

University of Maryland  
Department of Physics

Spring 2002  
Physics 122

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Final Exam

Answer all questions on these sheets. Please write clearly and neatly: We can only give you credit for what is on the paper! Put your name and section number on every page.

There are two kinds of problems. The first set of questions is multiple choice. This doesn't mean that words or pictures won't help you! And they will help me in figuring out what feedback to give you. I'll be dropping one multiple choice problem to compute your final grade.

For the last set of problems, you need to show your reasoning, in words and/or mathematics. **These problems all require explanation.** Full credit is for a correct answer with a clear explanation. You'll get partial credit if we can understand and see the physical sense of what you were thinking. But you'll get no credit at all, regardless of the answer you give, if we can't follow your reasoning.

If you are unclear about what a question is asking, ask me! If there is something I can't tell you, I won't tell you, but it doesn't hurt to ask!

\_\_\_\_\_  
Name (printed)

\_\_\_\_\_  
Section #

At the end of the exam, rewrite and sign the pledge: I pledge on my honor that I have not given or received any unauthorized assistance on this examination.

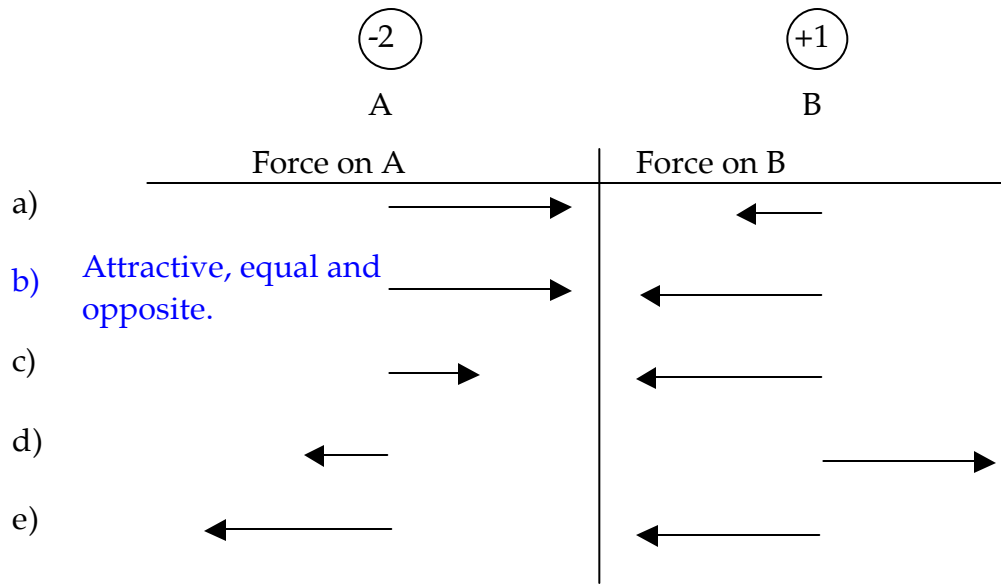
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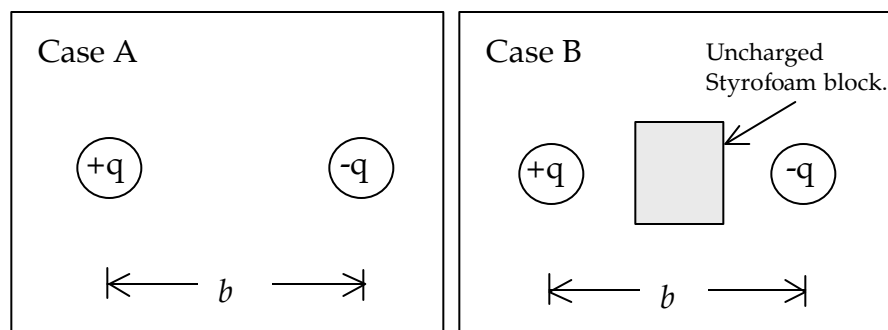
**Multiple choice questions.**

Just the answer counts for these. (8 points each)

1) The picture below shows a particle (labeled B) which has a net electric charge of +1 unit. Several centimeters to the left is another particle (labeled A) which has a net charge of -2 units. Choose the pair of force vectors (the arrows) that correctly compare the electric force on A with the electric force on B.



2) Regarding Cases A and B, which of these statements is true regarding the force on the +q charge?



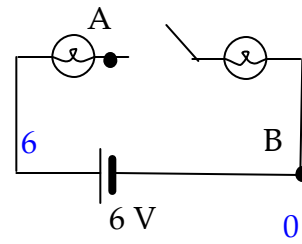
- a) The force on the +q charge is slightly smaller in case B.
- b) The force on the +q charge is much smaller in case B.
- c) The force on the +q charge is slightly larger in case B.
- d) The force on the +q charge is much larger in case B.
- e) The force on the +q charge is zero in case B.

Styrofoam has dipoles which polarize, but attractive force is weaker than for conductors or something with excess charge.

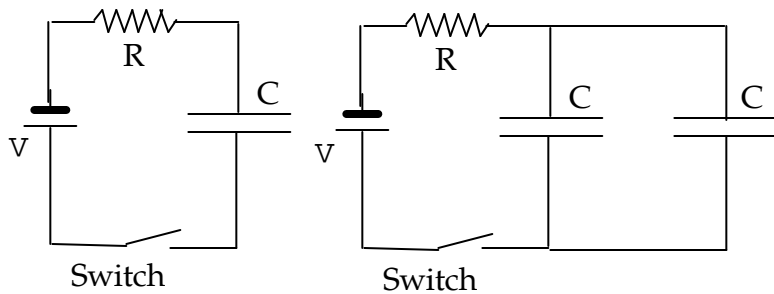
3) What is the potential difference between points A and B? The bulbs are identical.

- a) 0 V
- b) 3 V
- c) 6 V
- d) 12 V
- e) None of the above.

Call the voltage at B "0." This means the other side of the battery must be at 6 V. We know there is no current flowing in the circuit, so there must not be a voltage difference across either bulb. Thus, point A must be a 6 V, too.



4) Compare what happens when you throw the switch in the second circuit, with two capacitors in parallel, to what happens in the first circuit. The capacitors are all uncharged at first. Suppose the current through the resistor in the first circuit, when you first close the switch, is  $I_0$ , and it takes  $t$  seconds to fully charge the capacitor. When you first close the switch for the second circuit, you'd expect the current through its resistor would be



Two capacitors like this in parallel are kind of like one bigger capacitor (twice the area on both sides so twice the capacitance.) Thus, the time constant is twice as large. But the initial current is the same since the pressure forcing the current through the resistor, all from the battery, is the same.

- a)  $I_0/2$ , and it would take about  $2t$  seconds to fully charge the capacitors.
- b)  $I_0$  and it would take about  $2t$  seconds to fully charge the capacitors.
- c)  $I_0$  and it would take about  $t$  seconds to fully charge the capacitors.
- d)  $2I_0$  and it would take about  $2t$  seconds to fully charge the capacitors.
- e)  $2I_0$  and it would take about  $t$  seconds to fully charge the capacitors.

5) Suppose you looking at a tree with a pinhole camera. If you make the pinhole aperture larger, the image of the tree on the screen will get:

- a) blurrier
- b) brighter
- c) bigger
- d) all of the above
- e) brighter and bigger, but not blurrier
- f) blurrier and brighter, but not bigger

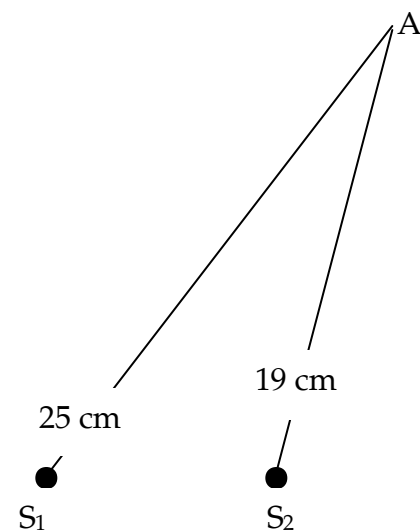
Only slightly bigger.

6) A converging lens is made with a material with an index of refraction that is 1.7 for violet and 1.5 for red. This implies that:

- a) The focal length is longer for red light than for violet.
- b) The focal length is shorter for red light than for violet.
- c) The lens cannot make a sharp image of an object that is reflecting (or producing) both red and violet light.
- d) The red light will be going slower than the violet light when it hits the screen.
- e) a and c
- f) b and c
- g) c and d

7) Two sources of waves (of wavelength 2 cm) are at points  $S_1$  and  $S_2$ . The sources are in phase (synchronized.) Point A is 25 cm from  $S_1$  and 19 cm from  $S_2$ . At point A, there is

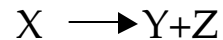
- a) constructive interference always
- b) destructive interference always
- c) constructive interference at this instant, then destructive a half cycle later, alternating back and forth
- d) we can't tell unless we know the distance  $d$  between the two sources and the angle  $\theta$  to point A.



8) If you can get them very cold, you can pour neutrons into a special bottle. There they will decay with their normal half-life of about 10 minutes and the electrons and protons that are produced will be absorbed into the bottle walls. If, after  $1\frac{1}{2}$  hours, you have 50 neutrons left, how many were initially poured into the bottle?

- a) about  $2 \times 10^{15}$
  - b) 51200
  - c) 25600
  - d) 900
  - e) 512
  - f) 450
- 1.5 hours = 9 half-lives.
- $50 = 25600 * (1/2)^9$

9) A type of radioactive decay we didn't learn about is called nuclear fission. Fission happens when a neutron is absorbed by a heavy atom (W), which becomes an even heavier atom (X), which then breaks into two other atoms. We can write this last step as:



Which of the following must be true?

I)  $m_X = m_Y + m_Z$ . (The mass of the X atom is equal to the sum of the masses of the Y and Z atoms.)

II)  $Q_X = Q_Y + Q_Z$ . (The sum of the charges on the Y and Z atoms must be equal to the charge on the X atom.)

III) If the X atom was standing still right before it decayed, Y and Z must come out moving, and move in opposite directions from each other.

a) I and II

b) II and III

c) I and III

d) I, II, and III

e) only one of I, II, or III

Mass is not conserved in a decay like this. If the mass was the same on both sides, there would be no reason for the Z atom to decay, since there's no lighter state to go into. (sortof... It's actually a little trickier than this....)

**Short answer questions, with explanations. For these, you do need to explain.**

10) (12 pts.) Explain why the pie plates on the Van de Graaf generator flew off at little while after we turned on the generator. Why did they fly off at all, why did it take a while before the first one flew off, why do they fly off one by one, and why is there a short delay between the first and second and so on?

11) (20 pts.) In class we used several analogies for electricity (electric circuits).

a) Why did we use these analogies?

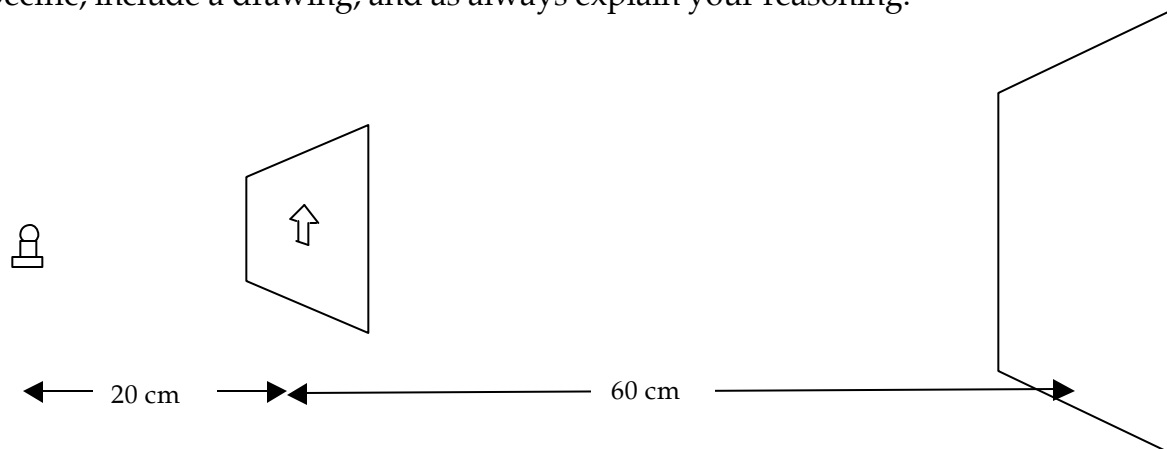
b) Give an example of something we saw in electricity that was unexpected and explain how using an analogy you could predict what you saw. Make sure you explain the relevant part of the analogy you are using.

c) Our model for electricity was much more precise than the analogies. It included precise definitions and concepts as well as mathematical formulas and rules (such as Kirchoff's.) Give an example of one such piece of the model (a foothold idea like a formula, concept, definition, or rule) and how it can be explained by the analogy you described above.

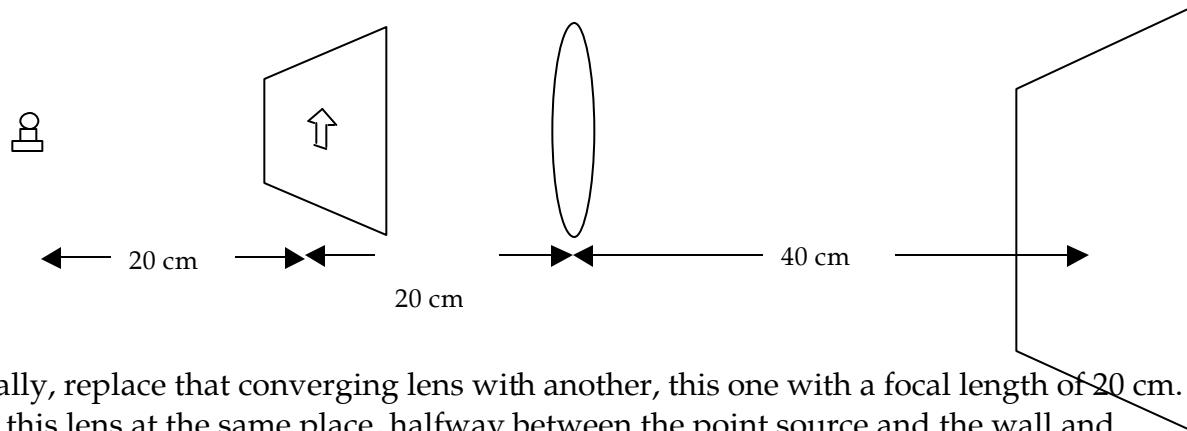
12) (8 pts.) Suppose you brought your camera to class and wanted to take a picture of the clicker results projected onto the screen above the blackboards. To get the best picture, would you use a flash? Why or why not?

13) (20 pts.) Light from a point source (tiny bright bulb) shines on a piece of cardboard with an arrow-shaped hole about 1 cm tall. The source is about 20 cm from the cardboard, and it's another 60 cm to the wall, which you're using as a screen.

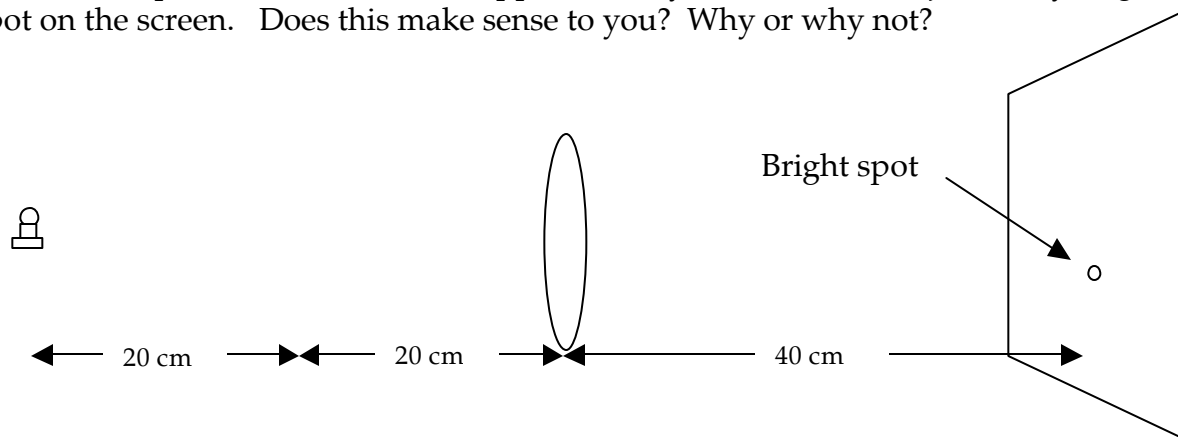
a) What would you see on the wall, from the light that passes through the hole? Try to be specific, include a drawing, and as always explain your reasoning.



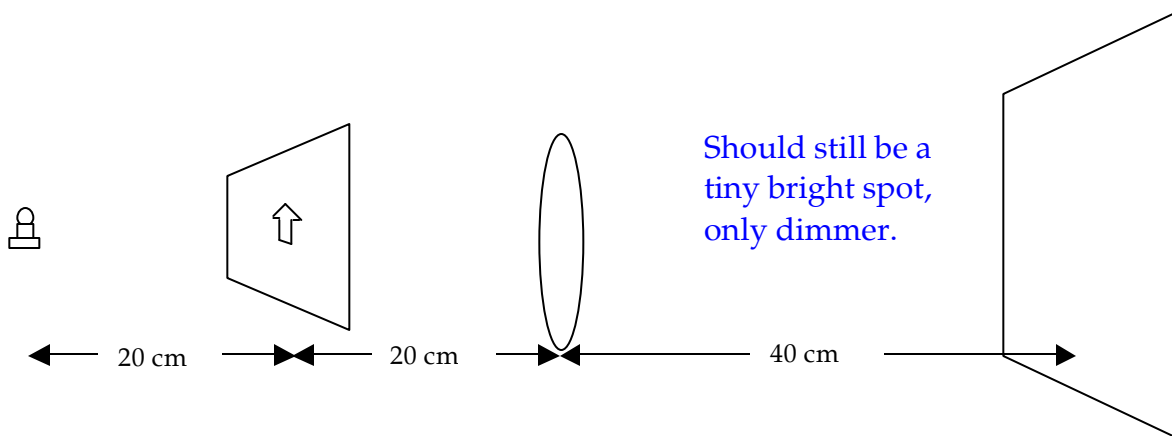
- b) Now put in a converging lens with a focal length of 40 cm, and place it as I've shown, so it's 40 cm from the point source, 20 cm from the cardboard and then 40 cm to the wall. What would you see on the wall now? Again, be specific and explain.



- c) Finally, replace that converging lens with another, this one with a focal length of 20 cm. Put this lens at the same place, halfway between the point source and the wall and remove the aperture board. Now suppose what you saw now was just a tiny bright spot on the screen. Does this make sense to you? Why or why not?



- d) Now suppose I add the aperture board back in. How does this change what you see?



- 14) (10 pts.) In your lab you pointed a laser at two tiny slits and saw many spots which you explained in tutorial was interference. If you move the slits closer to the screen, (or move the screen closer to the slits), do the spots get farther apart from each other? Explain why or why not?