Model: Magnetic Fields & Forces

Act 9.3.2 Magnetic Dipole Fields II (including FNTs from DLM 14) 50 min

Learning Goals:

- Understand how magnetic dipoles align with a magnetic field from an energy perspective
- Understand how magnetic dipoles align with other magnetic dipoles from an energy perspective
- Realize that loops of current (tightly wound coils of wire) produce dipole field patterns very similar to those of permanent magnets
- Understand that induced magnetic dipoles in an iron core enhance the field strength of dipole field from a current loop

Act 9.3.3 Magnetic Fields are Produced by Moving Charges – Right Hand Rule #1 45 min

- Understand that a moving electric charge has a magnetic influence at all points in space around it, which has a strength and direction at each of these points
- Understand the direction of the magnetic field and the pattern of the field at various distances from a wire of current
- Become familiar with right hand rule 1, which is used to predict the direction of a magnetic field

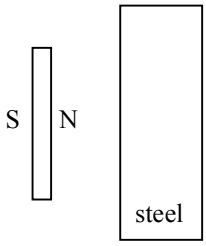
Act 9.3.4 Magnetic Forces on Moving Charges - Right Hand Rule #2 45 min

Learning Goals:

- Understand that moving electric charges, either individually or in currents, interact with magnetic fields
- Recognize that this interaction is a magnetic force exerted on the charge(s)
- Become familiar with right hand rule 2, which is used to predict the direction of the magnetic force on the moving charge(s)

1) (Application) Write out your response to ACT 9.3.4 Question 1

9.3-4) How is a refrigerator magnet stuck to a refrigerator analogous to a polar molecule attracting a non-polar molecule?



(Application) Your refrigerator is made of steel (which is mostly iron). The steel is usually not a magnetic dipole but it is made up of very small (less than 1mm size) very strong magnetic dipoles so it is **easily polarized by a magnetic field**. The picture to the right shows a refrigerator magnet with the N and S poles of its dipole shown and a piece of steel. Draw the magnetic field on the steel produced by the refrigerator magnet. Think about the electrical attraction between a polar molecule and a non-polar molecule. Use the electrical analogy to explain how the steel is magnetically polarized by the refrigerator magnet and why it then attracts the refrigerator magnet.

9.3-5) Explain why motors are typically made with coils of wire wound on soft pieces of iron

(Application) Almost all motors are made by winding many turns of wire around pieces of soft iron, arranged so that some of the pieces of iron can turn inside the other pieces. All motors work on the principle of magnetic dipoles attracting and repelling each other, depending on their relative positions. Why aren't motors made of simple coils of wire?

9.3-6) (Application) In each picture below *electrons* flow inside a tube that is evacuated (no air inside). There is an electric field in the tube that is created by electric charges placed at each end of the tube. A uniform magnetic field **B** is also present inside the tube, created by some external source. The magnetic field points either directly into the page or directly out of the page. For each diagram, decide if the electrons are slowing down or speeding up and decide if the magnetic field points into the page or out of the page. You may neglect gravity in this problem. **Clearly explain your reasoning**.