3055 BA SANGAM COLLEGE

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WEEK 11

SCHOOL: BA SANGAM COLLEGE **YEAR: 13**

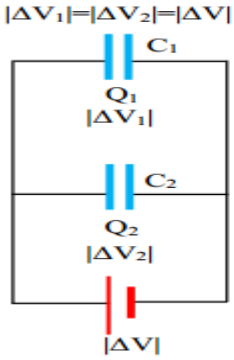
SUBJECT: PHYSICS **NAMEOF STUDENT: _____**

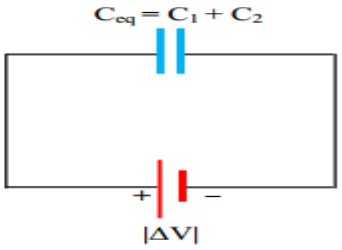
STRAND	**4- ELECTROSTATIC**
SUB-STRAND	**Capacitors in a circuit**
LEARNING OUTCOME	• To understand about capacitors connected in circuits

Capacitors in a circuit

Capacitors in Parallel

- we have two capacitors C1 with charge Q1and C2 with charge Q2 that are connected in parallel





- total capacitance of the circuit can be found by

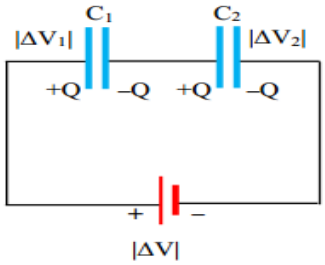
$$C_{eq} = C_1 + C_2 + C_3 + C_4 + \ldots$$

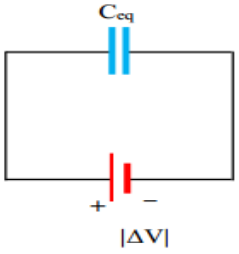
Rule

i. The equivalent capacitance is the sum for all the capacitors.
ii. The voltage across each capacitor is the same.
iii. The charge in each capacitor is different; depending on the capacitor values.

Capacitors in Series

Suppose two initially uncharged capacitors C1and C2are connected in series as shown





- the generalisation to any number of capacitors in series is:

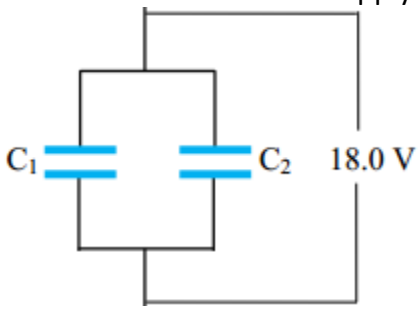
$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3} + \frac{1}{C_4} + \ldots$$

Rule

i. The equivalent capacitance is the inverted sum of the reciprocals of all the capacitors.
ii. The voltage across each capacitor is different; depending on the capacitor values.
iii. The charge across each capacitor is the same.

Example (parallel circuit)

Shown below are two capacitors (C1 = 3 µF, C2 = 6 µF) are connected to a18.0 V supply.



a) Determine the equivalent capacitance of the combination
b) What is the total charge flowing in the circuit.
c)Determine the voltage across C2.
d)Determine the charge across C2.
e) Calculate the energy stored in C2.

Solution

a) $C_{eq} = C_1 + C_2 = 3\mu F + 6\mu F = 9\ \mu F$

b) $Q = C\Delta V = \left(9\times10^{-6}\right)\times(18.0) = 1.62\times10^{-4}\ C = 0.162\ mC$

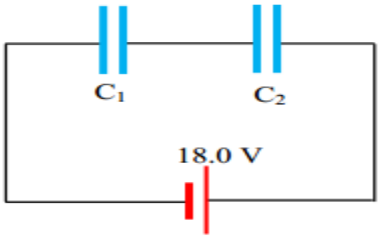
c) Since it's a parallel combination the voltage will be same in both the
$\Delta V = 18.0V$.

d) $Q_2 = C_2\ \Delta V = \left(6\times10^{-6}\right)(18.0) = 1.08\times10^{-4}\ C$
$Q_1 = C_1\ \Delta V = \left(3\times10^{-6}\right)(18.0) = 0.54\times10^{-4}\ C$
$Q_T = Q_1 + Q_2 = 0.108\ mC + 0.054\ mC = 0.162\ mC$

e) $E_2 = \frac{1}{2}C_2V^2 = \frac{1}{2}\left(6\times10^{-6}\right)(18.0)^2 = 9.72\times10^{-4}\ J$ OR
$E_2 = \frac{1}{2}Q_2V = \frac{1}{2}\left(1.08\times10^{-4}\right)(18.0) = 9.72\times10^{-4}\ J$ OR

Example (series circuit)

Shown below is two capacitors (C1= 3 µF, C2= 6 µF) connected to a 18.0 V supply.



a) Determine the equivalent capacitance of the combination
b) What is the total charge flowing in the circuit.
c)Determine the voltage across C2.
d)Determine the charge across C2.
e) Calculate the energy stored in C2.

a) $\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} = \frac{1}{3\mu F} + \frac{1}{6\mu F} = \frac{1}{2\mu F}$
$C_{eq} = 2\ \mu F$

b) $Q = C\Delta V = \left(2\times10^{-6}\right)\times(18.0) = 3.6\times10^{-5}\ C = 0.036\ mC$

c) $\Delta V_2 = \frac{Q_T}{C_2} = \frac{3.6\times10^{-5}}{6\times10^{-6}} = 6V$

d) The charge across each capacitor is the same;
$\therefore Q_T = Q_2 = 3.6\times10^{-5}\ C = 0.036\ Mc$

e) $E_2 = \frac{1}{2}C_2V^2 = \frac{1}{2}\left(6\times10^{-6}\right)(6.0)^2 = 1.08\times10^{-4}\ J$ OR
$E_2 = \frac{1}{2}Q_2V = \frac{1}{2}\left(3.6\times10^{-5}\right)(18.0) = 1.08\times10^{-4}\ J$ OR
$E_2 = \frac{(Q^2)^2}{2C_2} = \frac{\left(3.6\times10^{-5}\right)^2}{2\times\left(6\times10^{-6}\right)} = 1.08\times10^{-4}\ J$

EXERCISE

1. A 2 pF and 6 pF capacitors are connected to a 120 V power supply in parallel. Calculate:
a) total equivalent capacitance of the circuit. (1mark)

b) the total charge coming out of the power supply. (1mark)

c)the charge on each capacitor. (2marks)

2. A 5 µF and 7 µF capacitors are connected to a 24 V power supply in Series. Calculate:
a) total equivalent capacitance of the circuit. (2marks)

b) the total charge coming out of the power supply. (1mark)

c)the charge on each capacitor. (1mark)

d) Voltage across each capacitor (2marks)