AP® Physics B
1999 Sample Student Responses

These materials were produced by Educational Testing Service (ETS), which develops and administers the examinations of the Advanced Placement Program for the College Board. The College Board and Educational Testing Service (ETS) are dedicated to the principle of equal opportunity, and their programs, services, and employment policies are guided by that principle.

The College Board is a national nonprofit membership association dedicated to preparing, inspiring, and connecting students to college and opportunity. Founded in 1900, the association is composed of more than 3,900 schools, colleges, universities, and other educational organizations. Each year, the College Board serves over three million students and their parents, 22,000 high schools, and 3,500 colleges, through major programs and services in college admission, guidance, assessment, financial aid, enrollment, and teaching and learning. Among its best-known programs are the SAT®, the PSAT/NMSQT™, the Advanced Placement Program® (AP®), and Pacesetter®. The College Board is committed to the principles of equity and excellence, and that commitment is embodied in all of its programs, services, activities, and concerns.

6. (10 points)
You are given the following equipment for use in the optics experiments in parts (a) and (b).

A solid rectangular block made of transparent plastic

A laser that produces a narrow, bright, monochromatic ray of light

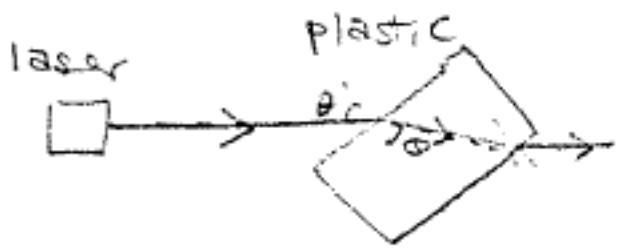
A protractor

A meterstick

A diffraction grating of known slit spacing

A white opaque screen

(a) Briefly describe the procedure you would use to determine the index of refraction of the plastic. Include a labeled diagram to show the experimental setup. Write down the corresponding equation you would use in your calculation and make sure all the variables in this equation are labeled on your diagram.



Place the laser and the plastic block,
Measure the angle of incident θ and angle of refraction θ_2.
Change the angle of incident several times and record the value of θ_2.

Use the equation

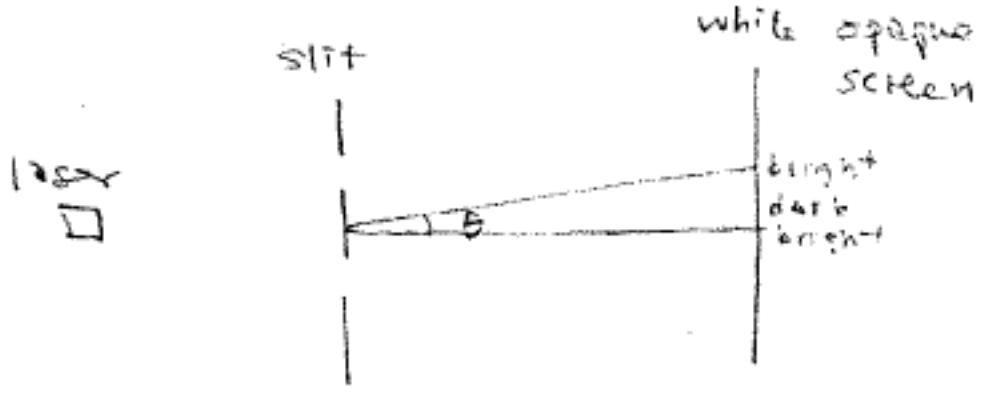
$$n_1 \sin\theta = n_2 \sin\theta_2$$

n_1: index of refraction of air
θ: angle of incident
θ_2: angle of refraction.

n_2 is the index of refraction of the plastic.

GO ON TO THE NEXT PAGE

(b) Since the index of refraction depends on wavelength, you decide you also want to determine the wavelength of your light source. Draw and label a diagram showing the experimental setup. Show the equation(s) you would use in your calculation and identify all the variables in the equation(s). State and justify any assumptions you make.



Set up the apparatus above.
The light from the laser come out from the slit and interfere.
There will be a interference pattern on the screen.
Mark the bright fringes and measure the distance of the fringes and an angle θ.

use the equation

$$d \sin\theta = m\lambda$$

d: distance between the slit.
m: integer indicating place of fringes
λ is wave length.

GO ON TO THE NEXT PAGE

6. (10 points)
You are given the following equipment for use in the optics experiments in parts (a) and (b).

A solid rectangular block made of transparent plastic

A laser that produces a narrow, bright, monochromatic ray of light

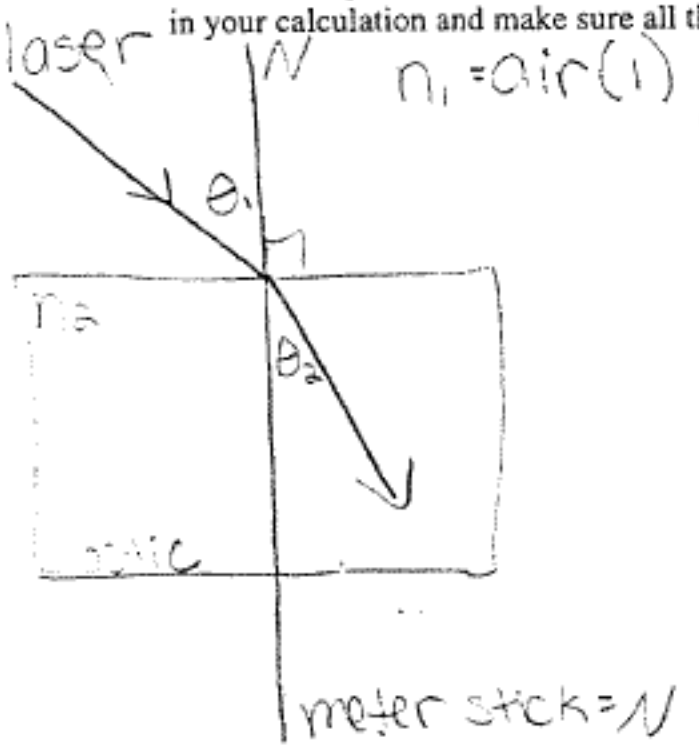
A protractor

A meterstick

A diffraction grating of known slit spacing

A white opaque screen

(a) Briefly describe the procedure you would use to determine the index of refraction of the plastic. Include a labeled diagram to show the experimental setup. Write down the corresponding equation you would use in your calculation and make sure all the variables in this equation are labeled on your diagram.



n_1 = air (1)

1) set up plastic w/ meter stick ⊥ to surface, creating the normal

2) shine laser into plastic at an angle of θ_1 with the normal

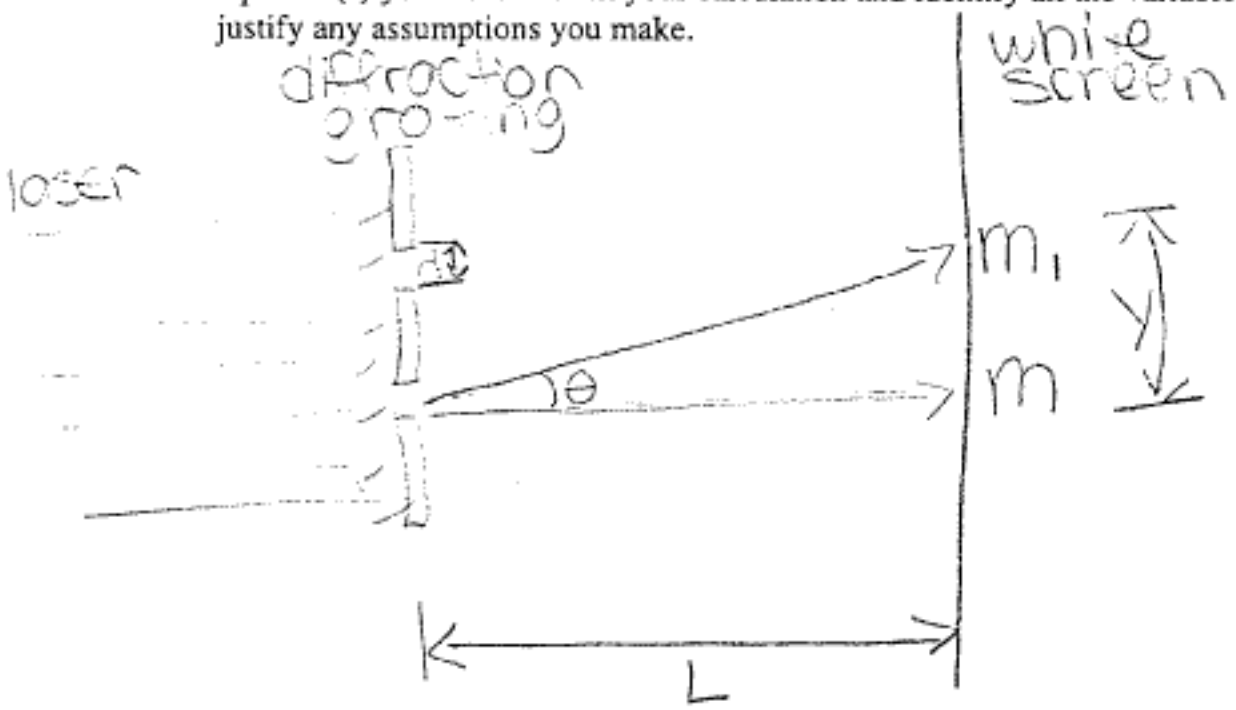
3) measure θ_2 w/ respect to the normal (the ∠ the laser makes w/ N in the plastic)

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

4) use $n_1 \sin\theta_1 = n_2 \sin\theta_2$ to solve for n_2

GO ON TO THE NEXT PAGE

(b) Since the index of refraction depends on wavelength, you decide you also want to determine the wavelength of your light source. Draw and label a diagram showing the experimental setup. Show the equation(s) you would use in your calculation and identify all the variables in the equation(s). State and justify any assumptions you make.



1) shine laser through grating to get a diffraction pattern (light & dark bands) on the screen
a) d is the separation between slits
3) measure the distance (y) between m & m_1, and the distance L between the screen & the grating

$\tan\theta = y/L \quad \theta = \tan^{-1} y/L$

4) use the equation $d\sin\theta = m\lambda$ to solve for λ
m is the integer # of the bright fringes away from the center (m=1 in pic)

GO ON TO THE NEXT PAGE