Capacitor Lab

Name:

Click on ‘Capacitance’.

Take a moment to look over the simulation and learn about each of the functions.

Click the reset button when you’re done.

*C* – Capacitance (F)

*V* – Potential (V)

*Q* – Charge (C)

For a parallel plate capacitor, capacitance (*C*) depends upon area of the plates, distance between plates and medium between plates. Since the simulation doesn’t have a dielectric option, we will set **=1.

The Capacitance is then given as:

$$C=\frac{ε\_{0}A}{d}$$

The charge on the plates is given as:

$$Q=CV$$

When the capacitor is connected to the battery, charge builds up in the capacitor.

The potential difference on the plates is related to the electric field as:

$V=Ed$ or $E=\frac{V}{d}$

Potential energy (Stored energy) in a charged capacitor is stored in the electric field between plates:

$$U=\frac{1}{2}QV=\frac{1}{2}CV^{2}$$

When the capacitor is disconnected from the circuit, the charge on the plates remains constant.

When the capacitor is connected with a resistor, such as a light bulb, it discharges (loses its charge).

A few pieces of information before we start.

* All the parameters (Plate charges, Bar Graphs, Electric Field, and Current Direction) must be selected.
* All the parameters (Capacitance, Top Plate Charge, and Stored Energy) must be selected.
	+ Keep in mind that the top plate charge never displays negative. The positive charge is when the graph is red and negative is blue.
* Connect the voltmeter across the capacitor by placing the red on the top plate and black on bottom. Make sure the voltage on the voltmeter is equal to the voltage of the battery. If the voltmeter reads a negative, switch the red and black.
* The amount of current depends on the brightness of the arrow. If the arrow fades away, current is decreasing. If the arrow gets brighter, current is increasing. If there’s no arrow, there’s no current.

Making predictions

**Capacitor connected to battery**

1. Based on the equations above, do you think the listed quantities (Q, C, V, E, and U) will increase (I), decrease (D), or stay the same (S) if each of the following changes are made?

|  |  |  |  |
| --- | --- | --- | --- |
| Quantity | Increase Separation | Increase Plate Area | Increase V of battery |
| Capacitance (C) of capacitor |  |  |  |
| Charge (Q) on each plate |  |  |  |
| Voltage (V) across capacitor |  |  |  |
| Electric field (E) between plates |  |  |  |
| Stored energy (U) of capacitor |  |  |  |

**Capacitor disconnected from battery**

1. Do you think the listed quantities (Q, C, V, and U) will increase (I), decrease (D), or stay the same (S) if each of the following changes are made?

|  |  |  |
| --- | --- | --- |
| Quantity | Increase Separation | Increase Plate Area |
| Charge (Q) on each plate |  |  |
| Capacitance (C) of capacitor |  |  |
| Voltage (V) across capacitor |  |  |
| Stored energy (U) of capacitor |  |  |

Playing with capacitor

**Capacitor connected to battery**

Slowly increase the battery voltage to 0.75 V.

1. Does the current increase or decrease when charging a capacitor?
2. How strong is the current when a capacitor is fully charged? Why?
3. What is the direction of the electric field? Why?

What changes (increase or decrease) did you have to make to each of the listed parameters (Separation, Area, and Voltage) to cause an increase in the quantities (Q, C, V, and U)? If a parameter change causes no change in the quantity, state that.

|  |  |  |  |
| --- | --- | --- | --- |
| Quantity | Separation | Plate Area | V of battery |
| Increase capacitance (C) of capacitor |  |  |  |
| Increase charge (Q) on each plate |  |  |  |
| Increase voltage (V) across capacitor |  |  |  |
| Increase stored energy (U) of capacitor |  |  |  |

Change the polarity of the battery voltage from 0.75 V to -0.75 V.

1. What is the direction of the electric field?

**Capacitor disconnected from battery**

What changes (increase or decrease) did you make to any of the parameters (Separation or Area) that caused an increase in the quantities (Q, C, V, and U)?

Include an explanation of why each quantity did or did not cause a change. You may use equations or words in your explanations.

1. Increase charge (Q) on each plate:
2. Increase capacitance (C) of capacitor:
3. Increase voltage (V) across capacitor:
4. Increase stored energy (U) of capacitor:

At the bottom of the simulation, click on ‘Light Bulb’.

Take a moment to look over the new simulation and see how this differs. You should notice that everything is the same except now there a light bulb (a resistor) so that you can discharge the capacitor.

Click the reset button when you’re done playing.

Making predictions

**Connecting capacitor to light bulb**

1. How do you think each of the quantities will change (increase, decrease, or stay the same) when the capacitor is connected to the light bulb?

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Top Plate Charge | Capacitance | Capacitor Voltage | Stored Energy | Brightness of bulb |
| Changes |  |  |  |  |  |

Playing with capacitor

Keep the capacitor connected to the battery and set the battery voltage to 1.5 V.

1. Record values for the following:

|  |  |  |  |  |
| --- | --- | --- | --- | --- |
|  | Top Plate Charge | Capacitance | Capacitor Voltage | Stored Energy |
| Value |  |  |  |  |

Connect the capacitor to the light bulb (you may need to repeat this process a few times to see all of the changes).

1. Record the changes (increase, decrease, or stays the same) to the following while the capacitor discharges:

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
|  | Top Plate Charge | Capacitance | Capacitor Voltage | Stored Energy | Brightness of bulb |
| Changes |  |  |  |  |  |

1. Does the current increase or decrease when discharging a capacitor? Why?

**Conclusion**

1. How do we charge a capacitor?
2. How do we discharge a capacitor?
3. What does it mean to say the capacitor is discharging?
4. Does capacitance depend upon the potential across capacitor?
5. How would you determine the brightness (power) of the lightbulb?
6. If you need to light up a bulb for longer duration, what could you do?