



Linear Circuits and Systems

Resistance and  
Current flow

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## Resistance

- Every object has a resistance to the flow of current
  - Conductors have small resistance
  - Insulators have large resistance

## Drinking straws

What's inside a straw? What is it doing?



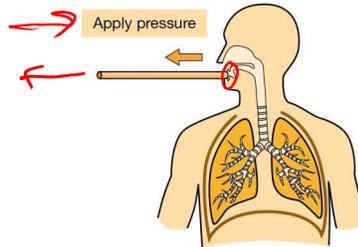
$q \equiv$  air molecules

(Air. The molecules move randomly, but there is no net movement!)

$A_{\text{current}} \equiv$  air flow



## Can you make the air flow?



pressure  $\equiv$  Voltage  $\rightarrow (v)$

(A force is needed to make anything start moving and, if there are resistive forces, to keep it moving.)

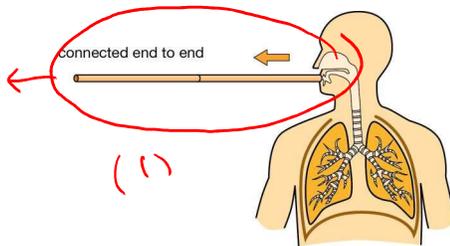
voltage  $\rightarrow$  current  
 $V \uparrow \rightarrow I \uparrow$

What if the pressure is bigger?

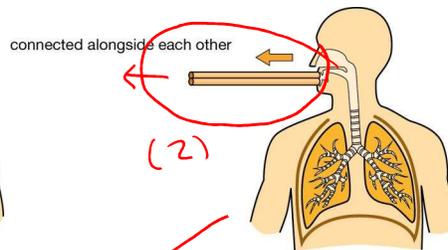
Straw  $\equiv$  Conductor

## What if there are two straws?

Same pressure  $\sim$  fixed voltage  $\sim$



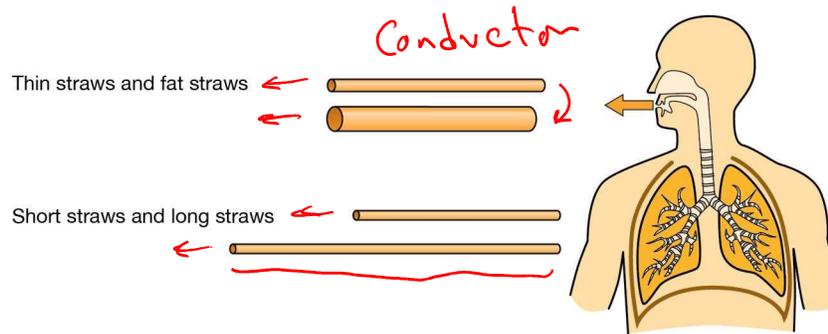
(1)



(2)

length  $\uparrow \rightarrow I \downarrow$   
 Area  $\uparrow \rightarrow I \uparrow$

## Straws of different shapes?



## Current, voltage and resistance

Current in a simple circuit will be larger if

- voltage of the supply is larger
- resistance in the circuit is smaller

$$R = \frac{\rho l}{A}$$

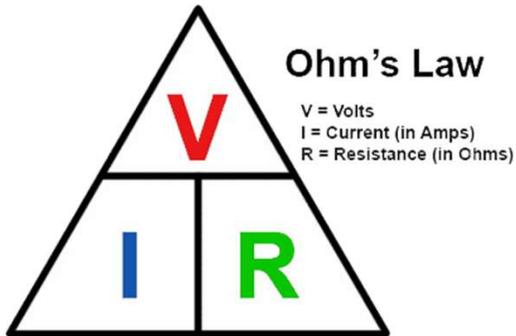
where  $R$  is resistance,  $\rho$  is resistivity of the material,  $l$  is its length and  $A$  is its cross-sectional area.

The same relationships apply in networks of identical resistors.

$$\uparrow I \propto V \uparrow$$

$$\downarrow I \leftarrow R \uparrow$$

# Ohm's Law



$$V = I \cdot R \quad (\text{volts} = \text{amps times ohms})$$

$$I = \frac{V}{R} \quad (\text{amps} = \text{volts divided by ohms})$$

$$R = \frac{V}{I} \quad (\text{ohms} = \text{volts divided by amps})$$



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