Physics Exploration Homework Supplement P111-18.pdf

Applications of Electromagnetic Induction including Eddy Currents:

Go to the Physics Exploration Center. Enter through the resource room in 311/312 Thaw Hall. This exploration involves exploring applications of the phenomena of electromagnetic induction including eddy currents.

(1) (a) Electromagnetic induction can be used to make a microphone and a speaker. A microphone is a device for converting sound energy into electrical energy and a speaker is a device for converting electrical energy to sound energy. Look closely at the hand-made microphone and speaker you have been provided (coils glued on a cardboard with a magnet, close to it) and speak into the microphone (make sure to put your mouth very close; to the microphone paper. If you can not hear your voice on the "homemade speaker", ***lightly*** tap or scratch on the microphone surface with your finger). What is the moving part of the microphone? The speaker will convert the electrical signal back into sound (and the amplifier provided will amplify it). Explain the process via which the microphone is converting sound into an electrical signal describing the roles played by the cardboard, coil and the magnet. (Set-up P111-18A.pdf)

(1) (b) Since the hand-made microphone may not work very well, speak into the commercial microphone and listen to the sound in the speaker. Does the hand-made speaker work as desired? Write down the feature of this experiment, that you like best. Also, write down two other applications of electromagnetic induction in your everyday experience.

(2) (a) You are provided with two long vertical hollow tubes made with different metals. If you drop a magnet and a metal piece (slug) both of which have identical shape through each tube, which of them will come out of the other end in shorter time? Explain your reasoning. Also, predict what should happen to the weight of the long vertical tubes while the magnet or slug is falling through it (set-up P111-18B.pdf). Explain your reasoning.

(2) (b) Now perform the experiment by dropping the magnet (single magnet, approximately mass: 60 gm) and slug (approximately mass: 35 gm) through each tube. Using a stopwatch, note the time it takes for the magnet and slug to travel through each of the tubes. Also record the weight of the tubes as the magnet and slug travel through each of the tubes. (Very soon after the magnet starts to fall in the tube, the change in the weight of the vertical tube stabilizes to a fixed value for both vertical tubes.) Explain how this change in the weight of the tube will be affected if the falling single magnet is replaced by the double magnet which has an approximate mass of 85 grams. Explain. Now perform the experiment to test your prediction by dropping the double magnet down the tubes.

(3) (a) Another manifestation of eddy current is in damping the motion of a moving metal piece

in a changing magnetic field. This exploration involves understanding how the magnitude of the eddy current, and the corresponding induced magnetic field and force depends on how large the eddies are. You are provided with three aluminum pieces one of which has no teeth, one has combs and one has slits (set-up P111-18C.pdf). Predict in which of these three aluminum pieces will the largest and smallest eddies be produced under the same changing magnetic field. Explain. Also predict which of the aluminum pieces will have its motion damped the fastest when you let it swing between the poles of the large horseshoe magnet. Explain the origin of the force which is responsible for damping the motion (ignore air resistance).

(3) (b) Now perform the exploration. Make a pendulum by hanging each of the three aluminum pieces from the support provided and swinging them from a fixed height in the magnetic field. (The magnetic field is provided by the poles of a magnet.) Explain any discrepancy in your prediction and observation, if any. What does your observation say about the relative magnitudes of the eddy currents induced in the three aluminum pieces?