

Multiple choice: Each question is worth 5 points.

1. Make sure that your name and seat number are appropriately and accurately filled in above. (Okay, so this isn't really a multiple choice question, but it is an easy five points.)
2. A ray of light is traveling from a material with a high index of refraction to a material with a low index of refraction. The incident angle, in the high index material, is 30° from the normal. The refracted angle, in the low index material, will be

A. exactly 30° from the normal.	<input checked="" type="radio"/> B. greater than 30° from the normal.	C. less than 30° from the normal.	D. There is no way to predict this.
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3. A charge is moving through a magnetic field. Which of the following will occur?

A. The charge will increase its kinetic energy.	B. The charge will decrease its kinetic energy.	<input checked="" type="radio"/> C. The charge's kinetic energy will not change.	D. More information is needed to know the outcome.
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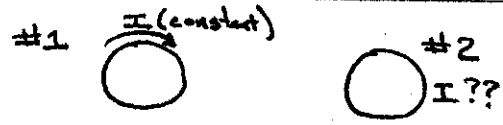
4. You pull a magnet out of a complete loop of wire. As a result, the wire exerts a force on the magnet that is

<input checked="" type="radio"/> A. "backward," pulling towards the wire.	B. "forward," pushing away from the wire.	C. left; perpendicular to the motion of the magnet.	D. right; perpendicular to the motion of the magnet.	E. More information is needed; specifically the orientation of the magnet.
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5. Your finger is in between a diverging lens and its focal point. What kind of image of your finger will you see when you look from the other side of the lens?

A. Real, upright	B. Real, inverted	<input checked="" type="radio"/> C. Virtual, upright	D. Virtual, inverted	E. More information is needed.
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6. As shown at right, two coils of wire are side-by-side, and in the same plane as your piece of paper. In coil #1, the current has been left on and is constant. Which of the following occurs?



A. A clockwise current is induced in coil #2	B. A counter-clockwise current is induced in coil #2	C. The magnetic field in coil #2 changes, but no current is produced	<input checked="" type="radio"/> D. The magnetic field in coil #2 does <i>not</i> change, and no current is produced
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7. A physics professor is projecting a real image through a lens and onto a screen. If the top half of the lens is blocked, then

A. the portion of the image on the bottom half of the screen disappears.	B. the portion of the image on the top half of the screen disappears.	<input checked="" type="radio"/> C. the image becomes dimmer.	D. no change to the image takes place.	E. More than one of these is correct.
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Situation I: Schroeder's Cat

Dr. Schroeder's cat, named Heisenberg, is viewed through a converging lens such that you see an upright image of it, and it is three times as tall as normal! Heisenberg is standing 20.0 cm away from the lens.

A. [10 points] What is the focal length of this lens?

$M = +3.00 = -\frac{d_i}{d_o}$

$d_i = -d_o M = -20 \text{ cm} (3.00)$

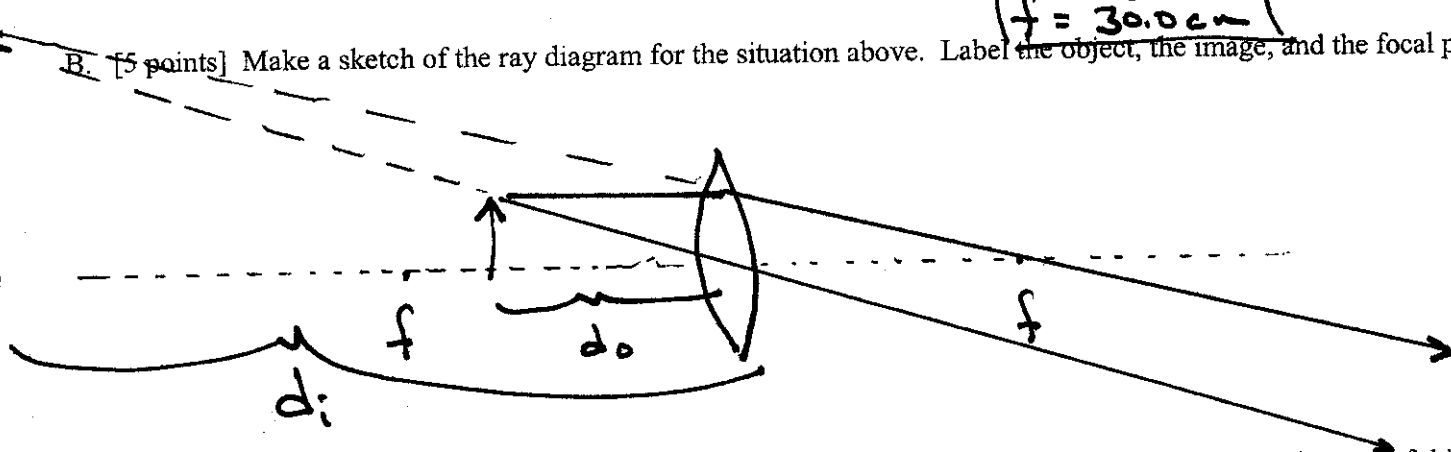
$d_i = -60 \text{ cm}$

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

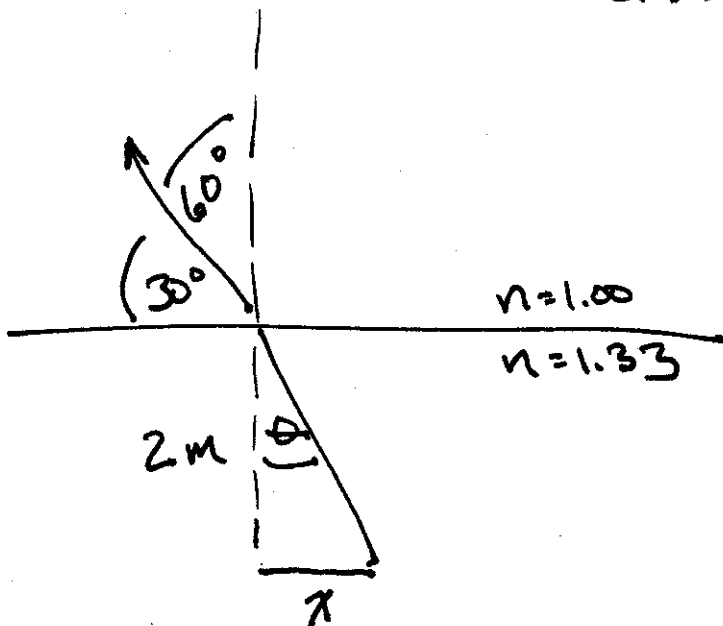
$f = \left(\frac{1}{-60 \text{ cm}} + \frac{1}{20 \text{ cm}} \right)^{-1}$

$f = 30.0 \text{ cm}$

B. [5 points] Make a sketch of the ray diagram for the situation above. Label the object, the image, and the focal point.



C. [15 pts] Where's Schroeder's cat now? Heisenberg is swimming in a pool of water. He is at the bottom of this pool, and you can see the cat as a ray of light that is emitted from the pool at an angle of 30.0 degrees above the water's surface. If the pool is 2.00m deep, what is the ~~farthest~~ closest to the edge of the pool that Heisenberg can be?



$n_1 \sin 60^\circ = n_2 \sin \theta$

$\sin \theta = \frac{1.00}{1.33} \sin 60^\circ$

$\theta = 40.5^\circ$

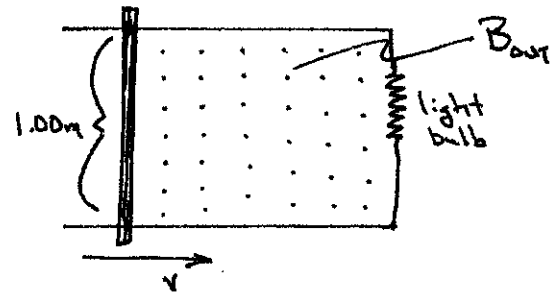
$x = 2 \tan \theta \Rightarrow x = 2 \tan 40.5^\circ$

$x = 1.71 \text{ m}$

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Situation II: Fun with magnetic fields and cats

A. [15 pts.] You are trying to produce a current around a rectangular circuit. The left "side" of this circuit is a movable bar that can slide back and forth. As shown, imagine the circuit drawn on the plane of your paper and the magnetic field is pointing *out* of the page. The magnetic field is 2.00 T and the length of your bar is 1.00 m. Opposite the bar is a light bulb. Originally, your bar is 4.00 m from the light bulb, but you move it toward the light bulb until it is 1.00 m away. If you need to produce an emf of 1.50V, what is the maximum amount of time that you can take to move the bar?



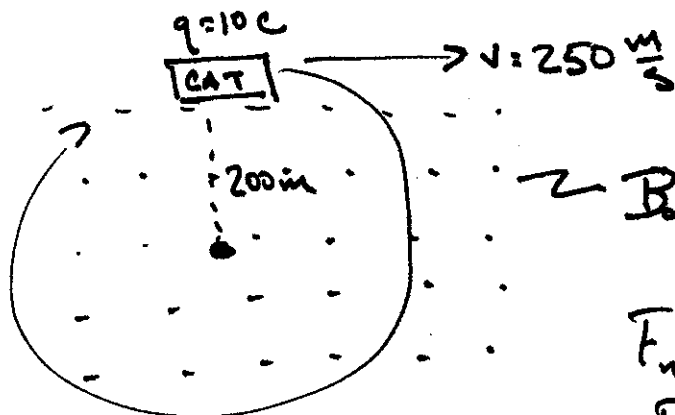
$$\mathcal{E} = - \frac{\Delta \Phi}{\Delta t} = - \frac{\Delta (BA \cos \theta)}{\Delta t} = - B \frac{(1.00 \text{ m})(4 - 1 \text{ m})}{\Delta t}$$

$$\Delta t = \frac{B (3 \text{ m}^2)}{\mathcal{E}} = \frac{2 \text{ T } 3 \text{ m}^2}{1.5 \text{ V}}$$

$$\Delta t = \boxed{4.00 \text{ s}}$$

B. Strangely, Heisenberg (the amazing swimming cat from the previous page) has a net charge with a magnitude of 10.0C (wow!), although you don't know the sign of the charge. This cat enters the magnetic field (3.00 T, out of the page) as it travels from the left, across the page, at a speed of 250 m/s (wow!). This causes the cat to move around in clockwise directed circles that have a radius of 200 m. What is:

- the mass of this cat [15 pts] (be sure to show your work), and
- the sign of the charge of this cat [5 pts]?



use RHR #1:

B (finger): out
 v (thumb): Right
 F (palm): center
 follows RHR,
 so q must
 be **POSITIVE**

$$F_{\text{net}} = ma$$

$$qvB = m \frac{v^2}{r}$$

$$m = \frac{qBr}{v} = \frac{(10 \text{ C})(3 \text{ T})(200 \text{ m})}{250 \frac{\text{m}}{\text{s}}} = \boxed{24.0 \text{ kg}}$$