# Final Exam (2015 Spring)

## PHYS 205B: University Physics

Date: 2015 May 12

(Name) (Signature)

## Instructions

1. Total time = 120 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?

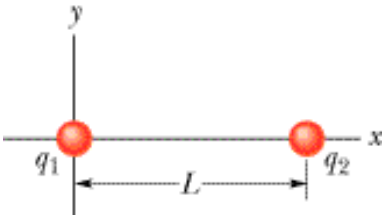


Figure 1: Problem 1.

2. (**10 points.**) A 53.4 pC point charge is placed at the origin. What is the electric flux through a sphere of radius $R = 5\,\text{cm}$ centered at the origin?
   Hint: Use Gauss's law.

3. (**10 points.**) Charges of $-q$ and $+2q$ are fixed in place, with a distance of $a = 2.0\,\mathrm{m}$ between them. See Fig. 2. A dashed line is drawn through the negative charge, perpendicular to the line between the charges. On the dashed line, at a distance $y$ from the negative charge, there is at least one spot where the total potential is zero. Find $y$.

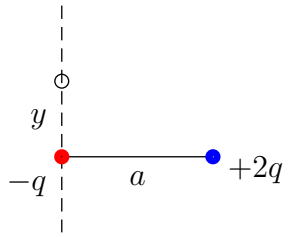


Figure 2: Problem 3

4. (**10 points.**) A potential difference $V = 10\,\mathrm{V}$ is applied across a resistor arrangement with two resistances connected in series, $R_1 = 10.0\,\Omega$ and $R_2 = 20.0\,\Omega$.

   (a) Find the equivalent resistance.

   (b) Find the currents $I_1$ and $I_2$ through each of the resistors.

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

   (d) Determine the power consumed by each resistor.

5. (**10 points.**) An electron that has velocity $\vec{\mathbf{v}} = (2.1 \times 10^6\,\mathrm{m/s})\,\hat{\mathbf{i}} + (2.7 \times 10^6\,\mathrm{m/s})\,\hat{\mathbf{j}}$ moves through a magnetic field $\vec{\mathbf{B}} = (0.03\,\mathrm{T})\,\hat{\mathbf{i}} - (0.15\,\mathrm{T})\,\hat{\mathbf{j}}$. Find the force on the electron.

6. (**10 points.**) A steady current $I$ flows through a wire shown in Fig. 6. Find the magnitude and direction of magnetic field at point $P$.

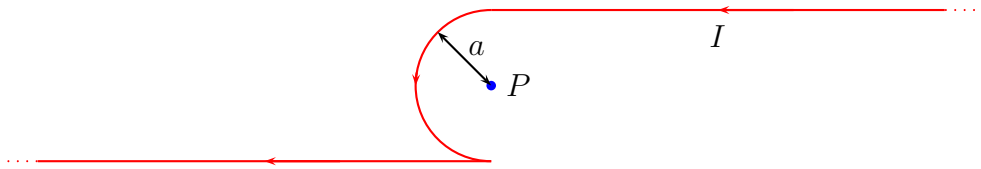


Figure 3: Problem 6

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

$$B_{\infty\text{-wire}} = \frac{\mu_0 I}{2\pi\rho} \qquad B_{\text{loop}} = \frac{\mu_0 I}{2R}, \tag{1}$$

respectively.

7. (**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 $L = 5\,\text{cm}$, $v = 2.0\,\text{m/s}$, $B = 0.8\,\text{T}$, and $R = 0.60\,\Omega$.

   (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.

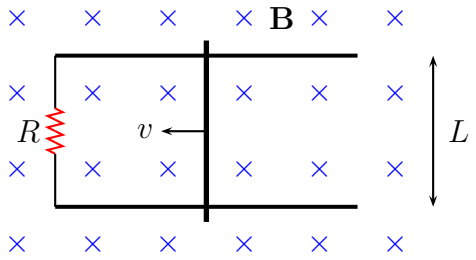


Figure 4: Problem 7

8. (**10 points.**) The index of refraction of benzene is 1.80. Determine the critical angle for total internal reflection, at a benzene-air interface.

9. (**20 points.**) A 2.0 cm object is placed upright at a distance 12.0 cm away from a concave mirror. The mirror's radius of curvature is 10.0 cm.

   (a) Calculate the image distance.

   (b) What is the magnification?

   (c) Is the image real or virtual?

   (d) Is the image inverted or upright?

   (e) Confirm your above results by drawing a ray diagram for the above case. Points will be awarded for precision.

10. (**10 points.**) An upright object is located between a concave lens and its focal point. Its 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.