AP® Physics B
2003 Sample Student Responses

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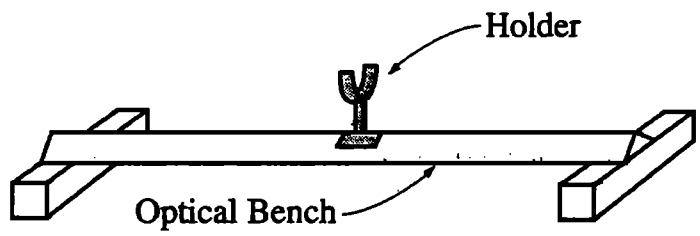
4. (15 points)
In your physics lab, you have a concave mirror with radius of curvature $r = 60$ cm. You are assigned the task of finding experimentally the location of a lit candle such that the mirror will produce an image that is 4 times the height of the lit candle.



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.

____ convex mirror in holder ____ concave lens in holder ____ convex lens in holder

✓ meter stick ✓ ruler ✓ 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.

① Place the screen on the left of the bench, candle in the middle and concave mirror to the right. Make sure that the distance between the candle and mirror is between 60 cm and 30 cm. (between C and F)

② Measure the height of the candle. Initially, @ 30 cm from the mirror, no image will be on the screen. Move the holder of the candle farther and farther from the mirror until the image projected on the screen is 4 times the height of the object. Measure the distance between the object and mirror.

condition: height of candle cannot exceed 25cm or else the meter stick cannot be used to measure the image

(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.

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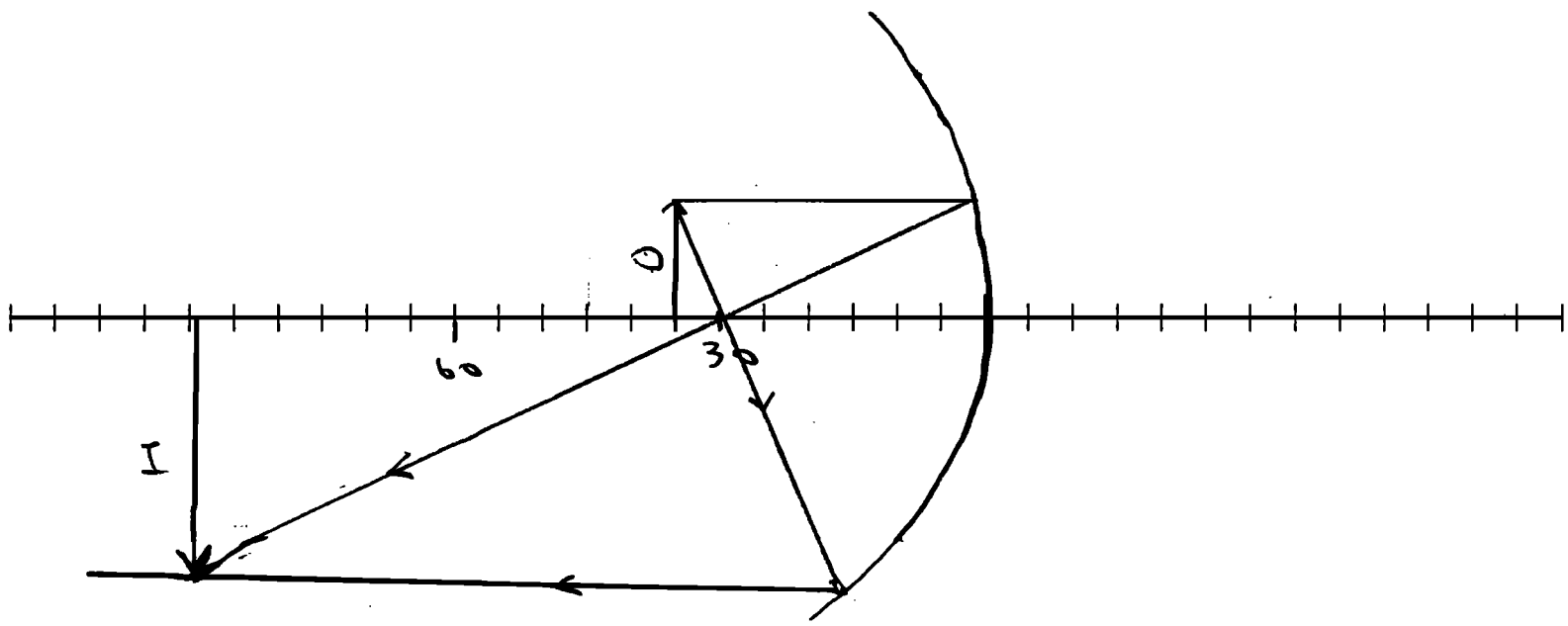
(c) On the scale below, draw a ray diagram of your lab setup in part (a) to show the locations of the candle, the mirror, and the image.



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

✓ real	____ upright	✓ larger than object
____ virtual	✓ inverted	____ smaller than object

(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.

A concave mirror can also produce images larger than the object if the object is placed between the mirror and F. This image, however, is virtual.

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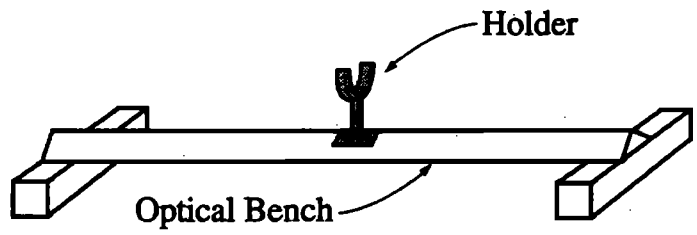
Q1

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.



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.

____ convex mirror in holder ____ concave lens in holder ____ convex lens in holder

____ meter stick ____✓ ruler ____ 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.

① Place the candle in the holder. Light candle.
② Take a ruler and find the height of the candle. Record.
③ Attach a concave mirror into a holder. Attach holder to the bench + the far left of the candle. Keep stationary.
④ Adjust the distance of the candle so that it is within the focal length of the mirror. Note: $f = r/2$.
⑤ Using a ruler, find the height of the image.
⑥ Continue to move the candle within the distance of 1 focal length from the mirror, until the image height in the mirror is 4 times the height of the candle.
⑦ Use the equations $M = -q/p$ where $M = 4$ and $\frac{1}{q} + \frac{1}{p} = \frac{1}{f}$ to justify results.

(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.

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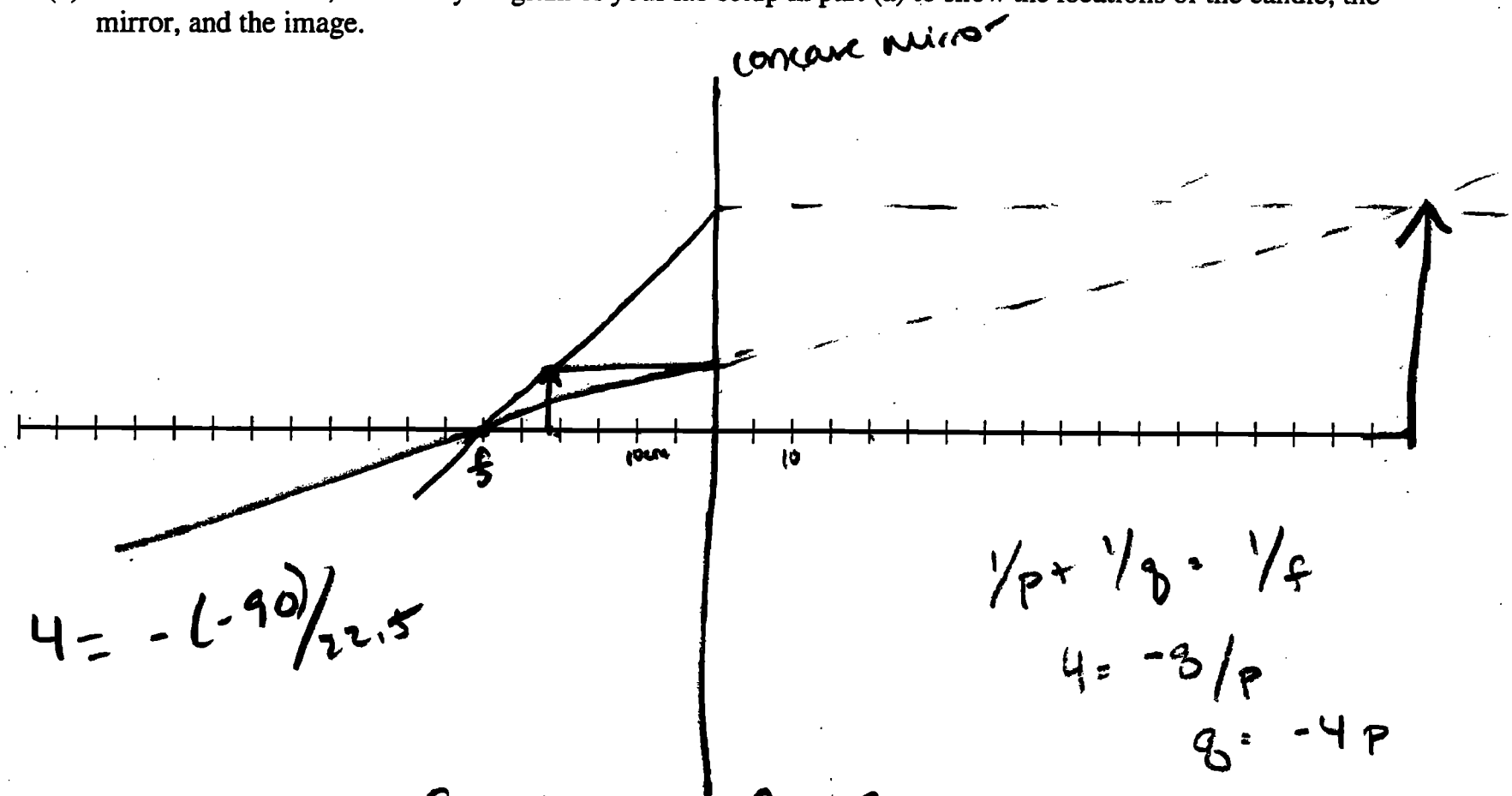
Q2

(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.



$4 = -(-90)/22.5$

$1/p + 1/q = 1/f$

$4 = -3/p$

$q = -4p$

$f = r/2$ so $f = 30$ cm.

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

____ real	✓ upright	✓ larger than object
✓ virtual	____ inverted	____ smaller than object

(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.

The mirror was manufactured incorrectly thus the focal length was diff. Creating an alternate result.

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