I_0 . The beam passes through an ideal polarizer whose axis is set at 60° with the vertical and then through an ideal analyzer whose axis is set horizontally. The ratio of the intensity of the final beam to I_0 is closest to:

- a) 0.25
- b) 0.43
- c) 1.2
- d) 0.37
- e) 0.19

12. A laser positioned on a ship is used to communicate with a small two man research submarine resting on the bottom of a lake. The laser is positioned 12 m above the surface of the water, and it strikes the water 20 m from the side of the ship. The water is 76 m deep and has an index of refraction of 1.33. How far is the submarine from the side of the ship?



- a) 74.1 m
 b) 94.1 m
 c) 84.1 m
 d) 25.5 m
 e) 104 m
13. Two lasers are shining on a double slit, with slit separation d . Laser one has a wavelength of $d/20$, while laser two has a wavelength of $d/15$. The lasers produce separate interference patterns on a screen placed at a large distance L away from the slits. Which of the following statements is correct?
- a) Laser One has its first maximum closer to the central maximum.
 b) The interference patterns of the two lasers exactly overlap.
 c) Laser Two has its first maximum closer to the central maximum.
 d) The relative position of the first maximum will depend on the ratio d/L .
 e) The number of bright fringes will be the same for both lasers.

14. Three sources of monochromatic coherent light of a single wavelength and intensity I are combined. If the phase angle between source 1 and 2 is $\pi/2$ radians and the phase angle between source 2 and 3 is also $\pi/2$ radians, what is the intensity of the combined beam?

- a) I
 b) $3I$
 c) $9I$
 d) 0
 e) I^2

15. Light of wavelength 500nm passes through a double slit device produces a set of interference fringes on a distant screen. The 6th and 12th interference fringes are observed to be absent. Which of the following is true?

- a) The missing fringes are due to the interference pattern of light coming from a single slit.
 b) The missing fringes are produced by destructive interference between light coming from different slits.
 c) The slit width is 12 times smaller than the slit separation.
 d) The difference between the path lengths from the slits to the screen is 500nm and 1000nm at the first and second missing fringe.
 e) The slit width is 1000nm .