

Physics 24 Practice Midterm - 50 minutes

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Write your answers in a blue book. Calculators and one page of notes allowed. No textbooks allowed. Please make your work neat, clear, and easy to follow. It is hard to grade sloppy work accurately. Generally, make a clear diagram, and label quantities. Make it clear what you think is known, and what is unknown and to be solved for. Except for extremely simple problems, derive symbolic answers, and then plug in numbers (if necessary) after a symbolic answer is available. **Put a box around your final answer... otherwise we may be confused about which answer you really mean, and you could lose credit.**

1. Consider the following two electric potentials:

#1 $\phi_1(x, y, z) = x^2 - y^2$

#2 $\phi_2(x, y, z) = x^2 + y^2 - 2z^2$

- (a) For each of these electric potentials, evaluate the:

- i. Electric field, $\vec{E}(x, y, z)$.
- ii. Charge density, $\rho(x, y, z)$.

- (b) If the charge densities are the same, how can the electric potentials not be the same?

2. A flat sheet of charge with charge density (per unit area) σ extends to infinity in all directions. There is a hole of radius a in the sheet, where there is no electric charge. Take the electric potential in the center of the hole to be 0, and find the electric potential a distance $\sqrt{3}a$ above the center of the hole.
3. A capacitor is fabricated from two cylindrical, concentric shells of conductor. Their length is L , the smaller one has radius a and the larger one radius b . The difference $b - a \ll L$, so 'end effects' may be neglected. Find the expression for the capacitance in terms of the given quantities.
4. A capacitor is formed by two square plates of conductor of length 10 cm. The voltage between the two plates is 1000 statvolts. Find the total electrostatic energy of the capacitor if:
- (a) The distance between the plates is $s = 0.1$ cm.
 - (b) The distance between the plates is $s = 0.3$ cm.
 - (c) If the two plates are attached to a power supply that keeps a fixed voltage of 1000 statvolts between them, compute the direction and magnitude of the force between the plates for $s = 0.1$ cm.

Neglect end effects.
