Due by 6:00 pm on Thursday, February 13

Assignments should be dropped into your Section TF's locked mailbox, located on the 2nd floor near room 201, and will be graded by your TF.

**Reading:** Chapter 16 & 17 of Giambattista et al *Physics*, 2nd edition, pp 584-612
For next week: Chapter 17 & 18, pp 612-654

**Problems:** [4 pts each]

1. The Earth has a net charge that produces an electric field of approximately 150 N/C downward at its surface.
   a) What is the magnitude and sign of the excess charge, noting the electric field of a conducting sphere is equivalent to a point charge at its center?
   b) What acceleration will the field produce on a free electron near the Earth’s surface?
   c) What mass object with a single extra electron will have its weight supported by this field?

2. Sketch the electric field lines in the vicinity of two opposite charges, where the negative charge is three times greater in magnitude than the positive.

3. Find the maximum potential difference between two parallel conducting plates separated by 0.50 cm of air, given the maximum sustainable electric field strength of air to be $3 \times 10^6$ V/m.

4. Sketch the equipotential lines in the vicinity of two opposite charges, where the negative charge is three times as great in magnitude as the positive.

5. Consider a hollow metallic conducting sphere and suppose we put some net charge on the inside of it. Being charges of the same polarity, we know that they will all be repelling each other and try to get as much distance from their neighboring charges as possible. What’s going to happen? They’ll end up on the outside surface with no charges left on the inside surface. Use Gauss’s law to prove that the electric field inside the hollow sphere is zero, notwithstanding that there is a net charge on the sphere.

6. A tiny sphere carrying a charge of $-25.0 \, \eta C$ is moved 100 cm in a uniform electric field with no acceleration. It goes from a location at a potential of zero to a point where the potential is 100 V. How much work is done on it by the applied force? What is the significance of the sign of $\Delta W$?

7. It is fairly easy to strip the two electrons off a helium atom, leaving a bare nucleus of two neutrons and two protons. The so-called *alpha particle* is to be accelerated, essentially from rest, up to a KE of 1200 keV by having it “fall” through a potential difference. What is the necessary voltage difference?
8. The fluid within a living cell is rich in potassium chloride, while the fluid outside it predominantly contains sodium chloride. The membrane of a resting cell is far more permeable to ions of potassium than sodium, and so there is a transport outward of positive ions, leaving the cell interior negative. The result is a voltage of about -85 mV across the membrane, called the resting potential. The membrane (about 50 atom-layers) is roughly 8.0 \( \eta \) thick. Assuming the E-field across the cell membrane is constant, determine its magnitude.

Multiple Choice Questions:

Each multiple choice question or incomplete statement has one best answer — determine the best answer and explain your choice by invoking the appropriate concept, principle, and/or mathematical relation. Answers without explanation will not receive full credit, even if correct. [2 pts each]

1. Work is required to push a solitary electron into an electric field where it attains an electric potential of 1 volt. If you instead push 2 electrons through the same path, the electric potential of the two electrons will be

   (a) 1 volt  \quad (b) 2 volts  
   (c) 4 volts  \quad (d) 1/2 volt  
   (e) 1/4 volt

2. Work is required to push a solitary electron into an electric field where it attains an electric potential of 1 volt. If you instead push 2 electrons through the same path, the work required to move the electrons is

   (a) 1 electronvolt  \quad (b) 2 electronvolts  
   (c) 4 electronvolts  \quad (d) 1/2 electronvolt  
   (e) 1/4 electronvolt

3. Suppose we examine a charged metal cup with a device that measures potential with respect to ground. What will happen as the probe from the device that touches the cup changes from contact with the outside to contact with the inside?

   (a) the reading will go up  \quad (b) the reading will go down a little bit  
   (c) the reading will be zero  \quad (d) nothing  
   (e) none of these
4. Which of the following is an accurate statement?

a) All parts of a perfect conductor are at the same potential.
b) If a solid metal sphere carries a net charge, the charge will be uniformly distributed throughout the volume of the sphere.
c) A conductor cannot carry a net charge.
d) In static equilibrium, the electric field at the surface of a conductor is not necessarily perpendicular to the surface, especially when the conductor has an odd shape.