Physics Midterm

2 Electric Charge and Electric Fields

1. a) $E_C = k * q / r^2$

   $k * q = E_C * r^2 = 0.002 * 0.001^2 = 2x10^{-9}$

   $E_C = k * q / 0.005^2 \rightarrow (2x10^{-9}) / (2.5x10^{-5})$

   $E_C = 8x10^{-5}$ V/m

   b) $E_C = k * q / r^2$

   $k / r^2 = E_C / q = 0.008 / 1x10^{-6} = 8000$

   $E_C = 8000 * (3x10^{-6})$

   $E_C = 0.024$ V/m

2. a) Weight = Electric force

   $m * g = q * E \rightarrow q = m * g / E$

   $q = (4x10^{-16}) * 9.81 / 6131.25 = 6.4x10^{-19}$ C

   # of electrons = q / electron charge = $6.4x10^{-19} / 1.6x10^{-19}$

   # of electrons = 4 electrons

   b) $F_t = W_d - F_E$

   $m * a = (m * g) - q_r * E \rightarrow a = [(m * g) - (q_r * E)] / m$

   $a = \{[(4x10^{-16}) * 9.81] - [(4.8x10^{-19}) * 6131.25]\} / (4x10^{-16})$

   $a = 3.924x10^{-15} - 2.943x10^{-15} / 4x10^{-16}$ J

   $a = 2.4525$ m/s^2

3 Potential Energy and Voltage, Capacitors

1. a) $KE_{total} = \sum(q * V)$

   $KE_{Hydrogen} = (1.6x10^{-19} * 4000) = 6.4x10^{-16}$ J

   $KE_{Helium} = (3.2x10^{-19} * 4000) = 12.8x10^{-16}$ J

   $KE_{total} = 6.4x10^{-16} + 12.8x10^{-16} = 19.2x10^{-15}$ J

   $KE_{total} = 1.92x10^{-15} / 1.6x10^{-19} = 12{,}000$ eV

   $KE_{Total} = 12{,}000$ eV

   b) $E = \Delta V / \Delta x$

   $E = 4000 / 0.05 = 80{,}000$ V/m

   E = 80,000 V/m

2. See Attached Paper

3. a) $C = \varepsilon_0 * A / d$

   $C = 8.85x10^{-12} * 1x10^{-4} / 2x10^{-3}$

   $C = 4.425x10^{-13}$ F

   b) $U_C = 0.5 * C * V^2$

   $U_C = 0.5 * 4.425x10^{-13} * 25$

   $U_C = 5.53x10^{-12}$ J

4. Connect an identical capacitor in parallel to store more energy.

4 Current, Resistance, and DC Circuits

1. a) (Series) $I = V_{total} / R_{total}$

   $V_{total} = V_1 + V_2 = 1.5 + 1.5 = 3$

   $R_{total} = r_1 + r_2 + R = 2 + 2 + 50 = 54$

   $I = 3 / 54$

   $I_{series} = 0.0556$ A

   (Parallel) $I = V_{total} / R_{total}$

   V_{total} $V_1 * r_1 + V_2 * r_2 / r_1 + r_2 = (1.5 *2) + (1.5 * 2) / (2 + 2) = 1.5$

   $R_{total} = [(r_1 * r_2) / (r_1 + r_2)] + 50 = [(2 * 2) / (2 + 2)] + 50 = 51$

   $I = 1.5 / 51$

   $I_{parallel} = 0.0294$ A

   b) $P_{series} = I * V$

   $P_{series} = 0.05556 * 3$

   $P_{series} = 0.168$ W

   $P_{parallel} = I * V$

   $P_{parallel} = 0.0294 * 1.5$

   $P_{parallel} = 0.0441$ W

2. a) Nerve stimulation in 2 ms

   b) $V_{peak\text{-}peak} = 35 - (-75)$

   $V_{peak\text{-}peak} = 110$ mV

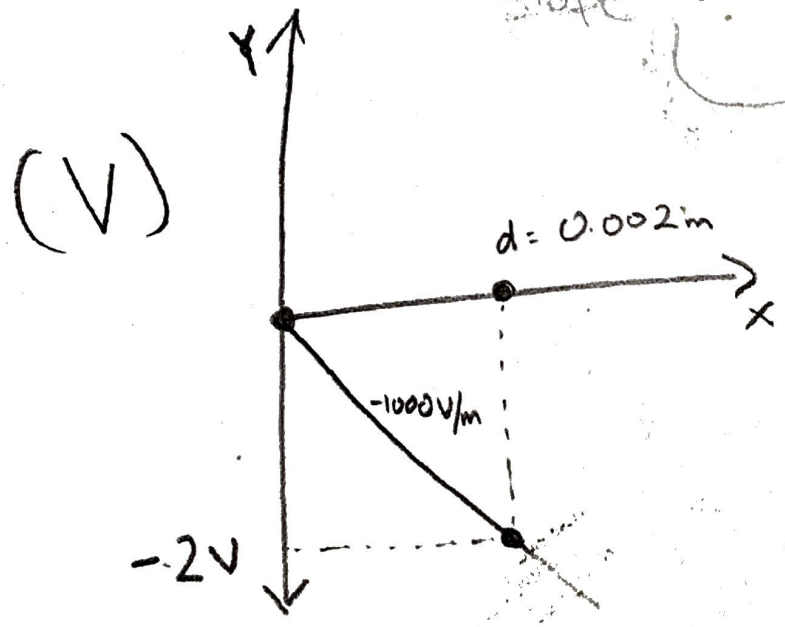
$E = 1000\ V/m$ $d = 0.002\ m$

$\mathcal{E} = -Vd$

$= 1000\ (0.002)$

$= -2\ V$

slope $= \frac{\Delta Y}{\Delta x} = \frac{-2}{0.002} = -1000\ V/m$



Y-intercept = 0 because the origin is the beginning of the function