Physics 228 - Exam 1 24 Feb 2011 Profs. Rabe and Coleman

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## SIGNATURE

## Turn off and put away cell phones now!

- 1. The exam will last from 9:40pm to 11:00pm.
- 2. Use a #2 pencil to make entries on the answer sheet. Enter the following ID information now, before the exam starts.
- 3. 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.
- 4. Under STUDENT # enter your 9-digit student ID.
- 5. Enter 228 under COURSE, and your section number (see label above) under SEC.
- 6. Under CODE enter the exam code given above.
- 7. During the exam, you may use pencils, a calculator, and one **handwritten** 8.5 x 11 inch sheet with formulas and notes, without attachments.
- 8. There are 16 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 ened of the exam, hand in the answer sheet and the cover page. Retain this question paper for future reference and study.

- 9. When you are asked to open the exam, make sure that your copy contains all 16 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.
- 10. Please SIGN the cover sheet under your name sticker and have your student ID ready to show to the proctor during the exam.

## Useful information

c = speed of light =  $3.00 \times 10^8$  m/s 1 nm =  $10^{-9}$ m 1  $\mu$ m =  $10^{-6}$ m  $n_W$ =refractive index of water =1.33

- 1. Diffracted light of wavelength  $\lambda$  produces the intensity pattern shown below. To what situation does the intensity pattern shown correspond to?
  - a) Single slit diffraction, where the slit width d is about the same as  $\lambda$
  - b) Interference from multiple, equally spaced, slits.
  - c) Double slit interference, where the slit width is much less than  $\lambda$ .
  - d) Single slit diffraction, where the slit width d is much less than  $\lambda$ .
  - e) Double slit interference, where the slit width is about the same as  $\lambda$ .



2. X-rays of wavelength 0.2 Å are diffracted off a cubic crystal with inter-atomic spacing a = 1 Å. One of the X-ray diffraction spots occurs when the beam makes an angle of 13 degrees to the planes. Which of the planes shown in the figure produces this reflection?



- 3. An object is placed 18 cm from a lens. The image is upright and one-quarter as big as the object. What is the focal length of the lens?
  - a) -24 cm
  - b) -6 cm
  - c) +3.6 cm
  - d) +14.4 cm
  - e) +24 cm
- 4. A fish tank, filled with water (n = 1.33) has a spherical convex surface made of very thin glass, with a radius of curvature of 1m, as shown in the figure. An object outside the tank is placed a distance 6m from the glass. Light from the object passes into the tank. At what distance from the vertex of the spherical surface does an image form? (You can neglect the thickness of the glass)
  - a) 2.68m outside the tank



- An object is placed 4cm in front of a spherical mirror that was 5. made by cutting a piece out of a polished metal spherical shell. In one orientation, the mirror is concave; in the reversed orientation it is convex. When used as a concave mirror, the image forms 6.0 cm from the mirror on on the same side as the object. When the mirror is reverse so that it becomes convex, how far from the mirror will the image be?
  - 12 cma)
  - 6 cmb)
  - c) 3 cm
  - d) 4 cm
  - e)  $1.5~\mathrm{cm}$
- 6. A dressing room is equipped with two mirrors facing each other at the front and back, so that you can see the reflection of your back when looking in the front mirror. How far away from you does the image of your back appear to be? Assume the mirrors are 6m apart, and that you are precisely half way between them.
  - 12ma)
  - $3\mathrm{m}$ b)
  - 15mc)
  - d) 6m
  - $9\mathrm{m}$ e)
- Consider the three lenses shown. Which 7. phrase best describes the group?
  - a) I and III converging, II diverging
  - I diverging, II and III converging b)
  - I converging, II and III diverging c)
  - I, II, III, all diverging d)
  - I and III diverging, II converging e)



Ι



- 8. Light is refracted through a diamond. If the angle of incidence is  $30^{\circ}$ , and the angle of refraction is  $12^{\circ}$ , what is the index of refraction?
  - a) 1.3
  - b) 2.8
  - c) 2.4
  - d) 1.8
  - e) 0.4
- A radio receiver mounted on a truck is midway between two 9. transmitters broadcasting coherently at the same frequency f. If the truck moves 100m towards one of the towers, no signal is detected. What is f?
  - 7500 kHza)
  - 1500 kHz b)
  - $75 \mathrm{kHz}$ c)
  - 1750 kHz d)
  - $750 \mathrm{kHz}$ e)
- 10. Three experiments involving a thin film (in air) are shown. If tdenotes the film thickness and  $\lambda$  denotes the wavelength of the light in the film, which experiments will produce constructive interference as seen by the observer?



- d) III only.
- I and III only. e)



- 11. Diffraction grating A has 5000 lines per cm. When monochromatic light shines normally on it, the first-order principal maximum is at 19.4°. If the same light shines normally on a different grating B, the first-order principal maximum is at 22.1°. How many lines per cm are in grating B?
  - a) About 5250
  - b) About 5660
  - c) About 6020
  - d) About 4410
  - e) About 4800
- 12. Single-slit diffraction is studied using light of wavelength 550 nm and a screen located 40 cm from the slit. The distance between the first and fifth minimum (on the same side of the center) is 0.35 mm. What is the width of the slit? Use the small angle approximation.
  - a) 2.5 mm
  - b) 3.1 mm
  - c) 2.0 mm
  - d) 3.5 mm
  - e) 1.5 mm
- 13. Three polarizing filters are stacked with the polarizing axes of the second and third at 49.5° and 90°, respectively, with that of the first. An unpolarized light beam of intensity  $I_0$  is incident on the stack. The intensity of light emerging from the third polarizer is:
  - a)  $0.25I_0$
  - b)  $0.0I_0$
  - c)  $0.12I_0$
  - d)  $0.21I_0$
  - e)  $0.24I_0$

- 14. Light of wavelength  $\lambda$  shines normally on a pair of narrow slits separated by a distance d. On a screen located a distance Laway  $(L \gg d)$ , the interference pattern shows that adjacent bright fringes are separated by a distance  $\Delta y$ . Which of the following changes will increase the value of  $\Delta y$ ?
  - a) Increasing the intensity of the light
  - b) Increasing the wavelength  $\lambda$
  - c) None of the other answers
  - d) Increasing the slit separation
  - e) Decreasing the distance L to the screen
- 15. What must be the minimum distance between two mountains on the moon, so that they can be distinguished by an observer on earth? Take the wavelength of light from the moon to be 580 nm, and assume the lens of the observer's eye has a diameter of 3 mm. The earth-moon distance is  $3.84 \times 10^5$  km.
  - a) About 590 km
  - b) About 790 km
  - c) About 190 km
  - d) About 90 km
  - e) About 390 km
- 16. A beam of yellow light in air ( $\lambda_0 = 550$  nm in air) shines on a glass microscope slide (n = 1.5) at an angle of incidence of 35°. Which of the following statements about the light in the glass is *false*?
  - a)  $f = 3.64 \times 10^{14} \text{ Hz}$
  - b) The light does not enter the glass because of total internal reflection at the surface.
  - c)  $v = 2 \times 10^8 \text{ m/s}$
  - d) The transmitted light makes an angle of  $22.5^{\circ}$  with the normal.
  - e)  $\lambda = 367 \text{ nm}$