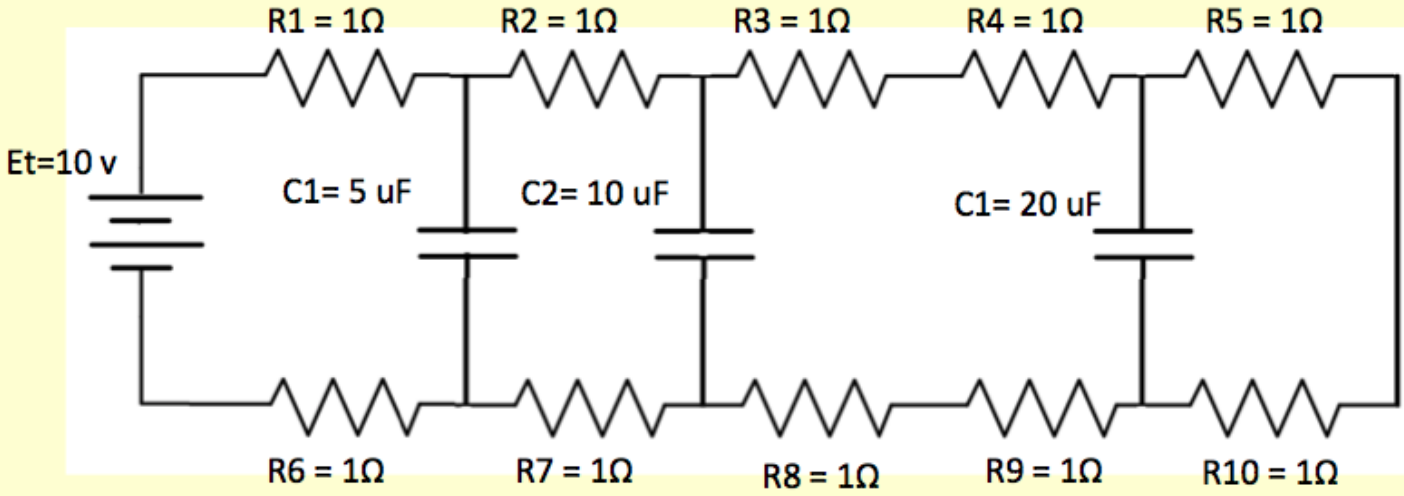
Basic Electricity – Unit 11: Capacitance

Homework 1

Worked Out Example: CIRCUIT ONE

Initial conditions:

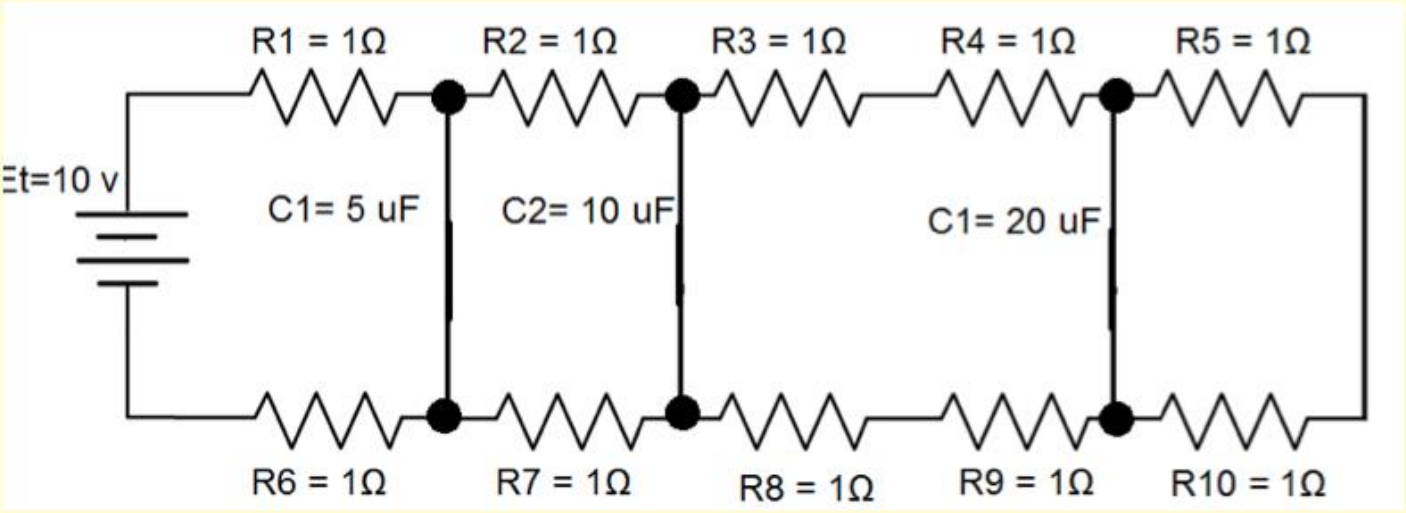
Switch 1 open
Capacitors uncharged.
Supply voltage off.

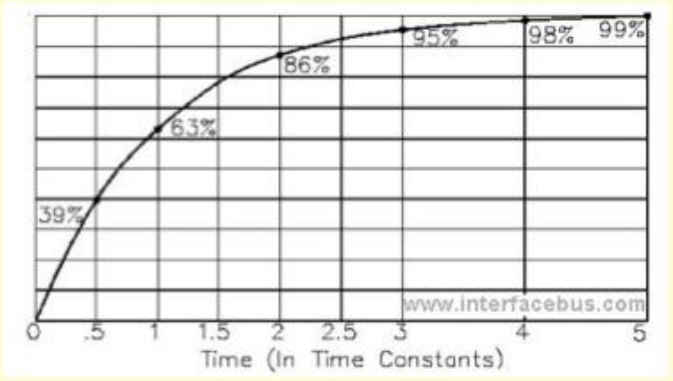


Basic Electricity – Unit 11: Capacitance

Homework 1

As soon as power is applied the capacitors act like a short for current.



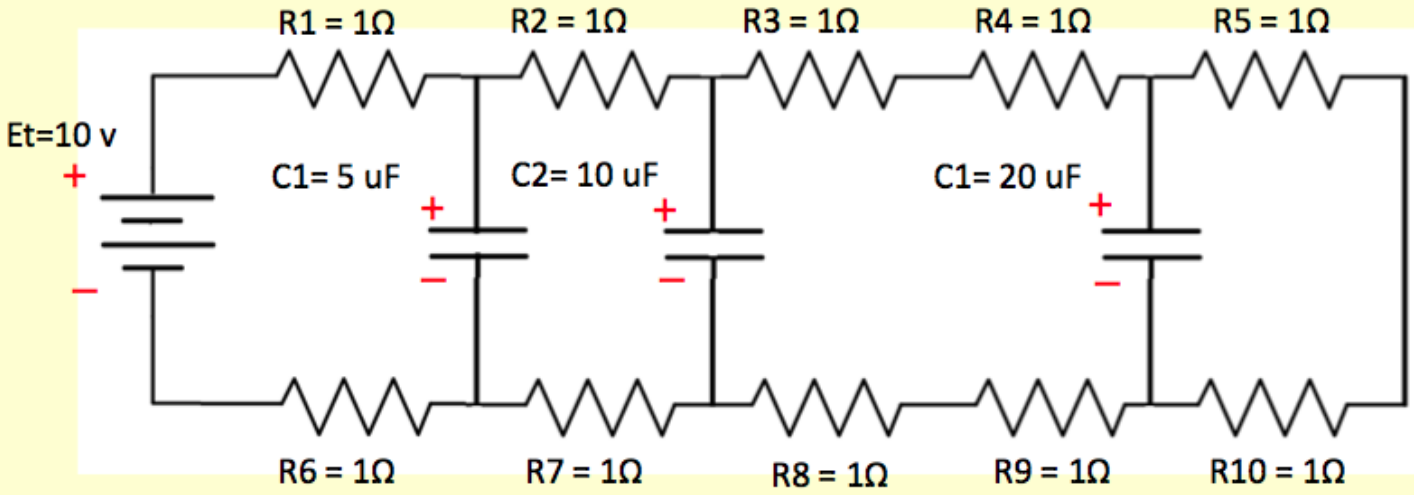


Basic Electricity – Unit 11: Capacitance

Homework 1

Steady State Conditions:

Capacitors charged.
Supply voltage on.



$$Rt = R1 + R2 + R3 + R4 + R5 + R6 + R7 + R8 + R9 + R10$$

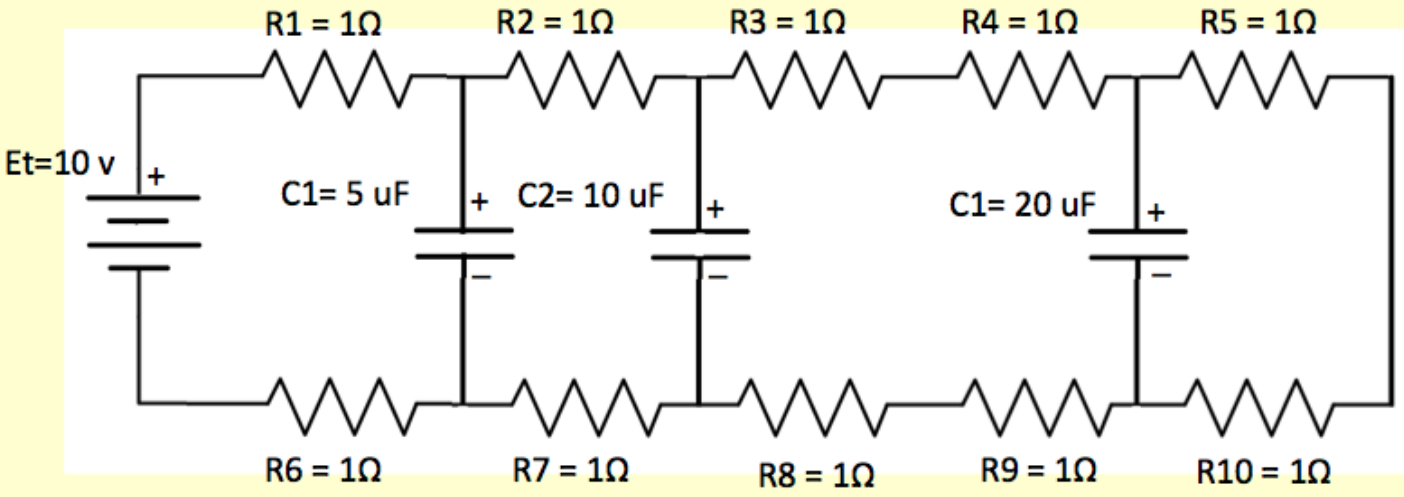
Basic Electricity – Unit 11: Capacitance

Homework 1

Capacitors charge.
Current then flows only through resistors.

$$Rt = R1 + R2 + R3 + R4 + R5 + R6 + R7 + R8 + R9 + R10 = 10\ \Omega$$

$$It = Et/Rt$$
$$= 10v / 10\Omega$$
$$= 1\ Amp$$

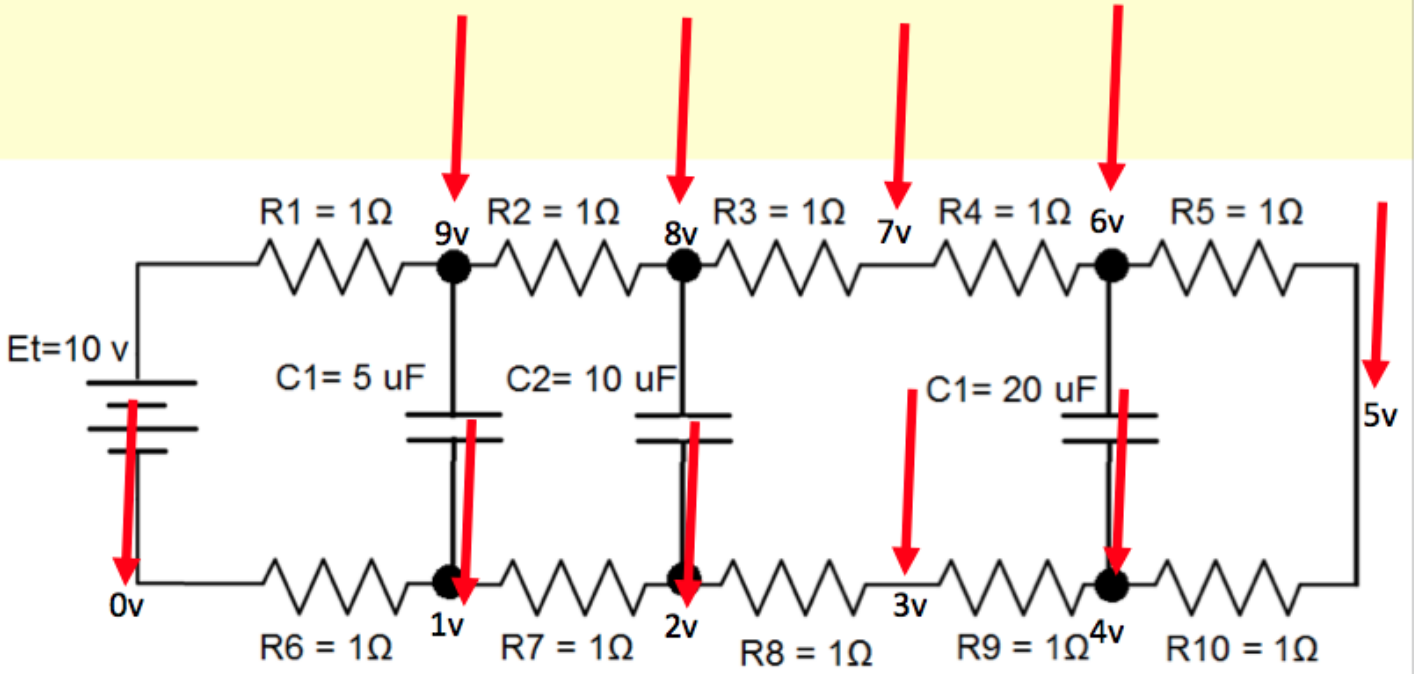


Basic Electricity – Unit 11: Capacitance

Homework 1

Voltage across each resistor = (It)(R)
= (1 Amp)(1 Ω)
= 1 V

This results in:

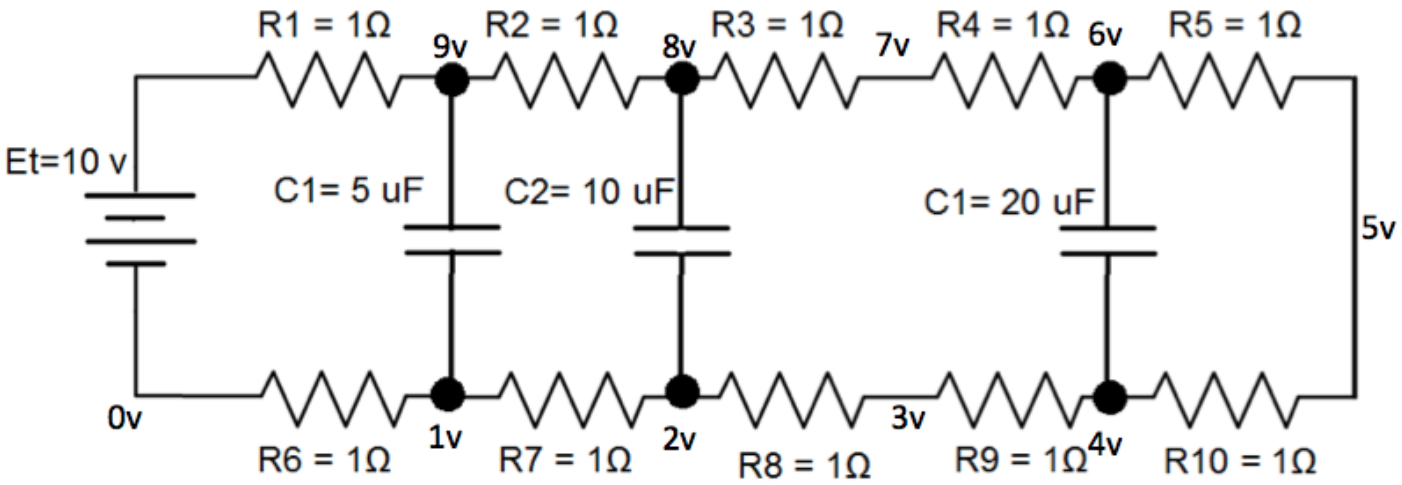


Basic Electricity – Unit 11: Capacitance

Homework 1

The potential difference across each capacitor is as follows:

VC1 = 9v – 1v = 8v
VC2 = 8v – 2v = 6v
VC3 = 6v – 4v = 2v

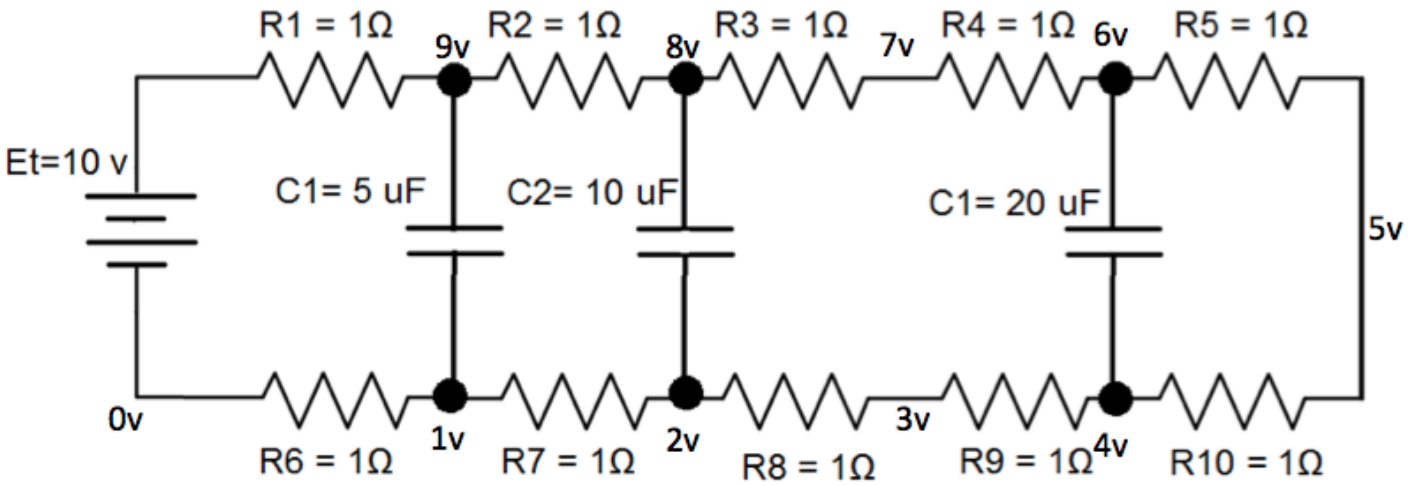


Basic Electricity – Unit 11: Capacitance

Homework 1

$$C = \frac{Q}{V}$$

Where:
C = Capacitance
Q = Charge in micro coulombs = uC
V = Voltage



Basic Electricity – Unit 11: Capacitance

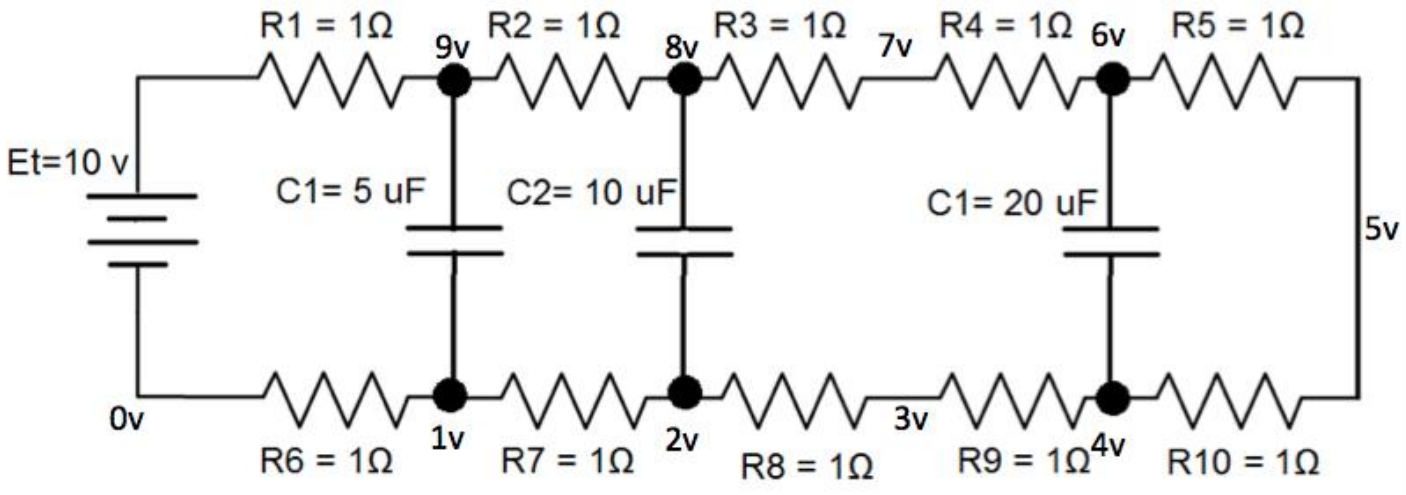
Homework 1

$$C = \frac{Q}{V}$$

If we manipulate the formula:

$$Q = CV$$

We can now solve for each capacitor charge.

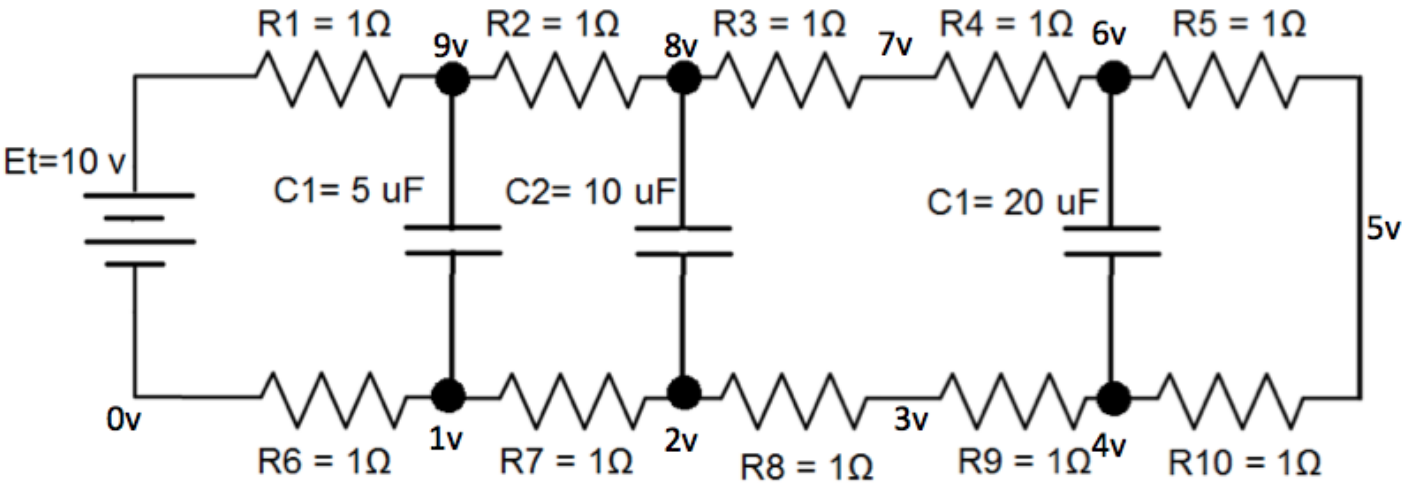


Basic Electricity – Unit 11: Capacitance

Homework 1

$$Q = CV$$

$$Q1 = (C1)(V1) = (\ 5uF)(8v) = 40\ uC$$
$$Q2 = (C2)(V2) = (10uF)(6v) = 60\ uC$$
$$Q3 = (C3)(V3) = (20uF)(2v) = 40\ uC$$

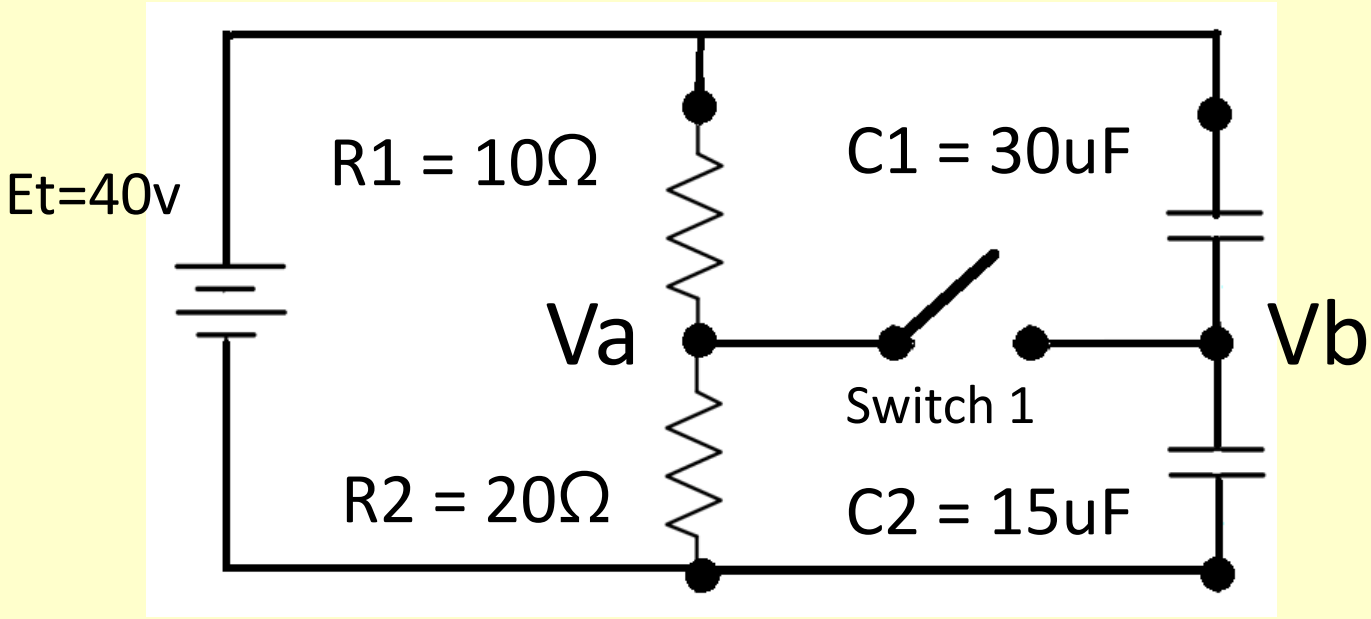


Basic Electricity – Unit 11: Capacitance

Homework 1

Homework Instructions: Solve the following DC Capacitive circuit based on the worked out examples.

CIRCUIT 2

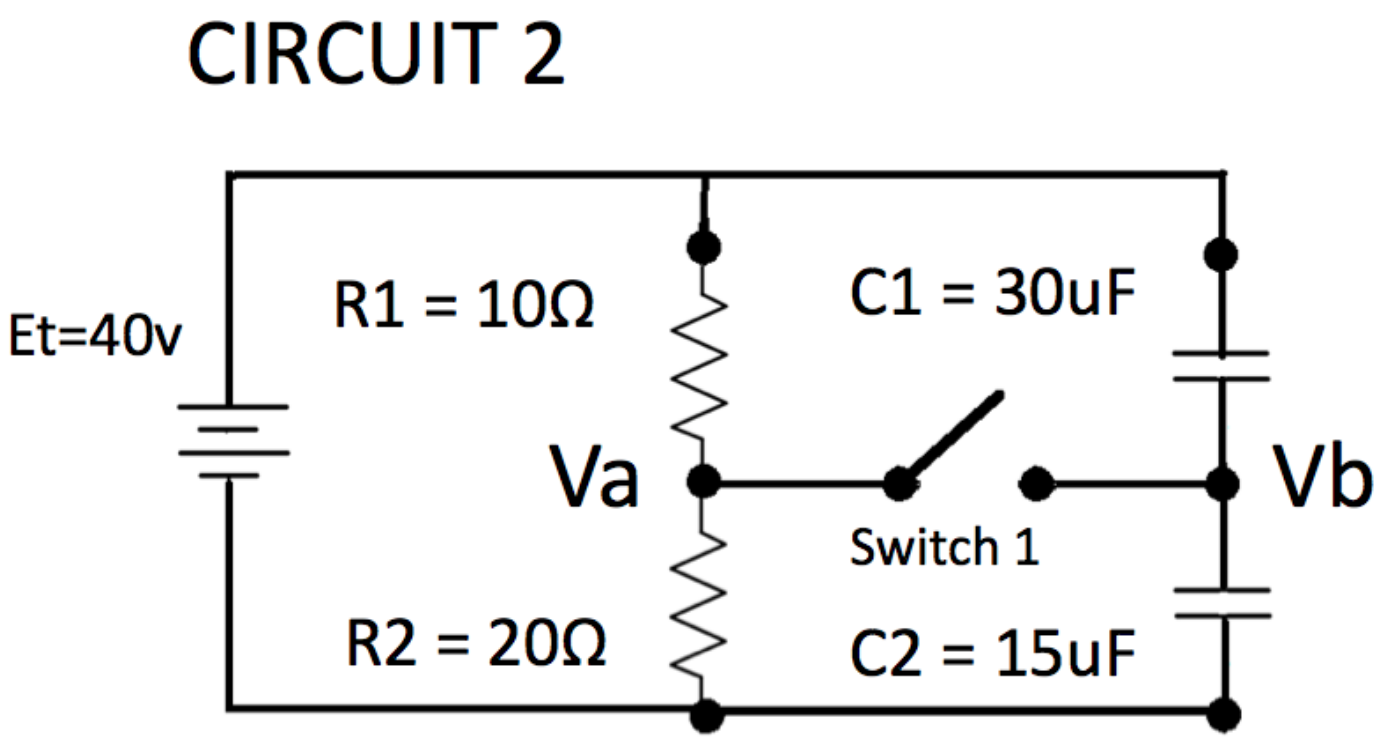


What is Va, Vb, Q1 and Q2
Switch open and switch closed.

Basic Electricity – Unit 11: Capacitance

Homework 1

Homework Solution:



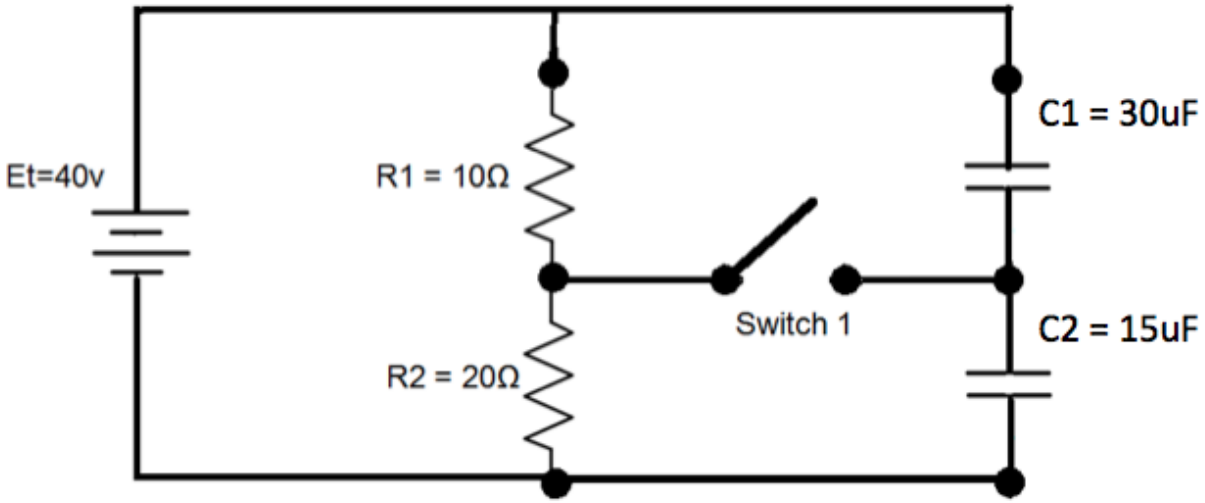
What is Va, Vb, Q1 and Q2
Switch open and switch closed.

Basic Electricity – Unit 11: Capacitance

Homework 1

Initial conditions:

Switch 1 open
Capacitors uncharged.
Supply voltage off.

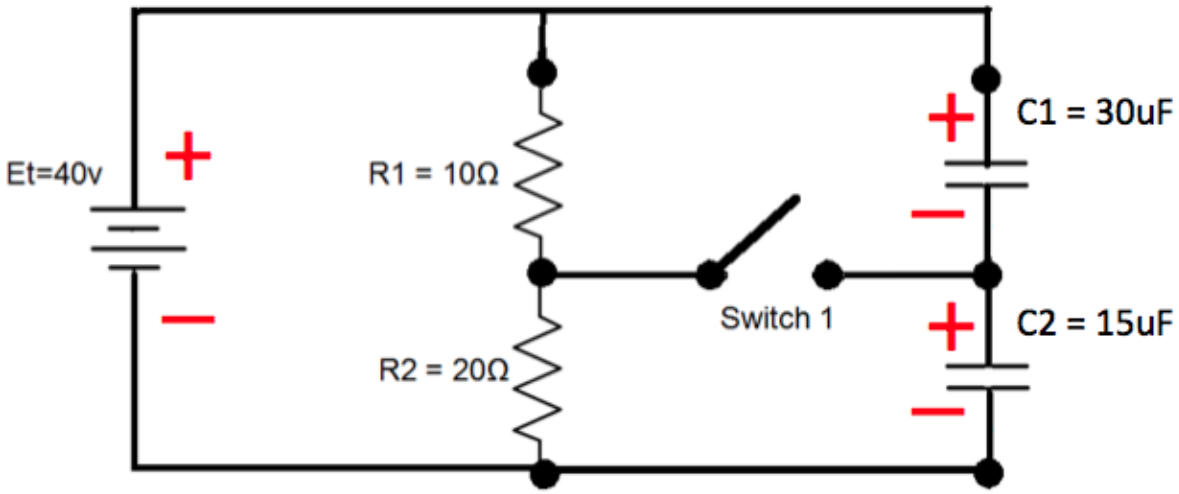


Basic Electricity – Unit 11: Capacitance

Homework 1

Steady State Conditions:

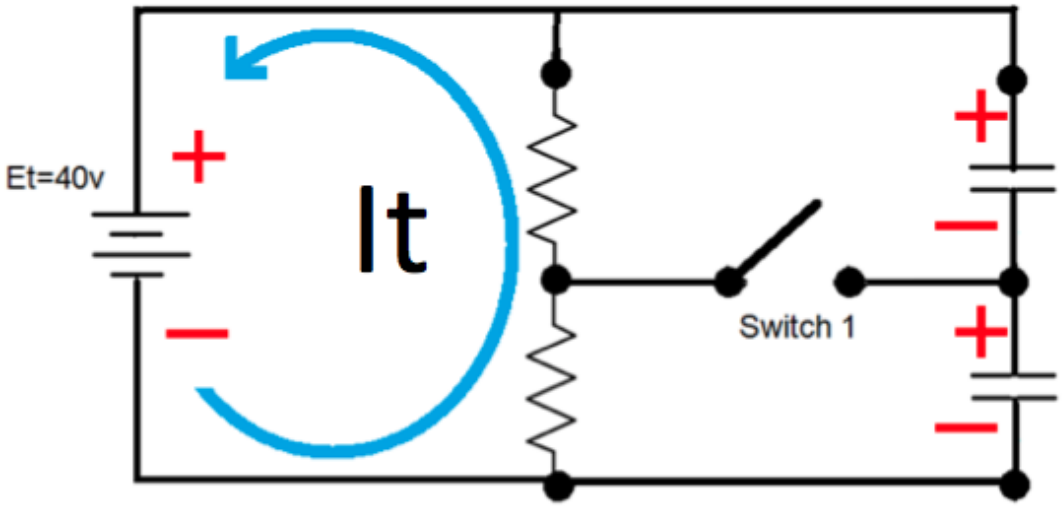
Switch 1 open
Capacitors charged.
Supply voltage on.



Basic Electricity – Unit 11: Capacitance

Homework 1

Once capacitors are fully charged current flows ONLY through the resistors.



Basic Electricity – Unit 11: Capacitance

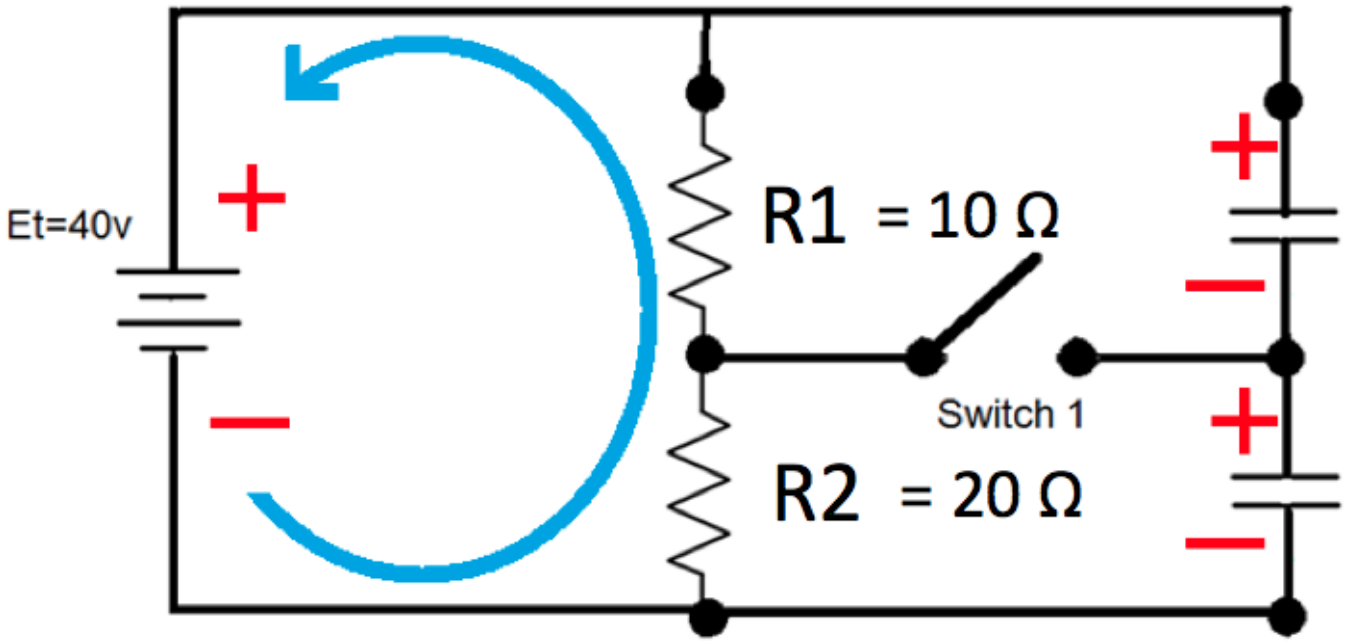
Homework 1

$$Rt = R1 + R2$$
$$= 10\Omega + 20\Omega$$
$$= 30\Omega$$

$$It = Et / Rt$$
$$= 40v / 30\Omega$$
$$= 1.33 \text{ Amps}$$

Basic Electricity – Unit 11: Capacitance

Homework 1

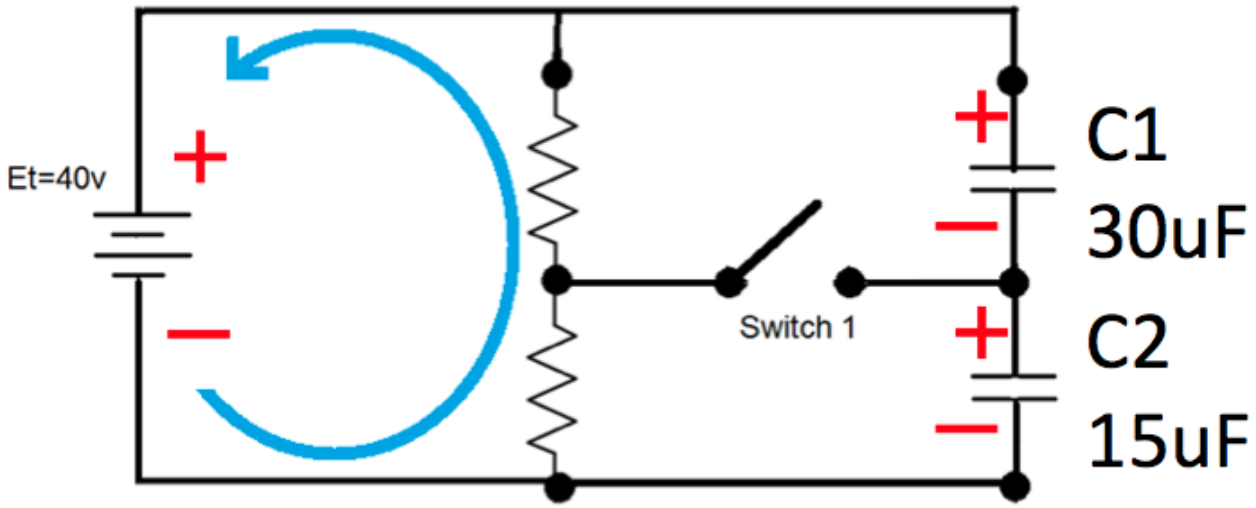


$$VR1 = (1.333A)(10\Omega) = 13.333\ V$$

$$VR2 = (1.333A)(20\Omega) = 26.667\ V$$

Basic Electricity – Unit 11: Capacitance

Homework 1



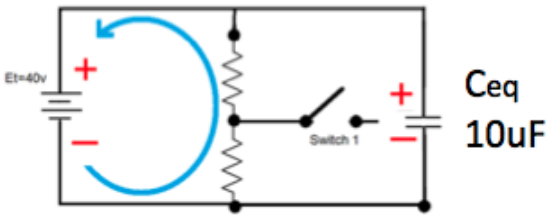
Q = CV

Using the product sum formula for capacitors in series:

Ceq = [(C1)(C2)]/[C1+C2]

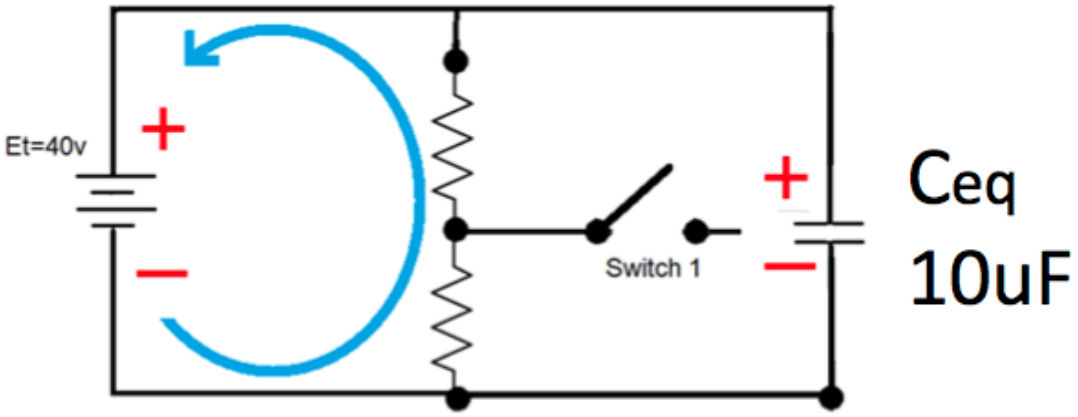
= 450/45

= 10 uF



Basic Electricity – Unit 11: Capacitance

Homework 1



The total charge across Ceq is worked out as follows:

$$Q_{total} = (Ceq)(Vt)$$
$$= (10uF)(40v)$$
$$= 400\ uC = 400 \text{ micro Coulombs}$$

Basic Electricity – Unit 11: Capacitance

Homework 1

The charge across each series capacitor is the same as the charge across C_{eq}.

The voltages VC1 + VC2 will add up.

Basic Electricity – Unit 11: Capacitance

Homework 1

$$Q = CV$$

$$VC1 = QC1/C1$$
$$= 400\ uC / 30uF$$
$$= 13.333\ V$$

$$VC2 = QC2/C2$$
$$= 400\ uC / 15uF$$
$$= 26.667\ V$$

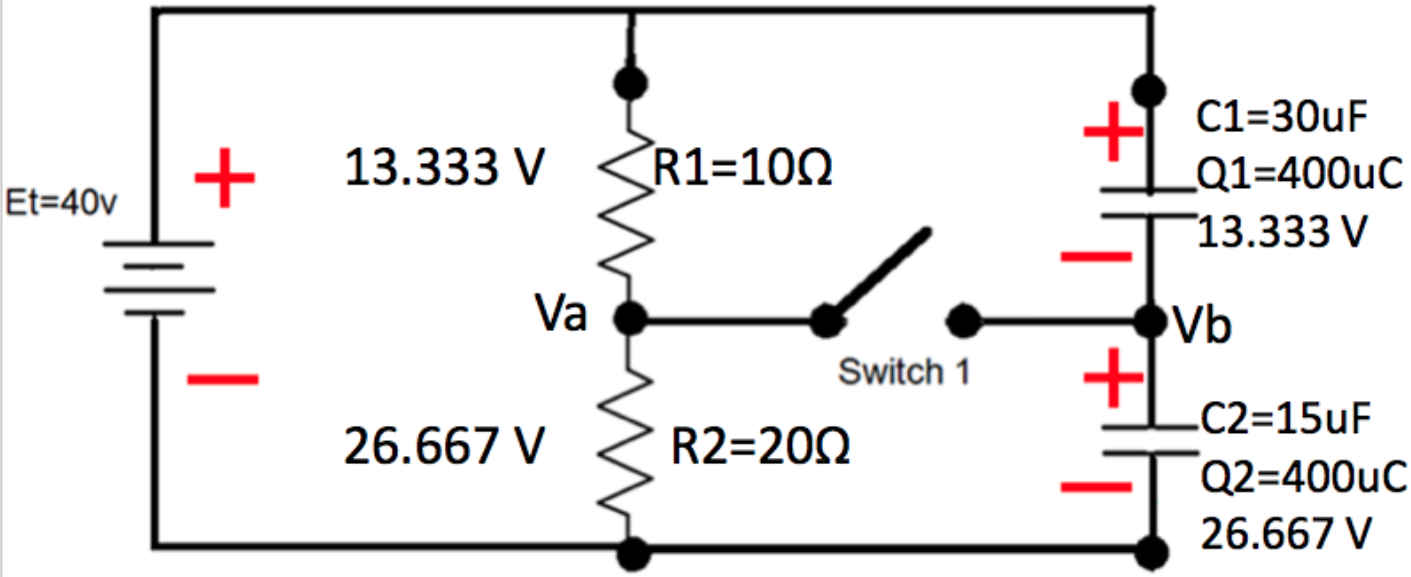
Basic Electricity – Unit 11: Capacitance

Homework 1

In order for the same charge to be placed on a smaller capacitor the voltage across the capacitor must be greater.

Basic Electricity – Unit 11: Capacitance

Homework 1



Va = 26.667 V

Vb = 26.667 V

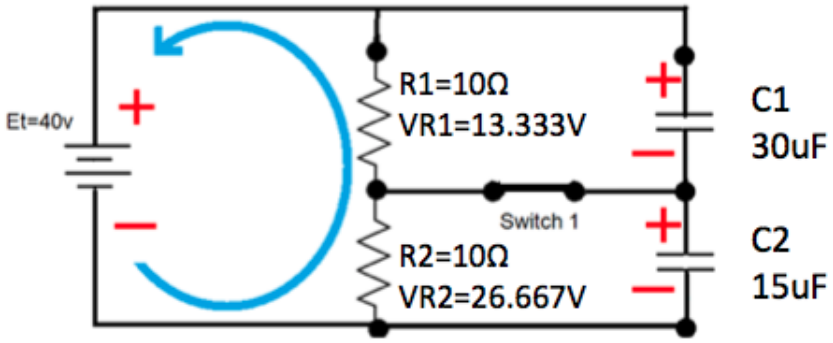
Basic Electricity – Unit 11: Capacitance

Homework 1

Switch Closed

Basic Electricity – Unit 11: Capacitance

Homework 1



C1 and C2 are no longer in series with each other.

Q1 = C1V1 = (30uF)(13.333V) = 0.00039999 uC
Q2 = C2V2 = (15uF)(26.667V) = 0.000400005 uC

Total Charge on both capacitors = 0.000799995 uC

Basic Electricity – Unit 11: Capacitance

Homework 1

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