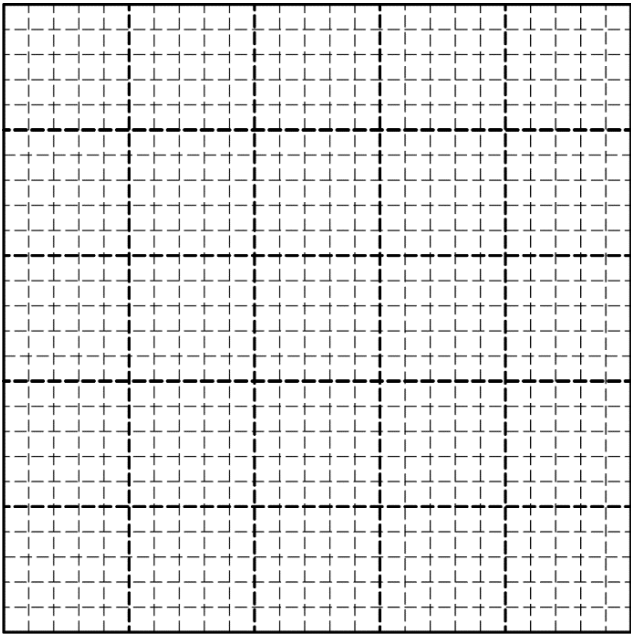


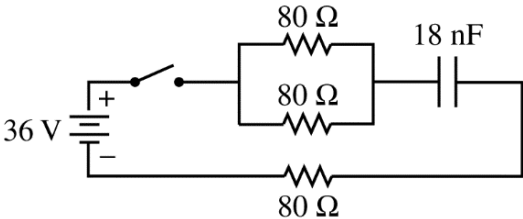
2. An experiment is designed to measure the dielectric constant of paper that has an area $A = 0.060\text{ m}^2$. Using aluminum foil, two parallel plates are created with the same area as the paper. Five hundred sheets of paper are placed between the aluminum foil plates to create a parallel plate capacitor, as shown in the figure above. Using a multimeter, the capacitance C of the capacitor is measured. The number of sheets and the total thickness d of the stack of paper are recorded. The experiment is repeated, reducing the number of sheets of paper each time. The data are recorded in the table below.

Sheets of Paper	d (m)	C (F)		
500	0.045	6.5×10^{-11}		
400	0.036	7.4×10^{-11}		
300	0.027	8.9×10^{-11}		
200	0.018	11.9×10^{-11}		
100	0.010	21.0×10^{-11}		

- (a) Indicate below which quantities should be graphed to yield a straight line whose slope could be used to calculate a numerical value for the dielectric constant of the paper.
- Vertical axis: _____
- Horizontal axis: _____
- Use the remaining columns in the table above, as needed, to record any quantities that you indicated that are not given. Label each column you use and include units.
- (b) Plot the data points for the quantities indicated in part (a) on the graph below. Clearly scale and label all axes, including units if appropriate. Draw a straight line that best represents the data.



- (c) Using the straight line, calculate a dielectric constant for the paper.



- The student now makes a capacitor using the same aluminum foil plates and just one sheet of paper. Using the experimentally determined dielectric constant, the student calculates the capacitance to be 18 nF. The student uses this uncharged capacitor to build a circuit using wire, a 36 V battery, 3 identical 80 Ω resistors, and an open switch, as shown in the figure above.
- (d) Calculate the current in the battery immediately after the switch is closed.
- (e) Determine the time constant for this circuit.
- (f) Students A and B measure the time it takes after the switch is closed for the voltage across the capacitor to reach half its maximum value and find that it is longer than expected.
- i. Student A assumes that the capacitance value is correct. Would Student A conclude that the resistance value is larger or smaller than measured?
- _____ Larger than measured _____ Smaller than measured
- Explain experimentally what could account for this.
- ii. Student B assumes that the resistance value is correct. Would Student B conclude that the capacitance value is larger or smaller than measured?
- _____ Larger than measured _____ Smaller than measured
- Explain experimentally what could account for this.