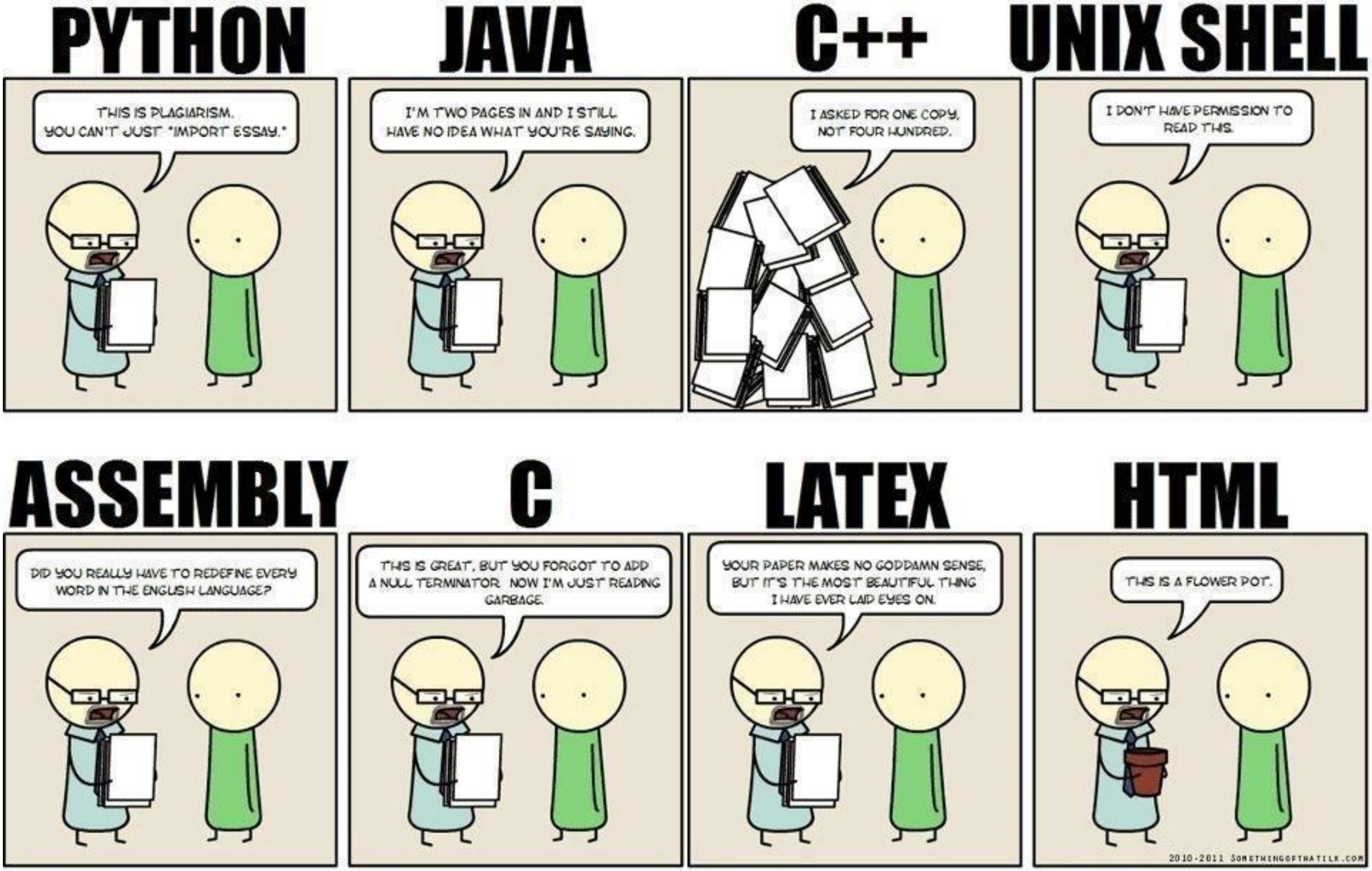
PHY294H

- Professor: Joey Huston
- email:huston@msu.edu
- office: BPS3230
- Homework will be with Mastering Physics (and an average of 1 hand-written problem per week)
  - **Help-room hours: 12:40-2:40 Monday (note change); 3:00-4:00 PM Friday**
  - **hand-in problem for next Wed: 31.79**
- Quizzes by iclicker (sometimes hand-written)
- Average on exam is around 65; will pass back tomorrow
- Course website: www.pa.msu.edu/~huston/phy294h/index.html
  - lectures will be posted frequently, mostly every day if I can remember to do so


PYTHON
THIS IS PLAGIARISM. YOU CAN'T JUST "IMPORT ESSAY."
JAVA
I'M TWO PAGES IN AND I STILL HAVE NO IDEA WHAT YOU'RE SAYING.
C++
I ASKED FOR ONE COPY, NOT FOUR HUNDRED.
UNIX SHELL
I DON'T HAVE PERMISSION TO READ THIS.
ASSEMBLY
DID YOU REALLY HAVE TO REDEFINE EVERY WORD IN THE ENGLISH LANGUAGE?
C
THIS IS GREAT, BUT YOU FORGOT TO ADD A NULL TERMINATOR. NOW I'M JUST READING GARBAGE.
LATEX
YOUR PAPER MAKES NO GODDAMN SENSE, BUT IT'S THE MOST BEAUTIFUL THING I HAVE EVER LAID EYES ON.
HTML
THIS IS A FLOWER POT.
2010-2011 SOMETHINGOFTHATILK.COM

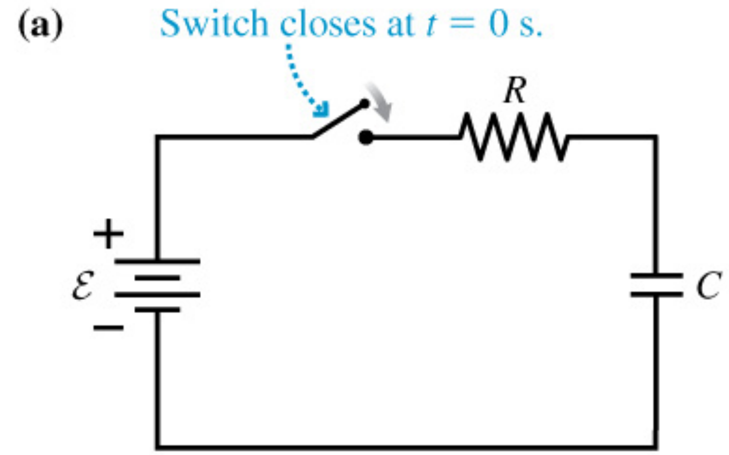
Quick review of RC circuits

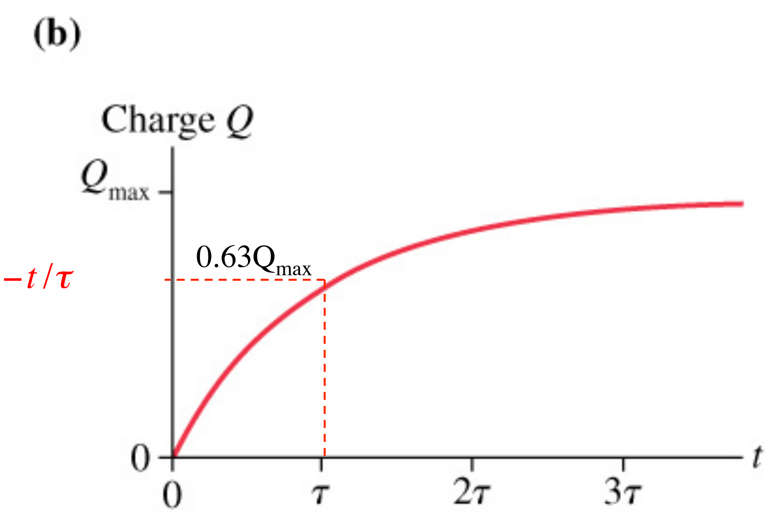
- Capacitor charging after closing the switch

$$Q = Q_{max}(1 - e^{-t/\tau})$$

- $\tau = RC$
- $Q_{max} = \varepsilon C$

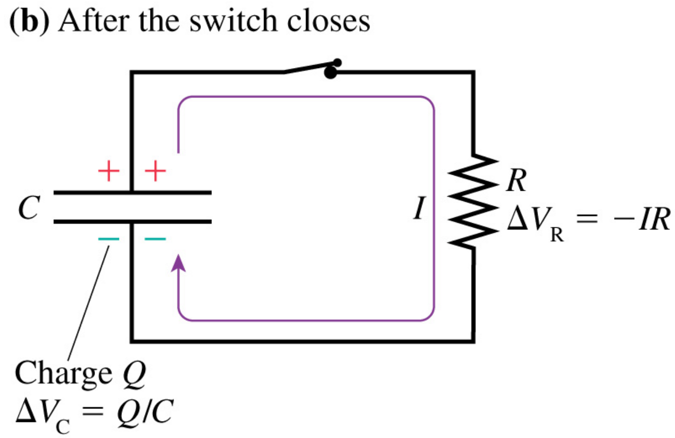
$$I = \frac{dQ}{dt} = I_{max}\, e^{-t/\tau} = \frac{Q_{max}}{\tau} e^{-t/\tau} = \frac{\varepsilon}{R} e^{-t/\tau}$$





Quick review of RC circuits

- Capacitor discharging after closing the switch



$$Q = Q_{\max} e^{-t/\tau}$$

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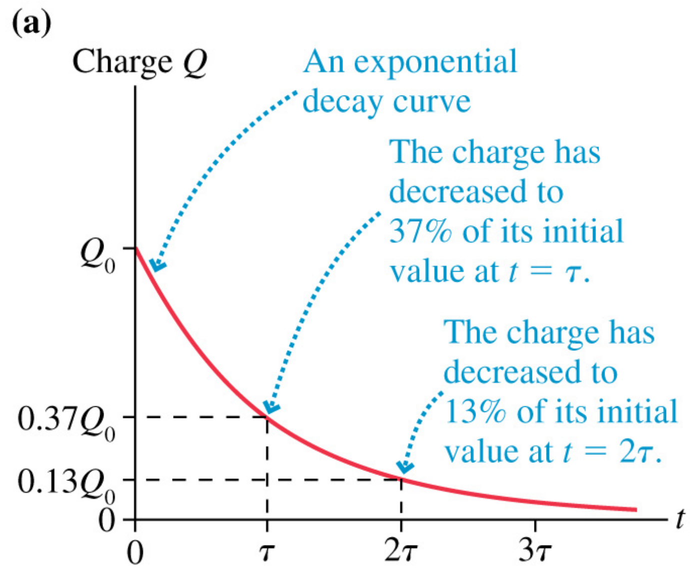
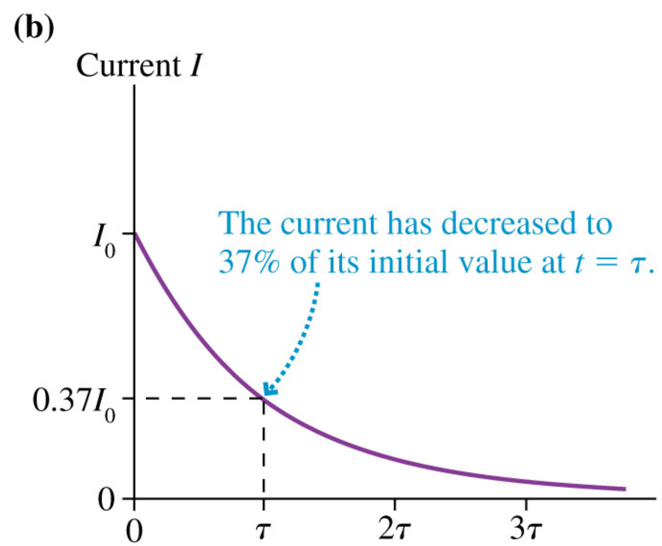
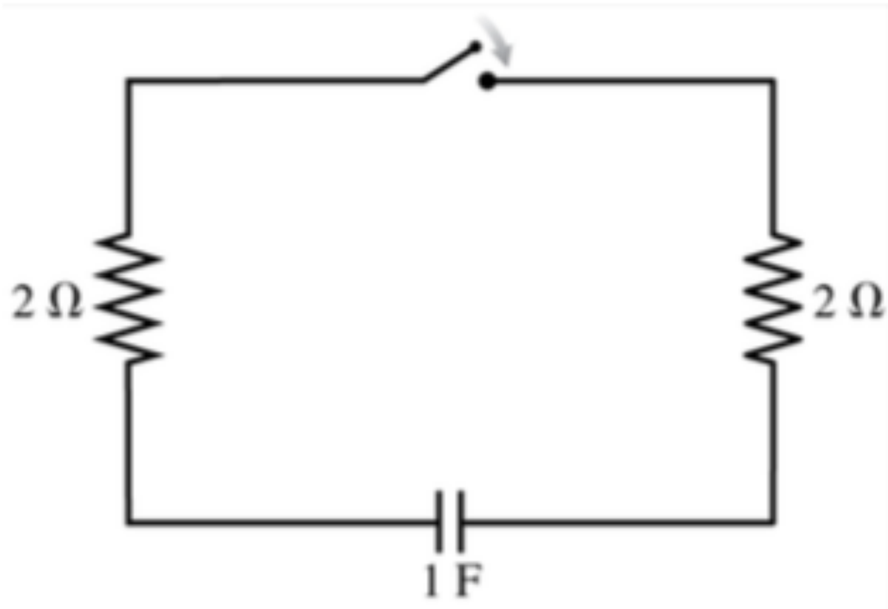




iclicker question

- What is the **time constant** of this circuit?

$$\tau = RC$$



A. 5 s.
B. 1 s.
C. 2 s.
D. 4 s.
E. The capacitor doesn't discharge because the resistors cancel each other.

iclicker question

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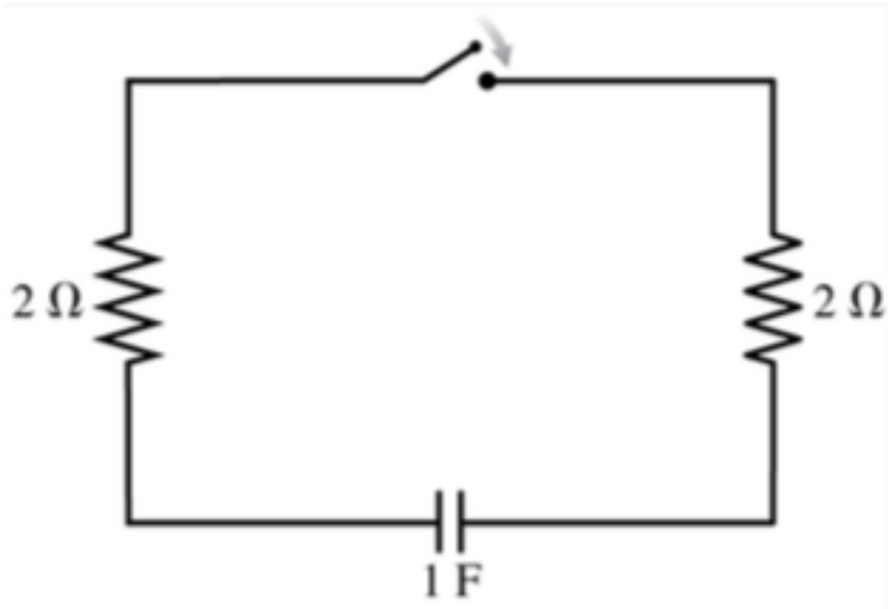
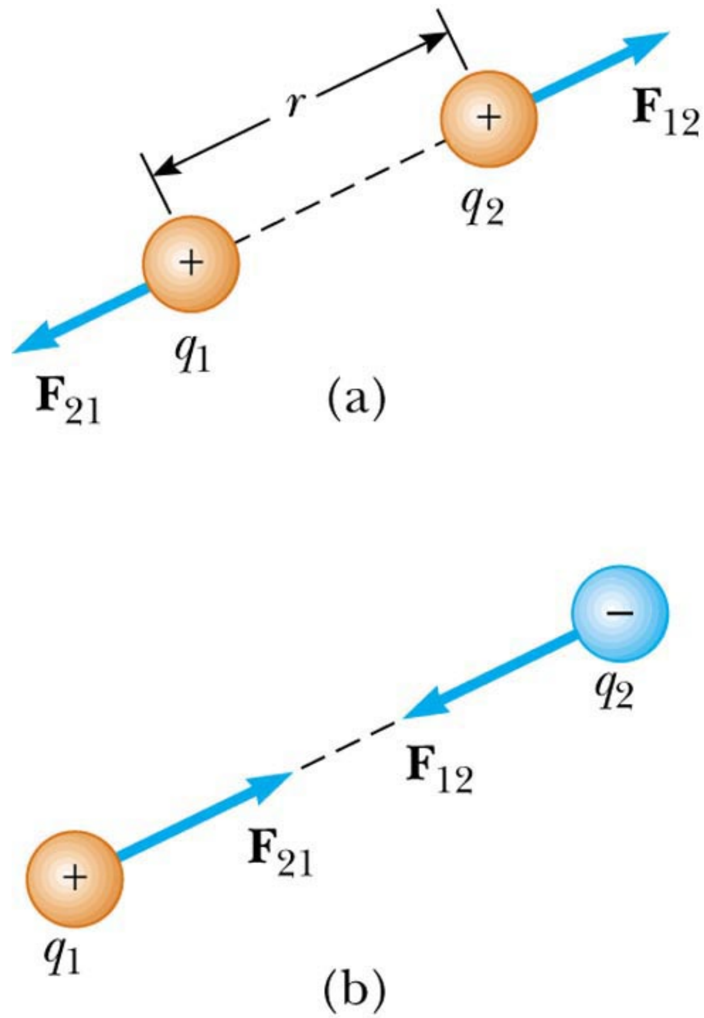


A. 5 s.
B. 1 s.
C. 2 s.
D. 4 s.
E. The capacitor doesn't discharge because the resistors cancel each other.

Magnetic forces

- Up til now, we've been dealing with electrostatic forces, i.e. forces between static charges
- We've used Coulomb's law to calculate the size of the force

$$F = \frac{1}{4\pi\varepsilon_o}\frac{q_1 q_2}{r^2}$$



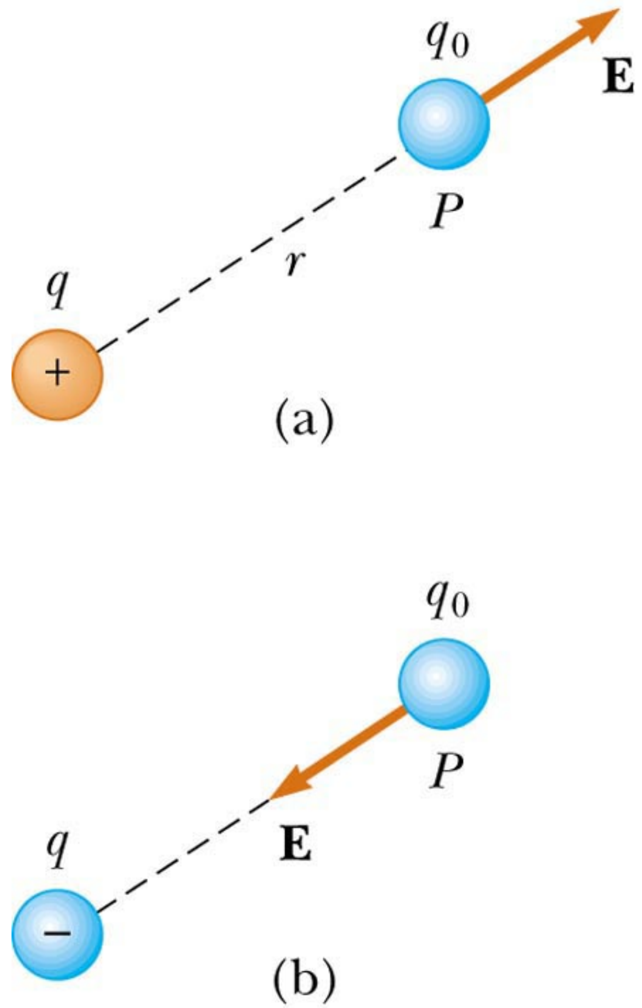
Fields

- We then introduced the idea of an electric field

$$E_q = \frac{1}{4\pi\varepsilon_o}\frac{q}{r^2}$$

$$F_{qo} = q_o E_q$$

- The idea of a field can be a difficult concept to grasp
- But we are going to encounter it again, when we talk about magnetic forces in this next chapter



Magnetic forces

- For electrostatic forces, I have positive and negative charges
- For magnetic forces, I have N and S poles
- I find that N poles repel N poles, S poles repel S poles, and N and S poles attract each other

Some materials are naturally occuring permanent magnets. One example is magnetite. Some materials can have magnetism induced. This occurs, for example, when I place a piece of iron near a magnet. Some materials are attracted to a magnet and some are not.

Magnesia

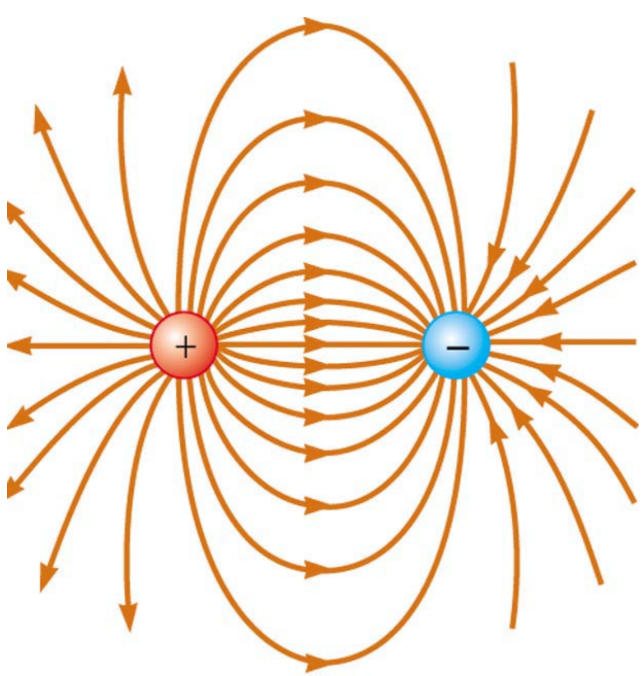
- The word magnesia comes from the region in Asia Minor in which rocks with magnetite ore were relatively common
- What else was this region in Asia Minor known for?

What causes magnetism

- The culprit again is the electron, but in this case the electron has to be moving
  - as in an electric current
  - or as in an atom where's it's spinning on its axis and is travelling in a circle around the nucleus
- But we'll need to go over the rest of the material in this chapter before we can understand the last statement and the connection between these two statements

Electric and Magnetic Fields

Just as we want to define an electric field for electrostatic forces, we also want to define a magnetic field for magnetic forces.



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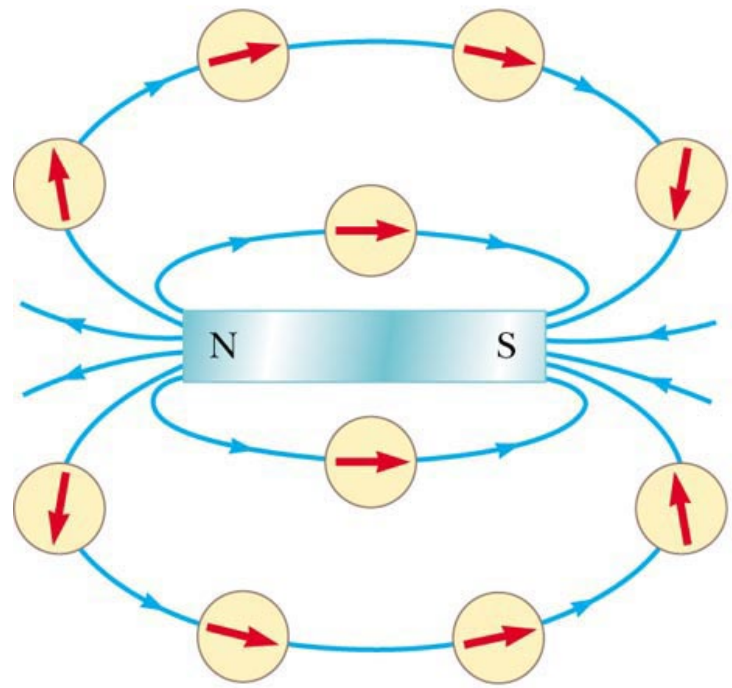

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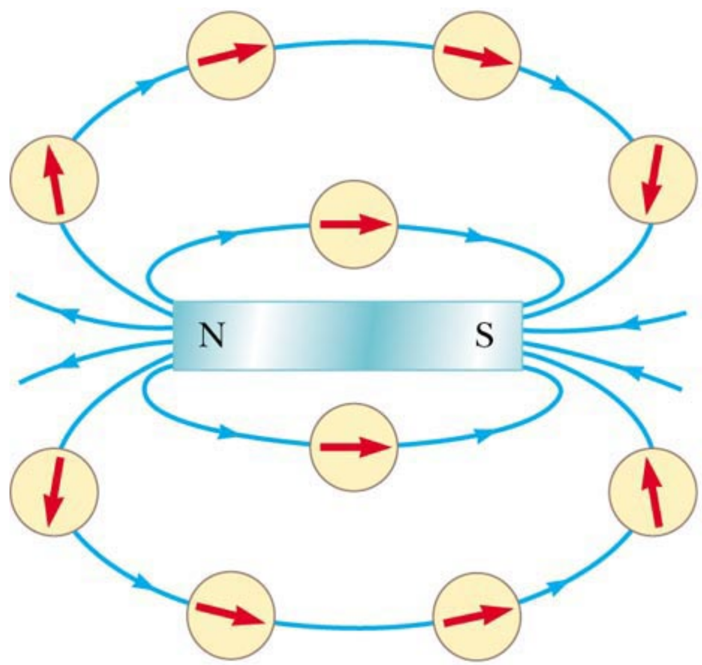
Magnetic field lines

- And for convenience, we' ll also want to talk about magnetic field lines
- Similar rules as for electric field lines
  - a tangent to a field line is the direction of the magnetic field at that position in space
  - the field lines are closer together where the magnetic field is stronger



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Electric and Magnetic Fields

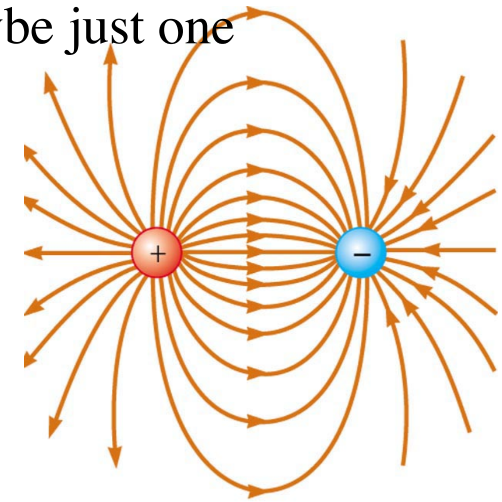
Note some similiarities:

•magnetic field lines originate on N poles and terminate on S poles

But there are differences:

•I can separate the + charge and the - charge of an electric dipole, leaving me with a single electric charge

Can't do that with a magnetic dipole: a N pole is always accompanied by a S pole and vice versa; unfortunately there are no magnetic monopoles, or maybe just one



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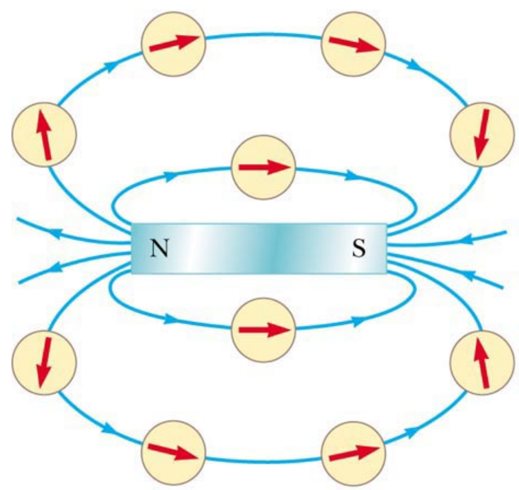

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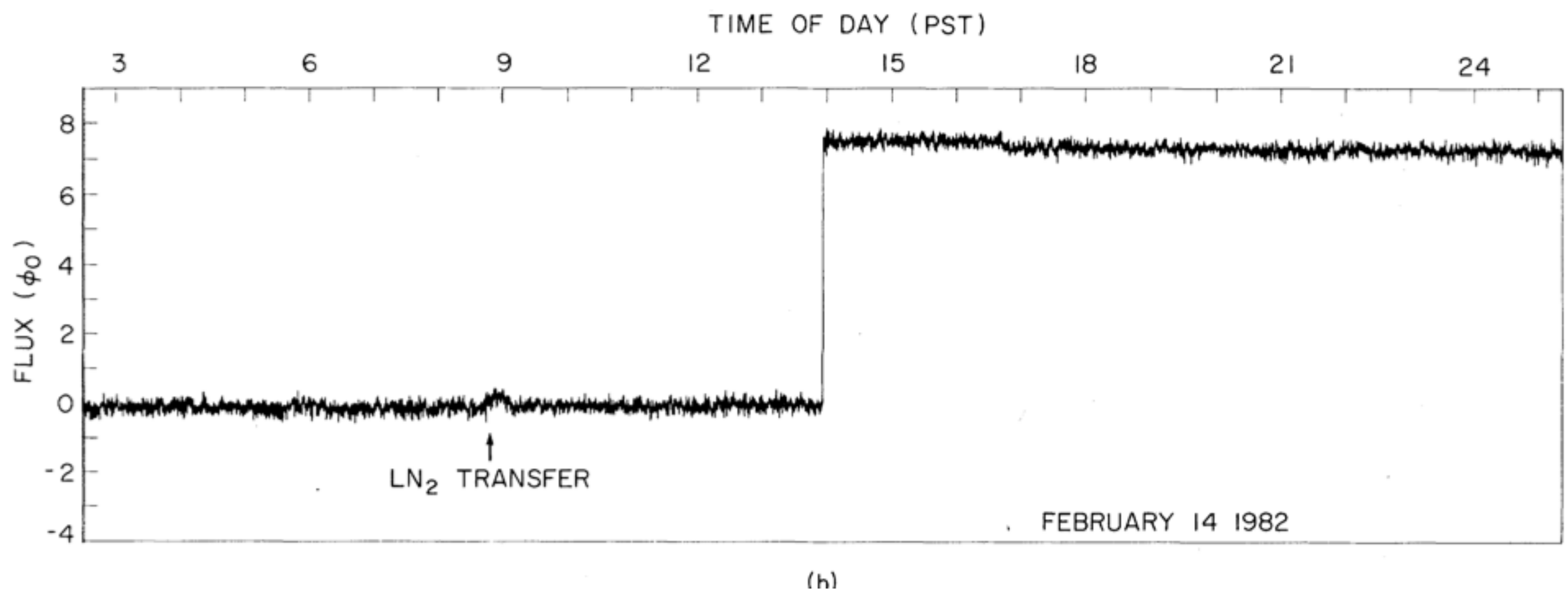
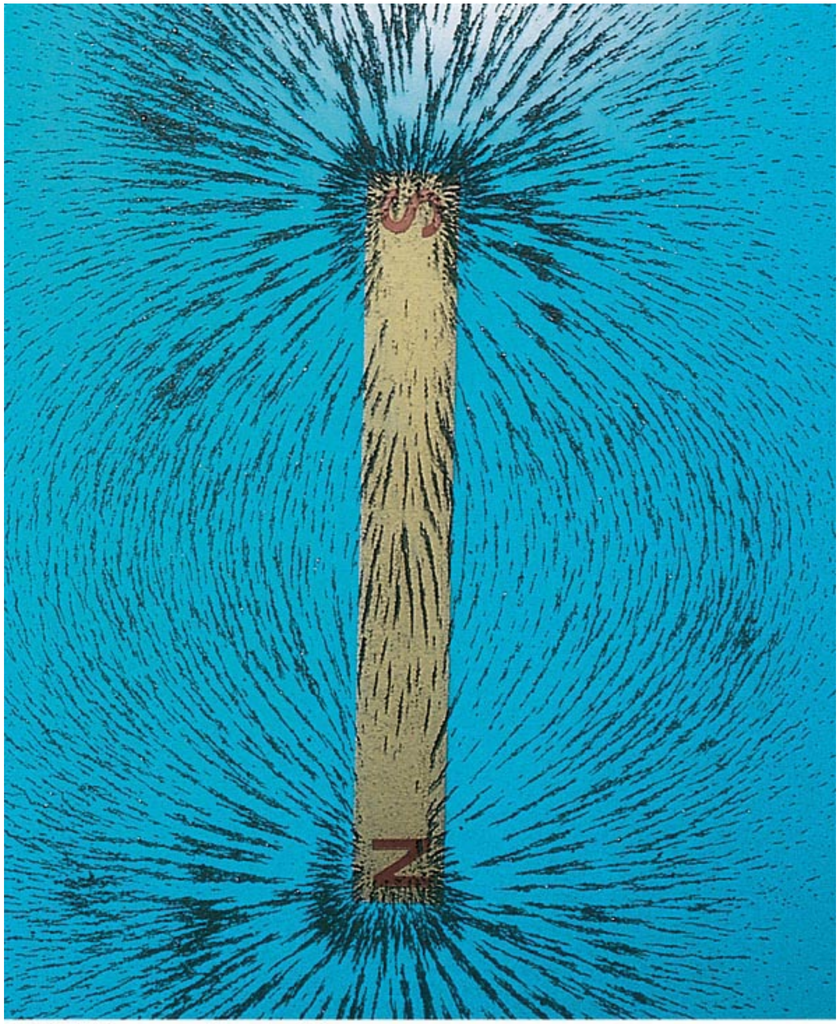
and later we'll find that magnetism is caused by the movement of electrons inside of atoms

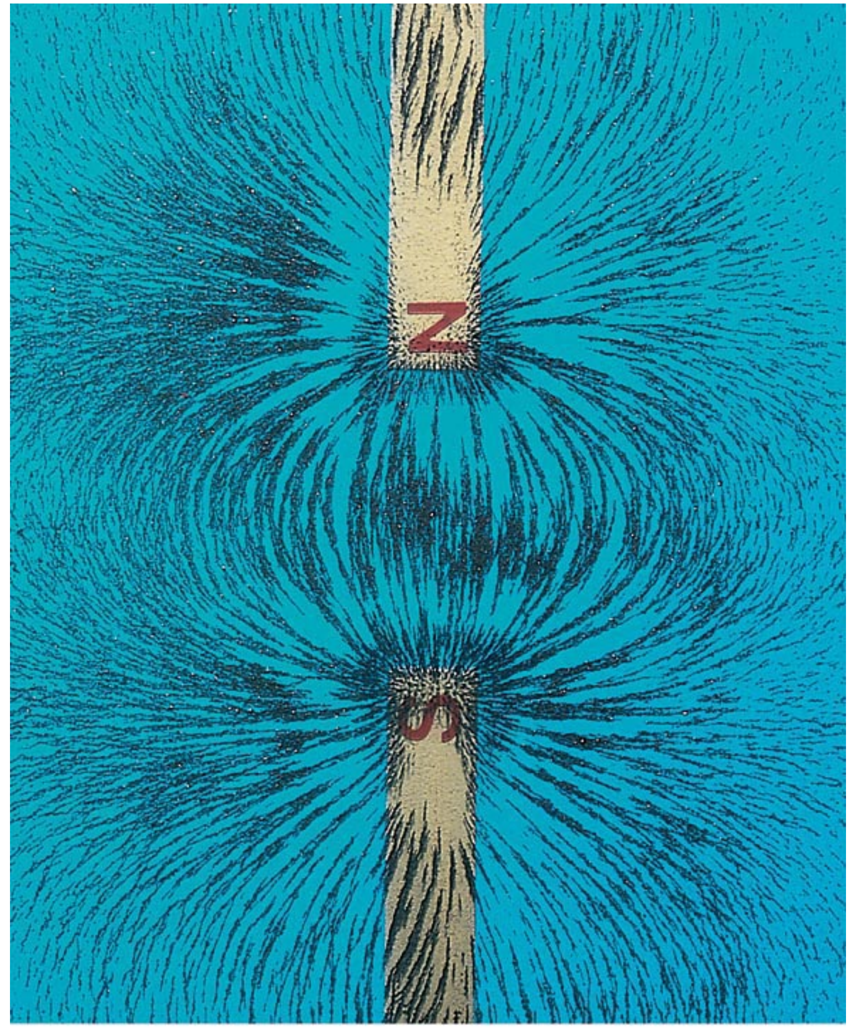
The one magnetic monopole

- Blas Cabrera From Wikipedia, the free encyclopediaJump to: Blas Cabrera is a physicist at Stanford University who was searching for magnetic monopoles; on the night of February 14, 1982, the detector recorded an event which had the perfect signature hypothesized for a magnetic monopole. After he published his discovery (B. Cabrera, *Phys. Rev. Lett. 48*, 1378–1381; 1982), a number of similar detectors were built by various research groups, and Cabrera's laboratory itself received a large grant to build an improved detector. However, no similar event has been recorded since, and his research group has since dropped the search.



Demonstrations of magnetic field lines

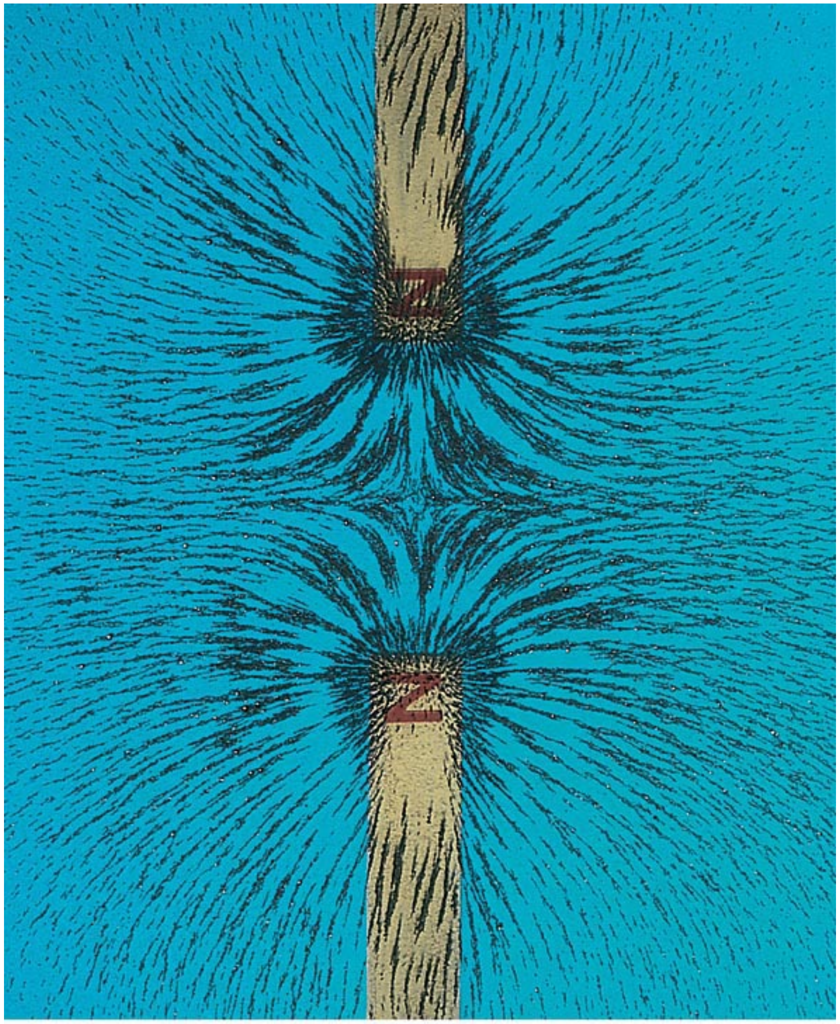




Two N poles

- Magnetic fields cancel in region between poles

- demos

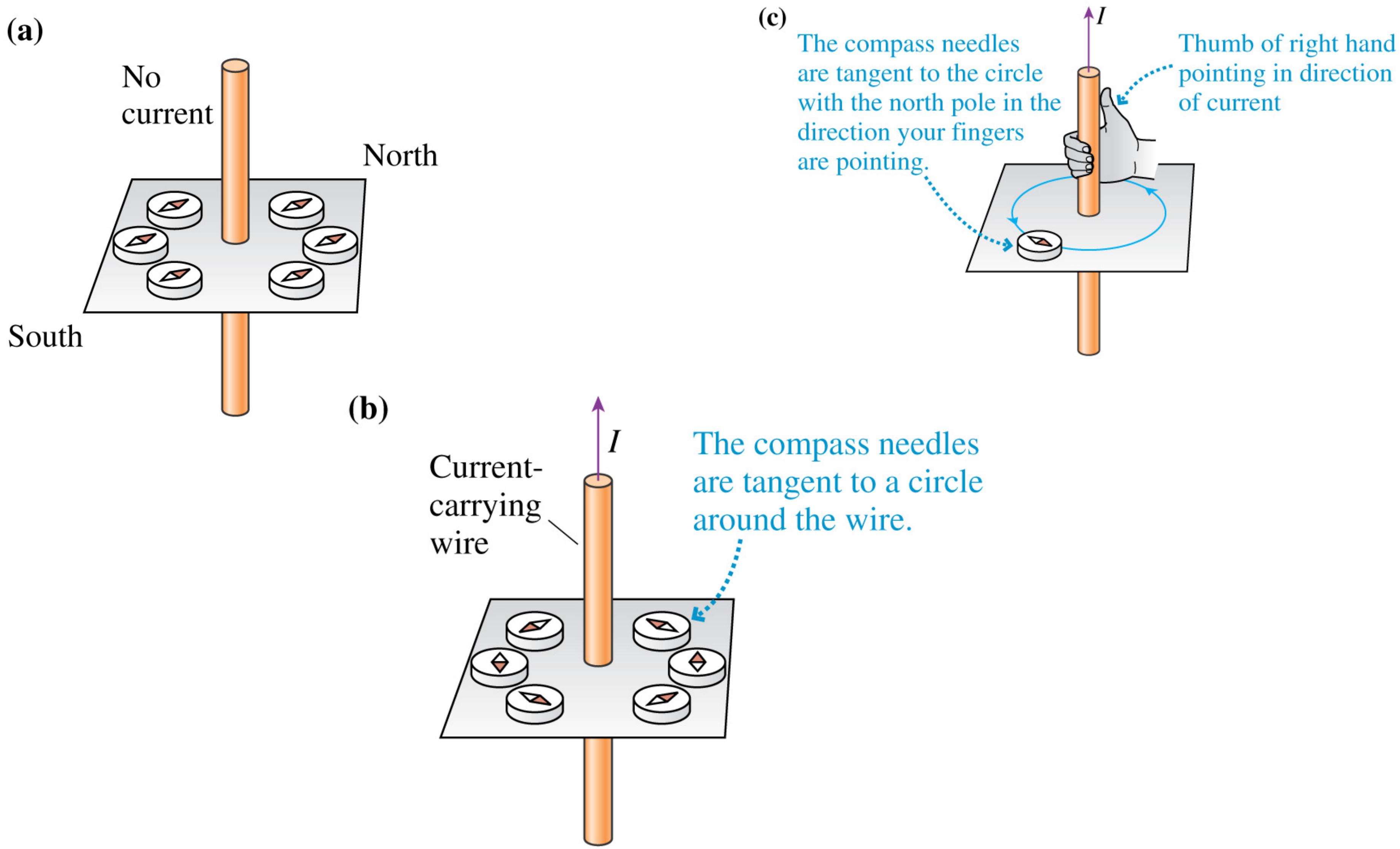


Connection with electric currents

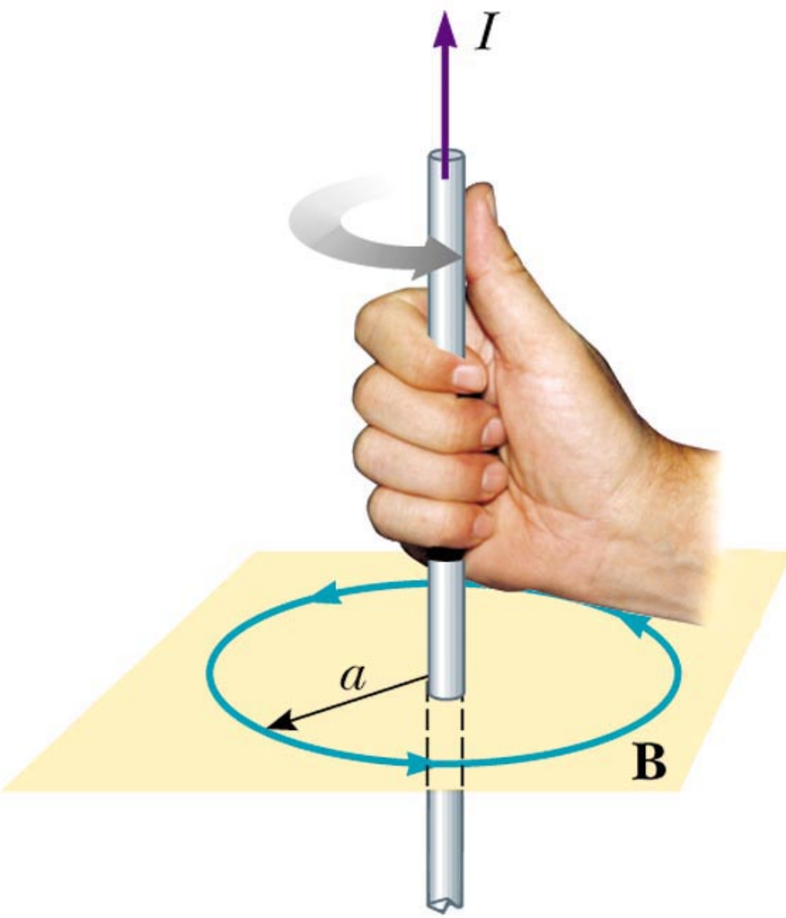
- The connection between electric currents and magnetic fields was discovered by Hans Christian Oersted in 1819 while doing a classroom demonstration

→ demo

Direction of B field from a current



With magnetic fields, you have to work with all 3 dimensions



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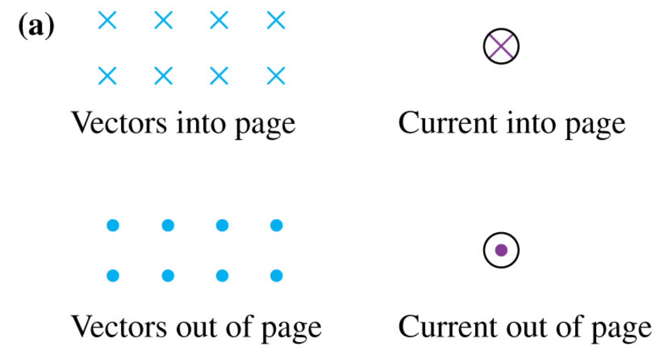

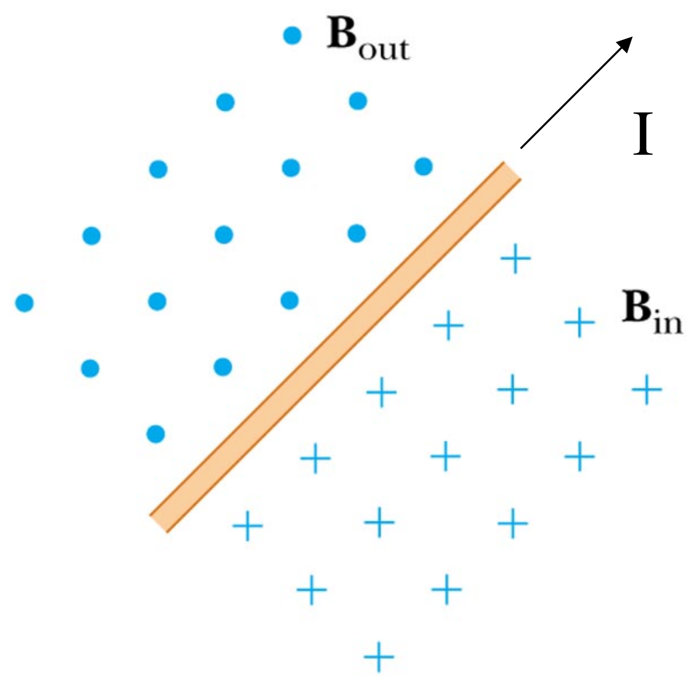

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