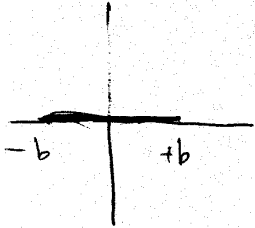


Don't waste time on questions you aren't sure of. Be clear and concise. A cluttered response will not get full credit.

1. (10 pts) A non-conducting rod lies on the x -axis from $(-b, 0, 0)$ to $(b, 0, 0)$, where b is a constant. It has charge per unit length $\lambda = 9\beta x^2$, where β is a constant. What units must b and β have? In terms of β and b , find the total charge Q on the rod, and the average charge per unit length $\bar{\lambda}$.



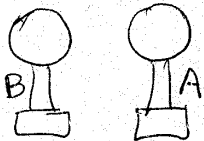
b in meters (m), β in C/m^3

$$Q = \int dQ = \int_{-b}^b \lambda dx = \int_{-b}^b 9\beta x^2 dx = 9\beta \frac{x^3}{3} \Big|_{-b}^b$$

$$= 6\beta b^3$$

$$\bar{\lambda} = \frac{Q}{L} = \frac{Q}{2b} = 3\beta b^2$$

2. (12 pts) Conducting globes A and B, on insulating bases, initially are neutral. An insulating charged rod with +4 units of charge is brought near A, without contact or sparking. Next, B is made to contact A and then is withdrawn. Finally, the charged rod is removed. A drawing with +5 units of charge on A and -3 units of charge on B violates what physics principles?



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1. Rod will attract negative charge to A, not +.

2. Sum of charges on A and B must be zero, not $5 - 3 = +2$.

3. Even if ~~+4~~ on the rod attracted ~~-5~~ on A (with +5 on B), that would be too much polarization.

3. (13 pts) An electron starts from rest at A, and accelerates leftward in a non-uniform electric field to B. If the potential changes by 5 volts when the electron moves by 4 cm, how fast is the electron moving at B? Is the potential higher or lower at B? In what general direction does \vec{E} point during the electron's motion?

B

A

velocity $v_A = 0$

$$\frac{1}{2} m v_A^2 + (-e)V_A = \frac{1}{2} m v_B^2 + (-e)V_B$$

$$\Rightarrow e(V_B - V_A) = \frac{1}{2} m v_B^2$$

$$\Rightarrow v_B = \sqrt{\frac{2e}{m} (V_B - V_A)} = 1.326 \times 10^6 \frac{m}{s}$$

clearly, for real v_B , we have $V_B > V_A$.

For electron to be attracted to B, \vec{E} must be \rightarrow .

or: \vec{E} points from high V regions to low V regions
or from B to A (\leftarrow).