Problem Set 4

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1. Consider a region with a uniform electrostatic field of intensity E. If the electric scalar potential at the point A is zero, the potential at the point B equals

Solution:

$$V_B = -Ed\cos\alpha$$

2. A point charge Q is situated in free space. The line integral of the electric field intensity vector $\vec{E}$ due to this charge along the contour C, composed of two circular parts of radii a and $2a$, respectively, and two radial parts of length a, amounts to

Solution: $\vec{E}$ is conservative, so the integral is 0.

3. What happens to electric potentials and voltages in an electrostataic system after a new reference point is adopted for the potential?

Solution: Potentials change by the same value and voltages remain unchanged.

4. The electrostatic potential V in a aregion is a function of the rectangular coordinate x only. Consider the electric field intensities at points A, B, C, D, and E. The largest field intensity is at point

Solution: It is where the slope is maximum, which is C.

5. Consider an electrostatic field in a region of space and the following two statements. Which of the statements is true?
   (a) If the electric scalar potential at a point in the region is zero, then the electric field vector at that point must be zero as well.
   (b) If the electric field vector at a point in zero, then the potential at the same point must be zero.

Solution: None of the statements are true. The statements simply discuss if there is any implication between $x = 0$ and $x' = 0$, where obvious counterexamples can be found.

6. An uncharged thin metallic rod is introduced into a uniform electrostatic field, of intensity vector $\vec{E}_0$, in free space, such that it is either perpendicular or parallel to $\vec{E}_0$. The rod affects the original field

> **Solution:** Less in case (a). As the rod is a conductor, the electric field becomes close to zero, depending on conductivity.

7. A uniform electric field, of intensity vector $\vec{E}_0$, is established in the air-filled space between two metallic electrodes. If an uncharged (thick) metallic slab is then inserted in this space, without touching the electrodes, the electric field intensity vector in region 3 in the new electrostatic state is

> **Solution:**
> $$E = \frac{V}{d}$$
> where d is the distance. Substituting V with $\frac{V}{2}$ and d with $\frac{d}{3}$ gives
> $$\vec{E}_3 = \frac{3\vec{E}_0}{2}$$

8. A negatively charged small body is situated inside an uncharged spherical metallic shell. The distribution of induced charges on the outer surface of the shell can be represented as in

> **Solution:** C

9. In order to protect body B from the electrostatic field due to a charged body A, an ungrounded closed metallic screen is introduced. The protection is achieved for

> **Solution:**