

General for Biological Sciences Majors II (171.104)

Midterm Exam #2, March 10, 8:00am-8:50am

- Exams are closed book but each student will be allowed to use a single sheet (8.5 x 11 inches, double-sided) of notes. The page (with your name) must be turned in with your blue book.
 - Calculators are allowed. Do not bring laptops, PDAs, cell phones, etc.
 - Please write all exams in ink. Exams written in pencil cannot be re-graded.
 - All work must be done in the blue book.
 - All students must bring their J-card IDs to the exam.
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Problem 1. (30pts)

Two small metal spheres with masses 2.0g and 4.0g are tied together by a 4.8cm -long massless string and are at rest on a frictionless surface. Each is charged to $+1.8\mu\text{C}$.

- (a) What is the energy of this system?
- (b) What is the tension in the string?
- (c) The string is cut. What is the speed of each sphere when they are far apart?

Problem 2. (45pts)

A spherical conductor of radius 9 mm and a second hollow, concentric, spherical conductor with inner radius of 10 mm each have a surface charge. The magnitude of the surface charge density on the inner surface of the outer sphere is $9\mu\text{C}/\text{mm}^2$

- (a) How much work was needed to separate the charge from the two initially uncharged spheres, assuming that contributions from the outermost surface are negligible?
- (b) What is the voltage difference between the two spheres?
- (c) What is the capacitance of the system?

Problem 3. (25pts)

When a voltage difference is applied to a piece of copper wire, a 6.7 mA current flows.

- (a) If the copper wire is replaced with a silver wire with twice the diameter of the copper wire, how much current will flow through the silver wire? The lengths of both wires are the same, and the voltage difference remains unchanged.
- (b) What is the current if the silver wire has the same diameter as the copper wire?

The resistivity of copper is $1.68 \times 10^{-8} \Omega \cdot \text{m}$, and the resistivity of silver is $1.59 \times 10^{-8} \Omega \cdot \text{m}$.