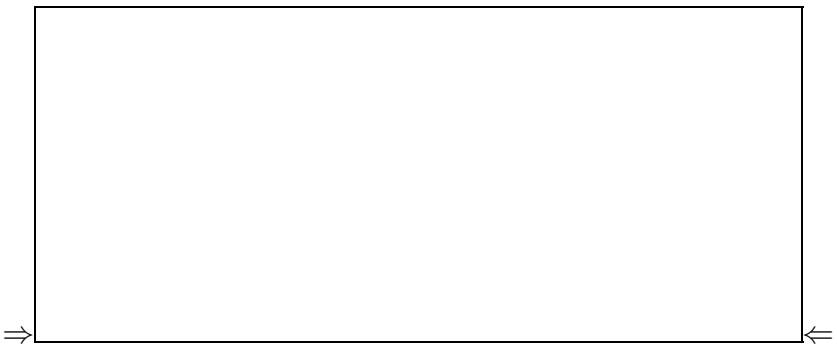
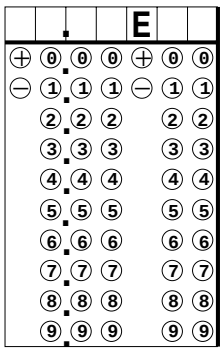
Physics 228 — First Hour Exam
17 February 2004
Profs. Shapiro and Conway



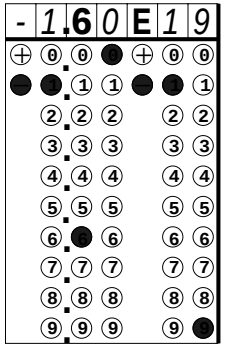
Your name sticker with **exam code**

Turn off and put away cell phones now!

1. **THIS EXAM INCLUDES QUESTIONS WHICH REQUIRE A NUMERICAL ANSWER.**
The format on the machine-graded answer sheets requires that you express your answer is a very specific format. Several examples are shown below:
5.30 should be entered as **+5.30+00**
437 should be entered as **+4.37+02**
0.62458 should be entered as **+6.25−01**



Form for numerical answers.



The electron's charge entered.

$-1.602176 \times 10^{-19}$ should be entered as **−1.60−19**.
Note that all answers should be accurate to three **significant** digits. A sample fragment of the mark-sense form is shown.

NOTE THAT MULTIPLE CHOICE QUESTIONS START WITH THE FIFTH QUESTION, BUT ITS NUMBER IS 16; ENTER THE ANSWERS ON THE MARK SENSE FORM ACCORDING TO THEIR PROBLEM NUMBERS, WHICH INCREASE HORIZONTALLY ACROSS THE FORM.

2. The exam will last from 8:00 pm to 9:20 pm 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 227 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 questions on the exam. Several questions require you to enter a numerical answers as described above. **Be sure to fill in the circles as well as writing your answer in the boxes.** The remainder are multiple-choice. For each multiple-choice 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.
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.

1. A jar is filled with liquid to a depth of 10.0 cm. A woman looks down on the liquid from above. The liquid appears to her to have a depth of 6.40 cm. What is the index of refraction of the liquid?

2. Light with $\lambda = 450$ nm is used in a Young's double slit experiment. The diffraction pattern on a screen placed 5.00 m from the slits exhibits bright fringes separated by 1.00 mm. What is the separation between the two slits? Express your answer in millimeters (mm).

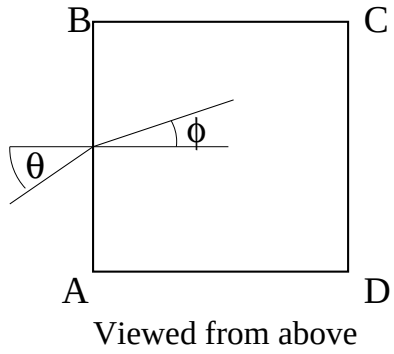
3. A lens has a focal length of -10.0 cm. An object at a distance of 35.0 cm in front of the lens has an image at what distance (in cm) from the lens (following the usual sign conventions)?

4. A light beam polarized in the vertical direction passes through a polarizing filter oriented at 40.0 degrees from the vertical. The transmitted intensity is what fraction of the incident intensity?

16. We can hear around corners, but we cannot see around corners. The reason is that
    a) Sound waves are longitudinal, while light waves are transverse
    b) Sound waves carry more energy than do light waves
    c) Sound waves are transverse, while light waves are longitudinal
    d) The wavelength of sound is much greater than that of light
    e) The frequency of sound is much greater than that of light

17. A fish looking up at the water surface sees a circular hole surrounded by a mirror. How far below the water surface is the fish, if the radius of the hole is 2.1 m and the index of refraction of water is 1.33?
    a) 2.1 m
    b) 1.6 m
    c) 2.4 m
    d) 1.8 m
    e) 2.8 m

18. A square slab of glass ABCD, of index refraction $n = 1.3$, is lying on a table. A ray of light parallel to the table top strikes side AB at its center as shown in the figure. Select the correct statement.
    a. The answers to the above questions depends on the length of AB.
    b. The light ray will emerge from the side BC as long as $\theta \leq 56.2°$
    c. The light ray will be totally internally reflected from side BC as long as $35.5° \leq \theta \leq 56.2°$



Viewed from above

    d. The light ray will not emerge from the slab.
    e. The light ray will emerge from the side CD as long as $\theta \geq 35.5°$

19. 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) -0.25 cm
    b) $+2.4$ cm
    c) $+0.6$ cm
    d) $+1.0$ cm
    e) -4.0 cm

20. A real object placed closer to a converging lens than its focal length always makes an image that is

a) Real, upright, smaller
b) Virtual, upright, smaller
c) Real, inverted, smaller
d) Virtual, upright, bigger
e) Real, inverted, bigger

21. A camera lens with 50-mm focal length is used to take a picture of a person 1.60 m tall. How far from the camera must the person stand so that the image size on the film is 24 mm?

a) 2.8 m
b) 2.2 m
c) 1.6 m
d) 3.4 m
e) 3.9 m

22. A thin, free standing polymer film that is 107 nm thick appears red ($\lambda = 600$ nm) when viewed in air by reflected white light. The index of refraction of the polymer is:

a) 1.4
b) 2.8
c) 1.2
d) 1.5
e) 1.33

23. A glass (n = 1.6) lens is coated with a thin film (n = 1.3) to minimize reflection of certain incident light. If $\lambda_{air} = 500$ nm is the wavelength of the light in air, the least film thickness is:

a) 200 nm
b) 78 nm
c) 96 nm
d) 162 nm
e) 250 nm

24. A beam of x-rays of wavelength 0.130 nm is incident on a crystal with a spacing between atomic planes of 0.314 nm. The beam has an angle to the crystal planes of 24.5°. If a diffraction maximum is seen at this angle, what is its diffraction order?

a) (need more information)
b) first order
c) (none of the other answers)
d) third order
e) second order

25. A beam of unpolarized yellow light ($\lambda_0 = 550$ nm) 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) The transmitted light makes an angle of 22.5° with the normal.
b) $f = 3.64 \times 10^{14}$ Hz
c) $v = 2 \times 10^8$ m/s
d) The transmitted light in not fully linearly polarized
e) $\lambda = 367$ nm

26. A diffraction limited laser of length ℓ and aperture diameter d generates light of wavelength λ. If the beam is directed at the surface of the moon a distance D away, the approximate diameter of the illuminated area is:

a) $1.22\frac{D\lambda}{\ell}$ b) $1.22\frac{\ell\lambda}{d}$ c) $1.22\frac{D\lambda}{d}$ d) $1.22\frac{dD}{\ell}$ e) $1.22\frac{dD}{\lambda}$

27. With light from a gaseous discharge tube incident normally on a grating with a distance 1.73 μm between adjacent slit centers, a green line appears with sharp maxima at measured transmission angles $\theta = \pm 17.6°, \pm 37.3°, \pm 65.2°$. The wavelength of the green line that best fits the data in (nm) is

a) 508
b) 534
c) 517
d) 523
e) 539