Name:

Physics 1320-(4,5,6) – Due March 5, 2024 – HW4 (Written)

Instructions:

There are ELEVEN QUESTIONS on this homework, but you only need to submit the answers to problems six through eleven. The first five are examples for the TAs to work during recitation. I will also discuss these problems on Thursday February 29.

All answers should be decimal numbers using scientific notation to three significant figures. SI units must be included on all answers.

To be worked by TAs:

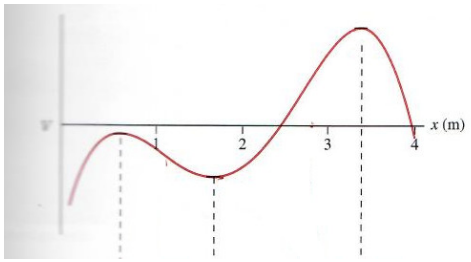

Fig. 1: Potential vs. position.

1. A 5 cm-diameter metal sphere carries a net charge of $1.2\mu C$.
   (a) What is the potential at the sphere's surface?
   (b) If a proton were released from rest at the sphere's surface, what would be its speed far from the sphere?

2. Figure 1 shows a plot of potential vs. position along the x-axis. Make a plot of the x-component of electric field for this situation.

3. The potential (voltage) at the surface of a 10-cm-radius sphere is 3.14 kV. What is the charge on the sphere, assuming it is distributed in a spherically symmetric way?

4. The potential as a function of position in a region is given by $V(x) = x^3/3 - x^2/2 - 6x$, with x in meters and V in volts.
   (a) Find all points on the x-axis where V=0.
   (b) Find all points where E=0.

5. Four 3 nC positive charges make a square with side 'a'=10 cm.
   (a) What is the potential in the center of the square?
   (b) What is the potential in the middle of the base of the square?

6. A coaxial cable consists of a 2.0-mm diameter inner conductor and an outer conductor of diameter 1.6 cm. If the conductors carry line charge densities of $\pm 0.67 nC/m$, what is the magnitude of the potential difference between them?

7. Figure 2 (next page) shows a plot of potential vs. position along the x-axis. Make a plot of the x-component of electric field for this situation.

8. The potential as a function of position in a region is given by $V(x) = 3x - 2x^2 - x^3$, with x in meters and V in volts.
   (a) Find all points on the x-axis where V=0.
   (b) Find all points where E=0.

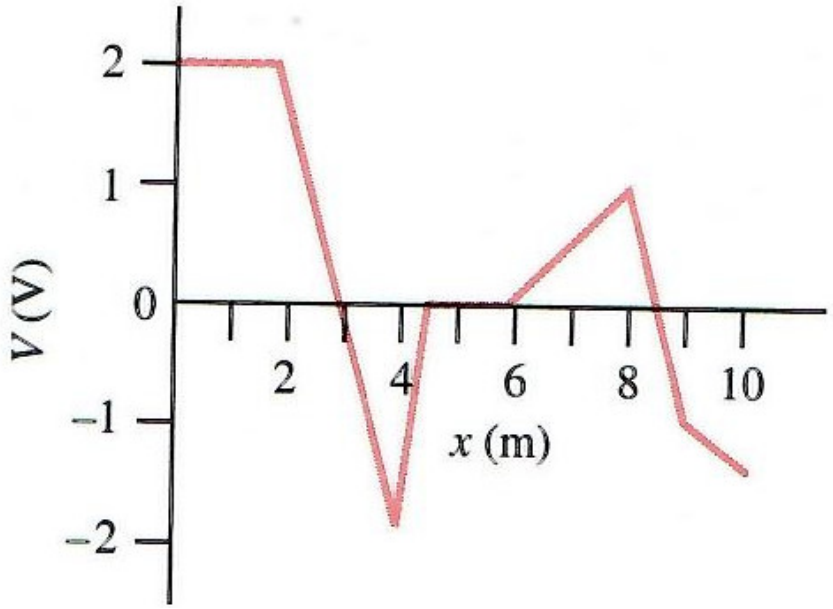

Fig. 2: Potential vs. position.

9. The spark plug in an automobile has a center electrode made from 2.0 mm-diameter wire. The electrode is roughly a hemisphere and may be treated as a sphere. What voltage on the spark plug is needed to assure that it sparks? (The breakdown field for air is $E_B = 3MV/m$)

10. Three 2 nC positive charges make an equilateral triangle with side 'a'=10 cm.
    (a) What is the potential in the center of the triangle?
    (b) What is the potential in the middle of the base of the triangle?

11. A power line with diameter 3.0 cm is at a voltage of 4.0 kV relative to a point one meter away. What is the line charge density (λ) of the power line?