1. (4 pts) If you stand next to a wall on a frictionless skateboard and push the wall with a force of 210 N, (a) how hard does the wall push you? If your mass is 70 kg, (b) what is your acceleration?

\[ F_1 = 210 \text{ N} \]
\[ m = 70 \text{ kg} \]
\[ F_2 - ? \]
\[ a - ? \]

\[ F_1 = - F_2 - 3 \text{ N} \cdot \text{L} \]
\[ a = \frac{F_2}{m} = 3 \text{ m/s} \]
\[ F_2 = 210 \text{ N} \]

2. (3 pts) What information is provided by a sketch of the field lines of an electric field?

3. (5 pts) Two small, identical, pointlike conducting spheres have charges \( q_1 = -2 \cdot 10^{-9} \text{ C} \) and \( q_2 = +6 \cdot 10^{-9} \text{ C} \). (a) Calculate the magnitude of the electrical force on each when they are separated by 3 cm. Are the forces attractive or repulsive? (b) The two spheres are brought momentarily into contact and then separated by a distance of 3 cm. Now what is the magnitude of the electric force on each? Are the forces attractive or repulsive?

\[ q_1 = -2 \cdot 10^{-9} \text{ C} \]
\[ q_2 = 6 \cdot 10^{-9} \text{ C} \]
\[ r = 3 \cdot 10^{-2} \text{ m} \]

(a) \[ F_1 = \kappa \frac{q_1 q_2}{r^2} = -1.2 \cdot 10^{-5} \text{ N}, \text{ attractive} \]
(b) \[ q_1' = q_2' = q' \]
\[ 2 q_1 = q_1' + q_2' = q_1 + q_2 = (6 -2) \cdot 10^{-9} = 4 \cdot 10^{-9} \text{ C} \]
\[ q_1' = +2 \cdot 10^{-9} \text{ C} \]
\[ F_2 = \kappa \frac{(q_1')^2}{r^2} = 4 \cdot 10^{-5} \text{ N}, \text{ repulsive} \]
4. (3 pts) An unknown resistor is connected between the terminals of a 3.0 V battery. Energy is
dissipated in the resistor at the rate of 0.54 W. The same resistor is then connected between the
terminals of 1.5 V battery. At what rate is energy now dissipated?

\[ V_1 = 3.0 \text{ V} \]
\[ P_1 = 0.54 \text{ W} \]
\[ V_2 = 1.5 \text{ V} \]
\[ P_2 = ? \]

\[
\begin{align*}
P_4 &= \frac{V_4^2}{R} \\
P_2 &= \frac{V_2^2}{R} \\
P_2 &= P_1 \left( \frac{V_2}{V_1} \right)^2 \]
\]
\[ P_2 = 0.54 \text{ W} \left( \frac{1.5 \text{ V}}{3 \text{ V}} \right)^2 = 0.18 \text{ W} \]

5. (4 pts) In the circuit shown below \( E = 1.5 \text{ V}, C = 6.5 \mu \text{F}, R_1 = R_2 = R_3 = 0.75 \Omega \). Internal resistance of
the battery is negligibly small. Determine (a) the current through each resistor and (b) the voltage on
the capacitor.

\[ I_1 = I_2 + I_3 \]
\[ I_3 = 0 \ (\text{no direct current through capacitor}) \]
\[ I_1 = I_2 = I \]
\[ I = \frac{E}{R_1 + R_2} = \frac{1.5 \text{ V}}{2 \cdot 0.75 \Omega} = 1 \text{ A} \]
\[ V_{AB} = I \cdot R_2 = V_{R_2} + V_C \]
\[ V_C = V_{4B} = I \cdot R_2 = 0.75 \text{ V} \]