AP® Physics B
2002 Sample Student Responses

The materials included in these files are intended for use by AP teachers for course and exam preparation in the classroom; permission for any other use must be sought from the Advanced Placement Program®. Teachers may reproduce them, in whole or in part, in limited quantities, for face-to-face teaching purposes but may not mass distribute the materials, electronically or otherwise. These materials and any copies made of them may not be resold, and the copyright notices must be retained as they appear here. This permission does not apply to any third-party copyrights contained herein.

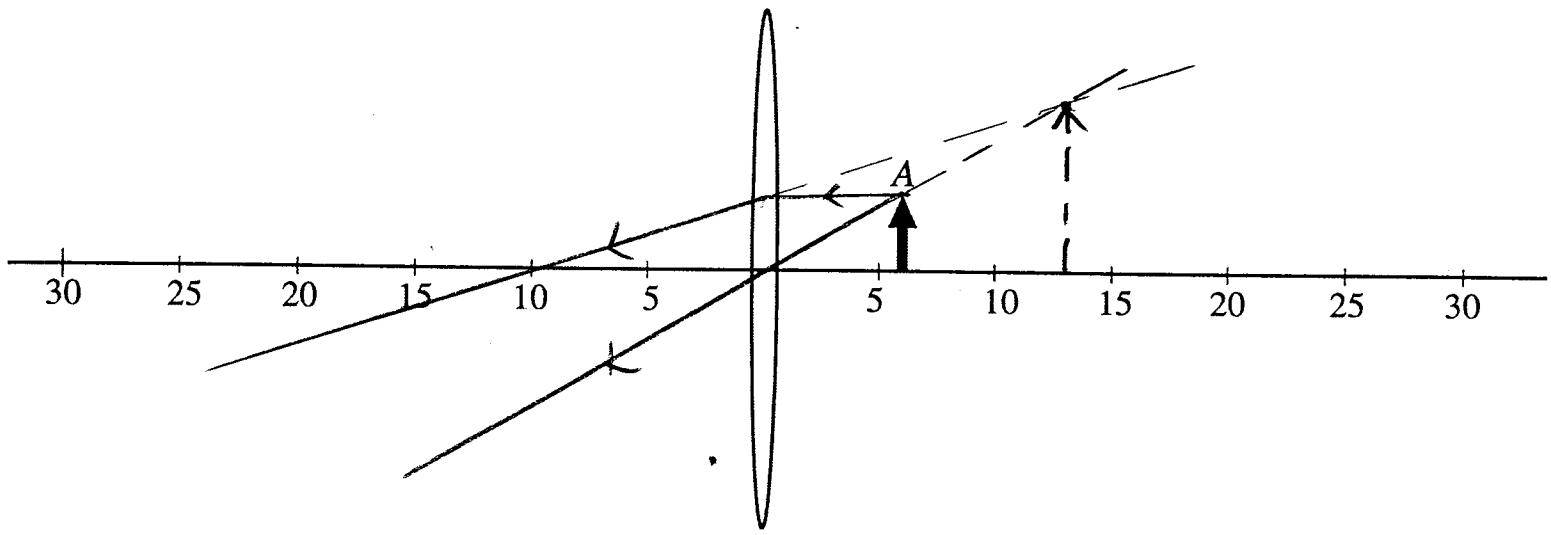
These materials were produced by Educational Testing Service® (ETS®), which develops and administers the examinations of the Advanced Placement Program for the College Board. The College Board and Educational Testing Service (ETS) are dedicated to the principle of equal opportunity, and their programs, 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 4,200 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®, and the Advanced Placement Program® (AP®). 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.

4. (15 points)

A thin converging lens of focal length 10 cm is used as a simple magnifier to examine an object A that is held 6 cm from the lens.

(a) On the figure below, draw a ray diagram showing the position and size of the image formed.



(b) State whether the image is real or virtual. Explain your reasoning.

Virtual. Because the d_o (object distence) is less then focal length, so the refracted rays cannot meet on the other side. Therefore, one the other side, people can see a virtue image.

(c) Calculate the distance of the image from the center of the lens.

$$\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$$

$$\frac{1}{10} = \frac{1}{6} + \frac{1}{d_i}$$

$$\frac{1}{d_i} = \frac{1}{10} - \frac{1}{6}$$

$$d_i = \frac{10 \times (-6)}{10 - 6} = -15 \text{ cm}$$

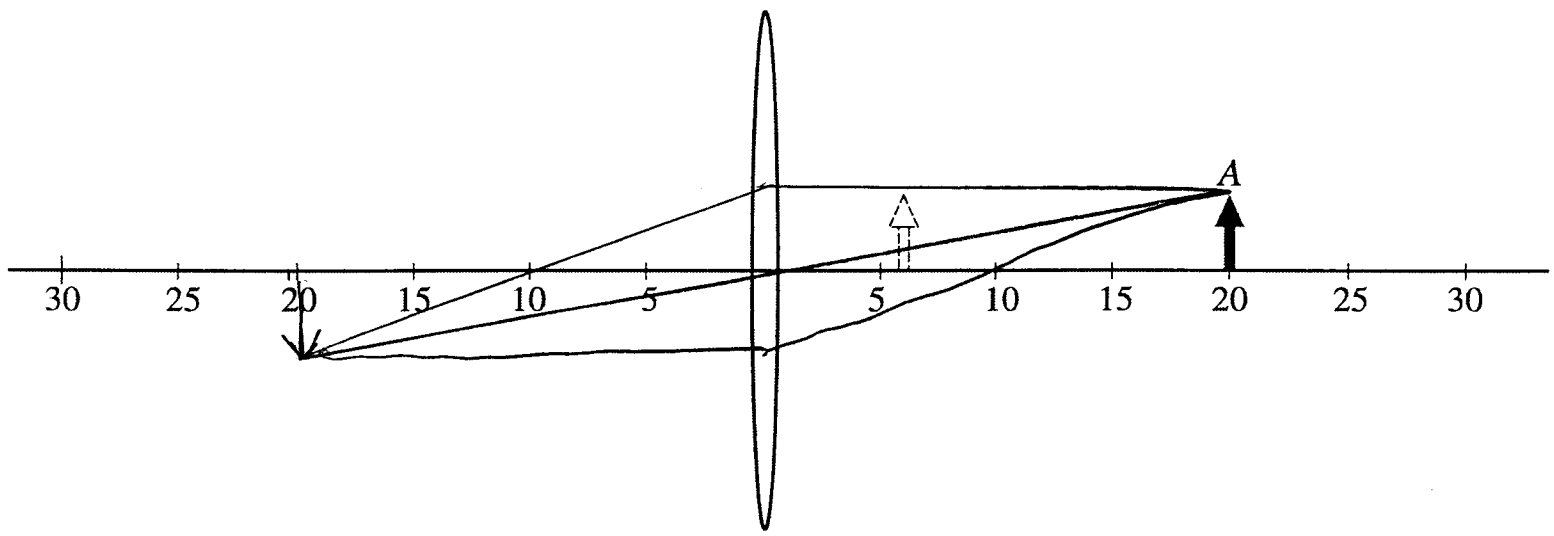
image is 15 cm from the center lens

GO ON TO THE NEXT PAGE.

(d) Calculate the ratio of the image size to the object size.

$\frac{h_i}{h_o} = \frac{d_i}{d_o} = \frac{15}{6}$

∴ the ratio is $\frac{15}{6}$



(e) The object A is now moved to the right from $x = 6$ cm to a position of $x = 20$ cm, as shown above. Describe the image position, size, and orientation when the object is at $x = 20$ cm.

∵ 20 cm is double the focal length

∴ the image is a real image 20cm on the other side of the len with same height

proof ∵ $\frac{1}{f} = \frac{1}{d_o} + \frac{1}{d_i}$ ∴ $\frac{1}{10} = \frac{1}{20} + \frac{1}{d_i}$ $d_i = 20$

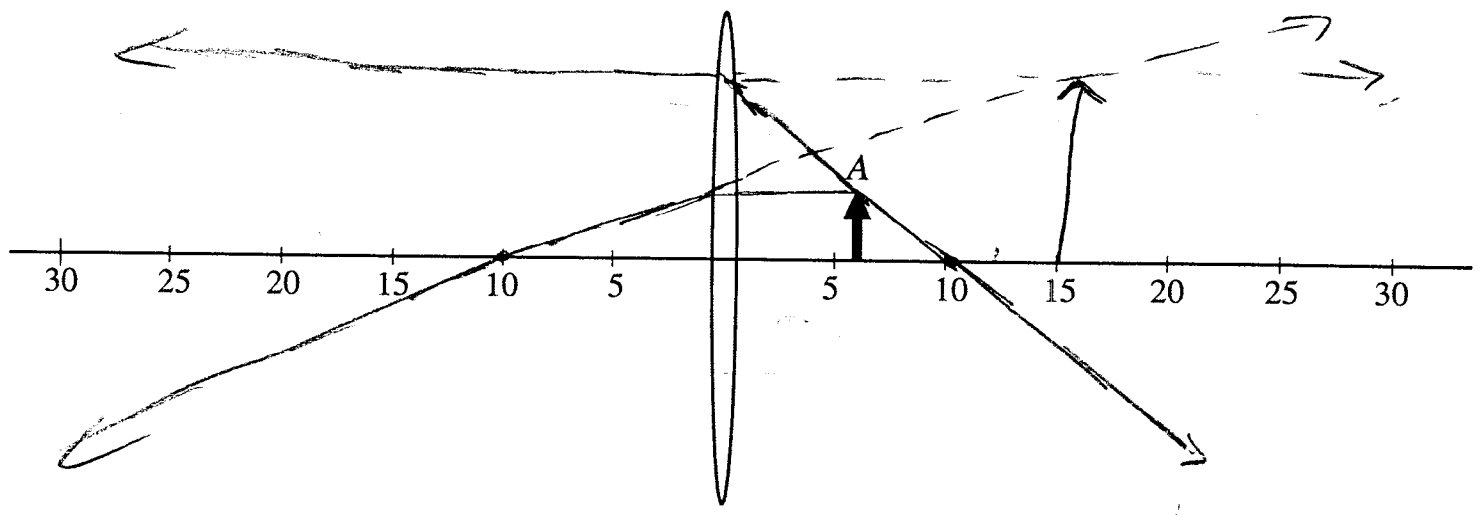
∵ $\frac{h_i}{h_o} = \frac{d_i}{d_o}$ ∴ $h_i = h_o$, ∴ same height

GO ON TO THE NEXT PAGE.

4. (15 points)

A thin converging lens of focal length 10 cm is used as a simple magnifier to examine an object A that is held 6 cm from the lens.

(a) On the figure below, draw a ray diagram showing the position and size of the image formed.



(b) State whether the image is real or virtual. Explain your reasoning.

the image is virtual, the object is placed between the lense and the focal point, and the image cannot be projected onto a screen.

(c) Calculate the distance of the image from the center of the lens.

$$\frac{Ho}{Hi} = \frac{So}{f} = \frac{f}{Si}$$

$$\frac{4}{10} = \frac{10}{x} \qquad x = 25$$

$25 - 10 = 15$

15 cm to the right of the lense

GO ON TO THE NEXT PAGE.

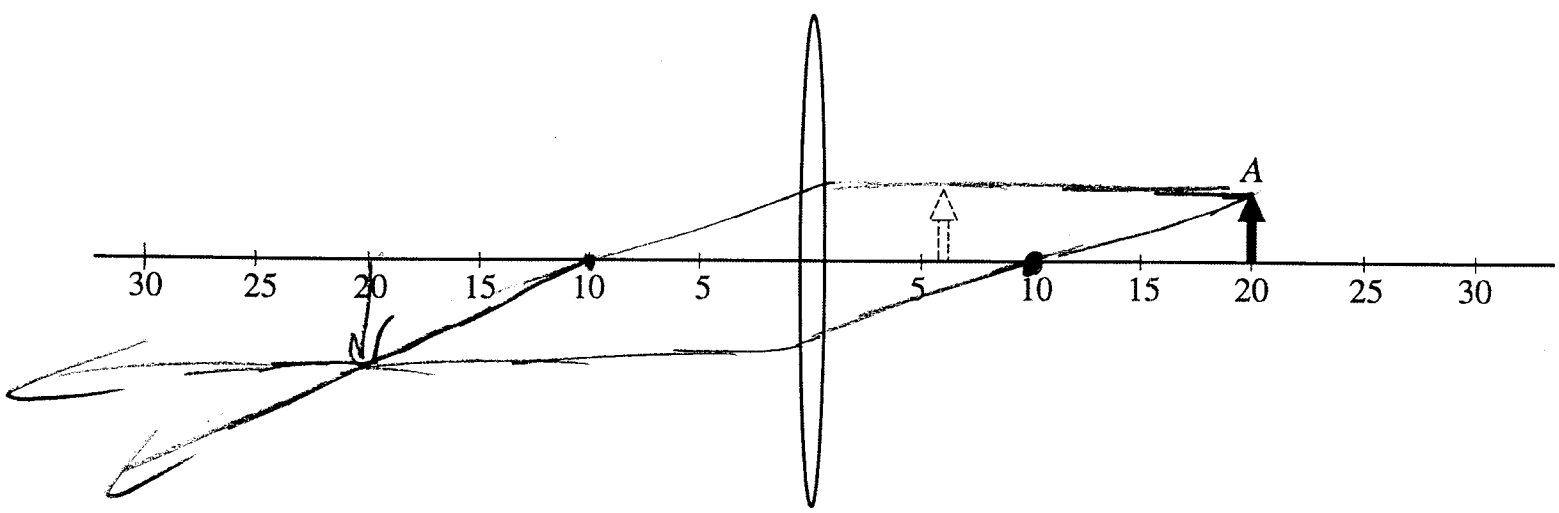
(d) Calculate the ratio of the image size to the object size.

$\frac{H_o}{H_i} = \frac{S_o}{f} = \frac{f}{S_i}$

$\frac{\text{Object Size}}{X} = \frac{4}{10}$

$X = \frac{5}{2}$ object size

The ratio of object size to Image size is 5/2



(e) The object A is now moved to the right from $x = 6$ cm to a position of $x = 20$ cm, as shown above. Describe the image position, size, and orientation when the object is at $x = 20$ cm.

$\frac{H_o}{H_i} = \frac{S_o}{f} = \frac{f}{S_i}$

$\frac{H_o}{X} = \frac{10}{10} = \frac{10}{X}$

The image will be real, 20 cm to the left of the lense, and in a 1/1 ratio of dimentions with the object.

GO ON TO THE NEXT PAGE.