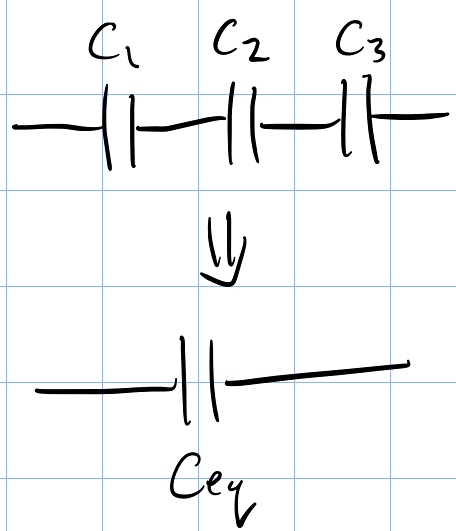
PHYS 121 — March 13, 2024

- ✓ Complete PrairieLearn HW by Friday @ 23:59
- ✓ Complete Pre-Lab #6 before the start of Lab #6
- ✓ Quiz #2 will be on Wednesday, March 20
  - ⇒ See course website for details.

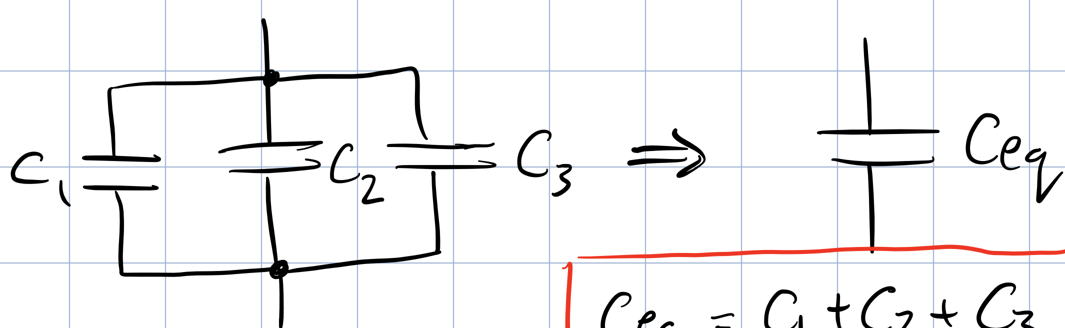
Previously:

Capacitors in Series:



$$\frac{1}{C_{eq}} = \frac{1}{C_1} + \frac{1}{C_2} + \frac{1}{C_3}$$

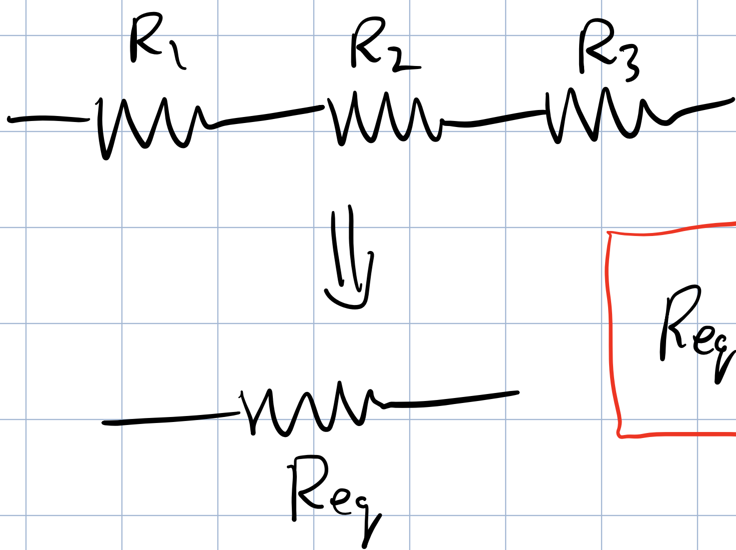
Capacitors in Parallel:



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

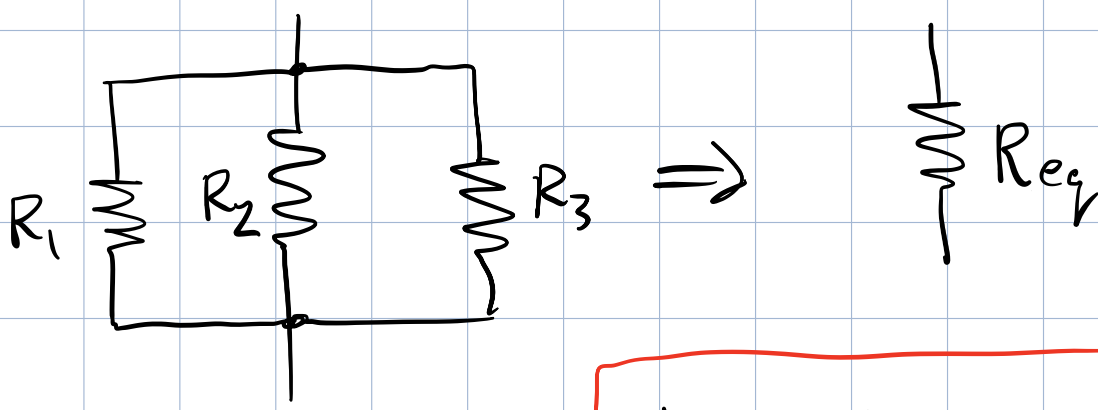
Today: Will show....

Resistors in series



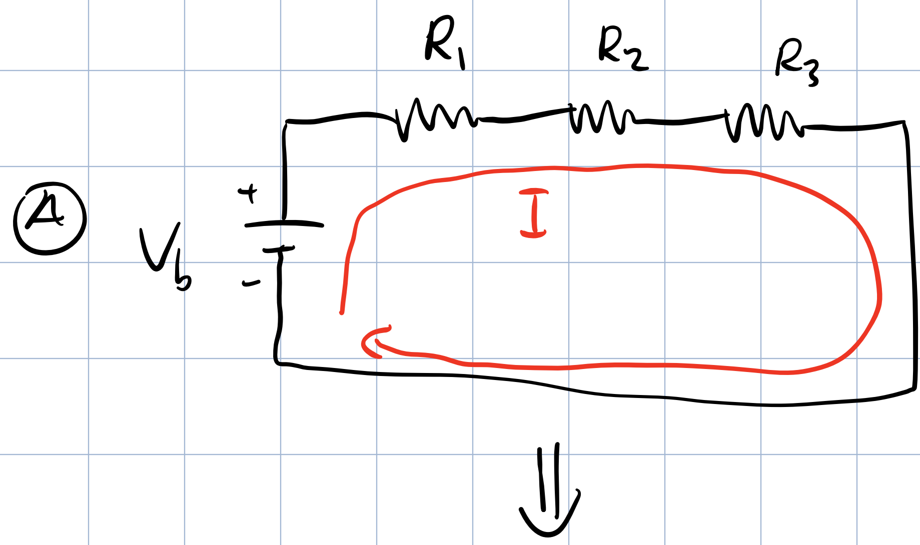
$$R_{eq} = R_1 + R_2 + R_3$$

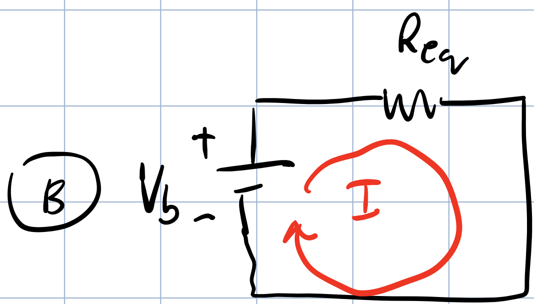
Resistors in Parallel



$$\frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}$$

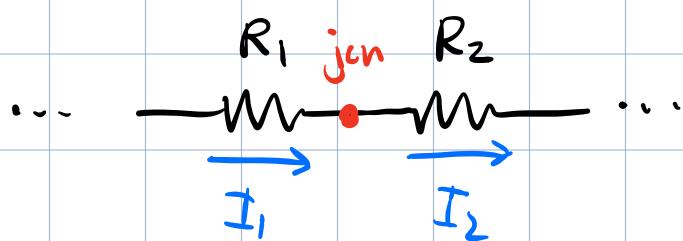
Resistors in Series (OSUPv2 Sec. 10.2)





Find R_{eq} that results in the current I in the two circuits.

Consider a small section of circuit (A)



Suppose that resistors R_1 & R_2 could have different currents.

By jcn ($I_{in} = I_{out}$), we require:

$$I_1 = I_2$$

I_{in} $\quad$ I_{out}

⇒ Any components that are in series must have the same current.

⇒ Any components that are in parallel must have the same voltage across them.

Do voltage loop analysis of circuits (A) & (B).

(A) $$V_b - IR_1 - IR_2 - IR_3 = 0$$

$$\therefore V_b = I(R_1 + R_2 + R_3) \quad (i)$$

(B) $$V_b - IR_{eq} = 0$$

$$\therefore V_b = IR_{eq} \quad (ii)$$

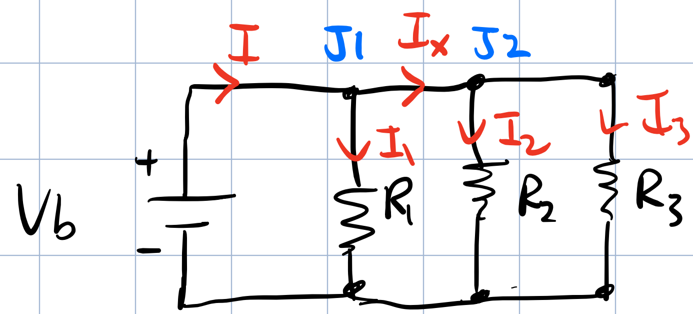
Require (i) = (ii)

$$\cancel{I}(R_1+R_2+R_3) = \cancel{I} R_{eq}$$

$$\boxed{R_{eq} = R_1 + R_2 + R_3}$$ Resistors in series.

Resistors in Parallel

(A)



Junction rule @ J1 :

$$I = I_1 + I_x$$

Junction rule @ J2 :

$$I_x = I_2 + I_3$$

Combining the two jcn rules gives:

$$I = I_1 + I_2 + I_3$$

For R_1, know $I_1 = \frac{V_1}{R_1}$

" R_2 " $I_2 = \frac{V_2}{R_2}$

" R_3 " $I_3 = \frac{V_3}{R_3}$

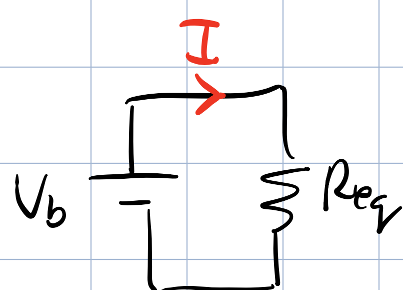
$$I = \frac{V_1}{R_1} + \frac{V_2}{R_2} + \frac{V_3}{R_3} \quad (\ast)$$

Since R_1, R_2, R_3, V_b are all in parallel, they must all have the same voltage across them $\Rightarrow$

$$V_b = V_1 = V_2 = V_3$$

$\therefore$ $(\ast)$ becomes $I = V_b\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$ (iii)

Circuit (B)



$I = \frac{V_b}{R_{eq}}$ (iv)

Require (iii) = (iv)

$$\frac{\cancel{V_b}^{\,1}}{R_{eq}} = \cancel{V_b}\left(\frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}\right)$$

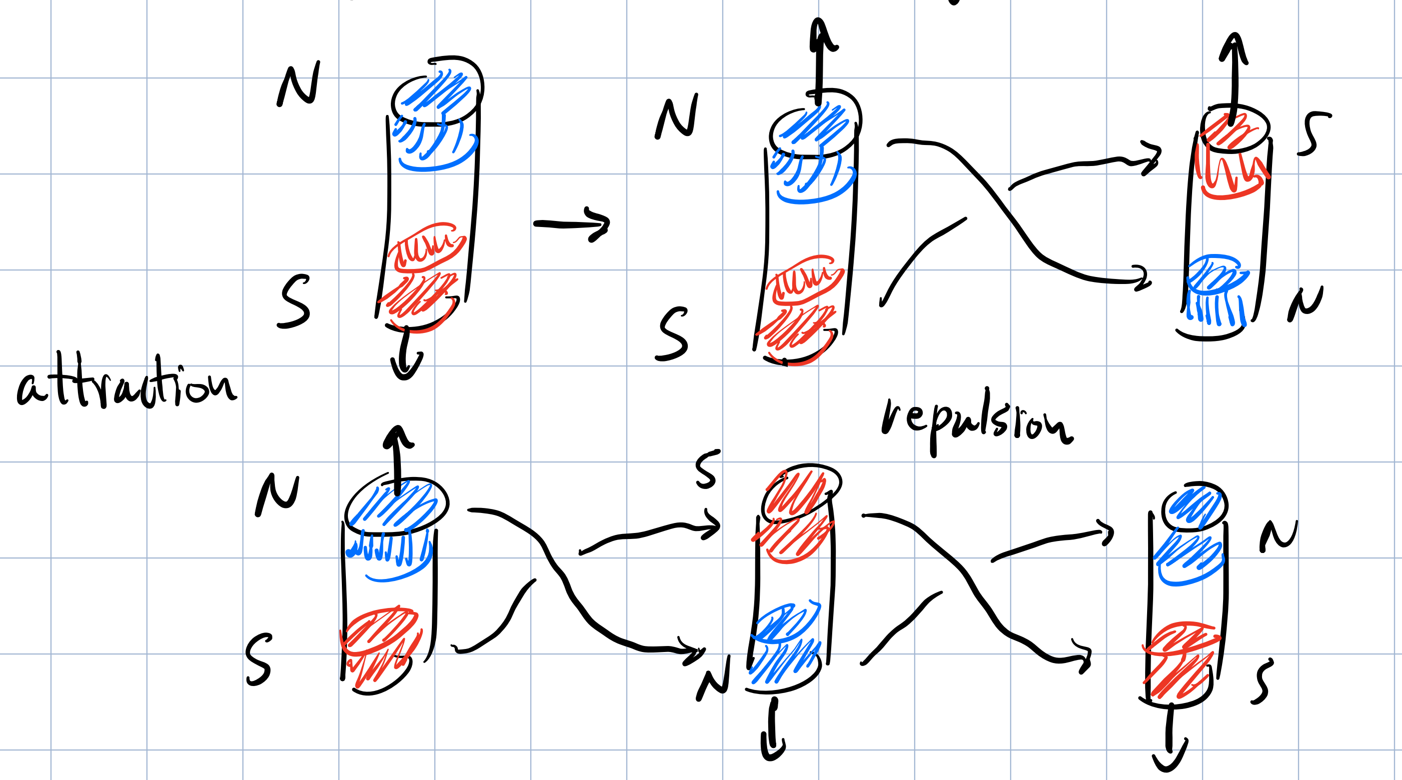
$$\boxed{\therefore \frac{1}{R_{eq}} = \frac{1}{R_1} + \frac{1}{R_2} + \frac{1}{R_3}}$$

Resistor in parallel.

—— Cut-off for Quiz #2 ——

OSUPv2 – Chapter 11 (Sec. 11.1 – 11.4)

Imagine a pair of bar magnetic



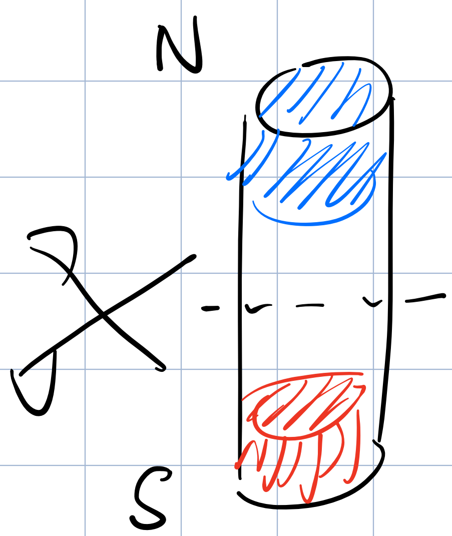
opposite poles attract
like poles repel

} similar to what we found for electric charges.

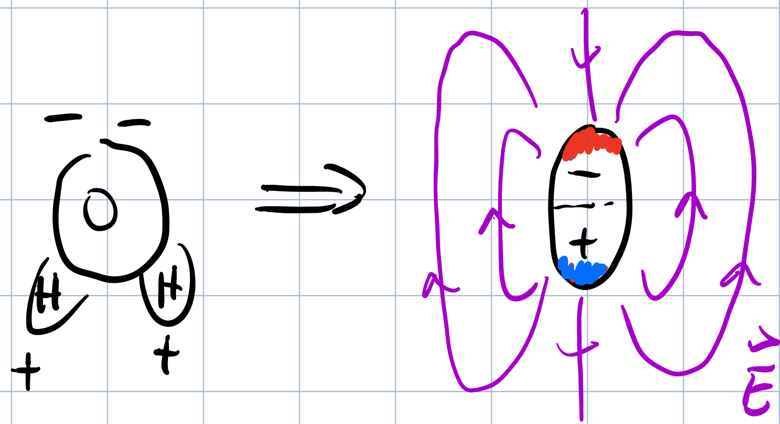
It turns out that, as far as we know, there are no isolated magnetic poles.

→ can't have just a North or just a South poles.

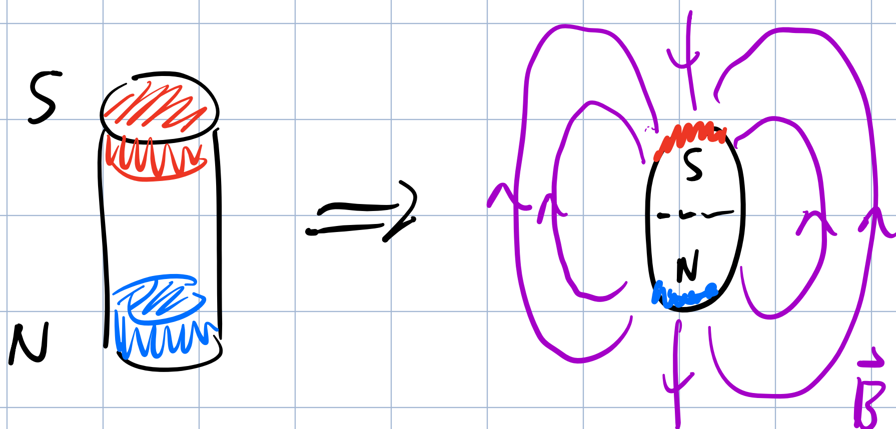
→ called monopoles.



Like a water molecule H_2O



Electric dipole



magnetic dipole

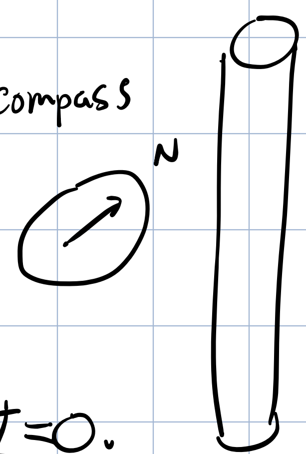
$\vec{B}$ magnetic field lines.

Magnetic fields point away from North poles & towards south poles

Interaction between charges & magnetic fields.

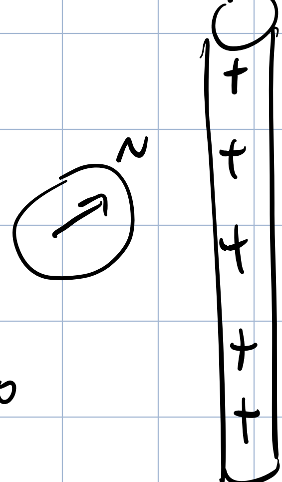
Imagine placing a compass near a wire.

Compass needle points towards the Earth's North pole due to Earth's magnetic field.



$Q = 0$ (neutral)
$I = 0$

Compass points North. No effect from neutral wire with $I = 0$.



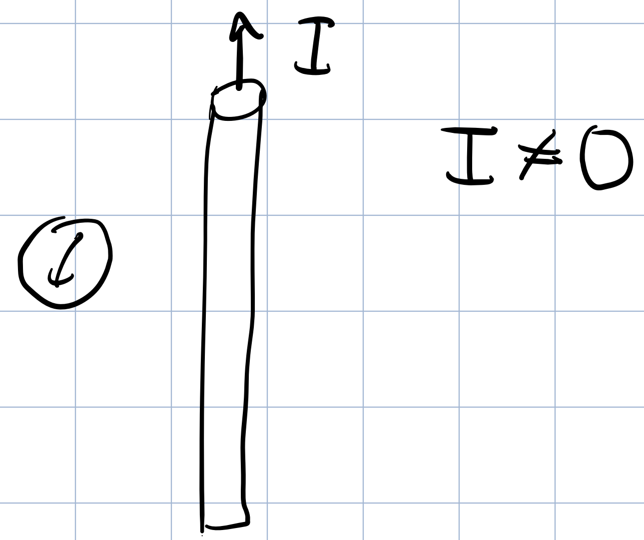
$Q \neq 0$
$I = 0$

static or stationary charges.

With $Q \neq 0$, compass needle still points North.

Charged wire has no effect on compass.

with $I \neq 0$
(i.e. the flow of charge) we observe that the compass needle is deflected.



The current in the wire creates a magnetic field that deflects the compass needle.

Like charge is a source of $\vec{E}$-fields, current or moving charges are a source of $\vec{B}$-fields.