PHYS 121 March 12, 2025

- Complete PrairieLearn HW by 23:59 on March 14.
- Complete Pre-Lab #6 before the start of your lab.

- Quiz #2 will be March 19. See the course website for details / formula sheet.

Today: Start discussing Magnetism

OSUPv2 - Chapter 11 (Sec. 11.1 - 11.4)

where we've been	where we're going
- two types of charge - opp. attract - likes repel	- two types of magnetic poles - opp. attract - likes repel
- charges est. $\vec{E}$-fields that exert forces on other charges	- moving charge / current est. magnetic fields $\vec{B}$ that exert forces on other moving charges / currents.
$\Vert$	$\Vert$

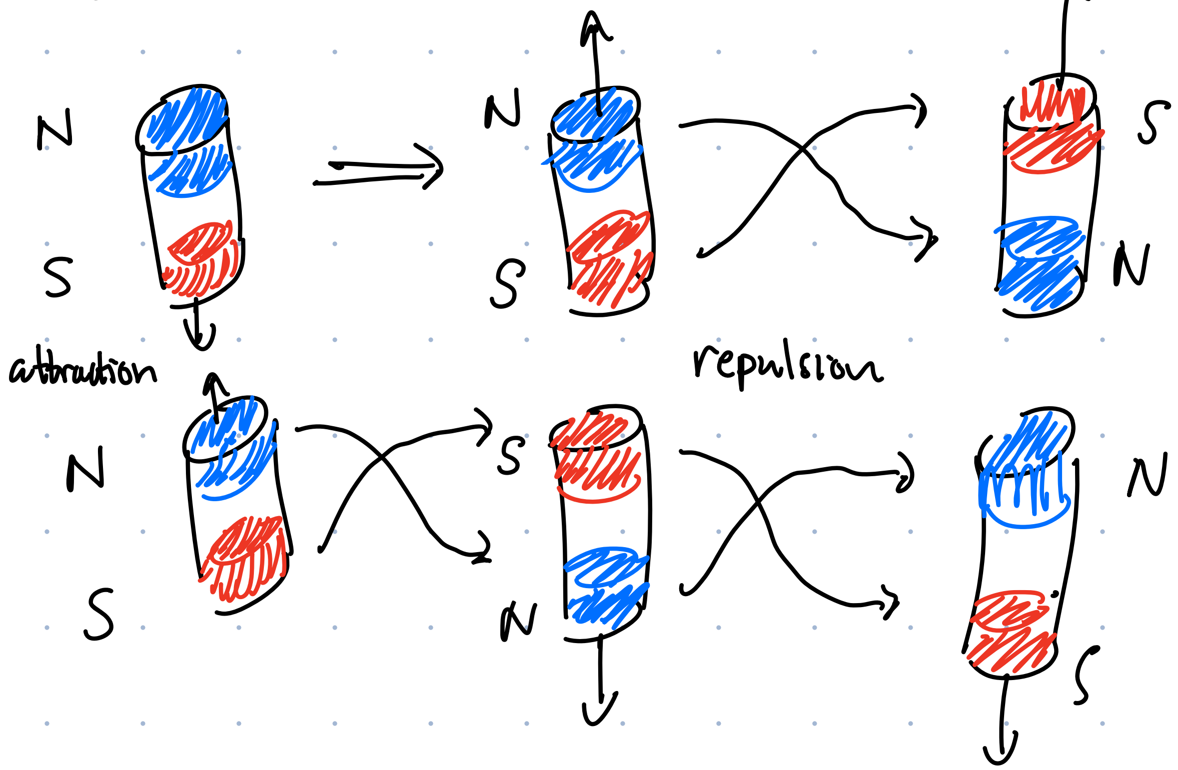
⇓

charge is a source of electric fields

⇓

moving charge/current is a source of magnetic fields.

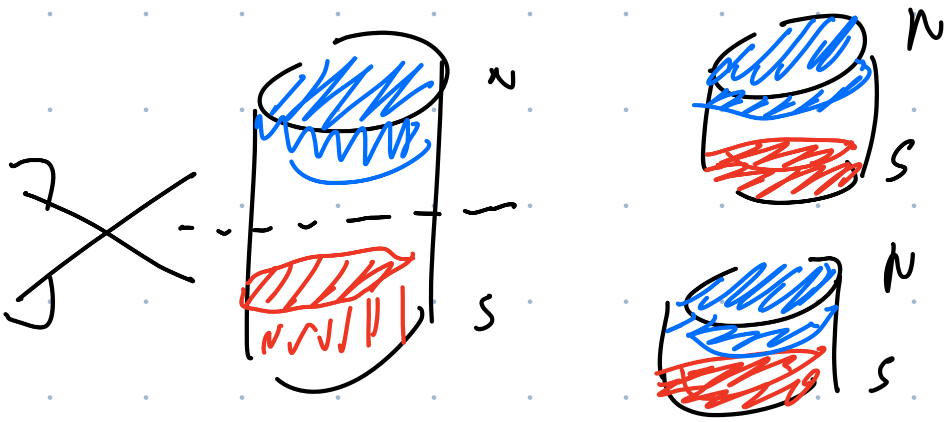
Imagine a pair of bar magnets



opposite poles attract }
like poles repel } similar to what we found for charge.

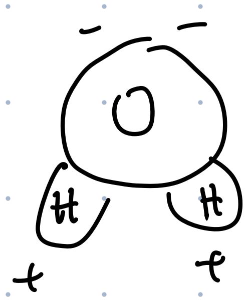
It turns out that, as far as we know, there are no isolated magnetic poles (just a mag. north or south)

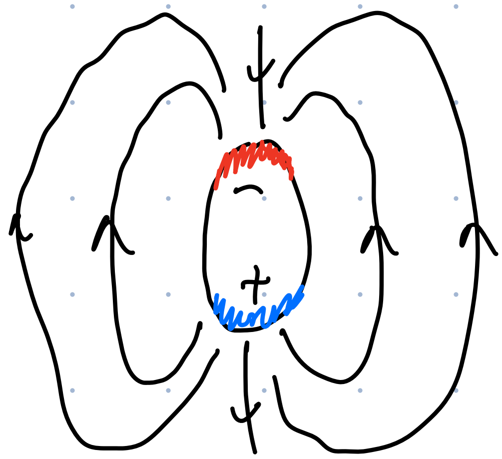
→ Magnets always have opp poles in pairs.



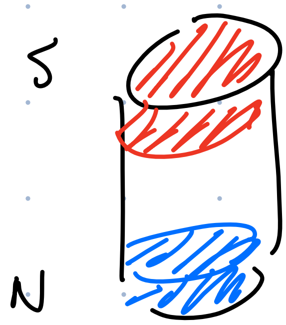
← poles have half the strength of originals.

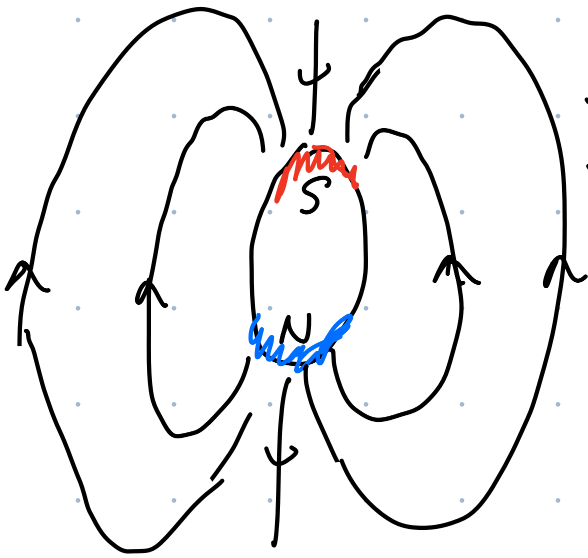
Like a water molecule H_2O





polarized object
⇓
Electric dipole





$\vec{B}$: magnetic field lines

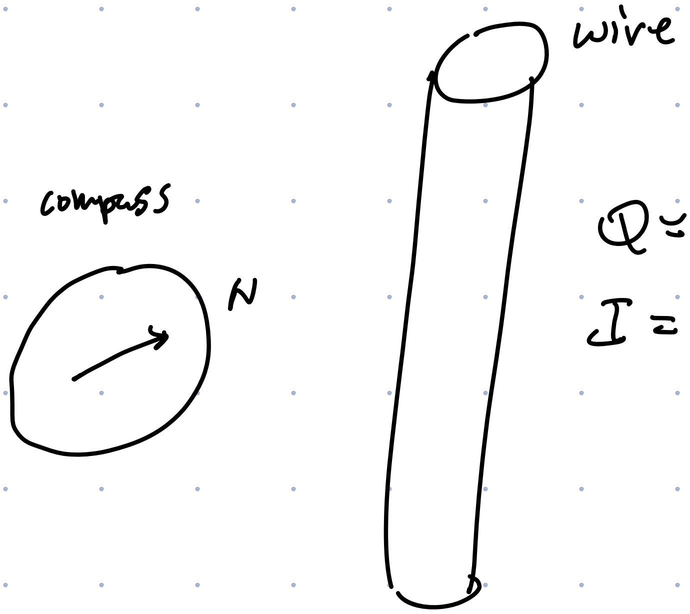
Magnetic dipole.

Magnetic field lines point away from North poles & towards south poles

Interaction between charges & magnetic fields.

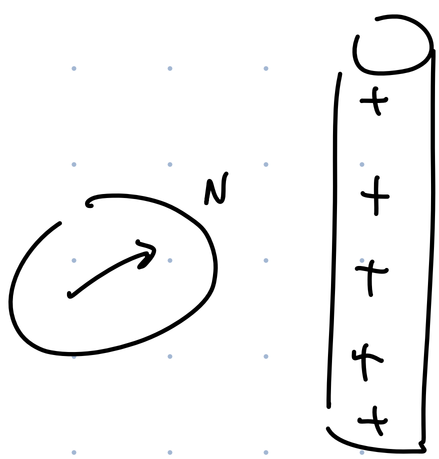
Imagine placing a compass near a wire.
Compass needle points towards the Earth's north pole due to Earth's magnetic field.

Compass points north. No effect from neutral wire w/ $I = 0$.



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

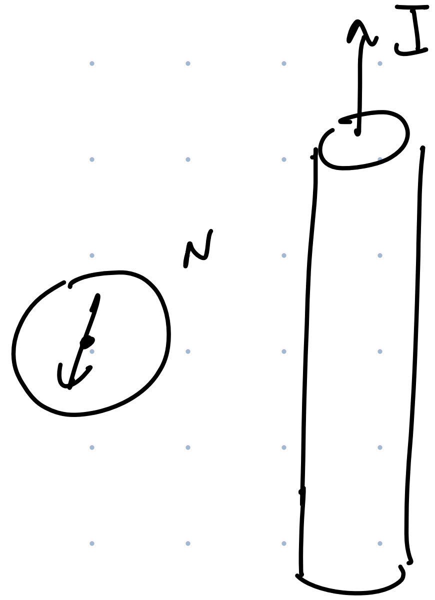
With $Q \neq 0$ compass needle still points to geographic north. Charge wires has no effect on compass.



$Q \neq 0$
$I = 0$

static or stationary charge.

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



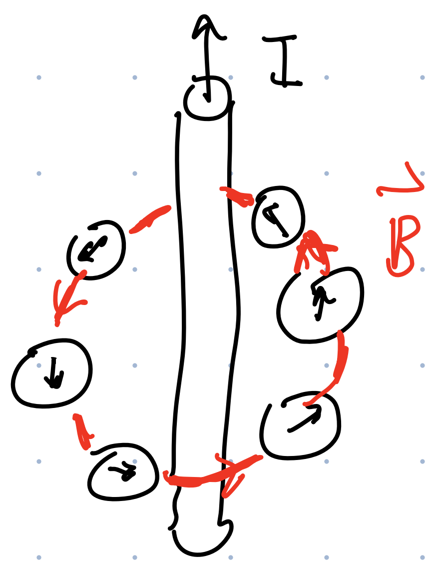
$I \neq 0$

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

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

Place many compass needles around wire w/ current I.

The current I creates a magnetic field $\vec{B}$ that loops around the wire.



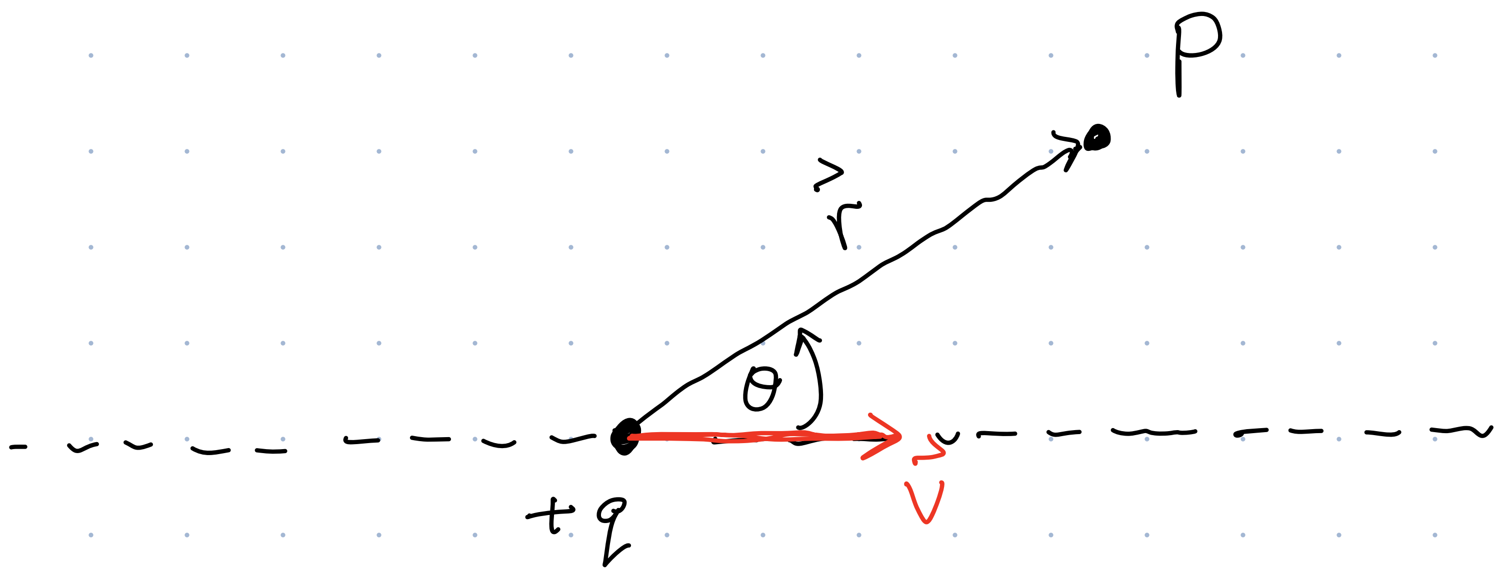
If we reverse the dir'n of I, the magnetic field changes dir'n as well (i.e. the rotate by $180°$).

To find the correct dir'n of $\vec{B}$ due to the current, we use a so-called right-hand rule (RHR)

1. Pt. thumb of right hand in dir'n of I.

2. Fingers naturally curl in dir'n of resulting $\vec{B}$-field.

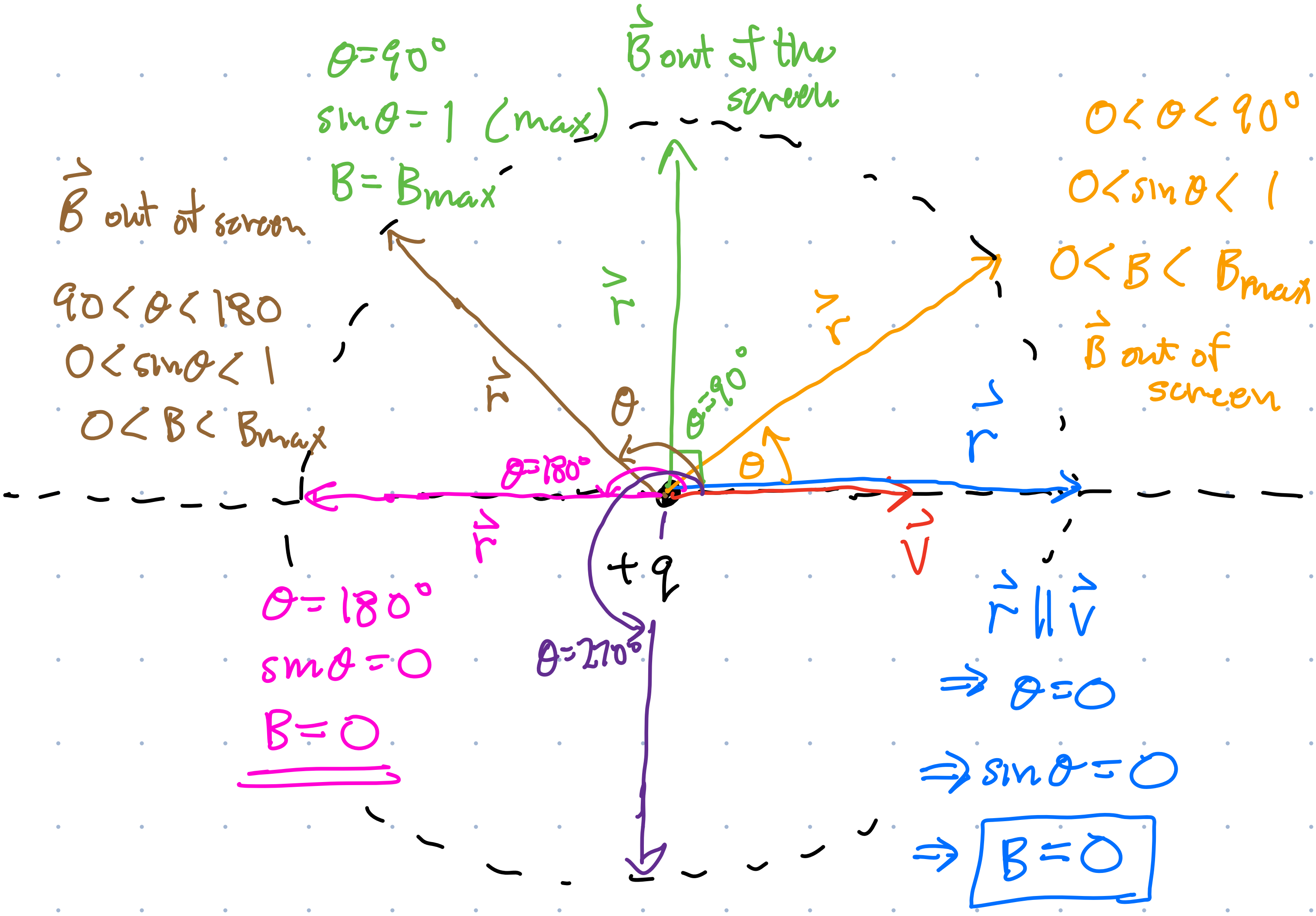
Imagine a pt. charge q moving in a straight line w/ velocity $\vec{v}$.



What is $\vec{B}$ @ P due to moving charge?

Find that the strength of magnetic field at P is prop. to:

- the value of q.
- the speed $|\vec{v}|$ of the charge.
- $\frac{1}{r^2}$
- $\sin\theta$ (perhaps surprizing/unexpected)



$\theta = 270°$

$\sin\theta = -1$

$B = -B_{max}$

$\vec{B}$ is into the screen.

$$B = \frac{\mu_0}{4\pi} \frac{q\, v \sin\theta}{r^2}$$

$\frac{\mu_0}{4\pi}$: constant of proportionality