PHYS 212E **Name _____**
First Hour Exam **February 19, 2004**

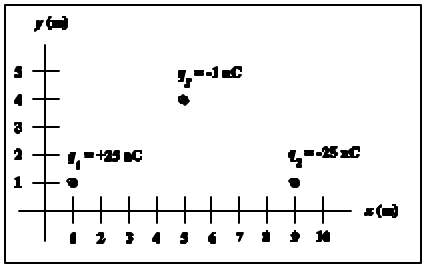
Show all work for full credit! Answers must have correct units and appropriate number of significant digits. For all the problems (except for multiple choice questions), start with either (a) a generally applicable equation or statement; (b) a sentence explaining your approach; or (c) a sketch.

$k = \frac{1}{4\pi\varepsilon_0} = 9.0\times10^{9}\ \mathrm{N\cdot m^2/C^2}$ $\quad \frac{\mu_0}{4\pi} = 10^{-7}\ \mathrm{T\cdot m^2/A = 10^{-7}\ N/A^2}$ $\quad 1\ \mathrm{eV} = 1.6\times10^{-19}\ \mathrm{J}$

$m_{\mathrm{electron}} = 9.11\times10^{-31}\ \mathrm{kg} = 511\ \mathrm{keV/c^2}$ $\quad m_{\mathrm{protom}} = 1.67\times10^{-27}\ \mathrm{kg} = 938\ \mathrm{MeV/c^2}$

$e = 1.6\times10^{-19}\ \mathrm{C}$ $\quad c = 3.0\times10^{8}\ \mathrm{m/s}$ $\quad G = 6.67\times10^{-11}\ \mathrm{N\cdot m^2/kg^2}$ $\quad g = 9.8\ \mathrm{m/s^2}$

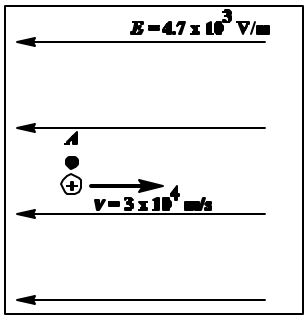
1. (12 points) Consider charges q_1 = +25 nC located at (1, 1); q_2 = –25 nC located at (9, 1); and q_3 = –1 nC located at (5, 4) as shown in the figure (all positions in meters).



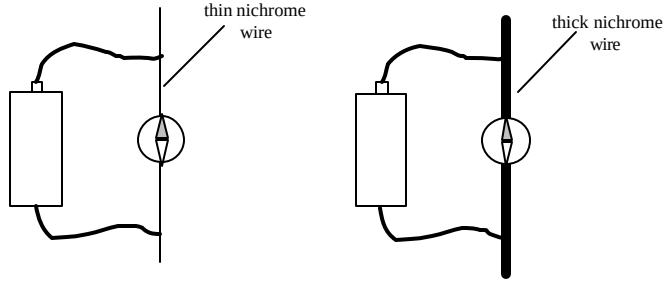
a) On the figure, draw the net electric force acting on q_3.

b) Find the magnitude of the net force acting on q_3.

2. (12 points) A proton passes point *A*, traveling with speed 3 x 10^4 m/s to the right. A uniform electric field of magnitude 4.7 x 10^3 V/m points to the left. How far does the proton travel past the point *A* before it comes to (momentary) rest?



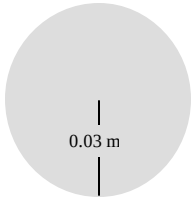
3. (5 points) Using items from your kit, you set up a circuit, shown below on the left. You place your compass above the length of thin nichrome wire, and momentarily complete the circuit. You repeat this experiment, but this time with the thick nichrome wire (using the same length of nichrome wire as the previous experiment).



In both cases, you observe the deflection of the compass needle. Assume the battery is source of constant potential difference. In which case is the deflection of the compass needle larger? (Circle one.)

thin wire	thick wire	no deflection	same deflection	can't be determined

4. (12 points) A solid conducting sphere with radius 0.03 m has a net charge of +2 μC. Assume the sphere has reached static equilibrium.



a) Determine the magnitude of the electric field at the center of the sphere.

b) Determine the electric potential at the center of the sphere. (Take the electric potential at infinity to be zero.)

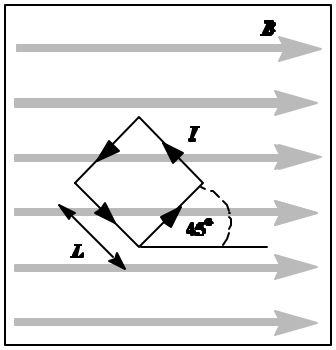
5. (12 points) A particle with charge –2 C moves with velocity $\vec{v} = (2\hat{i} + 1\hat{j})$ m/s in a uniform magnetic field $\vec{B} = (-3\hat{i} + 3\hat{j})$ T.

a) Determine the magnetic force acting on the charged particle.

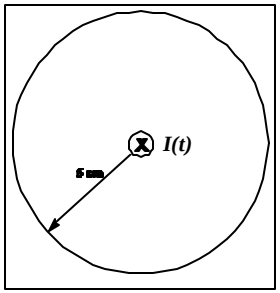
b) Which of the following best describes the motion of the charged particle? (Circle one.)

straight line circle helix can't be determined

6. (12 points) At the instant pictured, a square loop of current lies in the plane of the page, tilted at an angle of 45° as shown in the figure. The square has sides of length L = 2 cm, and carries current I = 5 A. A uniform magnetic field B = 0.03 T points to the right. Determine the torque on the loop about its center.



7. (10 points) A long straight wire is perpendicular to the plane of the page, and carries current going into the page. A circular round loop lies in the plane of the page, with the long straight wire going through its center as shown in the figure. The circular loop has 5 turns, a radius of 5 cm and a resistance of 0.24 Ω. The current in the long straight wire is **increasing** as a function of time: $I(t) = 5 + 2t^{1/2}$, where I is in Amperes when t is in seconds. Determine the magnitude of the induced current in the circular loop



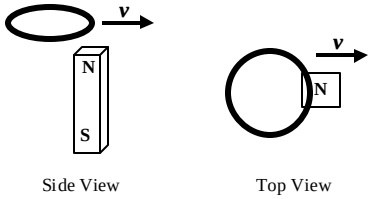
8. (6 points) A loop of wire is moved at constant speed past a bar magnet (the bar magnet is held fixed.) The figure below show a side view and a top view of the loop moving past the magnet . Consider the instant pictured. In this situation, what is the direction of the induced current in the wire loop, **from the top view perspective**? (Circle one.)

clockwise

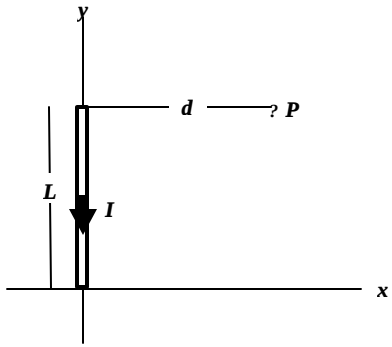
counterclockwise

no induced current

can't be determined



9. (19 points) A piece of a wire, length L, lies along the y-axis and carries current I in the negative $\hat{j}$ direction as shown in the figure. A field point P is a distance d away from the end of the piece of current.



a) Set up the integral that will allow you to calculate the magnetic field $\vec{B}$ at the field point P due to the section of wire pictured. Your integral should contain only physical constants, given quantities, and the integration variable.

b) Evaluate your integral from the previous part to determine the magnetic field $\vec{B}$ at the field point P due to the section of wire pictured. Show work for full credit.