Origins of Magnetic Field

- Whenever a system possesses charge, it will obviously cause an ___________ __________ to come into existence around it.
- Surprisingly, if a ____________ system or _____________ particle within a system has a relative velocity a ______________ ________ will come into existence around it. This field will exert a force on any charged particle within a system even if the system as a whole is electrically ___________. However, the charged particle must cross field lines to experience a magnetic force so only the _______________ motion component counts.

(Note: In truth, magnetic fields don't appear and disappear with velocity, there is actually one electromagnetic field surrounding a charge particle. Another charged particle experiences this electromagnetic field differently based on how it moves through the field, the concept of magnetism only exists because people original thought it was something completely different from electricity – which is reasonable to believe since neutral objects can be magnetic and/or experience magnetism due to the invisible microscopic motions of charge particles within them.)

Right Hand Rule Finding a Single B-Field (charge, loop, solenoid)

- A moving test-___________ creates a spherical B-field that wraps clockwise around the axis of motion.
- With a line of ______ __________ the spheres superimpose to create a rotating _________ shape.

Right Hand Rule Finding the Force Created by an External B-Field

- When a positive test charge ___________ through magnetic field of ___________ object, it experiences a _________ ____________.
- The strength of this force is F_B=_______________, where θ is the angle between the charge's velocity and the external B-field lines. Note: no force will be felt if _________________ or _______________

Mass Spectrometer

- A _________________ is a device used to measure the _________ of ions. It uses a combination of __________ and ___________ force to select ions with a specific velocity. Then it uses a combination of __________ and ________ force to measure the ion's ______.

Magnetic Force on a Wire

- F_B = ___________ = ____________ → For short wires
- A near infinite wire, like a ______________, experiences a total force near __________. But, the longer the power line the _______ poles are used to hold it. This creates a counter force that is also __________. So, total force doesn't tell what happens to the line. We must use force ____ __________. A pole only needs to be strong enough to resist the _________ and __________ forces acting on the part of the line that pole is responsible for supporting.
- Force per meter = __________ = _______ → for _______ wires

Motion of an Ion in B- and E-fields

- Since F_B is always _______ to v and B, charged particles moving perpendicular to a ________ will go in a perfect circle. NOTE: If v is not _______ to B-field, only the ______ component is bent into a ________, the _______ component is unaffected. This results in a _________ shape (and is the reason you see the aurora borealis near Earth's ________).
- Since F_E is always __________ to E, charged particles move in a ___________ shape from an E-field.

Permanent Magnets

- ______________ have a ______________ field (____).
- The field comes from "circular" motion of ___________ around the atom ___________.
  - There is always a _____________ and ___________.
  - __________ or _________ repel, but _________ attracts.
  - **<u>Temporary Magnets (two ways)</u>**
  - Have a ___-field only when near ____________ B-field. (i.e. ________)
  - **<u>Since orbiting ____________ create B-fields in permanent magnets, an ____________ through a ________ can also create a B-field.</u>**

Non-magnetic Material

- Ignores _________. Meaning it _________ feel magnetic forces and it __________ alter the direction of _________. For example, magnetic attract each other ________ with air separating then compared to wood separating them (assuming equal separations).