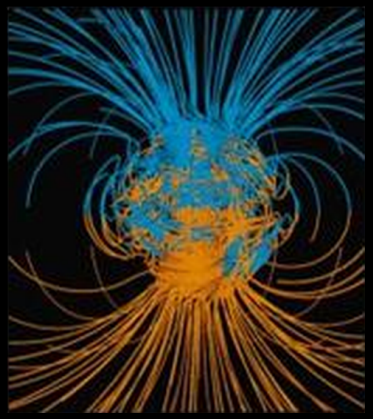


Phy2005
Applied Physics II
Spring 2016

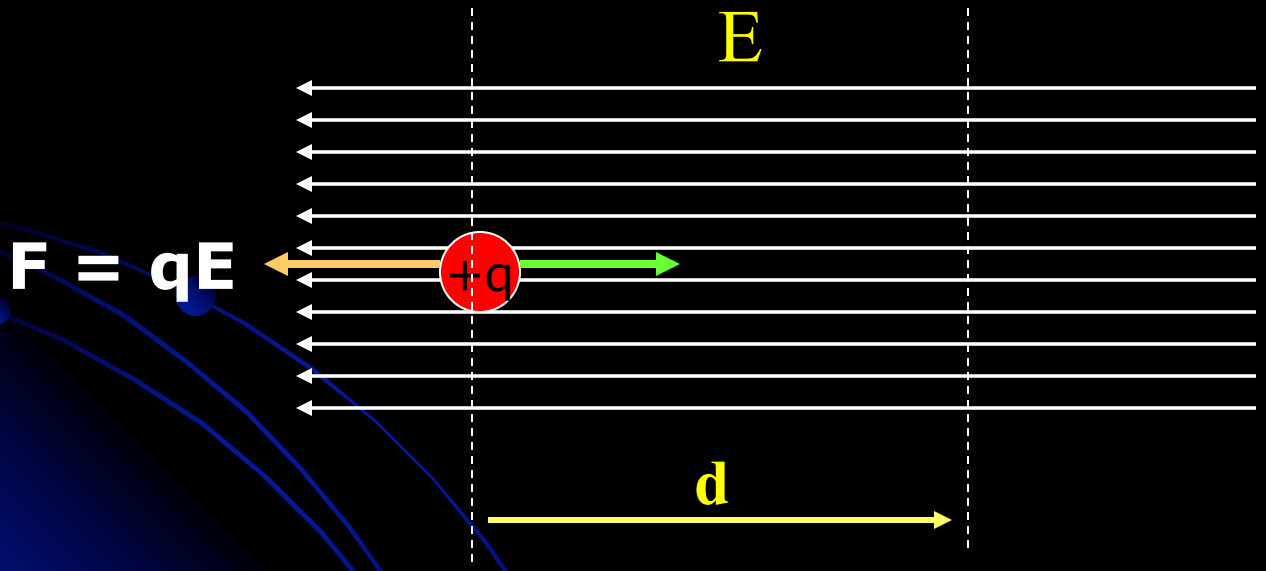
Announcements:

January	29	M	**9**	1, 5, 8, 11, 13, 17	20.1 - 20.5	capacitor, field line in capacitor	
January	31	W	**10**	23, 25, 26, 30, 35	20.6 - 20.11	current, resistance, Ohm's law, R-network	Ohm's law, series/parallel ct.
February	2	F	**11**	37, 38, 39, 43, 47, 51	20.12 - 20.14	power, resistivity	copper-steel wire, electron drift

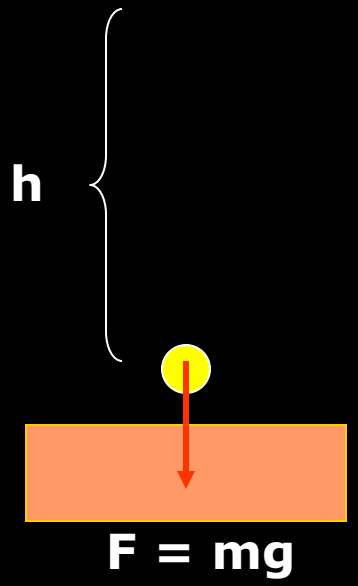
- Solutions to chapter 19 problems posted on HW page today.
- Answers to chapter 20 problems posted on HW page soon.
- On *Friday*, one Top Hat Question will be "directly" from HW

Last time: Electric potential/potential energy

Electric Potential Energy
(move the charge against the field with your hand)



Gravitational Potential Energy



Electric Potential Difference

$\Delta\varepsilon$ = E-pot. Energy/charge

$= qEd/q = Ed$

$[\varepsilon] = N.m/C$

$= J/C$

$=$ Volt

Electric potential has nothing to do with the type and size of the charge!

As you follow the electric field lines, the electric potential gets LOWER.

Today: Circuit elements: 1) capacitors

Science news page

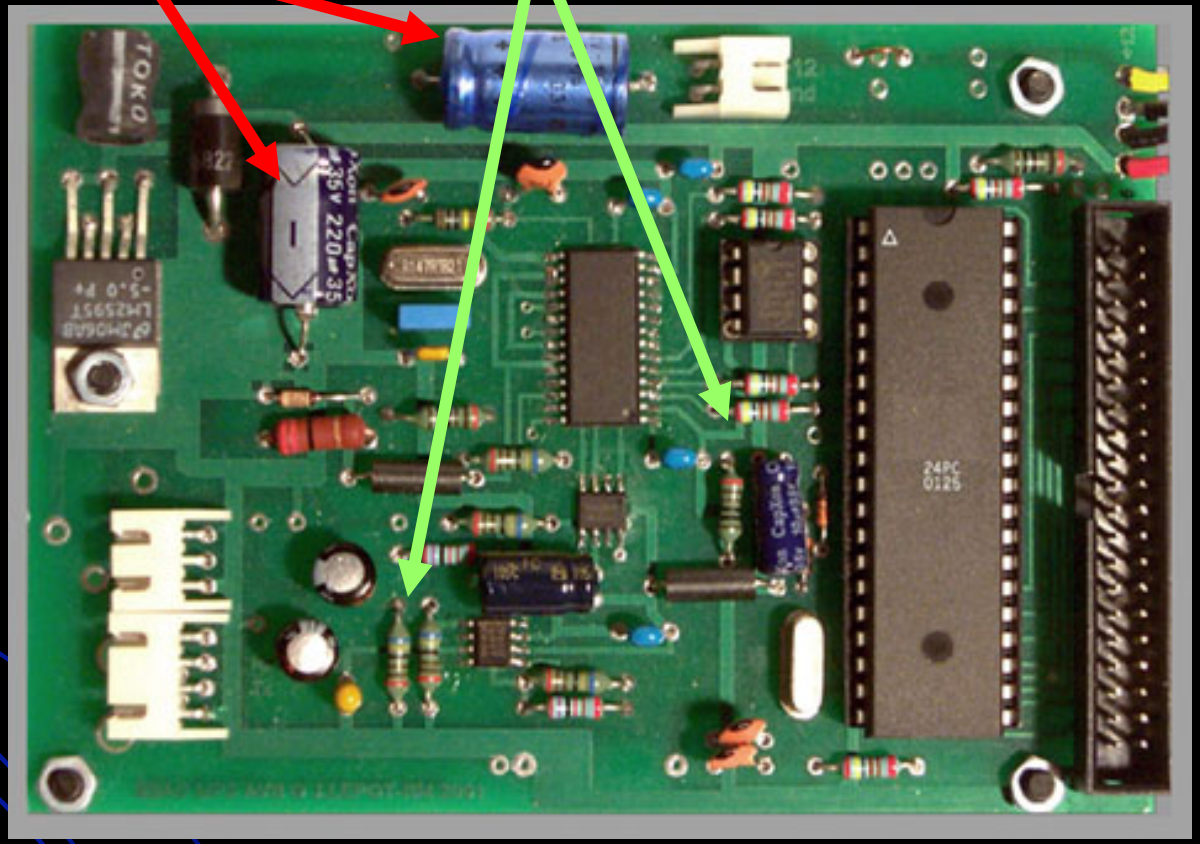
Rap Battle With B.o.B Over Flat Earth Theory

Link: NPR

"Aye, Neil Tyson need to loosen up his vest / They'll probably write that man one hell of a check."

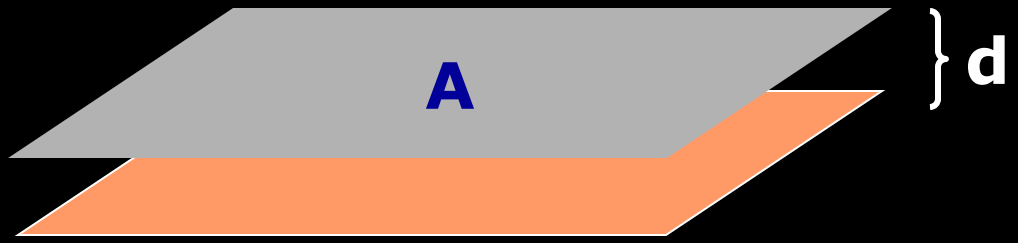
"I see only good things on the horizon / That's probably why the horizon is always rising / Indoctrinated in a cult called science / And graduated to a club full of liars."

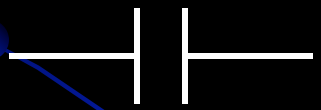
Circuit Elements: capacitor, resistor, and Ohm's law

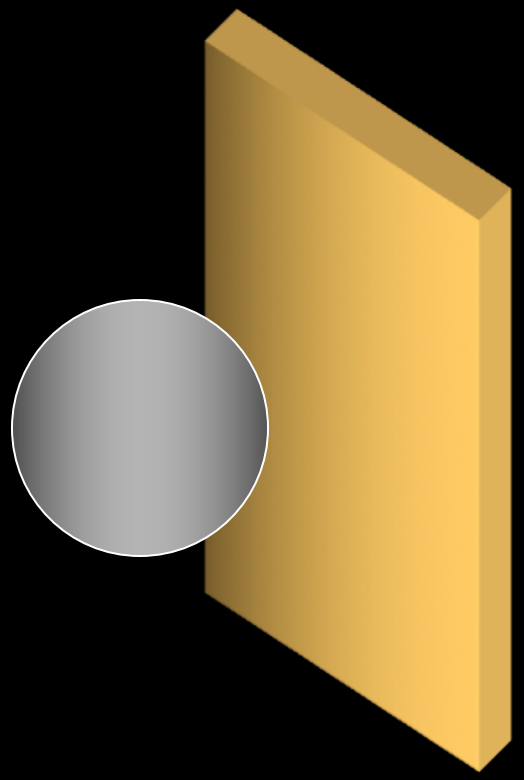


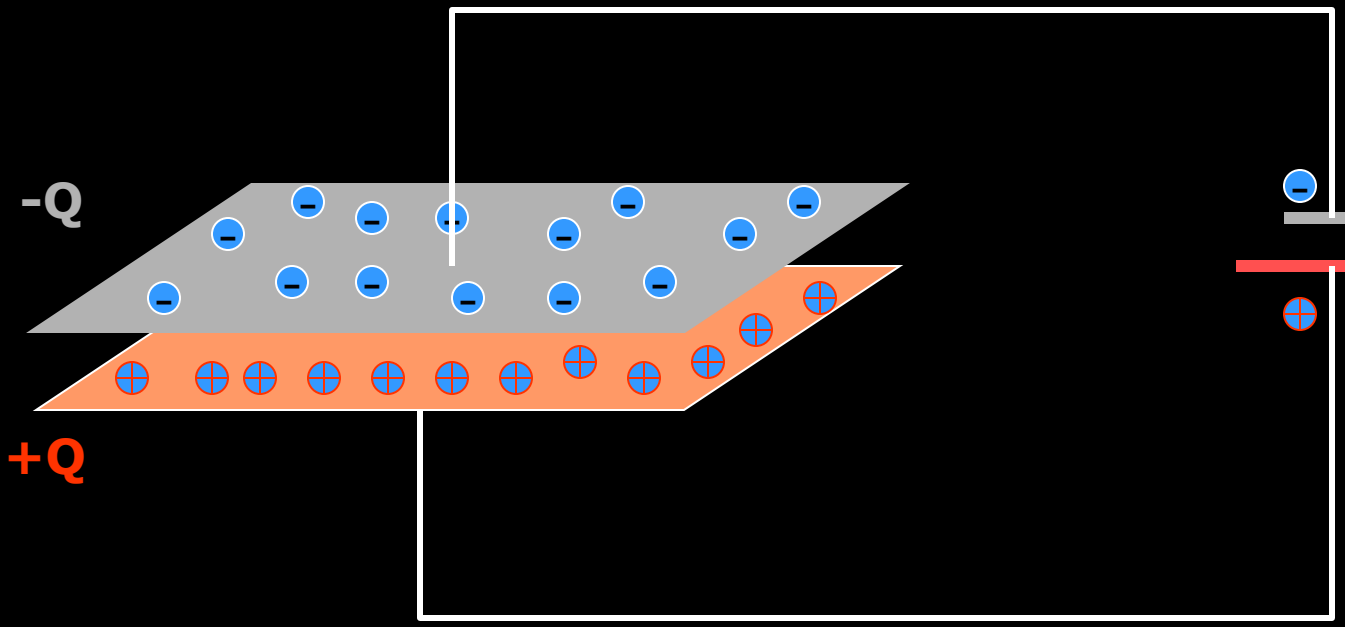
Capacitors

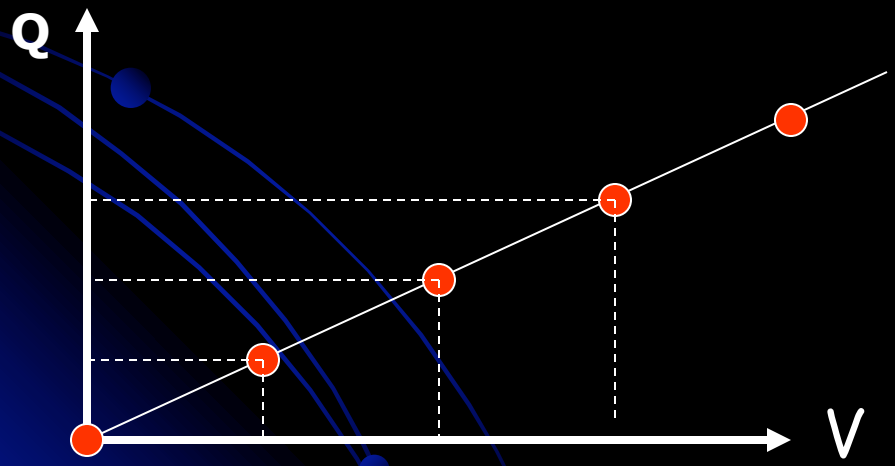
Any two conductors separated by an insulator: capacitor











$$Q = C\,V$$

Capacitance

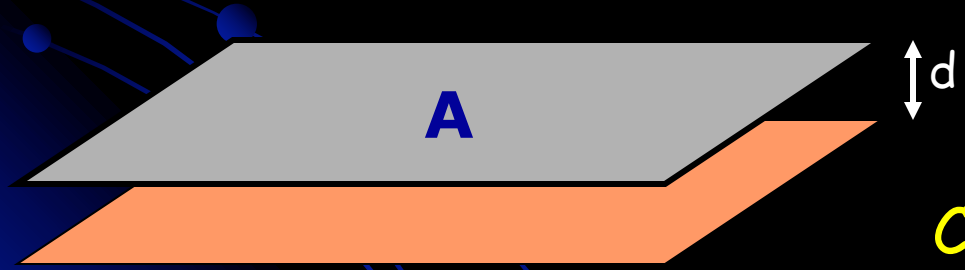
$$Q = CV$$

Unit of capacitance: $[C] = [Q/V] = C/V = F$ (farad)

Capacitance: measure of charge stored per unit potential difference

Ex. When a capacitor is connected to a 9-V battery, 3 μC of charge is stored. What is the capacitance?

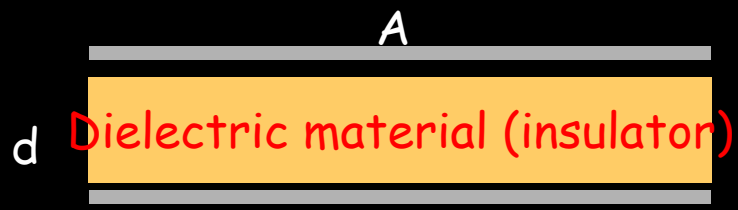
$$C = Q/V = (3 \times 10^{-6}\ C)/9\ V = 0.33\ \mu F$$



$C = \varepsilon_o A/d$
for a parallel plate capacitor

Note: ε_o related to Coulomb's const. k:
$k = 1/(4\pi\ \varepsilon_o)$

ε_o: permittivity of free space
8.85×10^{-12} F/m



$C = K \varepsilon_0 A/d$

K: dielectric constant (material property)

material	K
vacuum	1
glass	7.5
rubber	3.0
oil	4.0
water	80.4

Ex 10-1 Each plate of a parallel capacitor is 2 cm wide and 2 cm long. What separation between the plates is required to have a capacitance of 6 pF?

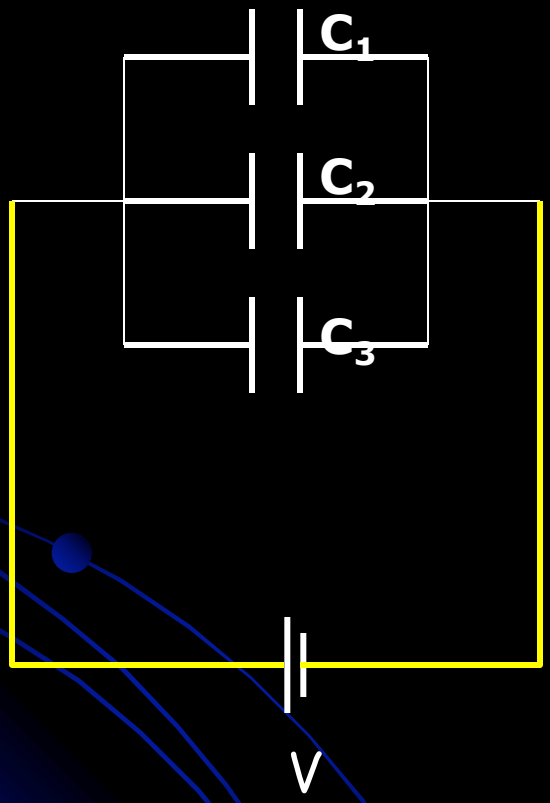
$d = 0.59$ mm

Ex 10-2 The 6 pF capacitor constructed in the previous Ex. is now immersed in oil. Will the capacitance change? If yes, what is the new capacitance value?

C = 24 pF

material	K
vacuum	1
glass	7.5
rubber	3.0
oil	4.0
water	80.4

Parallel connection

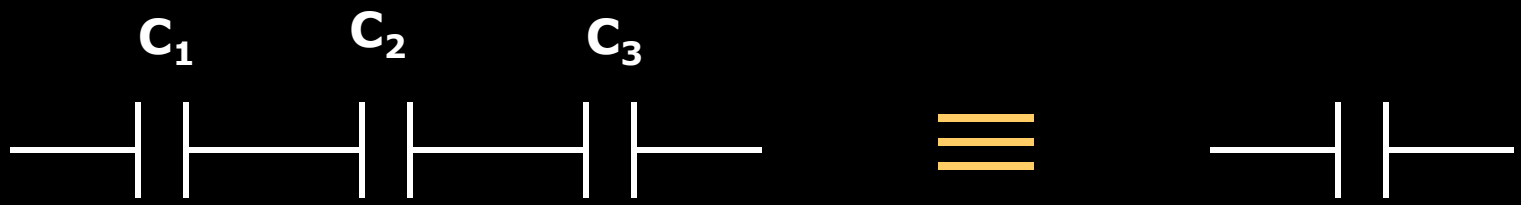


≡

$$C_{eq} = C_1 + C_2 + C_3$$

$$V_1 = V_2 = V_3 = V$$
$$Q_1 + Q_2 + Q_3 = Q$$

Series connection



$$1/C_{eq} = 1/C_1 + 1/C_2 + 1/C_3$$

$$Q_1 = Q_2 = Q_3 = Q$$
$$V_1 + V_2 + V_3 = V$$

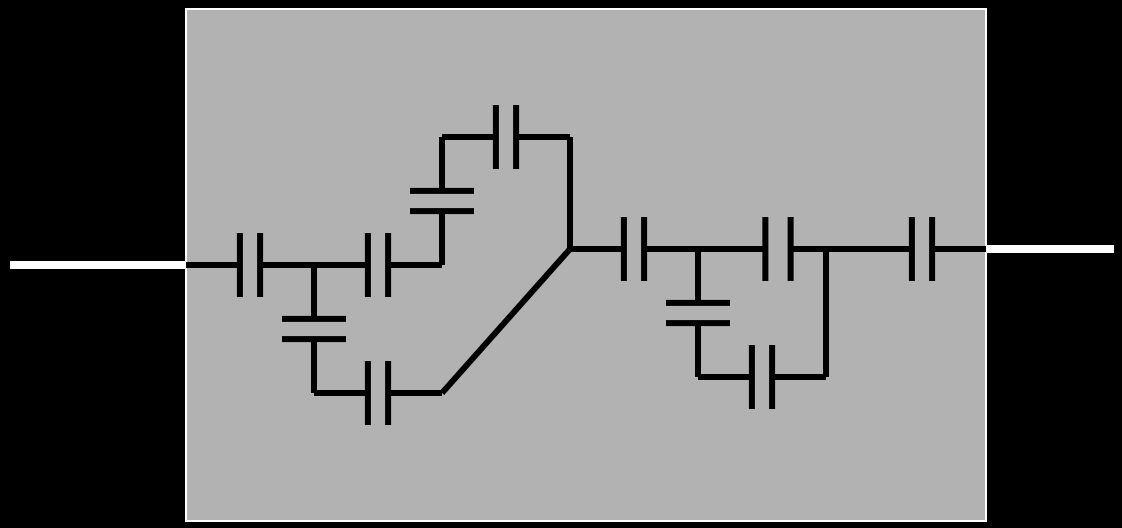
Ex 10-3 Two capacitors of 3 μF and 6 μF are connected in parallel. What is the equivalent capacitance?

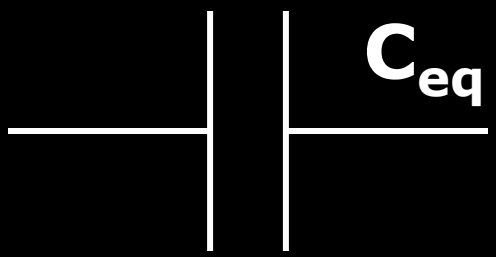
$$C_{eq} = C_1 + C_2 = 9\ \mu F$$

Ex 10-4 Two capacitors of 3 μF and 6 μF are connected in series. What is the equivalent capacitance?

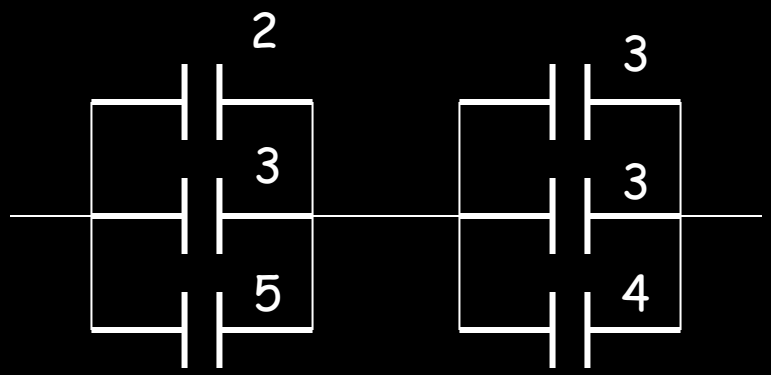
$$1/C_{eq} = 1/C_1 + 1/C_2 = ½$$

$$C_{eq} = 2\ \mu F$$




C_{eq}

Ex 10-4 What is the equivalent capacitance of the following circuit? Capacitance in pF.



$C_{eq} = 5$ pF

Top Hat Quiz Time

ACADEMIC HONESTY

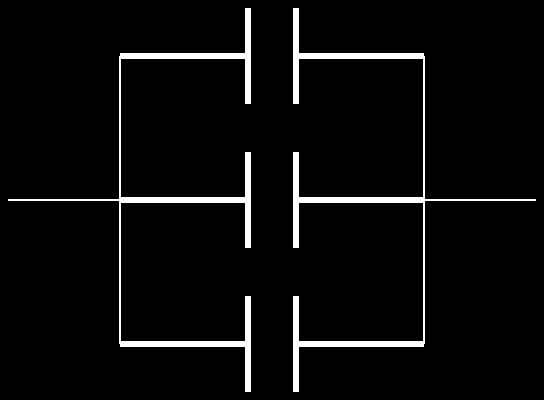
Each student is expected to hold himself/herself to a high standard of academic honesty. Under the UF academic honesty policy. Violations of this policy will be dealt with severely. There will be no warnings or exceptions.

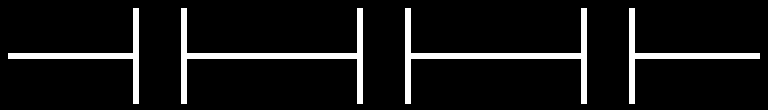
Have your phone ready!

Q1 (Prob. 20.1) A potential difference of 25 V exists across a 0.75F capacitor. How large is the charge on the capacitor?

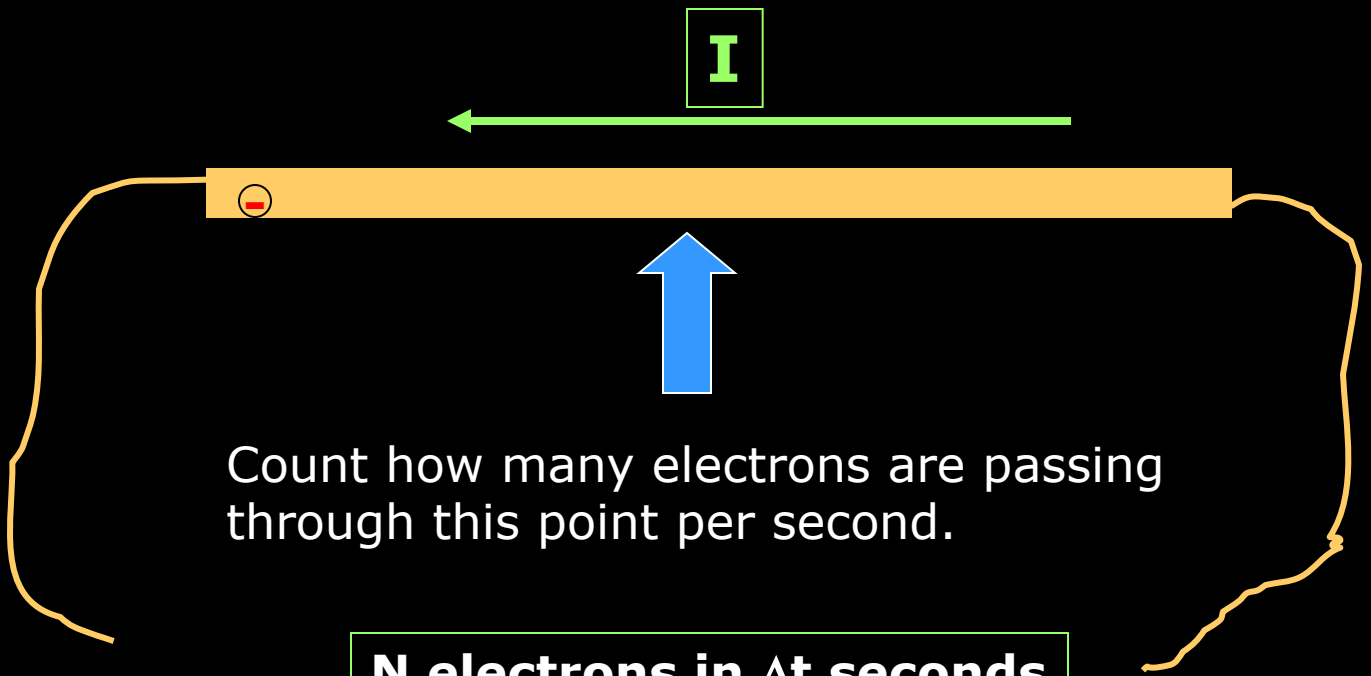
1. 19 mC
2. 0.3 N
3. 0.3J
4. 0.3C
5. 19 μC

Q2 Two circuits are constructed with identical 1 pF- capacitors. What are the equivalent capacitances?





1. 3 pF 3 pF
2. 1/3 pF 3 pF
3. 3 pF 1/3 pF
4. 1/3 pF 1/3 pF
5. 1/3 pF 2/3 pF



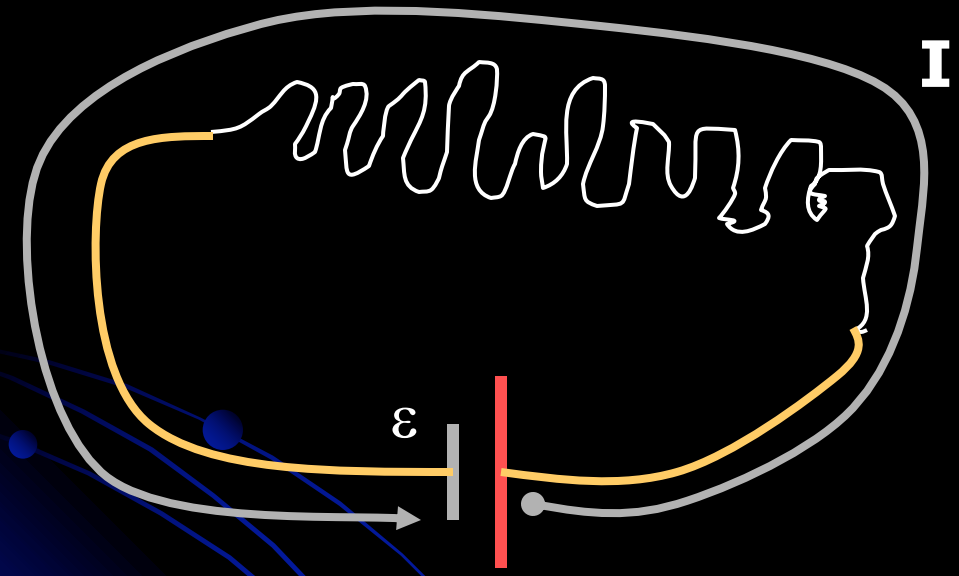
Electric current I = Ne/Δt [C/s = Ampere]

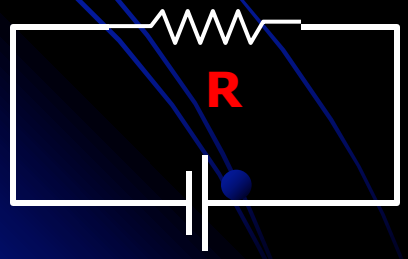
Current (I):

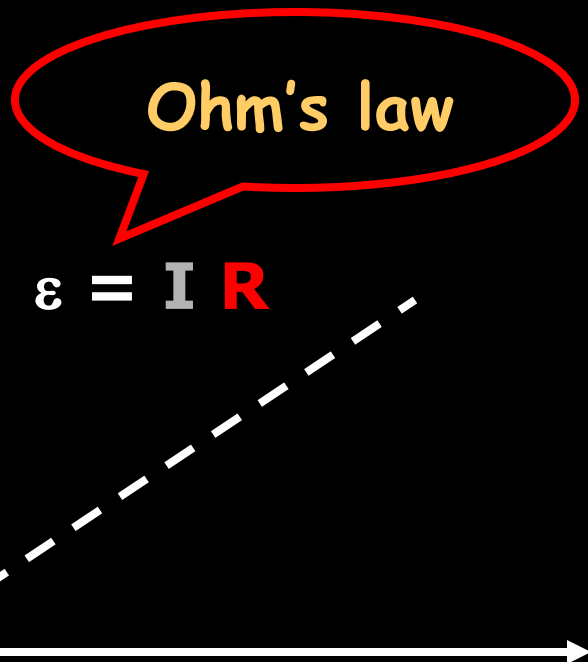
amount of charge flowing through a point per unit time

[I] = C/s = A (ampere)

Current flows from higher potential to lower potential.





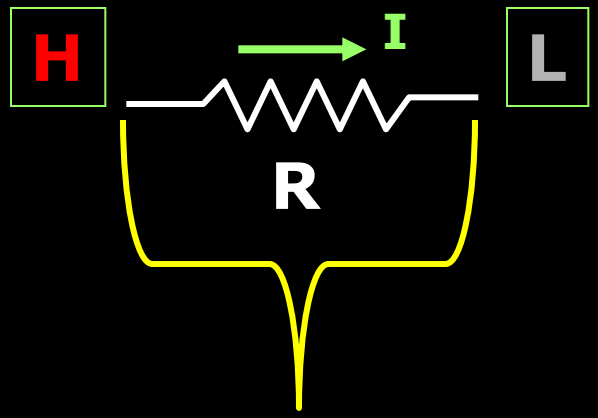


$V = R\,I$

Resistance, $R = V/I$

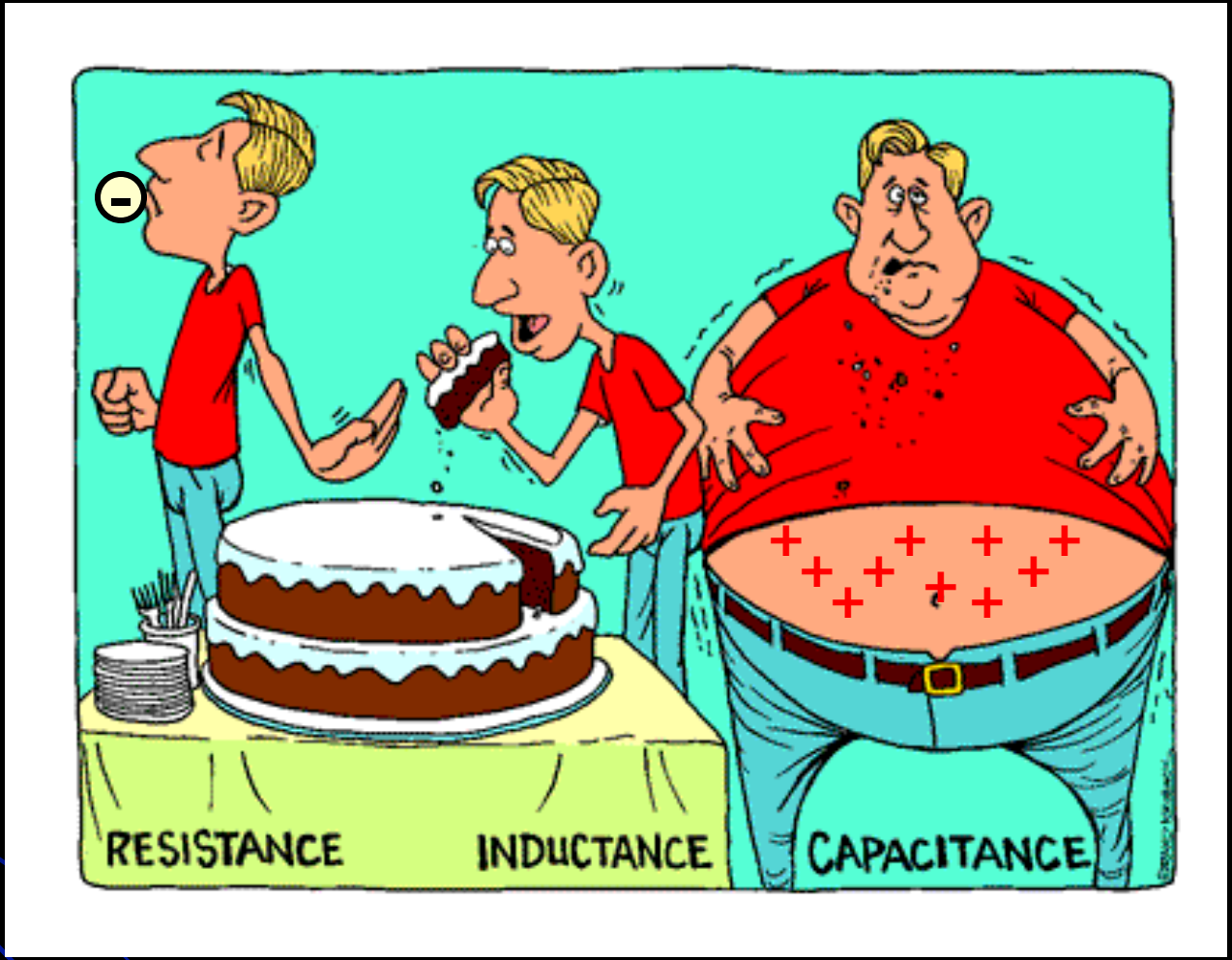
$[R] = V/A = \Omega$ (Ohm)

·For a fixed potential difference across a resistor, the larger R, the smaller current passing through it.



Develop a potential difference

$V = RI$

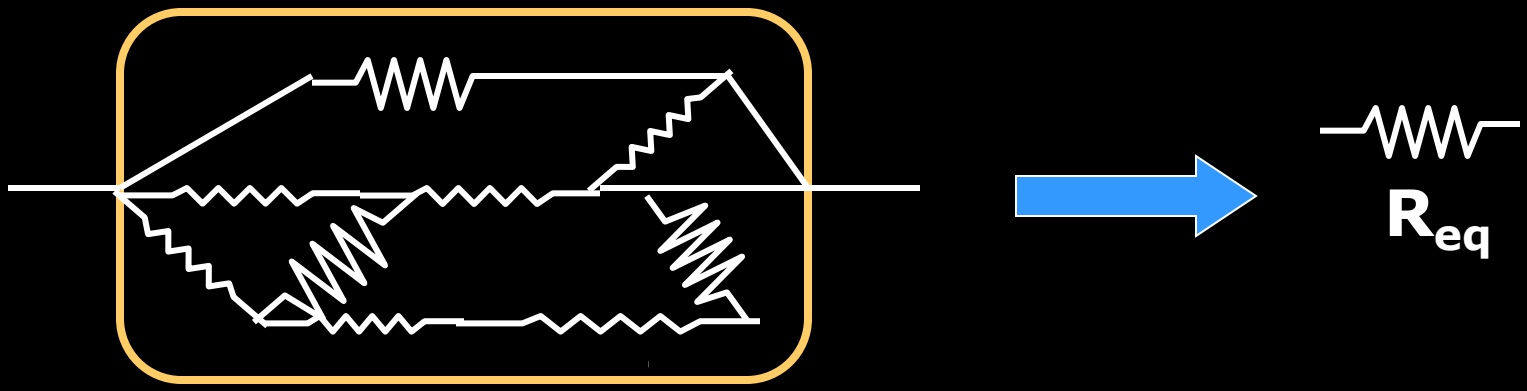


$R = V/I$
$V = IR$
$I = V/R$

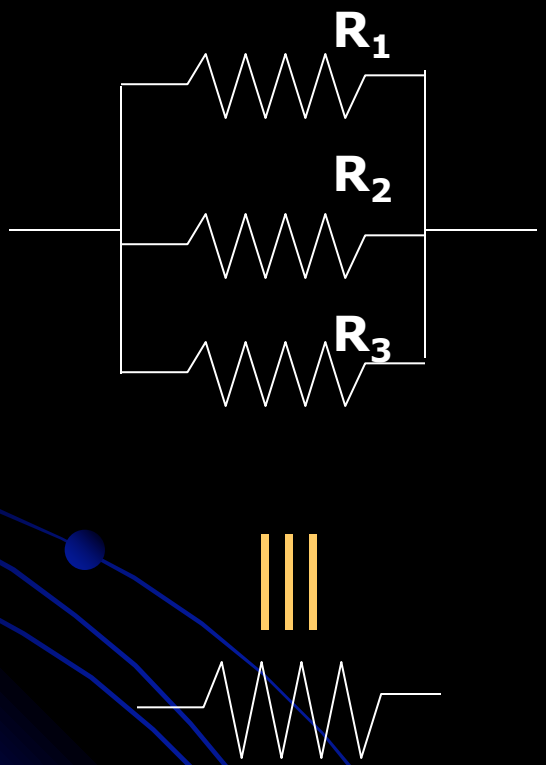
Ohm's Law

How much charge can it hold per Unit potential difference?

$C = Q/V$ [farad]

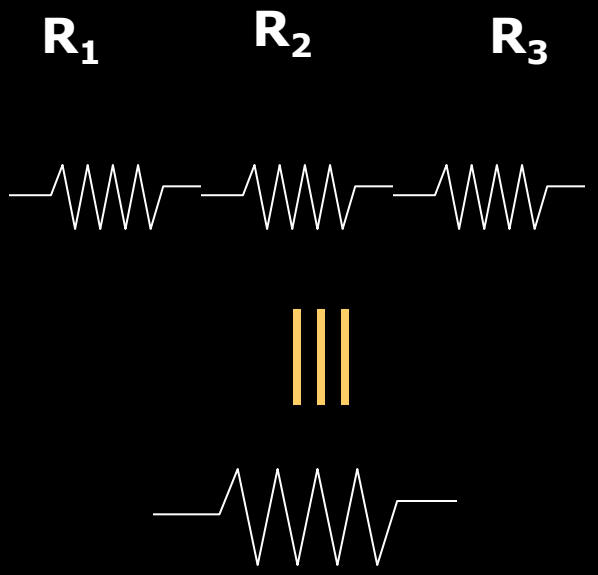

R_{eq}

Parallel connection



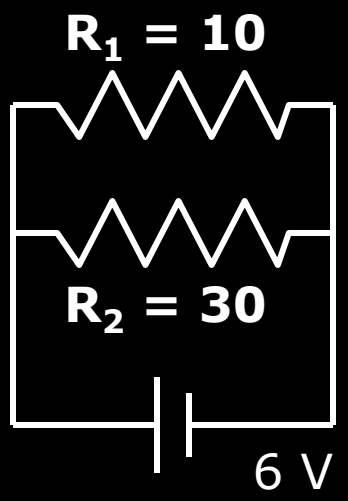
$$1/R_{eq} = 1/R_1 + 1/R_2 + 1/R_3$$

Series connection



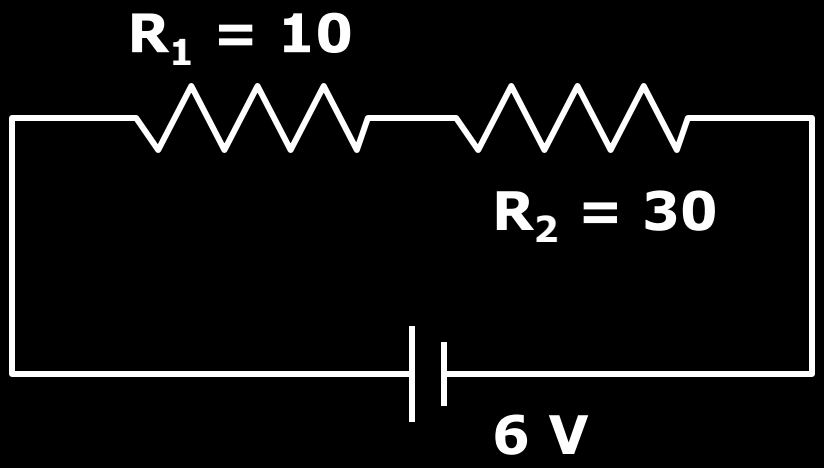
$$R_{eq} = R_1 + R_2 + R_3$$

Q2. What is the ratio of the current flowing through each resistor (I_1:I_2) in the circuit?



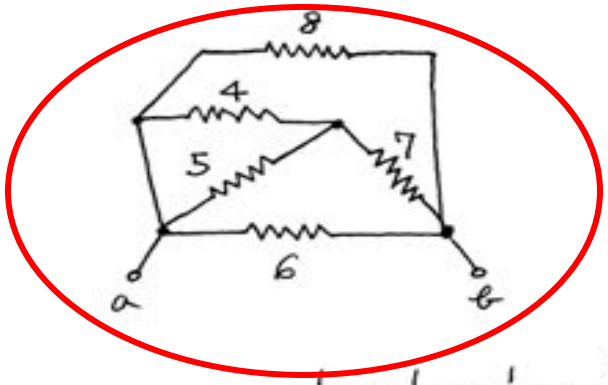
1. 1:1
2. 3:1
3. 1:4
4. Need more info.

Q3. What is the ratio of the current flowing through each resistor (I_1:I_2)?



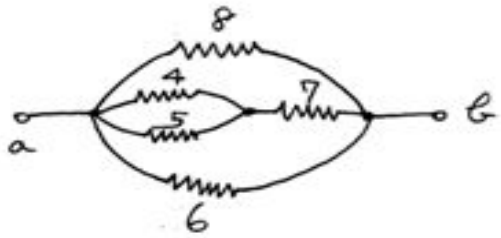
1. 1:1
2. 3:1
3. 1:4
4. None of above

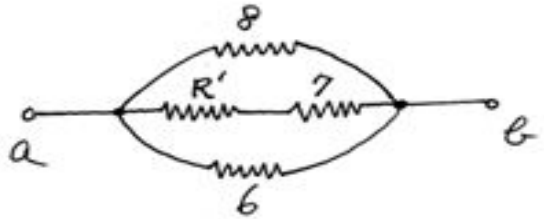
- No potential difference along the electrical wire (assume R = 0).
- Electrical wires can be bent and/or stretched.
- A Node point (branching point) can be moved arbitrarily along the wire (but cannot cross circuit elements).



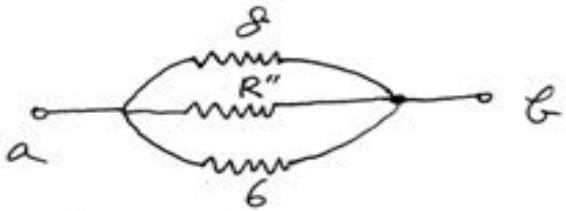
$$\frac{1}{R'} = \frac{1}{4} + \frac{1}{5} = \frac{9}{20}$$

$$R' = 2.22$$





$$R'' = R' + 7 = 9.22$$



$$\frac{1}{R_{eq}} = \frac{1}{8} + \frac{1}{R''} + \frac{1}{6}$$

$$R_{eq} = 2.50$$