Midterm Exam No. 01 (2022 Fall)

PHYS 205B: UNIVERSITY PHYSICS

School of Physics and Applied Physics, Southern Illinois University–Carbondale
Date: 2022 Sep 15

_____   _____
(Name)   (Signature)

Instructions

1. Seating direction: Please be seated on seats with seat-numbers divisible by 2.

2. Total time = 75 minutes.

3. There are 4 conceptual questions and 4 problems in this exam.

4. Equation sheet is provided separately.

5. To be considered for partial credit you need to show your work in detail and organize it clearly.

6. A simple calculator (with trigonometric functions) is allowed.

7. Use of mobile phones is strictly prohibited. It should stay out of reach during the exam.

1. (**5 points.**) Four identical conducting spheres A, B, C, and D carry positive charges $Q_A = +1.0\,\mu\text{C}$, $Q_B = +2.0\,\mu\text{C}$, $Q_C = +3.0\,\mu\text{C}$, $Q_D = +4.0\,\mu\text{C}$. See Figure 1. In Move 1 they are separated by a distance much larger than their diameters and placed along a line. In Move 2 they are brought closer such that adjacent spheres touch. In Move 3 they are separated by a distance much larger than their diameters. As a result, what are the charges on A, B, C, and D.

Move 1:　　　Ⓐ　　　Ⓑ　　　Ⓒ　　　Ⓓ

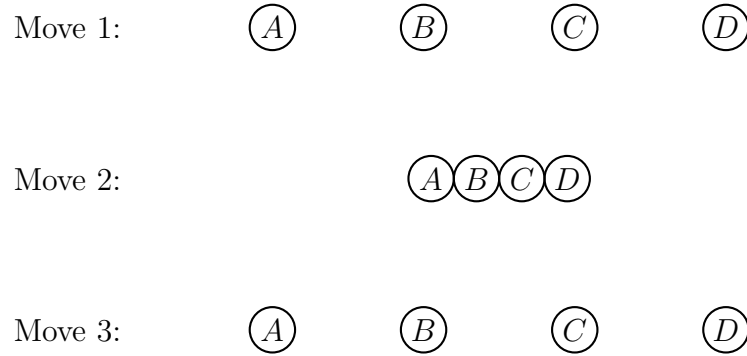Move 2:　　　　　　　　　ⒶⒷⒸⒹ

Move 3:　　　Ⓐ　　　Ⓑ　　　Ⓒ　　　Ⓓ

Figure 1: Problem 1

2. (**5 points.**) A total charge Q is placed on a conductor that has the shape of a torus (doughnut). What is the electric field inside the conducting torus?

3. (**5 points.**) A positive charge $q = +1.0\,\text{nC}$ is positioned on the y axis at $y = +2.0\,\text{cm}$. Determine the magnitude of the electric field due to this charge on the x axis at $x = +2.0\,\text{cm}$.

4. (**5 points.**) A spherical thin conducting shell of radius a has a positive charge $+Q$ on it. Another concentric spherical thin conducting shell of radius $b > a$ has a negative charge $-Q$ on it. The two shells Draw the electric field lines for this configuration. The diagram should illustrate the magnitude and direction of the field everywhere.
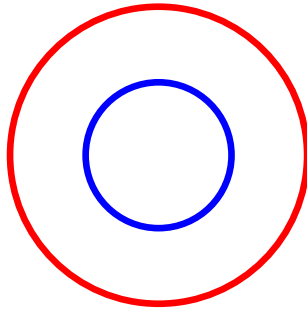

Figure 2: Problem 4

5. (**10 points.**) Four identical charges of equal magnitude q are placed at the corners of a square of side L. Determine the magnitude of the Coulomb force on one of the charges.

6. (**10 points.**) Two charges, $q_1 = +1.00\,\mu$C and $q_2 = -9.00\,\mu$C are $D = 10.0\,$cm apart. Refer Figure 3. Where on the line passing through the two charges is the total electric field zero?
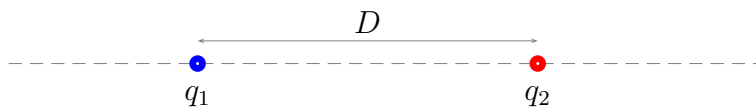

Figure 3: Problem 6

7. (**10 points.**) An electron and a proton are released from rest in a uniform electric field. The particles accelerate at a_e and a_p. Determine the ratio a_e/a_p.

8. (**10 points.**) Consider a thin spherical shell of radius 11.0 cm with a total charge of $25\,\mu$C distributed uniformly on its surface. Find the electric field 10.0 cm from the center of the charge distribution.