Phys 112
Spring 2013

General Physics: Class Exam III v2

24 April 2013

Name: Solution. **Total:** /70

Instructions

- There are 8 questions on 6 pages.
- Show your reasoning and calculations and always justify your answers.

Physical constants and useful formulae

Speed of light in a vacuum: $c = 3.0 \times 10^8\,\mathrm{m/s}$

Question 1 9D

The red light emitted by a helium neon laser has wavelength 632.8×10^{-9} m in a vacuum. The light passes travels through 2.0 m of a special type of glass in time 9.3×10^{-9} s. Determine the index of refraction of this glass **and** the wavelength of light in the glass.

$n = c/v$ ⇒ need v

But $v = d/t = \frac{2.0\,\mathrm{m}}{9.3\times10^{-9}\,\mathrm{s}} = 2.2\times10^8\,\mathrm{m/s}$

⇒ $n = \frac{3.0\times10^8\,\mathrm{m/s}}{2.2\times10^8\,\mathrm{m/s}} = 1.4$

For wavelength $\lambda_{glass} = \frac{\lambda_{vacuum}}{n} = \frac{632.8\times10^{-9}\,\mathrm{m}}{1.4}$

$= 454\times10^{-9}\,\mathrm{m}$

3 3 2 6 3 3

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$d\sin\theta_m = m\lambda$ Look at $m=1$ fringe

$d\sin\theta_1 = \lambda \Rightarrow \sin\theta_1 = \lambda/d$

Question 2 89

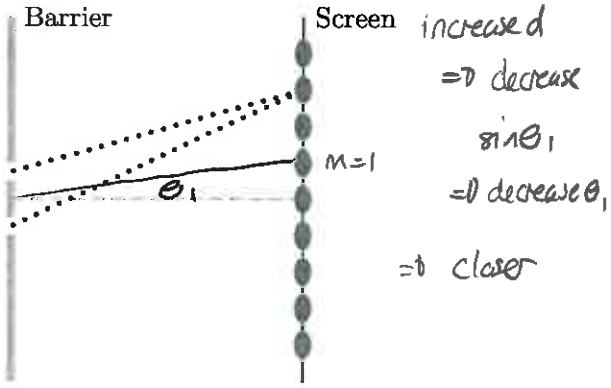
Light of wavelength 590×10^{-9} m is incident upon a double slit and produces bright fringes on a screen as indicated. Which of the following (choose one) would occur if the separation between the slits were increased to double of what it originally was?

a) Nothing would change.

b) The bright fringes would be in the same places but would become dimmer.

c) The bright fringes would be further apart.

(d) The bright fringes would be closer together.



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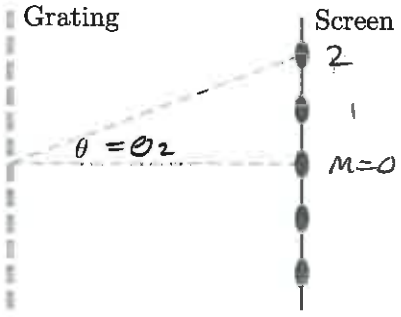
Question 3 87

Light of wavelength 490×10^{-9} m is incident on a diffraction grating and it produces a pattern of bright fringes as illustrated. The fringe in the middle of the screen on the diagram is directly opposite the incoming light beam. The distance between adjacent slits in the diffraction grating is 1.9×10^{-6} m. Determine the angle θ as illustrated.



For a bright fringe

+2 $d\sin\theta_m = m\lambda$

+2 Here $m=2$ $\Rightarrow$ $1.9\times10^{-6}\,m \sin\theta_2 = 2\times490\times10^{-9}$

$\Rightarrow$ $\sin\theta_2 = 0.516$

calculate +4

$\Rightarrow$ $\theta_2 = \sin^{-1}(0.516)$

$\theta_2 = 31^\circ$

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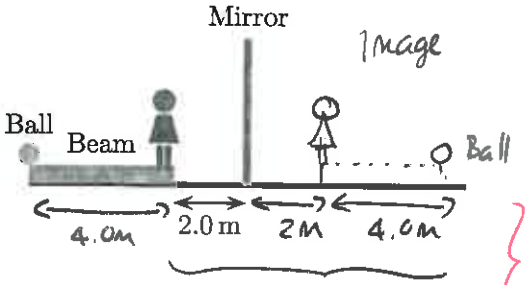
Draw/state image
4

Question 4 80

A beam, of length 4.0 m, lies to the left of a mirror. A ball is on the left end of the beam. A person stands on the right end of the beam. How far to the person's right does the image of the ball appear to be (to the person standing on the beam)? Explain your answer.



do this
2

Draw image

From the diagram we see that the image of the ball is 8.0m to right.

8.0m

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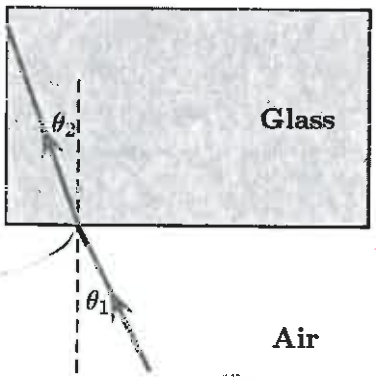
Question 5 80

A light ray travels toward the corner of a glass rectangle as illustrated. The angle between the normal and this ray is $\theta_1 = 20°$. Determine: a) the angle θ_2 at which the ray emerges within the glass and b) Whether any light will re-emerge from the glass after it strikes the side surface. The index of refraction of air is 1.00 and of glass is 1.50.



a) Snell's Law

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

$1.00 \sin 20° = 1.50 \sin\theta_2 \Rightarrow \sin\theta_2 = \frac{\sin 20°}{1.5} = 0.23$

$\Rightarrow \theta_2 = \sin^{-1}(0.23) = 13°$

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b) Consider triangle. The angle between incident ray in glass + normal is 77°. Is this larger than critical angle

$\theta_c = \sin^{-1}\left(\frac{n_2}{n_1}\right) = \sin^{-1}\left(\frac{1}{1.5}\right) = 42°$

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Yes! So total internal reflection occurs No light emerges

2

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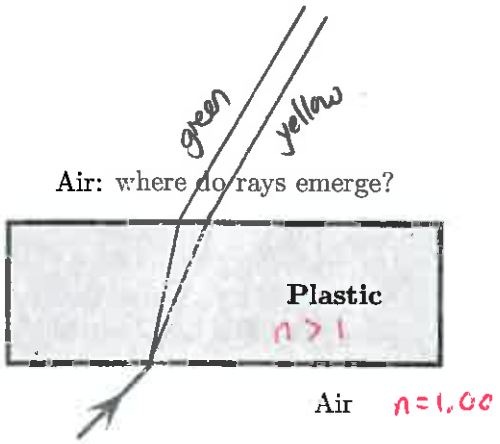
got critical angle but use wrong θ_2 (-2)

Question 6 62



Two light rays pass from air into a piece of plastic. Initially they overlap and follow the indicated path from the air to the plastic. The index of refraction for light green light in plastic is slightly larger than that of yellow light. Both colors emerge from the plastic at the top. Which of the following (choose one) is true of the rays once the re-emerge in the air?

Both bend toward then away from normal...

Green bends more since index is larger. Their paths are as illustrated. These will be parallel to initial ray. So no crossing

a) The rays overlap exactly.

b) Yellow emerges to the left of green and the rays do not cross in the air.

c) Yellow emerges to the right of green and the rays do not cross in the air.

d) Yellow emerges to the left of green and the rays cross in the air.

e) Yellow emerges to the right of green and the rays cross in the air.

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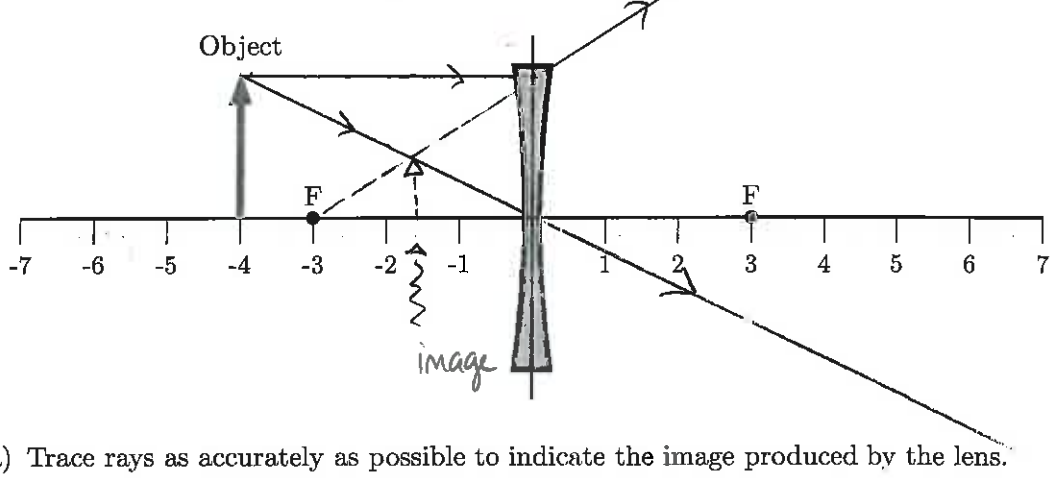
Question 7 71

An object, whose height is 2 cm, is placed to the left of a concave lens as illustrated. The focal points of the lens are labeled, F. The units along the horizontal axis are centimeters.



2 each ray
2 image
6

a) Trace rays as accurately as possible to indicate the image produced by the lens.

b) Determine the location and height of the image *using equations*.

Question 7 continued ...

1

correct s] 1

$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$ $\Rightarrow$ $\frac{1}{4} + \frac{1}{s'} = \frac{1}{-3}$ $f = -3\,cm$ since it's diverging] 2

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$\Rightarrow \frac{1}{s'} = -\frac{1}{4} - \frac{1}{3} = \frac{-3-4}{12} = \frac{-7}{12}$] 2

$\Rightarrow s' = -\frac{12}{7} = -1.7\,cm$

4

Height $m = \frac{h'}{h} = -\frac{s'}{s}$ $\Rightarrow$ $h' = -h\frac{s'}{s}$] 1

3

$= -2.0\,cm$ $\frac{-1.7\,cm}{4}$

$h' = 0.85\,cm$

c) Zog claims that it is possible to use this lens to produce an enlarged image of the object using just this lens. Is Zog's claim **true or false? Explain your answer.**

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Looking at the diagram the image will always be between the object + lens. If the object is shifted, the parallel ray will not change, the diagonal ray will

As the image lies along the diagonal ray, it will be smaller than object.

Zog's claim is false

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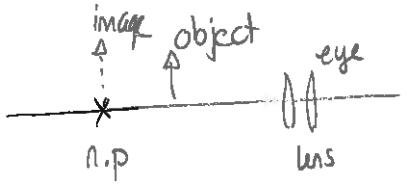
Question 8 5 7

Geraldine has a near point of 35 cm = 0.35 m and a far point of 1.25 m.

a) Determine the focal length of the corrective lenses which allow Geraldine to see an object located at the normal near point (25 cm = 0.25 m) clearly. Are these lenses are converging or diverging?

1 [$\frac{1}{s} + \frac{1}{s'} = \frac{1}{f}$ 1 [



1 [$s = 0.25m$

1 [$s' = -0.35m$

$\frac{1}{0.25m} - \frac{1}{0.35m} = \frac{1}{f}$

$\Rightarrow 1.1\ m^{-1} = \frac{1}{f} \Rightarrow f = \frac{1}{1.1m^{-1}} = 0.88m$

1 [f positive $\Rightarrow$ converging

5

b) Geraldine uses a magnifying glass without her corrective lenses. Zog, whose near point is 50 cm = 0.50 m uses the same magnifying glass, also without his corrective lenses. Which of the following is true?

i) The magnification attained by Geraldine is the same as that attained by Zog.
ii) The magnification attained by Geraldine is smaller than that attained by Zog.
iii) The magnification attained by Geraldine is larger than that attained by Zog.

Briefly explain your answer.

$M = \frac{S_{near}}{f}$ f same

S_{near} smaller for Geraldine

$\Rightarrow$ M smaller " "

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