WEEK 3: BASIC COMPONENTS

CENTENARY SUBURBS MEN'S SHED – ELECTRONICS GROUP

AGENDA

- Resistors
- Capacitors
- Inductors
- A simple capacitance meter using a Raspberry Pi

RESISTANCE


PROTECT THE 2ND AMENDMENT
DAY OF RESISTANCE
FEB. 23, 2013
DustinStockton.com
TheTeaParty.net
WesternPAC.com
RightWingNews.com
WomenWarriorsPAC.com

RESISTANCE

- What is resistance?

"A resistor is a passive two-terminal electrical component that implements electrical resistance as a circuit element." *Wikipedia*

RESISTANCE

- Useful for converting a current to a voltage and vice versa
- Used to limit current flow
- Useful for setting reference currents
- Adjust signal levels

RESISTANCE

Fixed:

"Fixed resistors have resistances that only change slightly with temperature, time or operating voltage."

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Fixed:

"Fixed resistors have resistances that only change slightly with temperature, time or operating voltage."

Variable:

"Variable resistors can be used to adjust circuit elements (such as a volume control or a lamp dimmer), or as sensing devices for heat, light, humidity, force, or chemical activity."

RESISTANCE

Remember Ohms law

$$V = I \times R$$

RESISTANCE

Second most important law

$$P = V \times I$$

Where P: power in Watts

RESISTANCE

Second most important law

$$P = V \times I$$

Where P: power in Watts

Therefore:

$$P = I \times R \times I$$

Or

$$= I^2 R$$

WARNING!

When using a resistor always make sure it’s operating below it’s rated power

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RESISTORS IN CIRCUITS

In series:

$R1 = 1k\Omega$ $R2 = 4k\Omega$

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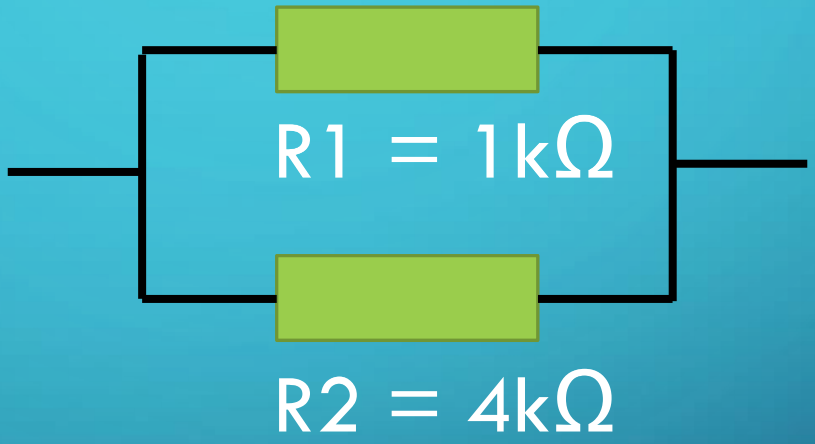
$$R_{total} = R1 + R2$$
$$= 5k\Omega$$

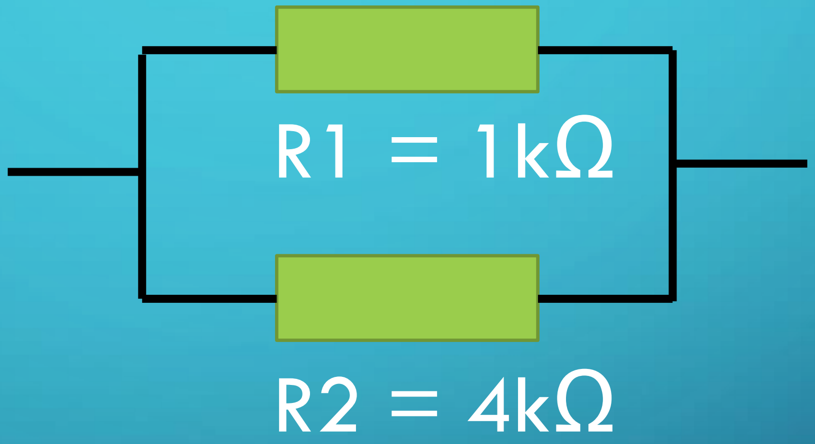
RESISTORS IN CIRCUITS

In parallel:



RESISTORS IN CIRCUITS

In parallel:



$$1/R_{total} = 1/R1 + 1/R2$$

$$R_{total} = (R1 \times R2) / (R1 + R2)$$

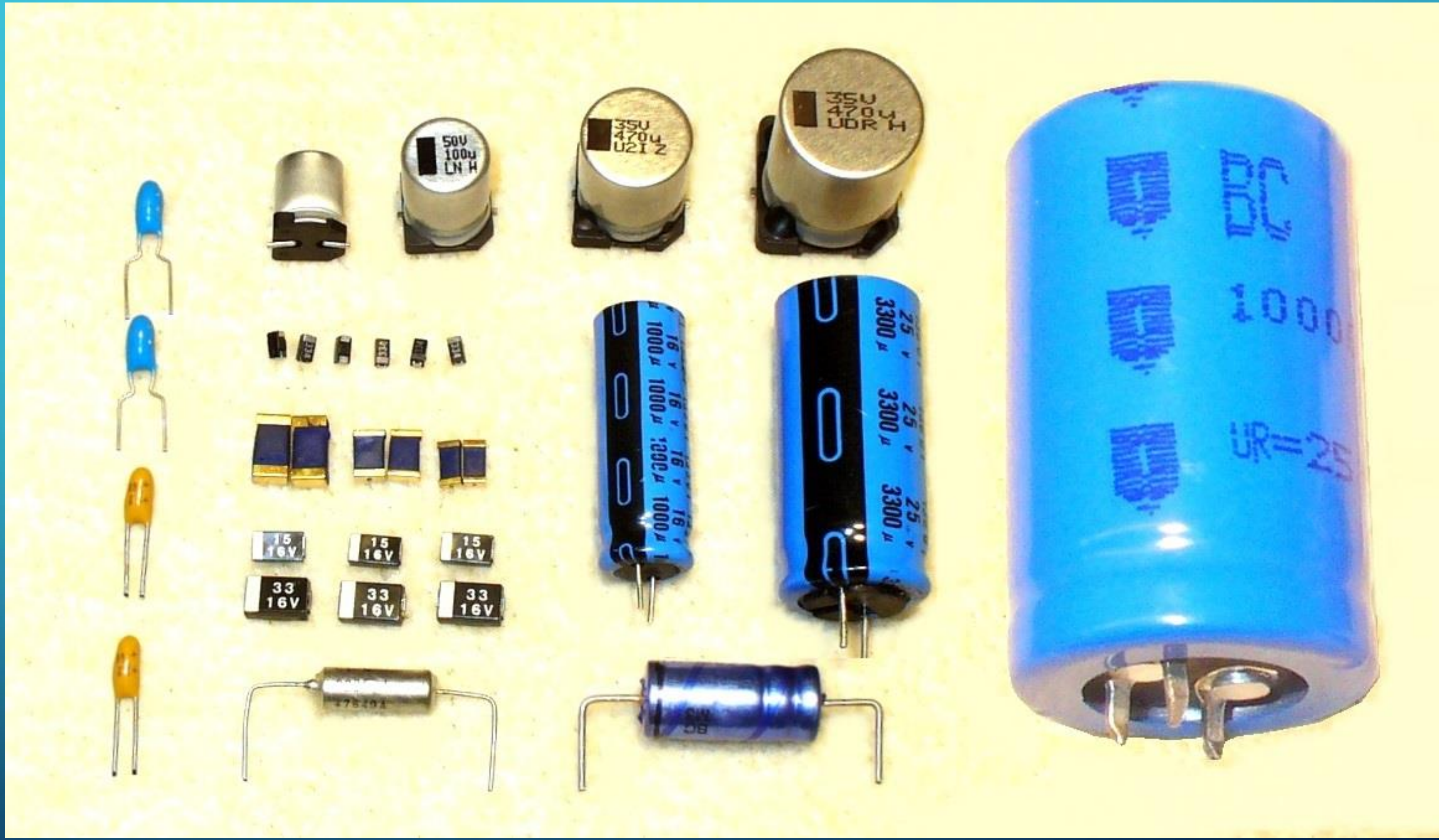
$$= 800\ \Omega$$

THINGS TO REMEMBER!

Resistors:

- Calculate power dissipation and always make sure power rating of resistor is greater than this
- Use resistors in parallel or series to boost power handling

CAPACITORS



50V
100u
LN H
35V
470u
U2I Z
35V
470u
UDR H
1000µ 16 V
3300µ 25 V
BC
1000
UR=25
15
16V
33
16V

CAPACITORS

CAPACITORS

CAPACITORS

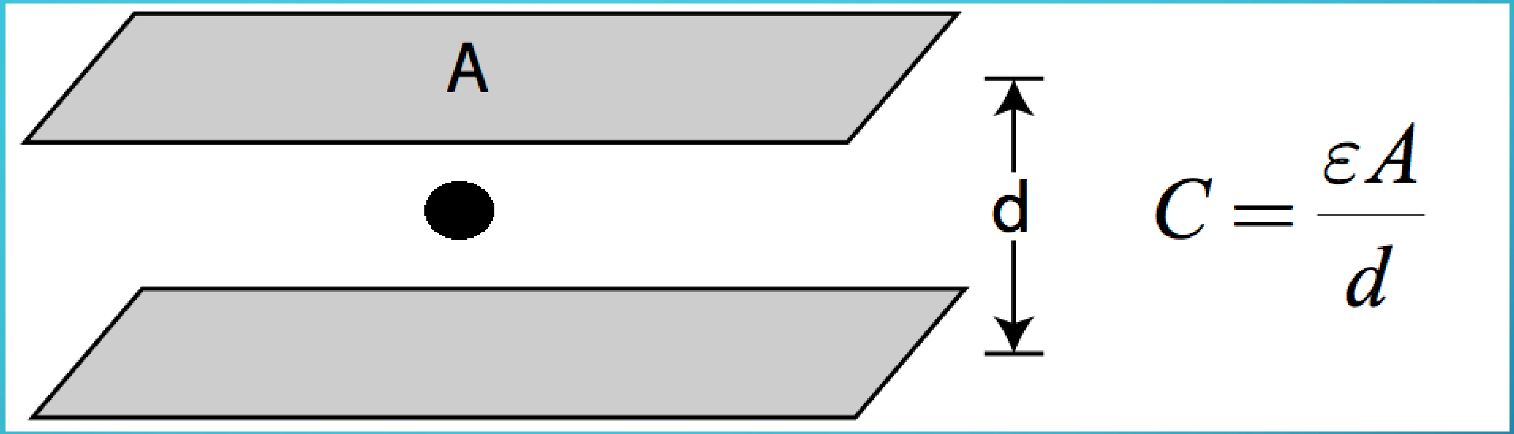
CAPACITANCE: WHAT IS IT?

"Capacitance is the ratio of the change in electric charge of a system to the corresponding change in its electric potential." *Wikipedia*

CAPACITORS: WHY WE USE THEM?

- Local energy storage
- Blocking DC voltages
- Smoothing voltage ripple
- Supressing noise and spikes
- Filtering or discriminating signals

CAPACITORS



Capacitance of two parallel plates:

$$C = \varepsilon_0 \times \varepsilon_r \times A / d$$

Where A: area (m^2)

d: distance between plates (m)

ε_0: permittivity (8.854×10^{-12} C N / m^2)

ε_r: relative permittivity (air = 1)

CAPACITORS

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ε_r: relative permittivity (air = 1)

We can use changes in capacitance to determine changes in moisture etc.

CAPACITANCE: WHAT IS IT?

How much electrical energy a component can store:

$$C = Q / \Delta V$$

where C : Farads

Q : Coulombs

V : Volts

CAPACITANCE: WHAT IS IT?

Since:

$$I = dQ / dt$$

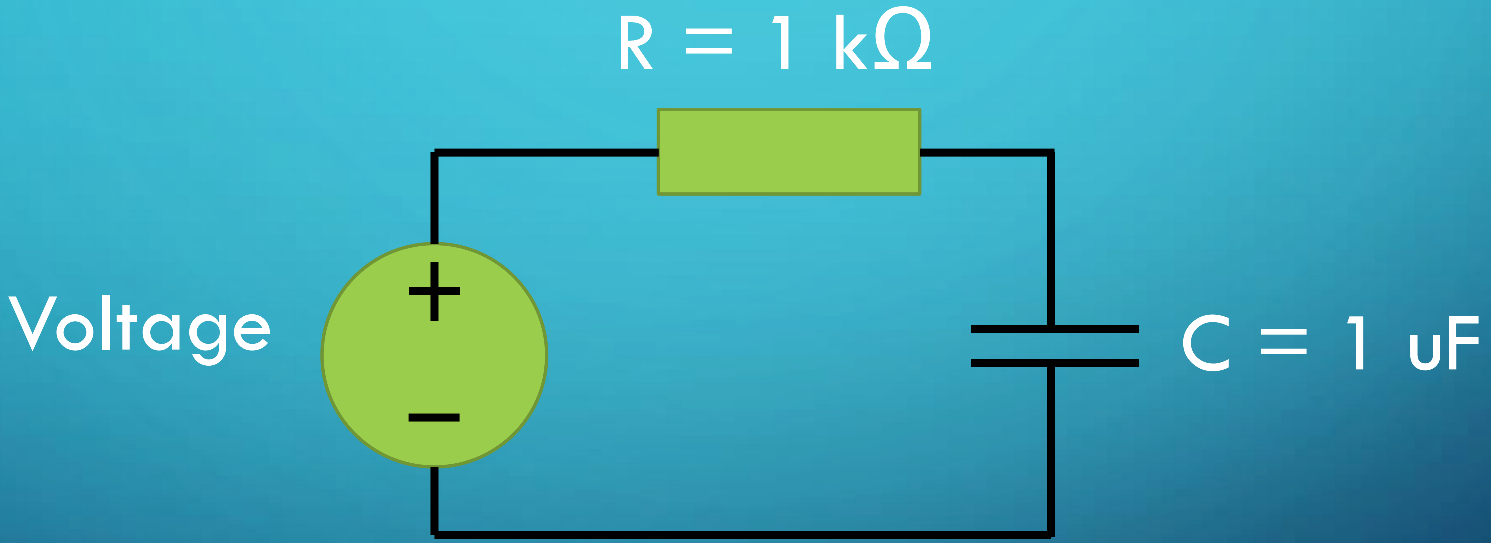
Then:

$$I = C\, dV / dt$$

This means the voltage across the leads of a capacitor can't change instantaneously!

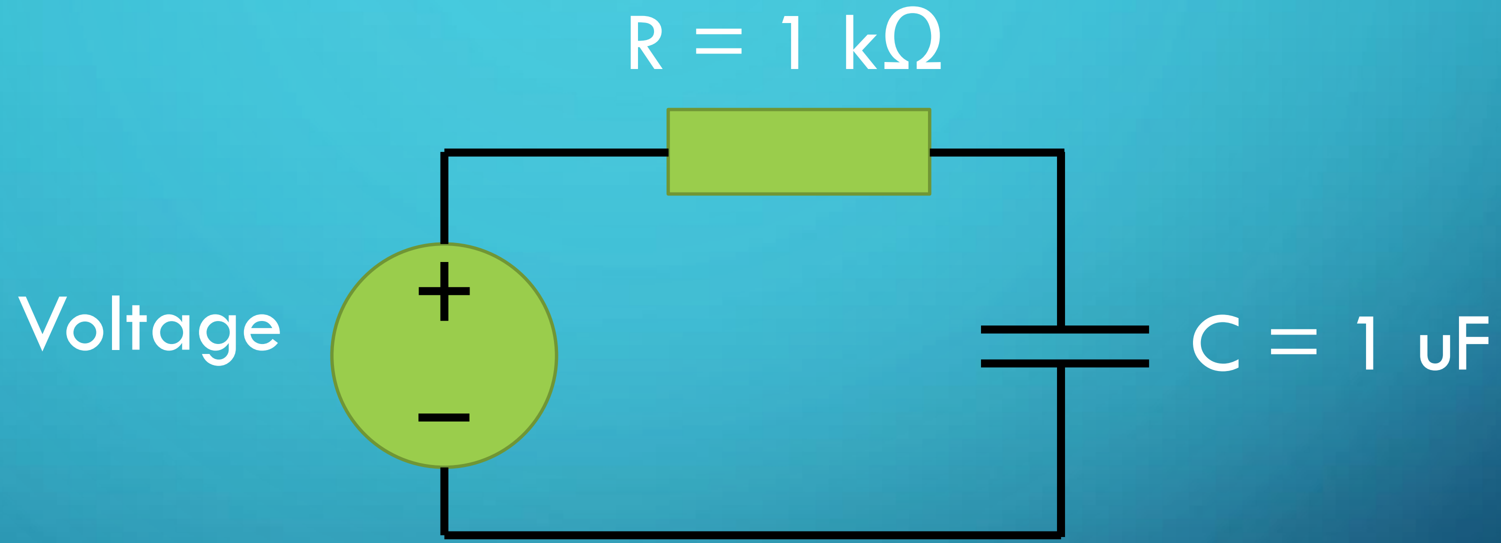
CAPACITORS WITH RESISTORS

Charging a capacitor:



CAPACITORS WITH RESISTORS

Charging a capacitor:



RC time constant (time for a capacitor to reach 2/3 of the charge voltage):

Tau = R x C

CAPACITORS IN CIRCUITS

In series:

CAPACITORS IN CIRCUITS

In series:

C1 = 1 uF   C2 = 4 uF

$$1/C_{total} = 1/C1 + 1/C2$$

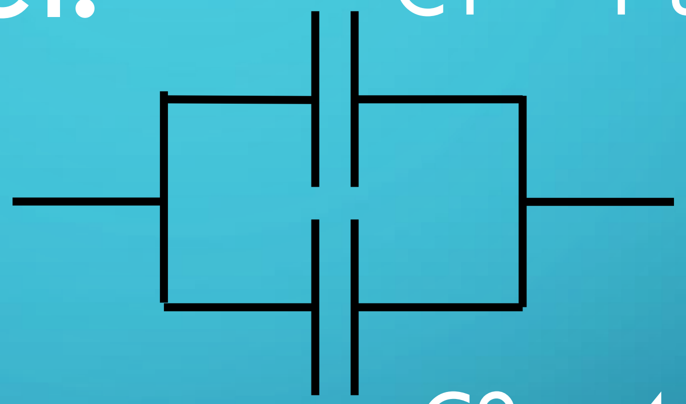
$$C_{total} = (C1 \times C2) / (C1 + C2)$$

$$= 0.8\ \text{uF}$$

CAPACITORS IN CIRCUITS

In parallel:

C1 = 1 uF



C2 = 4 uF

Ctotal = C1 + C2

= 5 uF

TYPES OF CAPACITORS

Electrolytic: Large values, large size, low cost,
unreliable at high temps, available at
high voltages, polarised

Tantalum: Medium values, medium size, mod cost
low to medium voltages, polarised

Ceramic: Small values, small size, low cost
low to medium voltages, *non*-polarised

THINGS TO REMEMBER!

Resistors:

- Calculate power dissipation and always make sure power rating of resistor is greater than this

Capacitors:

- Select capacitor based on required capacitance, size, characteristics and cost
- Make sure the operating voltage of the capacitor is always less than its rated voltage
- Ensure they have the right polarity

QUESTIONS?

DEMO: BUILD A CAPACITANCE METER

- Measure the time it takes to charge a capacitor to 2/3 its operating voltage

DEMO: BUILD A CAPACITANCE METER

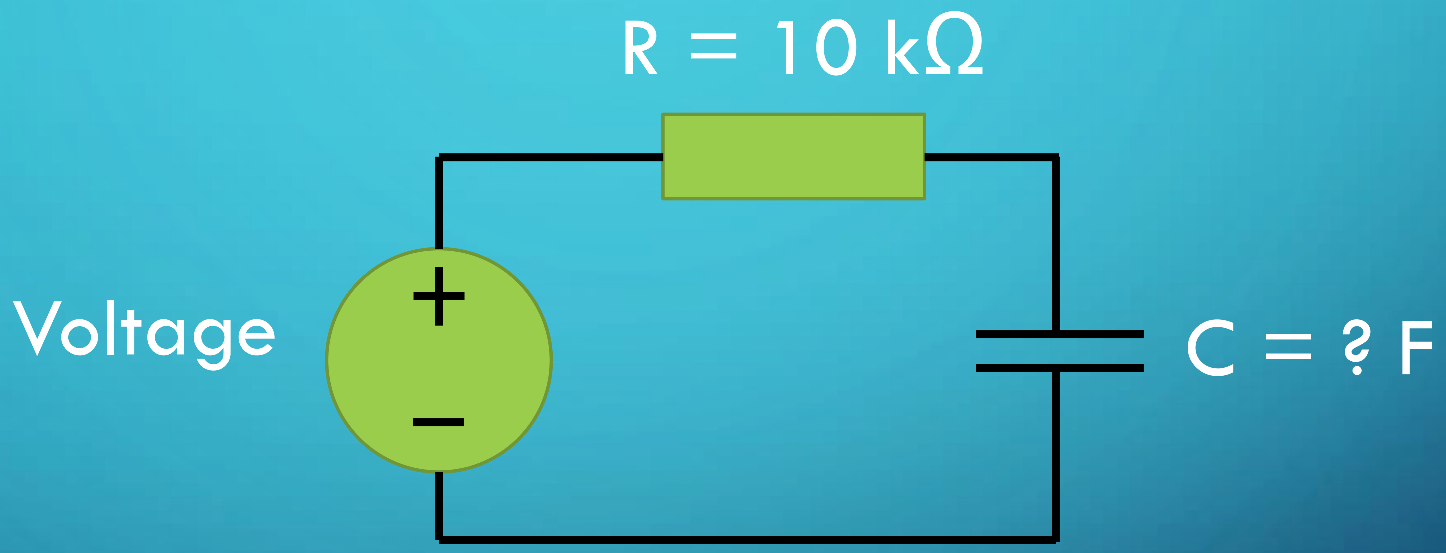
- Measure the time it takes to charge a capacitor to 2/3 its operating voltage
- Use this measured time constant and the known value of the resistor to calculate the capacitance

DEMO: BUILD A CAPACITANCE METER

Required:

- Capacitor to measure
- 4 resistors of the same value (ie. 10k)
- A comparator (eg. LM393)
- A pull-up resistor (1 to 10k)
- A Raspberry Pi

DEMO: BUILD A CAPACITANCE METER



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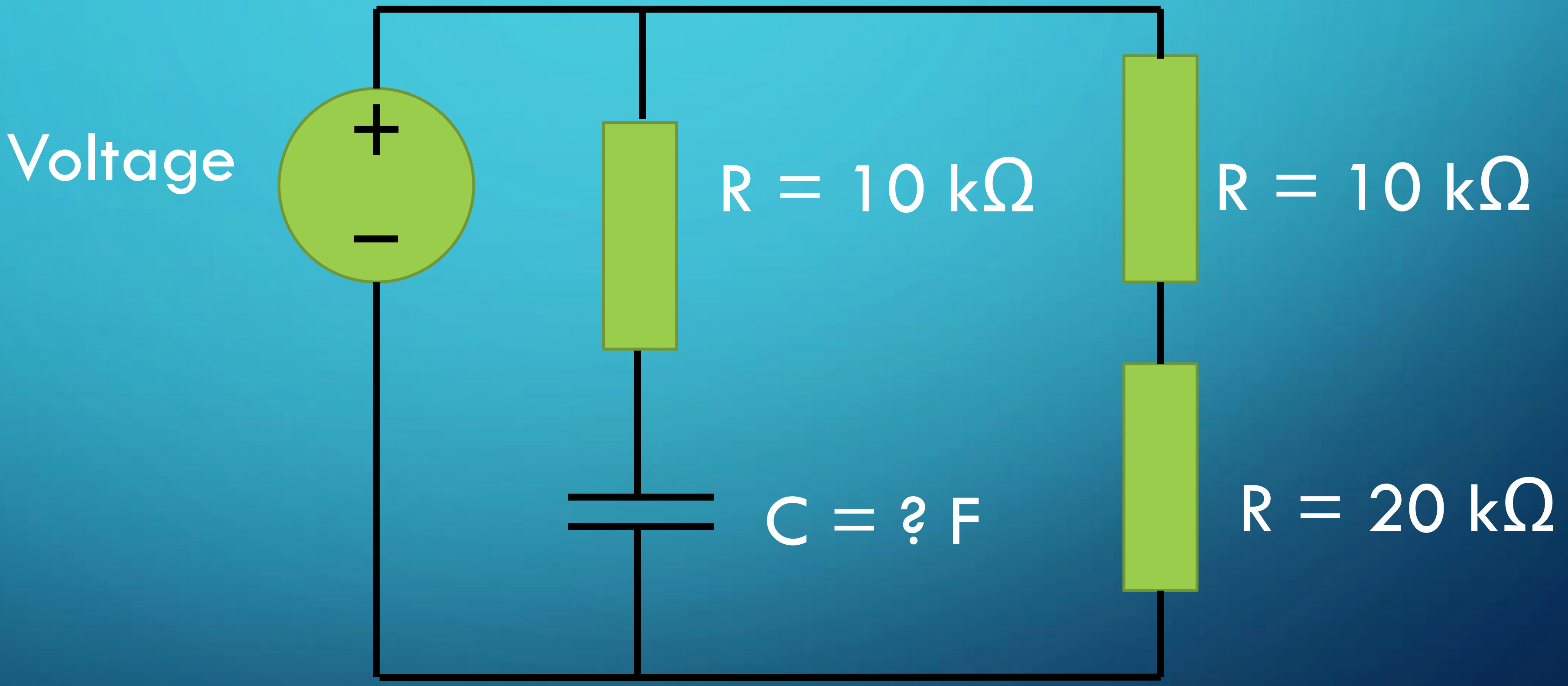

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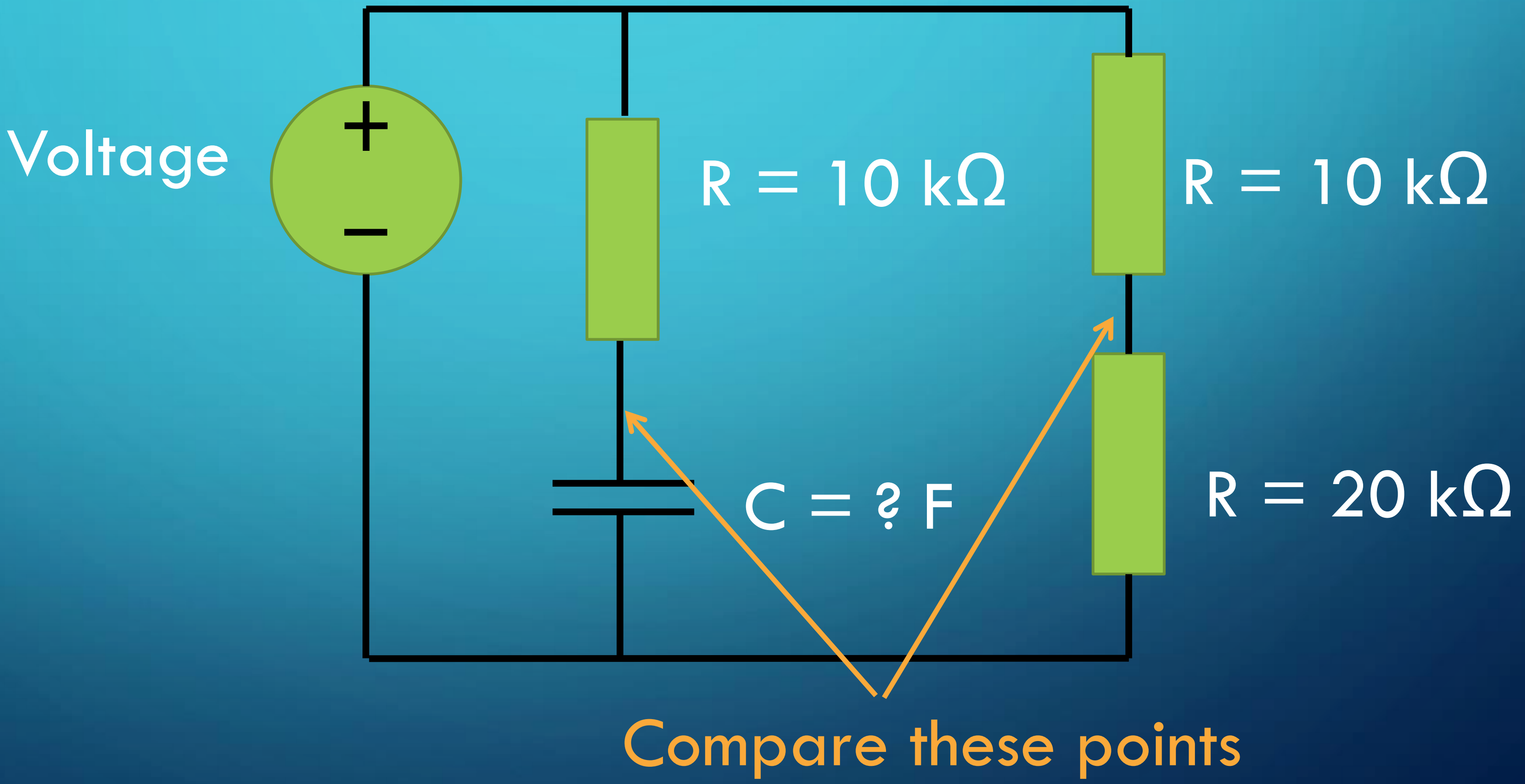

DEMO: BUILD A CAPACITANCE METER