Make certain to take three pieces of polarizer home with you for your FNTs.

Model: Electromagnetic Induction

Act 9.4.1 Finish (~20 min)

Act 9.4.2 Consequences of Changing Fields II (~40 min)

Learning Goals:

- understand that changing the amount of B field passing through a coil causes an induced voltage in the coil
- understand that the amount of B field passing through a coil can be changed by either changing the magnitude of B or by changing the orientation or shape of the coil.
- understand that the phenomena of creating a voltage by changing the amount of B can be understood by considering the forces produced on the charges in a conductor that moves relative to the magnetic field (RHR2)
- understand how two separate coils can interact so that a changing current in one produces an induced current in the other.

Model: Electromagnetic Waves (EM Waves) – Interactions with Matter

Act 9.5.1 Electromagnetic Waves (~20 min)

Learning Goals:

- Understand how an EM Wave unites the models of E-fields, B-Fields, and Electromagnetic Waves
- Understand that an EM wave "can wave" without needing a medium
- Understand the variety of waves that make up the EM spectrum
- Be familiar with typical frequencies and wavelengths of the EM spectrum
- Understand clearly the difference between sound waves and EM waves, including light
- Know that the speed of light of **all** EM waves in a vacuum is 3×10^8 m/s

Act 9.5.2 Polarization: Absorption and Transmission (~60 min)

Learning Goals:

- To visualize light and other electromagnetic waves as oscillations of electric and magnetic fields .
- To understand that the oscillating electric fields in EM waves will effect the electric charges in matter, which in turn, will effect how the wave is reflected, absorbed, and transmitted through matter
- To understand the meanings of: Linear Polarization, Absorption, and Transmission.
- To understand what a polarization filter does and how it works
- To understand and make sense of typical polarization phenomena of microwaves and visible light

Make certain to take three pieces of polarizer home with you for your FNTs.

FNTs

9.5-1 **(Application)** You typically use or you are familiar with several kinds of consumer electronics that use EM waves. These include AM and FM radios, television and cell phones. The EM waves are radiated out from broadcasting antennas and the electric field causes motion of the free electrons in a receiving antenna. For a particular wavelength, there is a small range of antenna lengths that are efficient at "picking up the signal." A general rule of thumb is that the receiving antenna should be about ¼ the wavelength. Make a list from what you remember or can observe about the lengths of antennas you know about. Beside the name of the "gadget," show the antenna length and a likely wavelength and frequency of the EM wave that gadget is responsive to. Get as many items on your list as you can. Note: The FM radio band is right in the middle of the VHF (channels 2-13) television band. UHF television is higher in frequency and AM radio is much lower than FM radio in frequency. Also, perhaps your parents or grandparents had a table top AM radio that had a long coil of wire mounted to the back of the set. The coil picked up the B field of the EM wave. Our rule of thumb for the antenna to pick up the electric field for AM radio doesn't work, because the wavelengths get so long.

9.5-2 **(Solidification)** For the same items on your list for 9.5-1, list the most likely polarization direction as vertical or horizontal with respect to the surface of the earth. You can tell from the direction of either the transmitting antenna or receiving antenna. In both cases, the long dimension of the antenna points in the polarization direction.

9.5-3 **(Application)** Summarize the similarities and differences between a sound wave and a very low frequency radio wave.

9.5-4 **(Application)** We have seen that both microwaves and visible light can be linearly polarized. Would the slotted-metal polarizer be useful to polarize visible light? Consider the way the mechanism of operation you discovered for the microwave polarizer and what you know about wavelengths of microwaves and visible light to explain why or why not the slotted metal filter would work for visible light.

Based on your response to the previous question, what size would objects need to be in order to work in a similar manner to polarize visible light?

The following FNT is optional, but **REALLY REALLY FUN:**

9.5-5 Certain materials, such as cellophane and some clear plastics, especially if under stress, will rotate the direction of polarization as light passes through it. However, the degree or rotation often depends rather strongly on wavelength, so different colors are rotated different amounts. If you put such materials between two "crossed polarizers" (turned 90˚ with respect to each other), you will see brightly colored regions with the color depending on the thickness of the material or amount of stress. By rotating one polarizer, the colors will dramatically change. Try to find materials that exhibit such behavior and bring them to the next DL. Some brands of clear tape work especially well, while others don't work at all. You can put different thicknesses of tape to make a design.