Physics 222

Quiz 4 – Electric Potential, Form: A

Name: ________________________

Date: ________________________

A solid, neutral conductor (i.e. piece of metal) is inserted between two capacitor plates as shown in Figure 1. The charge on the capacitor plates is $+Q$ and $-Q$, respectively. As a result, the metal becomes polarized such that the surface charge on either side of the metal piece is equal $-Q$ and $+Q$, respectively. The potential difference across the plates before inserting the conductor *was* 9 V.

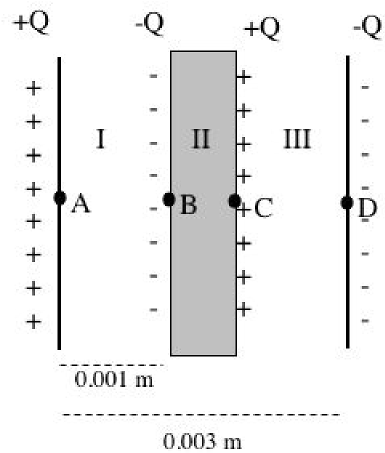

Figure 1:

1. Sketch each vector for the electric field in regions I, II, and III in the picture. If the electric field within any particular region is zero, then just write $E = 0$.

2. What is the potential difference $V_A - V_B$?

3. What is the potential difference $V_B - V_C$?

4. What is the potential difference $V_C - V_D$?

5. What is the total potential difference across the plates $V_A - V_D$?

Questions 6–6: An alpha particle, which is a Helium nucleus of charge +2e, is fired at a Uranium nucleus of charge +92e, starting from a long distance away, and as a result it scatters as shown in Figure 2.

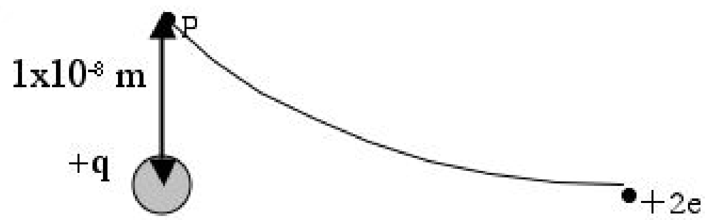

Figure 2:

6. What is the potential difference due to the Uranium nucleus between the locations of the initial and final point of the alpha particle $(V_f - V_1)$?

7. If the alpha particle's speed when it is a large distance (so large, you can treat it as being infinite) from the Uranium nucleus is 1.00×10^5 m/s, what is its speed at point P shown in the figure? The mass of an alpha particle is 6.7×10^{-27} kg.

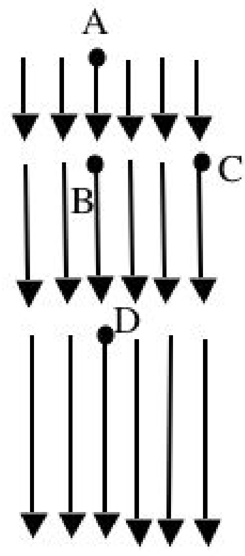

Figure 3:

Questions 8– 10: Electric field lines at various points in space are shown in Figure 3.

8. At which point is the electric potential the greatest?
   (a) A
   (b) B
   (c) C
   (d) D
   (e) B and C
   (f) A, B, and D
   (g) They are all at the same electric potential.
9. If you release a proton at rest at point B, in what direction will it accelerate?
   (a) toward A
   (b) toward C
   (c) toward D
   (d) It will not accelerate at all; but rather it will remain at rest since the net force on the proton is zero at this point.
10. Which of the following potential differences is equal to zero?
   (a) $V_B - V_A$
   (b) $V_C - V_B$
   (c) $V_D - V_B$
   (d) $V_D - V_C$
   (e) all of the above

Questions 11– 14: Suppose that an electron is "shot" between two oppositely charged parallel plates. Its path is shown in Figure 4.

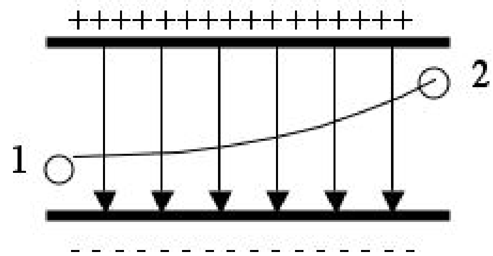

Figure 4:

11. The *change* in electric potential (V) of the electron from point 1 to point 2 ($V_2 - V_1$) is
    (a) negative.
    (b) positive.
    (c) zero.
12. The *change* in electric potential energy (U) of the electron from point 1 to point 2 ($U_2 - U_1$) is
    (a) negative.
    (b) positive.
    (c) zero.
13. The *change* in kinetic energy of the electron from point 1 to point 2 ($K_2 - K_1$) is
    (a) negative.
    (b) positive.
    (c) zero.
14. The potential difference between the plates is 120 V, the distance between the plates is 10 cm, and the distance between points 1 and 2 is 8 cm. What is the potential difference (ΔV) between points 1 and 2?
    (a) zero
    (b) 148 V
    (c) 120 V
    (d) 96 V
    (e) 24 V

Answer Key for Exam A

1. $\vec{E}_I$ is to the right. $\vec{E}_{II}$=0. $\vec{E}_I II$ is to the right.
2. $E_I = 9V/0.003m = 3000N/C$ so $\Delta V_{AB} = E_I \Delta x = 3V$
3. It is zero since E=0 within a conductor.
4. 3 V
5. 6 V
6. $\Delta V = V_f - V_i = 13.2$ volt
7. $\Delta E = \Delta K + \Delta U = 0$

$$\frac{1}{2}mv_1^2 = \frac{k(92e)(2e)}{r_2} + \frac{1}{2}mv_2^2$$

   $v_2 = 9.35 \times 10^4$ m/s

8. (a)
9. (c)
10. (b)
11. (b)
12. (a)
13. (b)
14. (d)