Physics 172
Winter Quarter 1986
February 7, 1986
George Williams

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SECOND MIDTERM

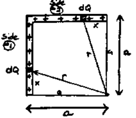
Name (Print) Paulmer Soderberg Name (Signed) $\bar{x} = 11.2$

Discussion Instructor (Circle One): Brown Chung Pollard Rothman

Discussion Section #:________ Schweizer (Soderberg) Vaseghi Viohl

REPORT ALL NUMBERS TO THREE SIGNIFICANT FIGURES!
Use the conversion constants and data given on the front page.

Two sides of a square of non-conductor of side length a are positively charged with a linear charge density of 3.70×10^{-9} C/m.



5(a) Calculate the electric potential at point P. P is at the corner of the rectangle. Both the rectangle and P are in the plane of the paper. (A numerical answer, in volts, is required.)

5 (b) Calculate the work to bring a proton from infinity to P. (The proton is the nucleus of a hydrogen atom. It has a positive charge equal in mangitude to the charge on the electron.)

a) $dV^{①} = \frac{K\,dQ}{r}$ where $r = \sqrt{a^2 + x^2}$ $K = 9.00 \times 10^9$ m/F

$dV^{②} = \frac{K\,dQ}{r}$ $dQ = \lambda\,dx$

$\lambda = 3.70 \times 10^{-9}$ C/m

$\therefore\ dV_{Total} = \frac{K\,dQ^{①}}{r} + \frac{K\,dQ^{②}}{r} = \frac{2K\,dQ}{r} = \frac{2\lambda K\,dx}{\sqrt{a^2+x^2}}$

$\Rightarrow V_T = 2\lambda K \int_0^a \frac{dx}{\sqrt{a^2+x^2}} = 2\lambda K \ln\left(x + \sqrt{x^2+a^2}\right)\Big|_0^a = 2\lambda K\left[\ln\left|a + \sqrt{a^2+a^2}\right| - \ln|a|\right]$

$\Rightarrow V_T = 2\lambda K \ln\left|\frac{a + \sqrt{a^2+a^2}}{a}\right| = 2\lambda K \ln\left|1 + \sqrt{2}\right|$

$\Rightarrow V_T = 2(3.70 \times 10^{-9}\text{ C/m})(9.00 \times 10^9\text{ m/F}) \ln\left|1+\sqrt{2}\right| \Rightarrow \boxed{V_T = 58.7 \text{ volts}}$

b) $\Delta\omega = {}^{+}q\,\Delta V$

$\Rightarrow \omega = {}^{+}q\,\Delta V \Rightarrow \omega = q\left[V(a) - V(\infty)\right] = q\,V(a) = 2q\lambda K \ln\left|1+\sqrt{2}\right|$

$\Rightarrow \omega = q(58.7\text{ volts}) = (1.602 \times 10^{-19}\text{ C})(58.7\text{ volts}) \Rightarrow \boxed{\omega_T = 9.40 \times 10^{-18}\text{ J}}$