

## Optics Exam Review

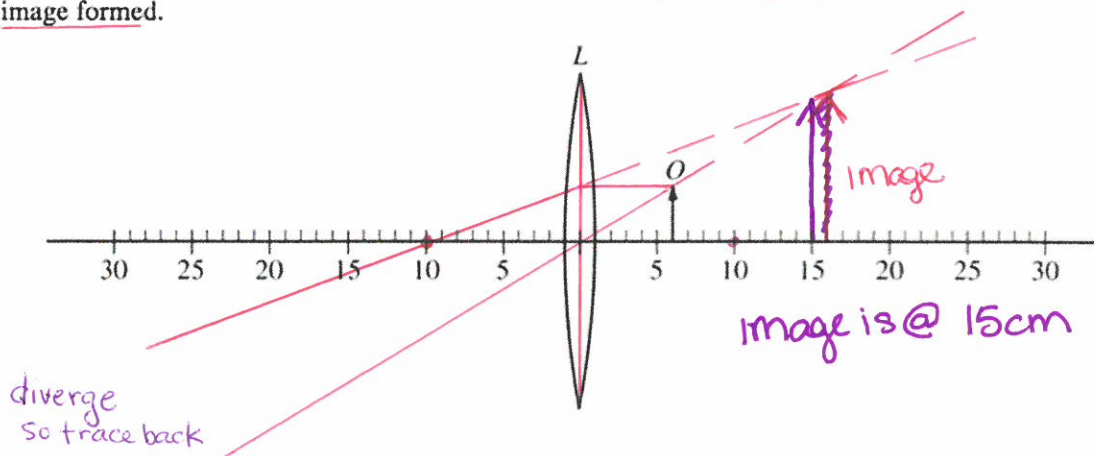
Directions – Complete the following problems to help prepare you for the upcoming test.

### 2008 AP<sup>®</sup> PHYSICS B FREE-RESPONSE QUESTIONS (Form B)

5. (10 points)

A thin converging lens  $L$  of focal length  $10.0\text{ cm}$  is used as a simple magnifier to examine an object  $O$  that is placed  $6.0\text{ cm}$  from the lens.

(a) On the figure below, draw a ray diagram showing at least two incident rays and the position and size of the image formed.



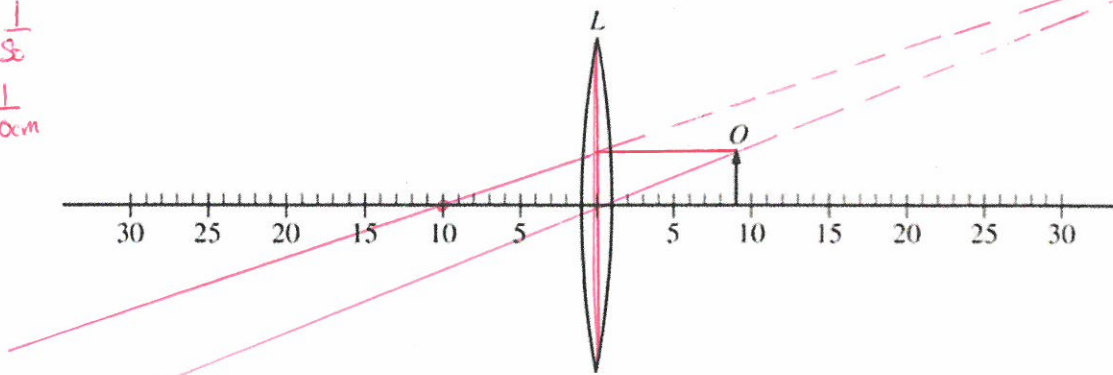
(b) i. Indicate whether the image is real or virtual.

Real      Virtual

ii. Justify your answer. *The rays do not meet after passing through the lens.*

(c) Calculate the distance of the image from the center of the lens. (Do NOT simply measure your ray diagram.)

$$\begin{aligned} c) \frac{1}{s_i} &= \frac{1}{f} - \frac{1}{s_o} \\ &= \frac{1}{10.0\text{cm}} - \frac{1}{6.0\text{cm}} \\ s_i &= -15\text{cm} \end{aligned}$$



(d) The object is now moved  $3.0\text{ cm}$  to the right, as shown above. How does the height of the new image compare with that of the previous image?

It is larger.      It is smaller.      It is the same size.

Justify your answer.

*1) The rays passing through the lens diverge less so their extensions meet farther away, making the image larger*

OR 2) construct new diagram

OR 3) show calculation:

$$19 \quad \textcircled{a} \quad \frac{1}{s_i} = \frac{1}{f} - \frac{1}{s_o} = \frac{1}{10\text{cm}} - \frac{1}{9\text{cm}} \quad s_i = -90\text{cm}$$

$$\textcircled{b} \quad m_1 = -\frac{s_{i1}}{s_{o1}} = +25 \quad m_2 = -\frac{s_{i2}}{s_{o2}} = +10$$

*The magnification is larger so the height is larger*

## 2006 AP<sup>®</sup> PHYSICS B FREE-RESPONSE QUESTIONS

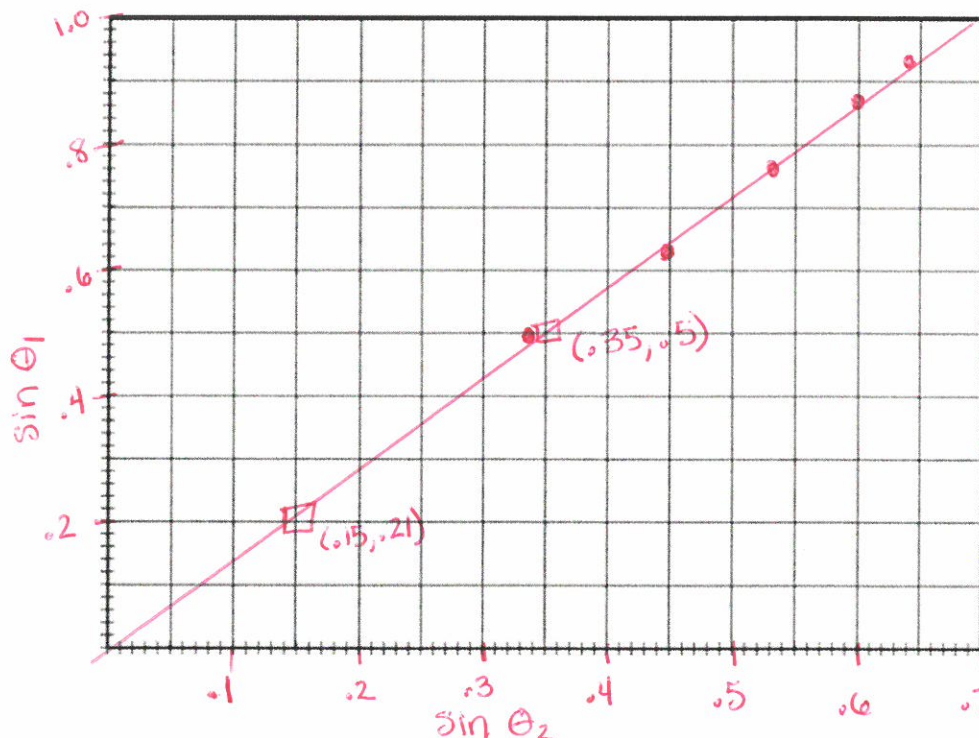
4. (15 points)

A student performs an experiment to determine the index of refraction  $n$  of a rectangular glass slab in air. She is asked to use a laser beam to measure angles of incidence  $\theta_i$  in air and corresponding angles of refraction  $\theta_r$  in glass. The measurements of the angles for five trials are given in the table below.

Trial	$\theta_i$	$\theta_r$	$\sin \theta_i$	$\sin \theta_r$
1	30°	20°	.50	.34
2	40°	27°	.64	.45
3	50°	32°	.77	.53
4	60°	37°	.87	.60
5	70°	40°	.94	.64

(a) Complete the last two columns in the table by calculating the quantities that need to be graphed to provide a linear relationship from which the index of refraction can be determined. Label the top of each column.

(b) On the grid below, plot the quantities calculated in (a) and draw an appropriate graph from which the index of refraction can be determined. Label the axes.



(c) Using the graph, calculate the index of refraction of the glass slab.

$$m = \frac{\Delta y}{\Delta x} = \frac{.5 - .21}{.35 - .15} = 1.45$$

$$n_2 = \frac{\sin \theta_1}{\sin \theta_2} = \frac{\Delta y}{\Delta x} = \text{slope}$$

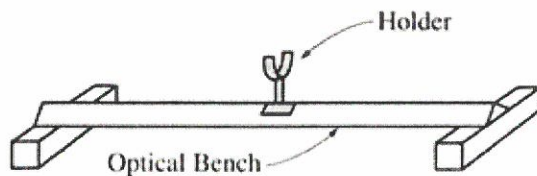
$$n_2 = 1.45$$

### 2003 AP<sup>®</sup> PHYSICS B FREE-RESPONSE QUESTIONS

4. (15 points)

In your physics lab, you have a concave mirror with radius of curvature  $r = 60$  cm. You are assigned the task of finding experimentally the location of a lit candle such that the mirror will produce an image that is 4 times the height of the lit candle.

$R$   $f = 30\text{cm}$



You have an optical bench, which is a long straight track as shown above. Objects in holders can be attached at any location along the bench. In addition to the concave mirror and the lit candle in holders, you also have the following equipment.

- |   |  |   |
|---|--|---|
| <input type="checkbox"/> <del>convex mirror</del> in holder | <input type="checkbox"/> <del>concave lens</del> in holder | <input type="checkbox"/> <del>convex lens</del> in holder |
| <input checked="" type="checkbox"/> meter stick             | <input checked="" type="checkbox"/> ruler                  | <input checked="" type="checkbox"/> screen in holder      |

- (a) Briefly list the steps in your procedure that will lead you to the location of the lit candle that produces the desired image. Include definitions of any parameters that you will measure. (see next page)
- (b) On the list of equipment before part (a) place check marks beside each additional piece of equipment you will need to do this experiment.
- (c) On the scale below, draw a ray diagram of your lab setup in part (a) to show the locations of the candle, the mirror, and the image. (see next page for two possibilities)



(d) Check the appropriate spaces below to indicate the characteristics of your image.

OR ↗	<input checked="" type="checkbox"/> real	<input checked="" type="checkbox"/> upright	<input checked="" type="checkbox"/> larger than object
	<input checked="" type="checkbox"/> virtual	<input checked="" type="checkbox"/> inverted	<input type="checkbox"/> smaller than object

$\swarrow$  real + invert  $\searrow$  virtual + upright

depends on diagram

(e) You complete your assignment and turn in your results to your teacher. She tells you that another student, using equipment from the same list, has found a different location for the lit candle. However, she tells both of you that the labs were done correctly and that neither experiment need be repeated. Explain why both experiments can be correct.

(see next page)

- a)
- Place the concave mirror at the end of the optical bench.
  - Place the candle more than 30 cm from the mirror. Light the candle.
  - Place the ~~candle~~ screen beyond the candle and ~~an~~ reposition it to get a clear image.
  - Measure the height of the object and image using a meter stick.
  - Continue to reposition the candle and screen until the image height is four times the object height.

e) Depending on if the group placed the object in front of the focal point or ~~away~~ far behind it, <sup>creates</sup> a virtual image or a real image with quadruple the height

Also, the other group may have added a lens to their concave mirror system

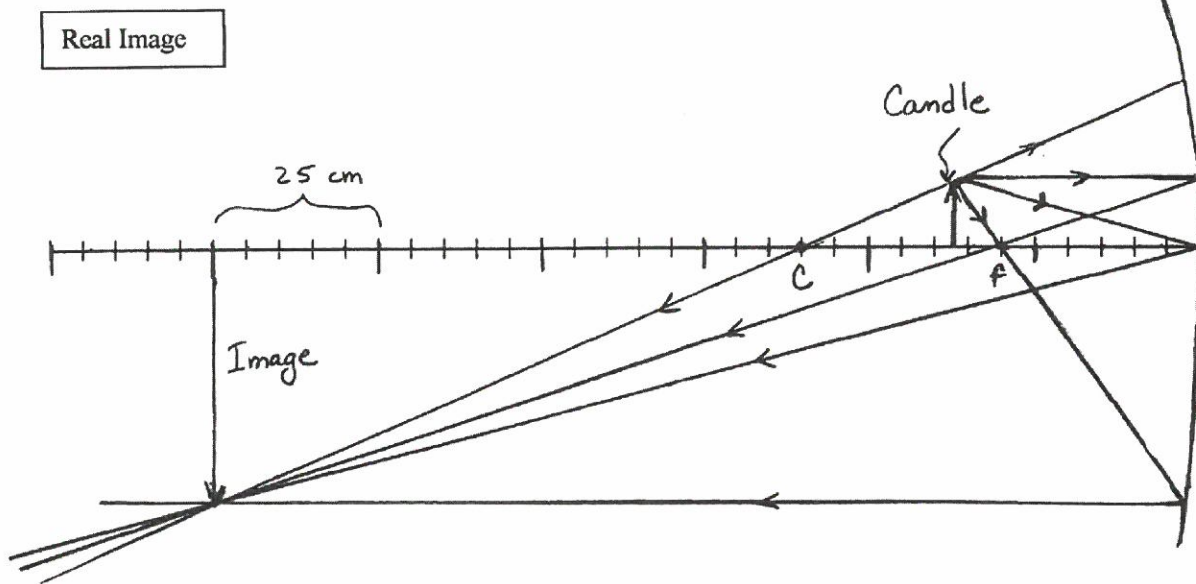
Two possible correct answers

AP PHYSICS B  
2003 SCORING GUIDELINES

Question 4 (continued)

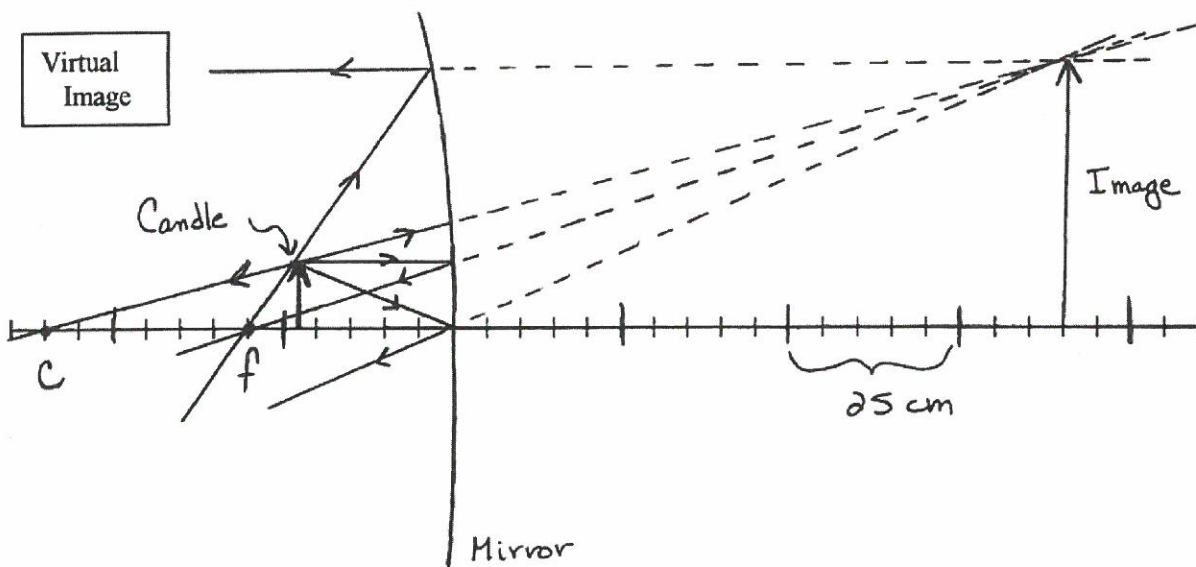
Image should be larger

Distribution  
of points  
Mirror



OR

(c) (continued)



For showing the concave mirror

1 point