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**Interactive: PhET Simulation Capacitor Lab**

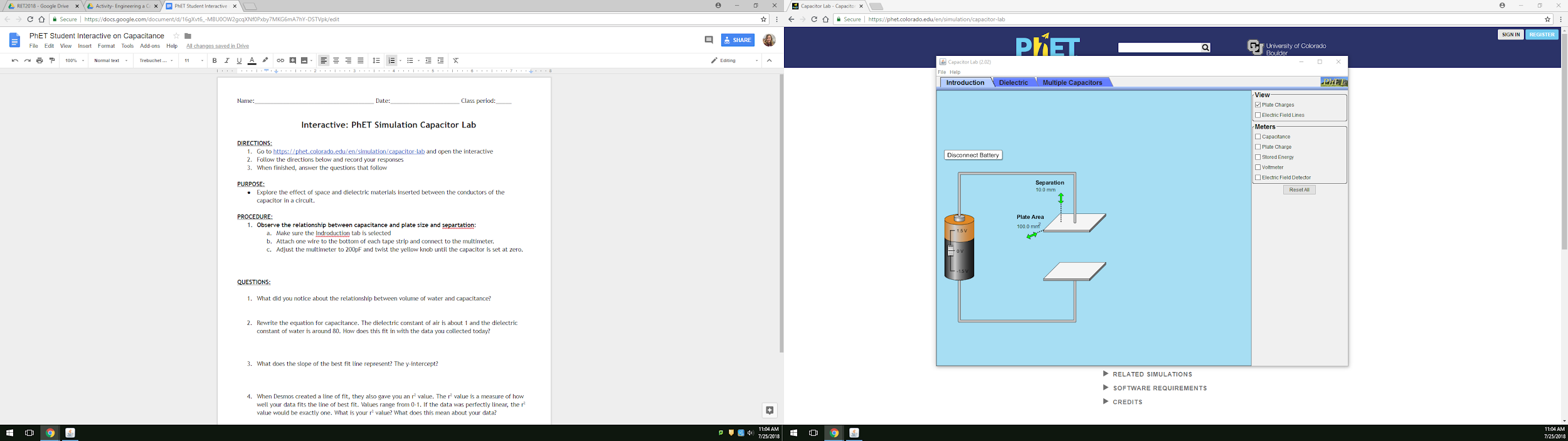
**DIRECTIONS:**

1. Go to <https://phet.colorado.edu/en/simulation/capacitor-lab> and open the interactive
2. Follow the directions below and record your responses
3. When finished, answer the questions that follow

**PURPOSE:**

Explore the effect of space and dielectric materials inserted between the conductors of the capacitor in a circuit.

**PROCEDURE:**

1. **Set up:**
   1. Make sure the Introduction tab is selected 
   2. Set battery to +1.5V, Separation to 10.0mm and Plate Area to 100.0mm2
   3. Select the options under View for Plate Charges and Electric Field Lines, and under Meters select Capacitance
2. **Observe the relationship between capacitance and plate size and separation:**
   1. Adjust the plate area by pulling and pushing on the green arrow. What do you notice as you make the plate area larger? What values change?

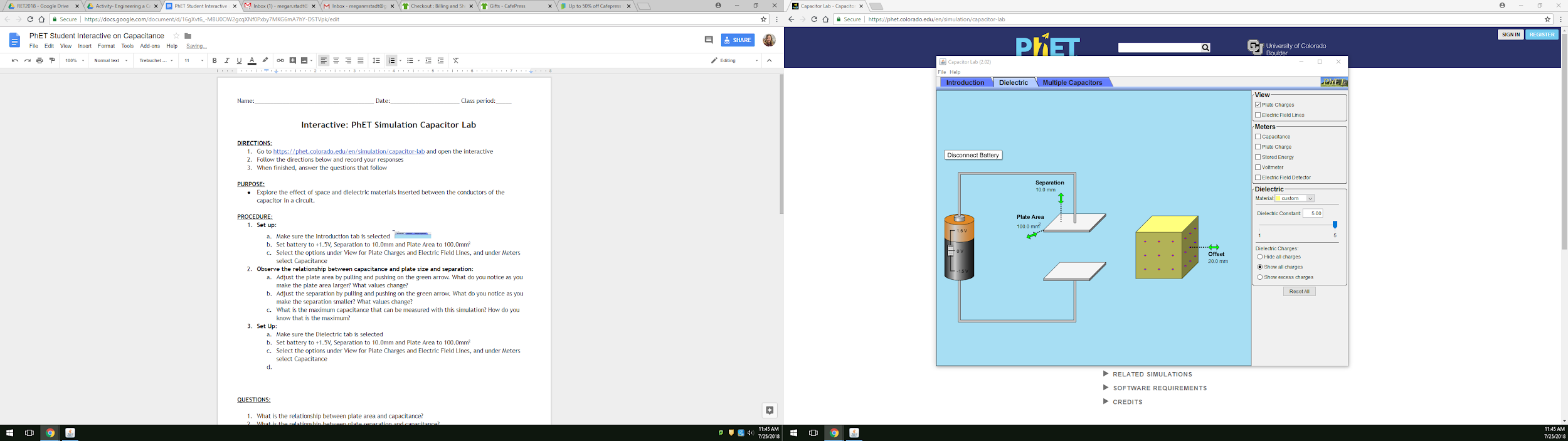
The capacitance increases, the number of electric field lines increases and the red + and blue - increase

* 1. Adjust the separation by pulling and pushing on the green arrow. What do you notice as you make the separation smaller? What values change?

The capacitance increases, the number of electric field lines increases and the red + and blue - increase

* 1. What is the maximum capacitance that can be measured with this simulation? How do you know that is the maximum?

Maximum will happen when the plate area is the greatest value (400.0mm2) and the separation is the smallest (5.0mm). This value is 0.71x10-12 F.

1. **Set Up:**
   1. Select the Dielectric tab at the top 
   2. Click the “Reset All” button located near the bottom right and set battery to +1.5V
   3. Select the options under View for Plate Charges, and under Meters select Capacitance
   4. Under Dielectric make sure Custom is selected from the drop down menu with the dielectric constant of 5 and “Show all charges” button selected
2. **Observe the relationship between capacitance and dielectrics**
   1. Slide the dielectric box in between the capacitor plates. What do you notice about the red + charges on the top plate?

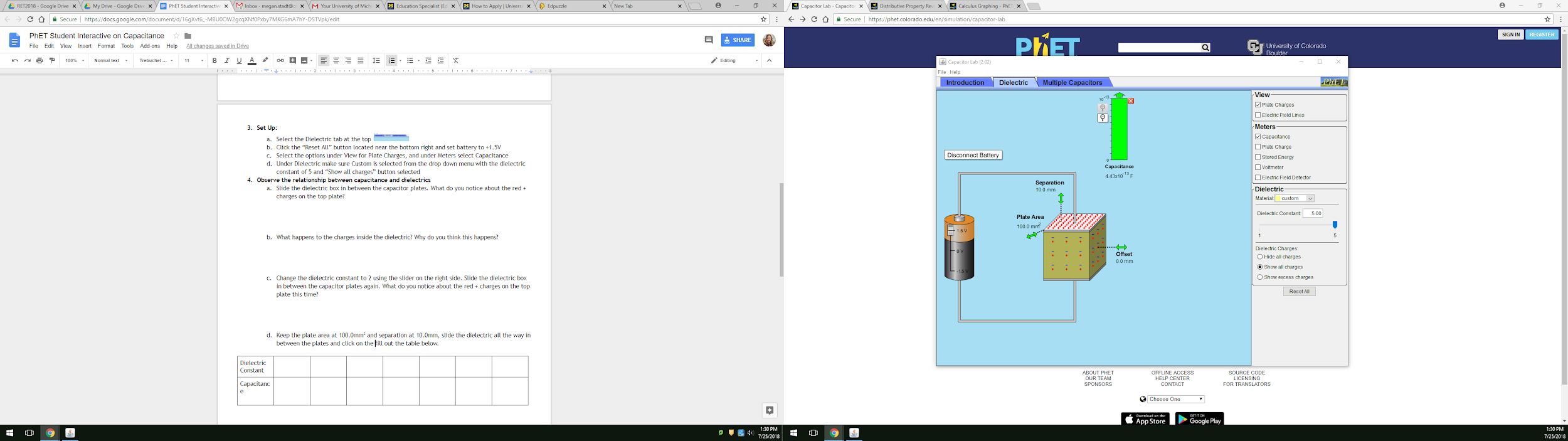
They increase as you slide the dielectric between the plates. If you slide it half way in, you can see the difference between the amounts of charge the plate can hold.

* 1. What happens to the charges inside the dielectric? Why do you think this happens?

The charges separate from each other. They are attracted to the opposite slide of the plate.

* 1. Change the dielectric constant to 2 using the slider on the right side. Slide the dielectric box in between the capacitor plates again. What do you notice about the red + charges on the top plate this time?

The amount of charge increases, but not nearly as much as when the constant is 5

* 1. Keep the plate area at 100.0mm2 and separation at 10.0mm, slide the dielectric all the way in between the plates and click on the  next to the capacitance meter. Fill out the table below for the various insulators.

|  |  |  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- | --- | --- |
| **Dielectric Constant** | **5** | **Glass**  **(4.7)** | **4** | **Paper (3.5)** | **3** | **Teflon (2.1)** | **1** |
| Capacitance  (pF = x 10-12) | **0.44** | **0.42** | **0.35** | **0.31** | **0.27** | **0.19** | **0.09** |

* 1. Describe the pattern you found.

As the dielectric constant decreases, so does the capacitance (amount of charge the plates can hold)

**QUESTIONS:**

1. What is the relationship between plate area and capacitance?

Bigger area = more charge can be held (higher capacitance)

1. What is the relationship between plate separation and capacitance?

Less separation = more charge can be held (higher capacitance)

1. What does the dielectric object do in a capacitor?

Insulates the plates, so that more charge can build up

1. Room temperature water has a dielectric constant of 80. How could you use the data you collected to predict the capacitance at such a large value?

Find the pattern (it’s linear if x = dielectric constant and y = capacitance in pF the line of fit is y = 0.0876x + 0.00423) and extrapolate the data (plug in 80 for x and you get 7.01pF).