



AP[®] Physics B

2002 Sample Student Responses

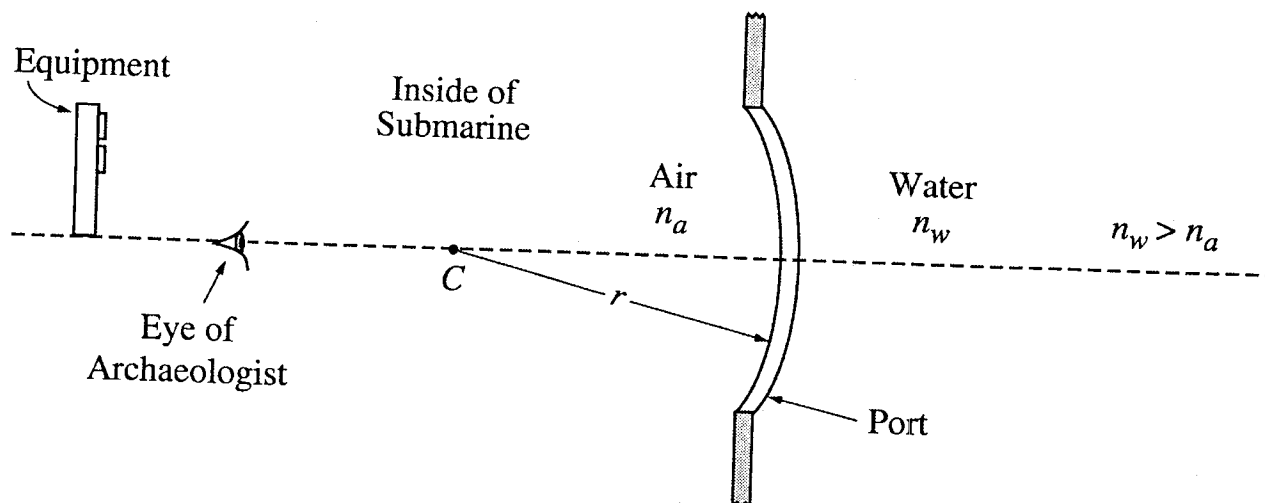
Form B

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4. (15 points)

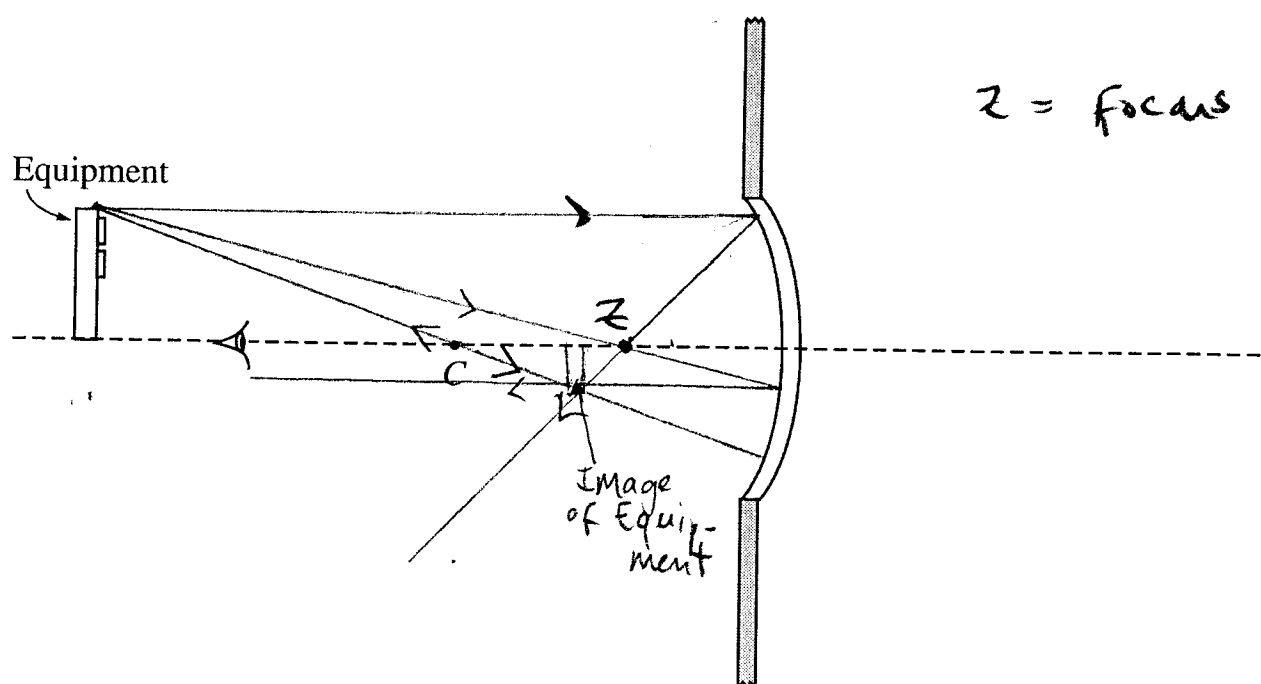
A marine archaeologist looks out the port of a research submarine, as shown above. The port is spherically shaped with center of curvature at point C and radius of curvature r . It is made of a material that has an index of refraction of n_w , the same as the index of refraction of seawater, which is greater than n_a , the index of refraction of air. The archaeologist is located to the left of point C and some equipment in the submarine is located behind the archaeologist. The archaeologist can see through the port, but the port also acts as a mirror so the archaeologist can see the reflection of the equipment.

(a) What is the focal length of the mirror?

$$f = \frac{R}{2} = \frac{r}{2} \quad \text{assuming } R = 3.5 \text{ cm}$$

$$f = \frac{3.5 \text{ cm}}{2} = 1.75 \text{ cm}$$

(b) On the following figure, sketch a ray diagram to locate the position of the image of the equipment formed as a result of the mirror effect.



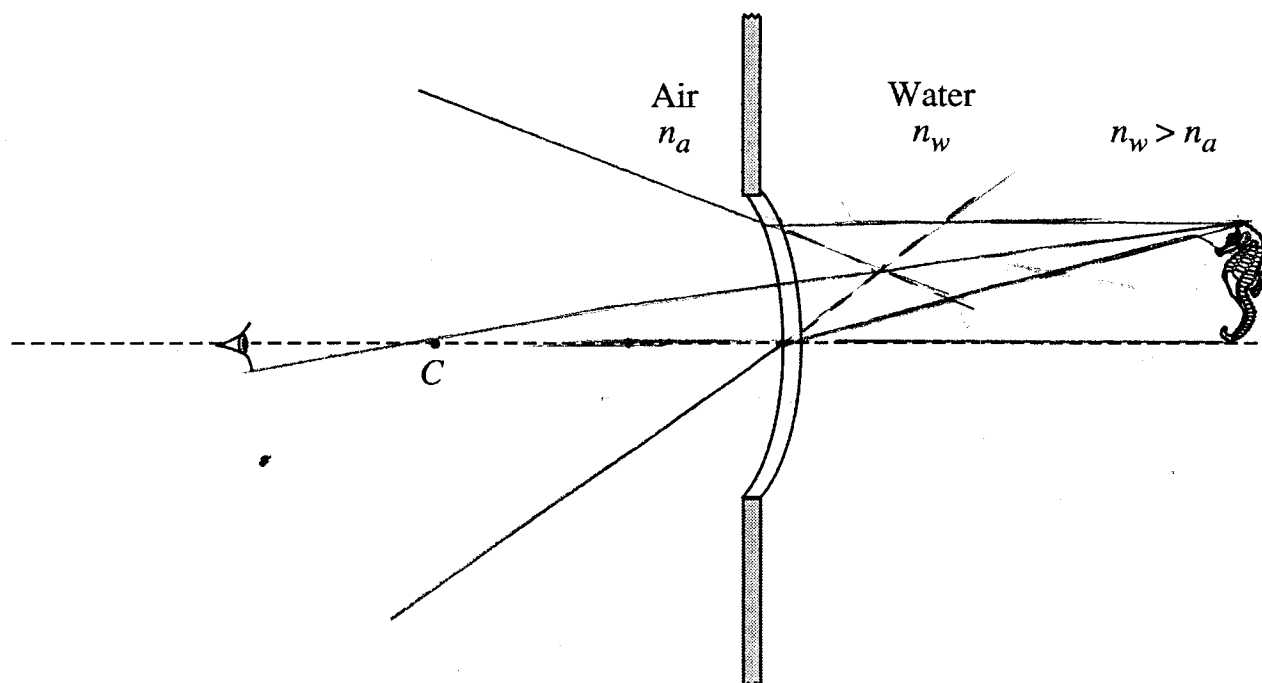
GO ON TO THE NEXT PAGE.

(c) Based on your ray diagram, check the appropriate spaces below to describe the image of the equipment formed as a result of the mirror effect.

- i. Image is: ☐ upright ☒ inverted
 ii. Image is: ☒ real ☐ virtual
 iii. Image is: ☐ larger than the equipment ☒ smaller than the equipment

The archaeologist also observes a seahorse located outside the port directly in front of the archaeologist. Due to refraction of light at the inner surface of the port, the seahorse does not appear to be at its actual location.

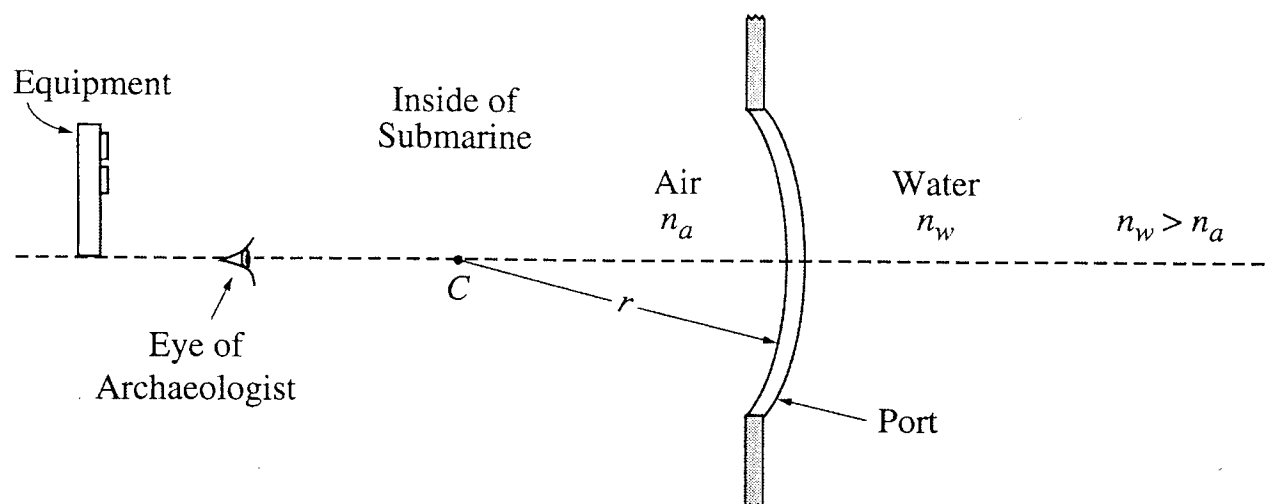
(d) On the following figure, sketch a ray diagram to locate the position of the image of the seahorse formed by the refraction of light at the port.



(e) Based on your ray diagram, check the appropriate spaces below to describe the image of the seahorse, as seen by the archaeologist, formed by the refraction of light at the port.

- i. Image is: ☒ upright ☐ inverted
 ii. Image is: ☐ real ☒ virtual
 iii. Image is: ☐ larger than the seahorse ☒ smaller than the seahorse

GO ON TO THE NEXT PAGE.



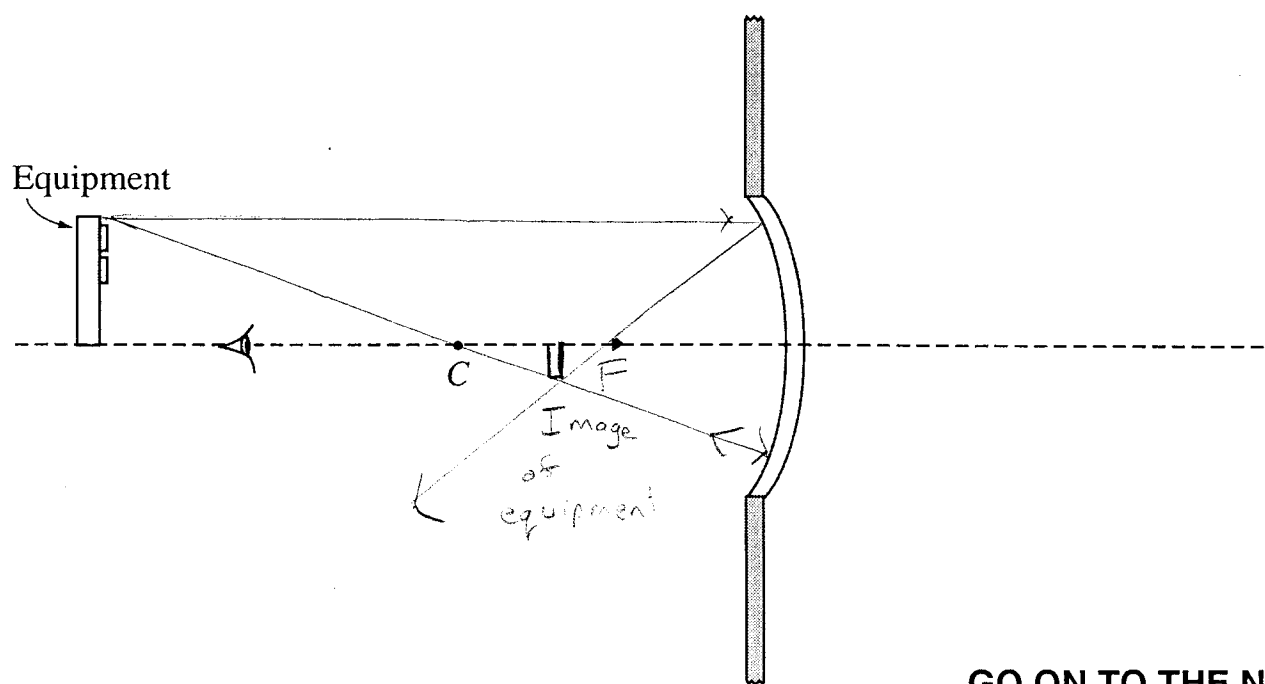
4. (15 points)

A marine archaeologist looks out the port of a research submarine, as shown above. The port is spherically shaped with center of curvature at point C and radius of curvature r . It is made of a material that has an index of refraction of n_w , the same as the index of refraction of seawater, which is greater than n_a , the index of refraction of air. The archaeologist is located to the left of point C and some equipment in the submarine is located behind the archaeologist. The archaeologist can see through the port, but the port also acts as a mirror so the archaeologist can see the reflection of the equipment.

(a) What is the focal length of the mirror?

The focal length is half the distance between the center of curvature at point C and the port.

(b) On the following figure, sketch a ray diagram to locate the position of the image of the equipment formed as a result of the mirror effect.



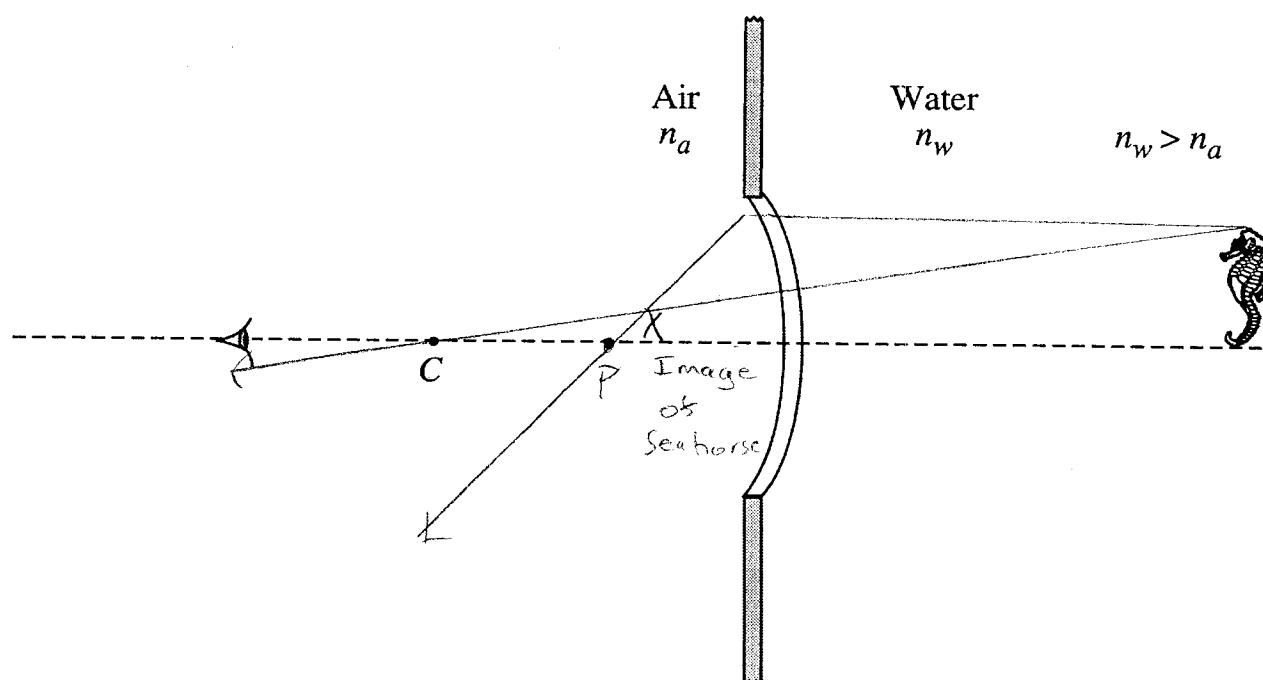
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(c) Based on your ray diagram, check the appropriate spaces below to describe the image of the equipment formed as a result of the mirror effect.

- i. Image is: ☐ upright ☒ inverted
 ii. Image is: ☒ real ☐ virtual
 iii. Image is: ☐ larger than the equipment ☒ smaller than the equipment

The archaeologist also observes a seahorse located outside the port directly in front of the archeologist. Due to refraction of light at the inner surface of the port, the seahorse does not appear to the archaeologist to be at its actual location.

(d) On the following figure, sketch a ray diagram to locate the position of the image of the seahorse formed by the refraction of light at the port.



(e) Based on your ray diagram, check the appropriate spaces below to describe the image of the seahorse, as seen by the archaeologist, formed by the refraction of light at the port.

- i. Image is: ☒ upright ☐ inverted
 ii. Image is: ☐ real ☒ virtual
 iii. Image is: ☐ larger than the seahorse ☒ smaller than the seahorse

GO ON TO THE NEXT PAGE.