Electromagnetism

Name: ____________________

Video 1203 (5:25)

Electrostatics:

Electric charge is <u>quantized</u>:

-- charge is measured in coulombs (C)

-- charge on one p^+ or e^- =

-- WHICH of these particles tend to move?

-- WHY?

<u>law of conservation of charge</u>:

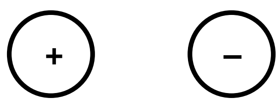
EX. When a balloon is rubbed against denim, the denim loses 6.56×10^8 electrons. What is the net charge on the balloon? On the denim?

EX. Assume that we measure that a conductor loses -1.05×10^{-18} C of charge. How many e^- did it lose?

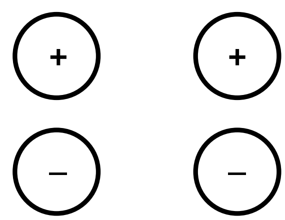
Video 1206 (4:40)

Electrostatic force can be:

ATTRACTIVE



REPULSIVE



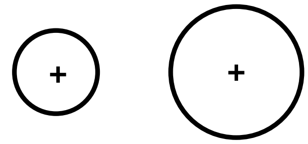
Magnitude of elec. force between two charges is found using Coulomb's law:

$k_c = 9 \times 10^9$ N·m^2/C^2

q = magnitude of charge (C)

r = separation between charges (m)

EX. A $+4.0 \times 10^{-8}$ C charge and a $+7.6 \times 10^{-9}$ C charge are 28 cm apart. Find the magnitude and direction of the electric force between them.

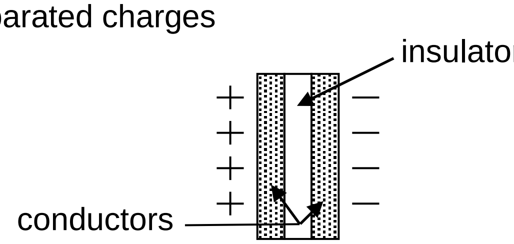


EX. How far apart must two protons be for them to repel each other with a force of 7.6×10^{-26} N?

Video
1209
(5:29)

<u>capacitor</u>: stores electrical energy by virtue of separated charges

<u>capacitance</u>: a measure of capacitor's ability to store charge/energy



Depends on: 1.

2.

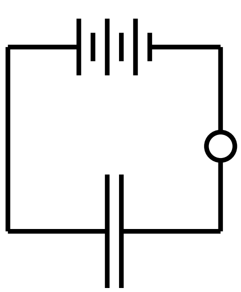
values of dielectric constant κ: vacuum…1.00000
air………. 1.00059
water…….80

One equation for capacitance: C = capacitance (F) $\varepsilon_o = 8.85 \times 10^{-12}$ $C^2/N \cdot m^2$
A = area of one plate (m^2) d = plate separation (m)

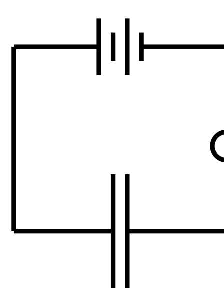
Capacitance can be measured another way. A potential difference ΔV applied to the plates causes:

one plate to get a charge of +Q and **the other to get a charge of –Q**

Circuit A



Circuit B



Second equation for capacitance:

Video 1212 (6:16)

EX. Capacitor of capacitance 5.5 μF is connected to a potential difference of 18 V. How many e^- will move from one plate to the other?

EX. Capacitor ^{w}/rubber as dielectric (κ = 4.8) has plate area 2.0 cm^2 and plate separation 1.0 mm. For a 9.0 V potential difference, how much charge will each plate store?

Video 1215 (3:36)

Because it takes work to separate electric charges, capacitors store…

-- unit is…

Equation:

EX. Find energy stored when a 0.33 μF capacitor is connected across a 120 V potential difference.

Electric Current and Circuits

<u>current</u>: the rate of charge flow (NOT the speed of charge flow)

Amount of Charge Flow	**Time of Flow**	**Rate of Charge Flow**
100 charges	2 s	
500 charges	25 s	

One equation for current:

EX. 5.8 C of charge flow through a bulb filament in 3.1 s. Find current.

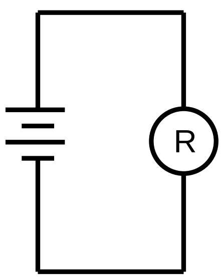
How many e^- flow through the bulb in one hour?

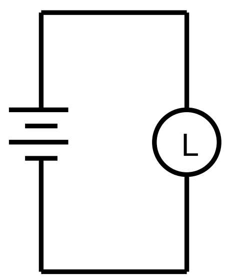
EX. If 1.0 mole of e^- flow through an appliance in 5.6 hours, find current pulled by appliance.

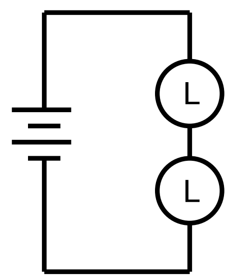
Video
1230
(6:29)

Ohm's Law

Voltage is an electric…

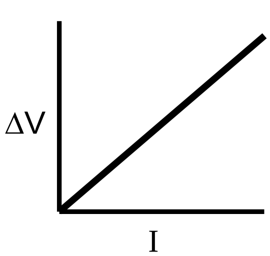






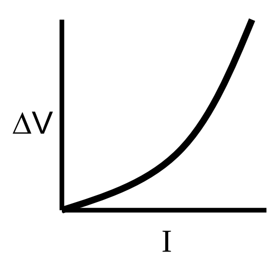
Equation for Ohm's law:

R = resistance, in ohms (Ω)



<u>ohmic</u> resistor

--



<u>non-ohmic</u> resistor

--

EX. Hair dryer ^{w}/resistance 280 Ω is plugged into a standard outlet.

What current flows through hair dryer?

Suppose hair dryer is plugged into an outlet with potential difference 220 V. Find current.

Video 1233 (4:53)

Electric Power Equation**:**

P = power rating / power consumed (W)

EX. A microwave has power rating 1.0×10^3 W. What current flows through it?

EX. A refrigerator "pulls" 6.25 A. What is its power rating?

EX. What is the resistance of a 75 W light bulb?

For a 100 W bulb…

Video 1236 (3:01)

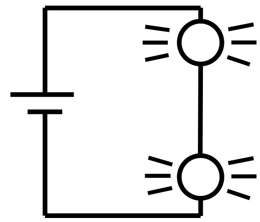
Cost of Electricity Equation:

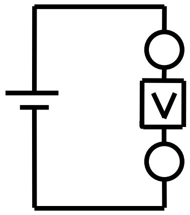
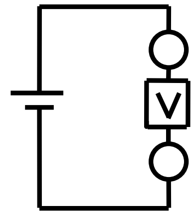
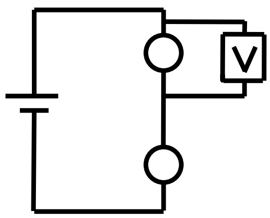
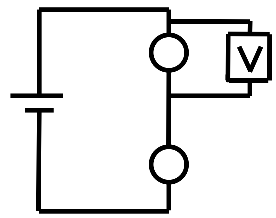
EX. A drying oven in a chemistry lab pulls 4.0 A and runs constantly. Electricity costs $0.080/kWh. Find the cost to run the oven for one year.

Video 1239
(6:18)

<u>voltmeter</u>: measures…

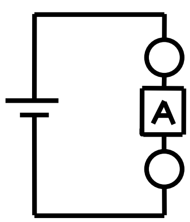
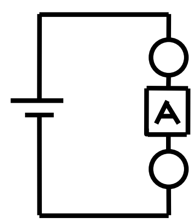
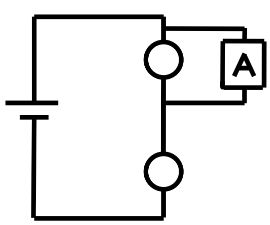
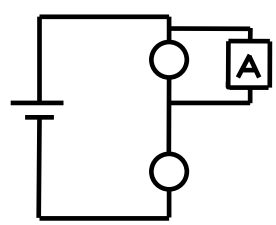
TARGET CIRCUIT



	low resistance	high resistance
series		
parallel		

voltmeter →

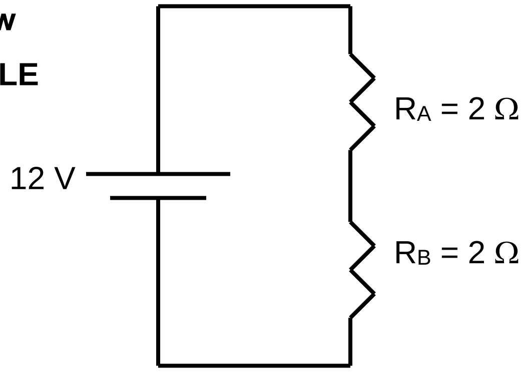
<u>ammeter</u>: measures…

	low resistance	high resistance
series		
parallel		

ammeter →

Ohm's Law and CASTLE

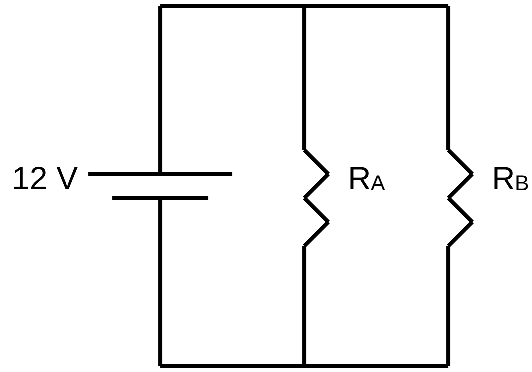
Video 1242 (5:46)



I_A =

I_B =

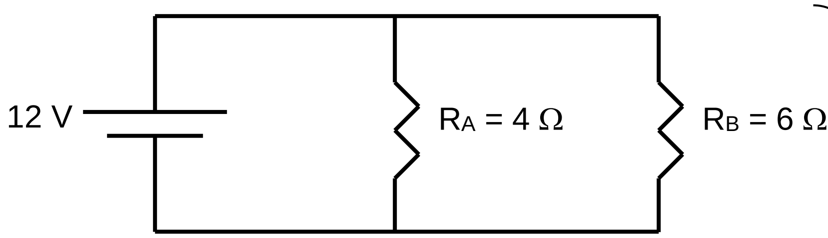
I_{BATT} =



I_A =

I_B =

I_{BATT} =



I_A =

I_B =

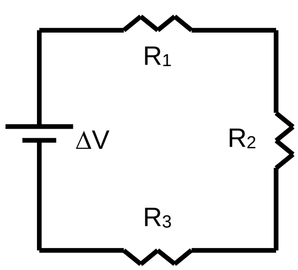
I_{BATT} =

Video 1245 (6:40)

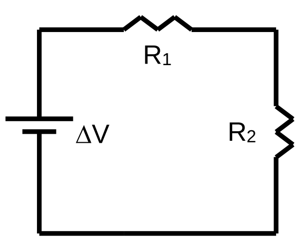
Series Circuits

<u>equivalent resistance</u>: the resistance of several resistors taken together; it depends on the value of each resistor and on the configuration of resistors

For series circuits:



	ΔV (V)	**I (A)**	**R (Ω)**
Batt.	**24**		
R_1			**2**
R_2			**6**
R_3			**4**

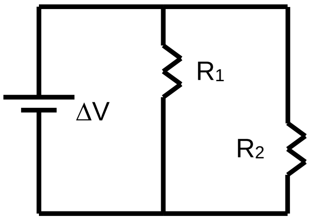


	ΔV (V)	**I (A)**	**R (Ω)**
Batt.	**15**	**1.5**	
R_1		**1.5**	
R_2	**6**	**1.5**	

Also for series circuits:

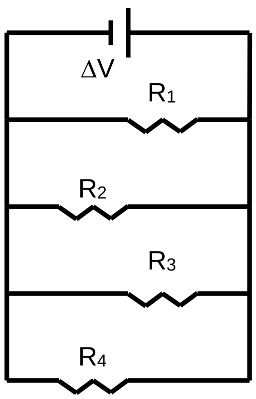
Video
1248
(7:09)

Parallel Circuits For parallel circuits:



	ΔV (V)	I (A)	R (Ω)
Batt.	**12**		
R_1			**6**
R_2			**3**

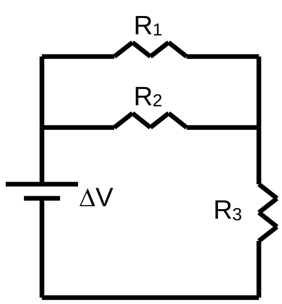
Also for parallel circuits:



	ΔV (V)	I (A)	R (Ω)
Batt.			
R_1	**16**		**2**
R_2			**4**
R_3			**6**
R_4			**8**

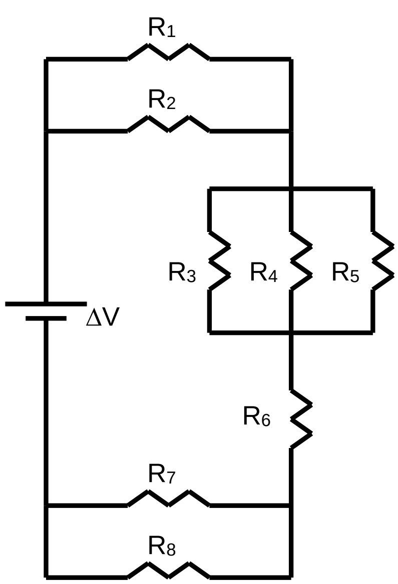
Video
1251
(5:46)

Combination Circuits Solve the following problems.



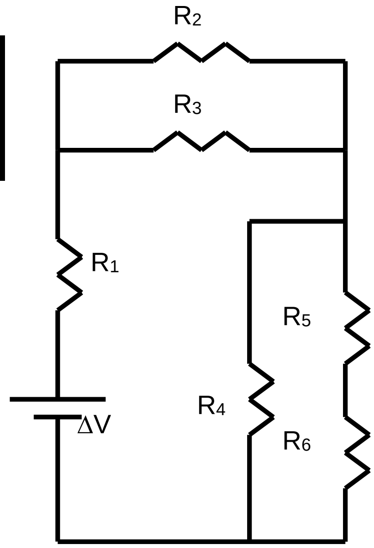
	ΔV (V)	I (A)	R (Ω)
Batt.	**24**		
R_1			**8**
R_2			**8**
R_3			**4**

Video
1252
(7:43)



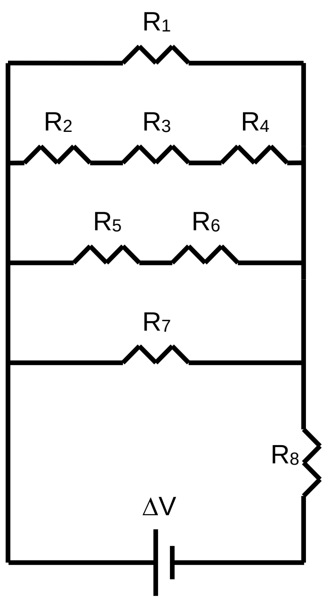
	ΔV (V)	I (A)	R (Ω)
Batt.	**36**		
R_1	**8.7**		**6.5**
R_2			**8.5**
R_3			**4.2**
R_4			**4.8**
R_5	**4.3**		**10.6**
R_6			**7.5**
R_7			**5.7**
R_8			**3.8**

Video
1254
(7:10)



	ΔV (V)	I (A)	R (Ω)
Batt.	**25**		
R_1			**3.5**
R_2			**5.5**
R_3		**1.77**	**3.5**
R_4			**4.5**
R_5			**2.5**
R_6			**6.5**

Video
1257
(8:16)



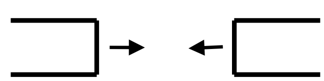
	ΔV (V)	I (A)	R (Ω)
Batt.	**12**		
R_1			**8**
R_2		**0.202**	**10**
R_3			**12**
R_4			**12**
R_5			**10**
R_6			**8**
R_7			**6**
R_8			**2**

Video
1260
(4:53)

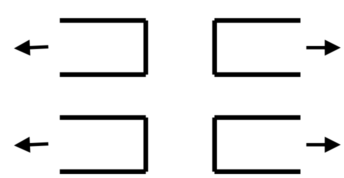
Magnetism

A <u>magnetic field (B)</u> is generated by…

ATTRACTIVE



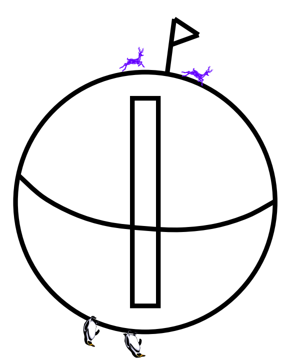
REPULSIVE



-- Magnets have a north pole and a south pole.

The Earth acts like a big magnet.

--



<u>true north</u>:

<u>magnetic north</u>:

<u>magnetic declination</u>:

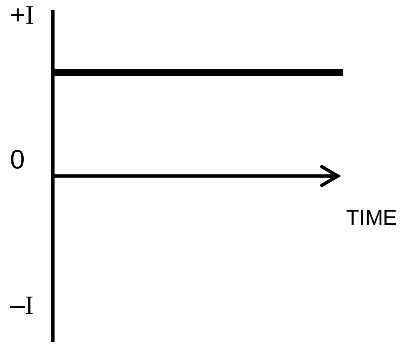
motor:

generator:

Video 1263 (3:41)

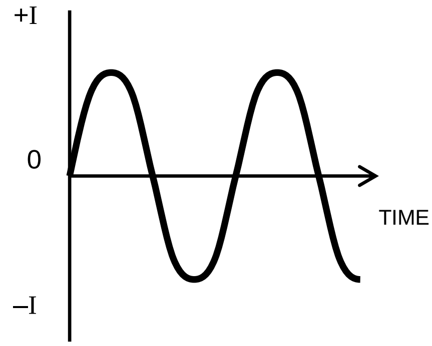
two types of current:

direct current (DC)



e.g.,

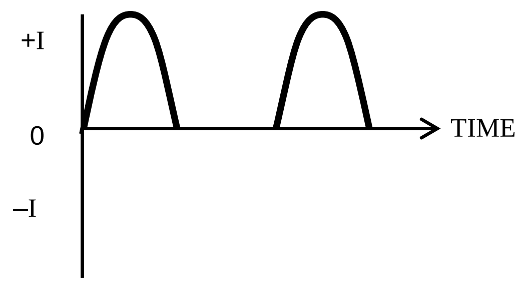
alternating current (AC)



e.g.,

diode: allows current to pass more easily in one direction than another

--



Lenz's Law

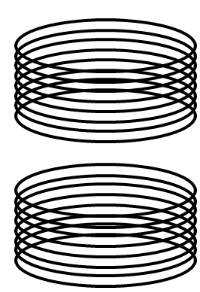
Video 1266 (2:42)

With AC, the current in WIRE 1 is constantly changing in magnitude and direction.

This causes *B* field in WIRE 1 to change constantly.

When WIRE 2 – a separate, closed loop – senses WIRE 1's changing *B* field, a current is induced in WIRE 2.

The induced current in WIRE 2 generates its own *B* field, which opposes the *B* field from WIRE 1.



This last statement is called Lenz's law.

Video
1269
(7:08)

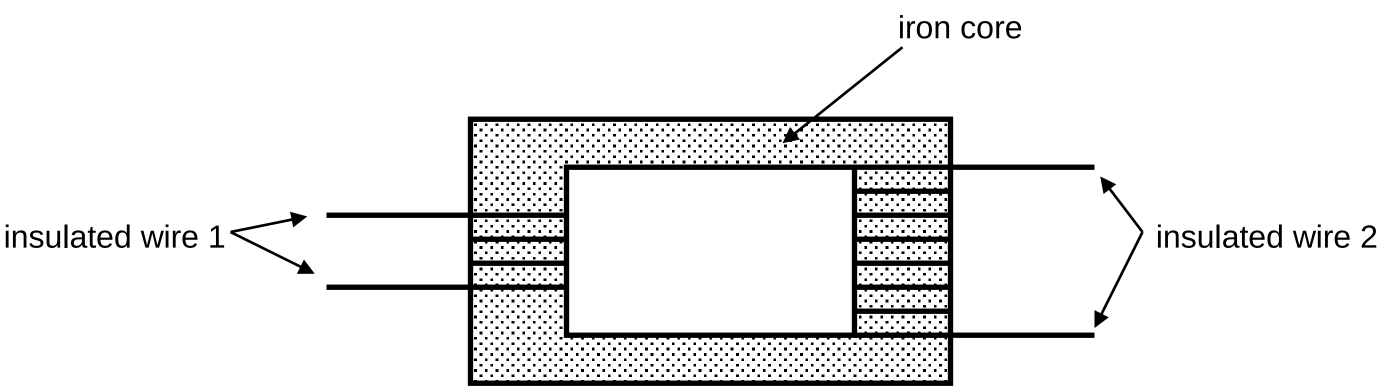
Transformers

A transformer is a device that allows voltage to be increased or decreased.

-- The voltage must be…

--

A <u>step-up transformer</u> _____________ the voltage;



<u>primary</u>

N_1 turns

<u>secondary</u>

N_2 turns

A <u>step-down transformer</u> ____________ the voltage;

Change in voltage is directly proportional to ratio of number of turns.

Change in current is inversely proportional to change in voltage.

Change in current is inversely proportional to ratio of number of turns.

Transformers are used in transporting electrical power.