# Final Exam (2014 Fall)

## PHYS 205B: University Physics

Date: 2014 Dec 11

(Name) (Signature)

## Instructions

1. Total time = 105 minutes.
2. There are 10 questions in this exam.
3. Equation sheet is provided separately.
4. To obtain partial credit for your work you need to show your work in detail and organize it clearly.

1. (**10 points.**) See Figure 1. Particle 1 of charge $q_1 = -4.00q$ and particle 2 of charge $q_2 = +8.00q$ are fixed to an $x$ axis. As a multiple of distance $L$, at what coordinate on the axis is the net electric field of the particles zero?

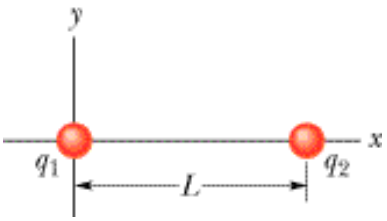


Figure 1: Problem 1.

2. (**10 points.**) Three positive charges of magnitude $Q$ are placed at the corners of an equilateral triangle of length $L$. Determine the magnitude and direction of the force on one of the positive charges due to the other two charges.

3. (**10 points.**) What is the magnitude of the flux of the electric field,

$$\vec{\mathbf{E}} = \left[137\,\hat{\mathbf{i}} + 207\,\hat{\mathbf{j}} + 10\,\hat{\mathbf{k}}\right] \frac{\mathrm{N}}{\mathrm{C}}, \tag{1}$$

through a $2.0\,\mathrm{m}^2$ portion of the $x$-$y$ plane?

4. (**10 points.**) A potential difference $V = 10\,\mathrm{V}$ is applied across a capacitor arrangement with two capacitances connected in parallel, $C_1 = 10.0\,\mu\mathrm{F}$ and $C_2 = 20.0\,\mu\mathrm{F}$.

   (a) Find the equivalent capacitance.

   (b) Find the charges $Q_1$ and $Q_2$ on each of the capacitors.

   (c) Find the voltages $V_1$ and $V_2$ across each of the capacitors.

   (d) Find the potential energies $U_1$ and $U_2$ stored inside each of the capacitors.

5. (**10 points.**) Figure 2 shows three resistors connected in parallel to a battery. The battery has a voltage of $V = 30.0\,\text{V}$, and the resistors have equal resistances of $R = 300.0\,\Omega$.

   (a) Determine the equivalent resistance across the battery.

   (b) Determine the voltage across each of the resistor.

   (c) Determine the current passing through each resistor.

   (d) Determine the power consumed by each resistor.

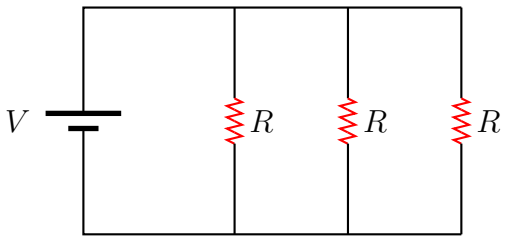


Figure 2: Problem 5

6. (**10 points.**) A proton moves through a uniform magnetic field given by

$$\vec{\mathbf{B}} = (0\,\hat{\mathbf{i}} + 0\,\hat{\mathbf{j}} + 10.0\,\hat{\mathbf{k}})\,\mathrm{mT}. \tag{2}$$

At time $t_1$, the proton has a velocity given by

$$\vec{\mathbf{v}} = v_x\,\hat{\mathbf{i}} + v_y\,\hat{\mathbf{j}} + (2000\,\mathrm{m/s})\,\hat{\mathbf{k}} \tag{3}$$

and the magnetic force on the proton is

$$\vec{\mathbf{F}} = \left[(4.24 \times 10^{-17})\,\hat{\mathbf{i}} + (1.60 \times 10^{-17})\,\hat{\mathbf{j}}\right]\,\mathrm{N}. \tag{4}$$

At that instant, what is $v_y$?

7. (**10 points.**) A steady current $I$ flows through a wire shown in Fig. 3. Find the magnitude and direction of magnetic field at point $P$.

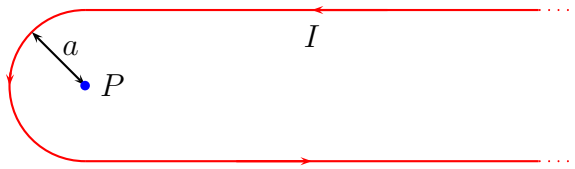


Figure 3: Problem 7.

Hint: The magnitude of the magnetic field due to a wire of infinite length at distance $\rho$, and a circular loop of wire of radius $R$ at the center of loop, is

$$B_{\infty\text{-wire}} = \frac{\mu_0 I}{2\pi\rho} \qquad B_{\text{loop}} = \frac{\mu_0 I}{2R}, \tag{5}$$

respectively.

8. (**10 points.**) Figure 4 shows a conducting rod being pulled along horizontal, frictionless, conducting rails at a constant speed $v$. A uniform magnetic field $\mathbf{B}$ fills the region in which the rod moves. Assume $L = 10\,\text{cm}$, $v = 5.0\,\text{m/s}$, $B = 1.2\,\text{T}$, and $R = 0.40\,\Omega$.

   (a) Is the magnetic flux in the loop increasing or decreasing?

   (b) What is the direction of the induced current in the loop?

   (c) Determine the magnitude of the induced current in the loop.

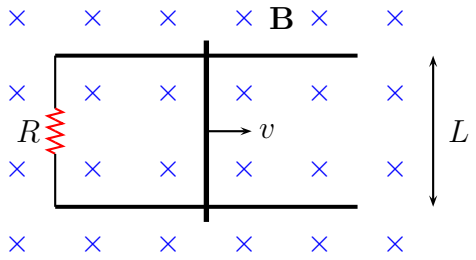


Figure 4: Problem 8

9. (**10 points.**) A series $RL$ circuit with $L = 9.00\,\mathrm{H}$ and a series $RC$ circuit with $C = 4.00\,\mu\mathrm{F}$ have equal time constants. The two circuits contain the same resistance $R$.

   (a) What is the value of $R$?

   (b) What is the time constant?

10. (**10 points.**) An upright object is located between a concave mirror and its focal point. The image is: (Pick the correct answer.)

    (a) real, upright, and larger than the object.

    (b) real, upright, and smaller than the object.

    (c) real, inverted, and larger than the object.

    (d) real, inverted, and smaller than the object.

    (e) virtual, upright, and larger than the object.

    (f) virtual, upright, and smaller than the object.

    (g) virtual, inverted, and larger than the object.

    (h) virtual, inverted, and smaller than the object.