Problem Set 2
Due: see website for due date
Chapter 19: Electric Potential
Questions: A, B, 11, 12
Problems: 2, 6, 10, 14, 19, 27, 38, 60

**Question A:** Charge q is fired through a small hole in the positive plate of a capacitor.
   a. If q is a positive charge, does it speed up or slow down inside the capacitor?
      Answer this question twice: (i) Using the concept of force. (ii) Using the concept of energy.
   b. Repeat part (a) if q is negative charge.

**Question B:** As shown in the figure, two protons are launched with the same speed from point 1 inside a parallel-plate capacitor. One proton moves along the path from 1 to 2, the other from 1 to 3. Points 2 and 3 are the same distance from the positive plate.
   a. Is $\Delta E_{PE12}$, the change in potential energy along the path 1→2, larger than, smaller than, or equal to $\Delta E_{PE13}$? Explain.
   b. Is the proton’s speed $v_2$ at point 2 larger than, smaller than, or equal to the proton’s speed $v_3$ at point 3? Explain.

**Q19.11:** The drawing shows edge-on views of three parallel plate capacitors with the same separation between the plates. The potential of each plate is indicated above it. Rank the capacitors as to the magnitude of the electric field inside them, largest to smallest.
   (a) A, B, C;
   (b) A, C, B;
   (c) C, B, A;
   (d) C, A, B;
   (e) B, C, A

**Q19.20:** The drawing shows a plot of the electric potential V versus the displacement s. The plot consists of four segments. Rank the magnitude of the electric fields for the four segments, largest to smallest.
   (a) D, C, B, A
   (b) A and C (a tie), B and D (a tie)
   (c) A, B, D, C
   (d) B, D, C, A
   (e) D, B, A and C (a tie)

**P21.2:** A particle with a charge of $-1.5 \mu C$ and a mass of $2.5 \times 10^{-6}$ kg is released from rest at point A and accelerates toward point B, arriving there with a speed of 42 m/s. The only force acting on the particle is the electric force. (a) Which point is at the higher potential? Give your reasoning. (b) What is the potential difference $V_B - V_A$ between A and B? **Answer:** B, 1500V
P19.6: Review Multiple-Concept Example 4 to see the concepts that are pertinent here. In a television picture tube, electrons strike the screen after being accelerated from rest through a potential difference of 25,000 V. The speeds of the electrons are quite large, and for accurate calculations of the speeds, the effects of special relativity must be taken into account. Ignoring such effects, find the electron speed just before the electron strikes the screen. Answer: $9.4 \times 10^7$ m/s

P19.10: A moving particle encounters an external electric field that decreases its kinetic energy from 9520 eV to 7060 eV as the particle moves from position A to position B. The electric potential at A is $-55.0$ V, and the electric potential at B is $+27.0$ V. Determine the charge of the particle. Include the algebraic sign ($\pm$) with your answer. Answer: $+4.80 \times 10^{-18}$ C

P19.14: An electron and a proton are initially very far apart (effectively an infinite distance apart). They are then brought together to form a hydrogen atom, in which the electron orbits the proton at an average distance of $5.29 \times 10^{-11}$ m. What is $E_{\text{PE}_{\text{final}}} - E_{\text{PE}_{\text{initial}}}$, which is the change in the electric potential energy? Answer: $-4.35 \times 10^{-18}$ J

P19.19: The drawing shows six point charges arranged in a rectangle. The value of $q$ is $9.0 \mu$C, and the distance $d$ is $0.13$ m. Find the total electric potential at location P, which is at the center of the rectangle. Answer: $+7.8 \times 10^6$ V

P19.27: A charge of $-3.00 \mu$C is fixed in place. From a horizontal distance of 0.0450 m, a particle of mass $7.20 \times 10^{-3}$ kg and charge $-8.00 \mu$C is fired with an initial speed of 65.0 m/s directly toward the fixed charge. How far does the particle travel before its speed is zero? Answer: $0.0342$ m

P19.38: An electron is released from rest at the negative plate of a parallel plate capacitor and accelerates to the positive plate (see the drawing). The plates are separated by a distance of 1.2 cm, and the electric field within the capacitor has a magnitude of $2.1 \times 10^6$ V/m. What is the kinetic energy of the electron just as it reaches the positive plate? Answer: $4.0 \times 10^{-15}$ J

P19.60: The drawing shows a graph of a set of equipotential surfaces seen in cross section. Each is labeled according to its electric potential. A $+2.8 \times 10^{-7}$ C point charge is placed at position A. Find the work that is done on the point charge by the electric force when it is moved (a) from A to B, and (b) from A to C. Answer: $-5.6 \times 10^{-5}$ J, 0J