Capacitor Lab **Grade: 11th - 12th**

Brief Notes:

- Charge on a capacitor, while charging, is directly proportional to the applied potential across its terminal.
  It is calculated as:

$$Q = C \times V$$

  Where:
  Q - Charge (coulomb)
  C – Capacitance (farad)
  V - Potential (volt)

- For a parallel plate capacitor, capacitance (C) depends upon area of the plates, distance between plates and medium between plates.
  It is given as:

$$C = \frac{\varepsilon A}{d} = \frac{k\varepsilon_0 A}{d}$$

- Potential energy in a charged capacitor is stored in the electric field between plates.

$$U = \frac{1}{2}\, C\, (V \times V)$$

- When capacitor is connected with a resistor, it discharges. As a result, the stored potential energy decreases.

Explore:

Disconnect the capacitor from battery:

1. Select a value of plate separation (d) and plate area (A).
   Calculate capacitance (C).

   Use the formula, $C = \frac{\varepsilon_0 A}{d}$

   Is it same as the given value of capacitance in simulation?

2. Keeping separation (d) constant, change the plate area (A).
   How do you think the capacitance will change?

3. Keep the plate area (A) constant, change separation (d).
   How do you think the capacitance will change?

Now, connect capacitor with battery and:

4. Keep plate separation (d) and area (A) constant. Now, slowly increase potential. Observe the changes in following quantities:

a) Charge (Q) on capacitor
b) Capacitance (C) of capacitor
c) Potential (V) across capacitor
d) Electric Field (E) between plates
e) Direction of motion of electrons through battery

Fill in Table 1 with your observations.

Table 1: Battery Connected, Potential Increases

Quantity	Observations	Reasons
Charge (Q) on capacitor		
Capacitance (C) of capacitor		
Potential (V) across capacitor		
Electric Field (E) between plates		
Direction of motion of electrons through battery		

5. Answer the following questions based upon your observations in Table 1.

    - Is the charge (Q) on capacitor directly proportional to potential (V) across its plates?
    - How does the direction of motion of electrons change, when polarity of plates changes? What happens to the motion of electrons when potential is constant? What do you think are reasons?

6. Charge capacitor. Once it is charged, disconnect it from battery. How do the quantities in Table 1 change?

7. Connect capacitor with battery. Charge it to certain potential. Keep potential constant and slowly ***increase*** capacitance, observe change in the following quantities:

Table 2: Battery Connected, Capacitance Increases:

Quantity	Observations	Reasons
Charge (Q) on capacitor		
Potential (V) across capacitor		

Electric Field (E) between plates		
Direction of motion of electrons through battery		

8. Does battery supply energy to capacitor in above process? If yes, how can you be sure about it?

9. Charge capacitor to certain potential and then disconnect it from battery. Slowly ***increase*** the capacitance, observe the change in the following quantities:
    a) Charge (Q) on capacitor
    b) Potential (V) across capacitor
    c) Electric Field (E) between plates
    d) Motion of electrons

Table 3: Capacitor Charged, Battery Disconnected and Capacitance Increases

Quantity	Observations	Reasons
Charge (Q) on capacitor		
Potential (V) across capacitor		
Electric Field (E) between plates		
Direction of motion of electrons through battery		

Bulb and Capacitor:

10. Charge capacitor to a certain potential. Now connect it to bulb. Observe change in following quantities:
    a) Charge (Q) on capacitor
    b) Capacitance (C) of capacitor
    c) Potential (V) across capacitor
    d) Stored Energy (U) between plates
    e) Electric Field (E) between plates

Table 4: Capacitor Charged, Bulb Connected

Quantity	Observations	Reasons
Charge (Q) on capacitor		
Capacitance (C) of capacitor		

Potential (V) across capacitor		
Stored Energy (U) between plates		
Electric Field (E) between plates		

11. Will bulb glow for longer time if more energy is stored between the capacitor plates?

Think:

1. Does capacitance depend upon the potential across capacitor?
2. Is electric field between plates of a capacitor uniform or non-uniform?
3. Why does capacitor discharge when you connect it across a resistor?
4. On capacitor plates, are the charges same on both plates at any time?
5. If you need to light up a bulb for longer duration, which of the following, you will select to supply power to bulb?
    a. A 1.5 Volt cell
    b. A 1.5 Volt charged capacitor.

Contributions:

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