Phys 0175 **Practice Midterm Exam I** Jan 28, 2009

Note: THIS IS A REPRESENTATION OF THE ACTUAL TEST. *It is a sample and does not include questions on* every topic covered since the start of the semester.

Also be sure to review

Homework assignments on WebAssign

White board problems worked in the class

Exercises, Examples, and Review Questions (at the end of each chapter) in your textbook

On the actual test, do not use other paper. If you need more space, write on the blank page included at the beginning of the test, and indicate that you did this.

- **Read all problems carefully before attempting to solve them.**
- **Your work must be legible, and the organization must be clear.**
- **You must show all your work, including correct vector notation.**
- **Correct answers without adequate explanation will be counted wrong.**
- **Incorrect work or explanations mixed in with correct work will be counted wrong.** *Cross out anything you don't want us to read!*
- **Make explanations complete but brief. Do not write a lot of prose.**
- **Include diagrams!**
- **Show what goes into a calculation, not just the final number:**

$$\frac{a \cdot b}{c \cdot d} = \frac{(8 \times 10^{-3})(5 \times 10^{6})}{(2 \times 10^{-5}))(4 \times 10^{4})} = 5 \times 10^{4}$$

- **Give standard SI units with your results.**

Unless specifically asked to derive a result, you may start from the formulas given on the formula sheet, including equations corresponding to the fundamental concepts. If a formula you need is not given, you must derive it.

If you cannot do some portion of a problem, invent a symbol for the quantity you can't calculate(explain that you are doing this), and use it to do the rest of the problem.

NAME: ____

INSTRUCTIONS: Please print your name above in the space provided.

The exam consists of N questions worth differing number of points. WRITE NEATLY. Clearly mark your answers with a bounding box at the bottom of your work area. It is important to show your work to get credit. You may use calculators.

Question Number	Possible Points	Score
1	?	
2	?	
⋮	⋮	
N	?	
Total	100	

1. (a) A particle with a charge +3 nC is located at $\langle 2, 2, 4\rangle$ m. Calculate the electric field due to this charge at location $\langle -1, -1, -1\rangle$ m. Show your work.

(b) A charge -2 nC is now placed at $\langle -1, -1, -1\rangle$ m. What is the vector force experienced by this charge due to the electric field?

2. Two equal charges $+6\ \mu$C are placed, one at $\langle -1, 0, 0 \rangle$ m and the other at $\langle 5, 0, 0 \rangle$ m. What is the electric field vector at location A, which is at $\langle 0, 0, 0 \rangle$ m? Show your work.

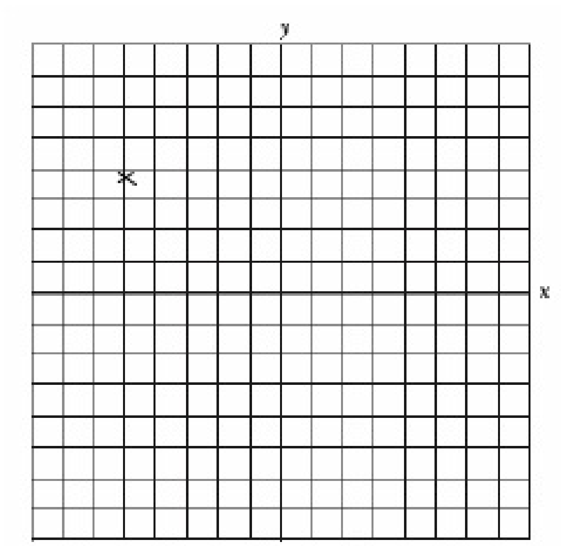
3. A charge +2 nC placed at the location marked x experiences a force $F = \langle 3\text{e}-3, -5\text{e}-3, 0\rangle$ N.

   (a) Calculate the electric field vector at this location. Show your work.

   On the grid to the below, represent

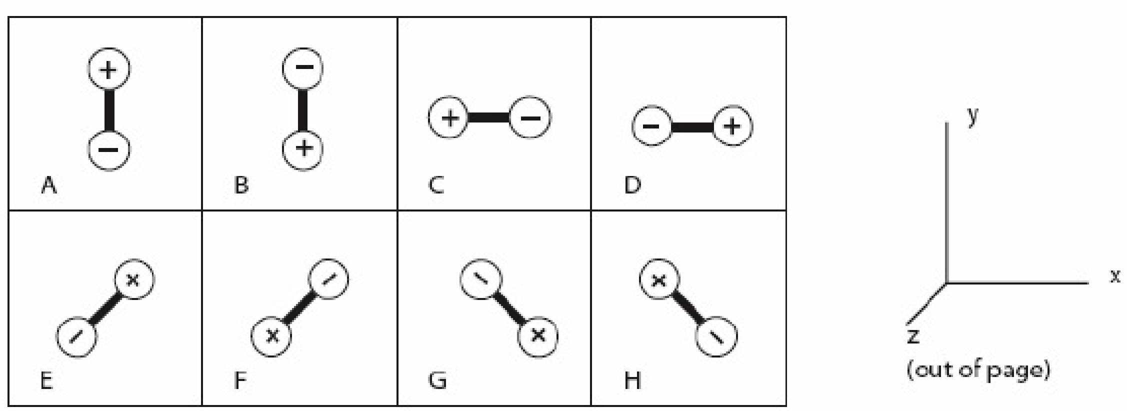
   (b) the force vector and label it $\vec{F}$

   (c) the electric field vector and label it $\vec{E}$



4. A dipole is centered at the origin. It exerts a force $\langle 0, 4e-6, 0\rangle$ N on a small sphere of charge + 8 nC located at $\langle 0.09, 0, 0\rangle$ m.

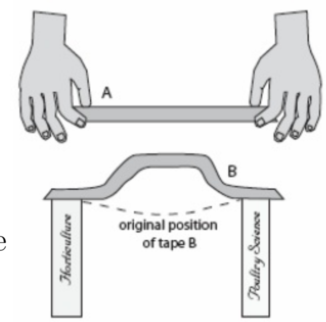
(a) Which diagram below correctly shows the orientation of the dipole?
(enter the leter)____



(b) The distance between the positive and negative charges making up the dipole is 0.2 mm (2e-4 m). What is the charged of the positive end of the dipole? Clearly show all steps in your work. Remember that this includes showing the algebraic formula(s) you use, and also showing what numbers you used (see front page of test for an example).

5. You have two strips of invisible tape, each about 15 cm long, with a mass of about 0.20 g. You smooth them down onto a table, one on top of the other, as you did in class. You label the top tape "A" and the lower tape "B". The "sandwich" of two tapes is pulled slowly off the table. You rub your hand along the slick side of the upper tape. and observe that the tapes, still stuck together, do not interact with your hand.

   Now you quickly pull the tapes apart. You observe that both tape "A" and tape "B" are attracted to your hand, and the tapes are attracted to each other. Tape "B" is repelled by a negatively charged plastic pen.

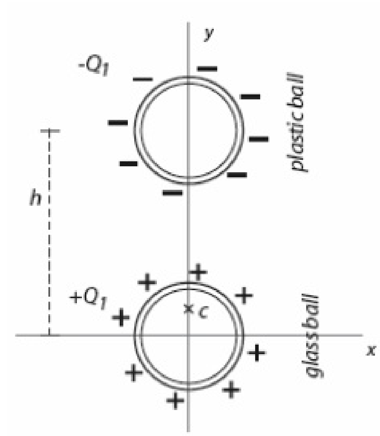
   

   You attach the ends of tape "B" to the tops of two books, so it hangs loosely, in the position shown by the dotted line. You hold tape "A" above it, and slowly bring it down above tape "B". When tape "A" is 2.3 cm above tape "B", you see the middle of tape "B" begin to buckle upwards, as shown in the diagram.

   (a) Calculate approximately the amount of charge on tape "B", both magnitude and sign. Clearly show all steps in your work.

   (b) What approximation(s) or assumptions did you make in this calculation? Explain briefly.

6. A hollow ball of radius R, made of very thin glass, is rubbed all over with silk, and gains a positive charge $+Q_1$, distributed uniformly over its surface. A second hollow ball of radius R, made of very thin plastic, is rubbed all over with wool, and gains a negative charge $-Q_1$, distributed uniformly over its surface. A cross-sectional view of the balls is shown in the diagram. The glass ball is centered at the origin. The center of the plastic ball is at location $\langle 0, h, 0 \rangle$. Location C is inside the glass ball, on the +y axis, at location $\langle 0, c, 0 \rangle$.



Answer T(rue) or F(alse):

____ The net electric field at C is zero, because the electric field inside a uniformly charged spherical shell is always zero.

____ The net electric field at C points in the -y direction, because the positive charges on the class ball are closer to location C then the negative charges on the plastic ball are.

____ The negative charges on the plastic ball do not contribute to the net electric field at location C, because the plastic ball is outside of the glass ball.

____ The contribution of the positive charges on the glass ball to the net electric field at location C is zero, because the field due to the nearby positive charges is canceled out by the field due to the positive charges farther away.

____ The contribution of the negative charges on the plastic ball to the net electric field at location C is zero, because the plastic ball is uniformly charged.

____ It is impossible to determine the direction of the net electric field at location C without knowing the magnitudes of Q_1, h, and c.

Fundamental Concepts

Equations you must know:

(1) Electric field of a point charge (2) Relationship between electric field and electric force

Other fundamental concepts: the Superposition Principle Conservation of charge

Specific Results

Electrif field due to a uniformly charged spherical shell: outside shell, like point charge; inside shell, 0

$$\left|\vec{E}_{\text{dipole}}\right| \approx \frac{1}{4\pi\epsilon_0}\frac{2qs}{r^3} \text{ along dipole axis, where } r \gg s$$
$$\left|\vec{E}_{\text{dipole}}\right| \approx \frac{1}{4\pi\epsilon_0}\frac{qs}{r^3} \text{ along perpendicular axis, where } r \gg s$$

electric dipole moment $p = qs$

Physical Constants

$$\frac{1}{4\pi\epsilon_0} = 9 \times 10^9 \frac{\text{N} \cdot \text{m}^2}{\text{C}^2} \qquad \epsilon_0 = 9 \times 10^{-12} \frac{\text{C}^2}{\text{N} \cdot \text{m}^2} \qquad e = 1.6 \times 10^{-19} \text{ C}$$

c = 3×10^8 m/s $m_{\text{proton}} \approx m_{\text{neutron}} \approx m_{\text{hydrogen atom}} = 1.7\times10^{-27}$ kg $m_{\text{electron}} = 9\times10^{-31}$ kg

$g = 9.8$ N/kg 6.02×10^{23} molecules/mole atomic radius $\approx 10^{-10}$ m proton radius $\approx 10^{-15}$ m

Geometry

area of circle = πr^2 circumference of a circle = $2\pi r$

area of curved surface of cylinder = $2\pi r L$ surface area of sphere = $4\pi r^2$

volume of sphere = $\frac{4}{3}\pi r^3$