

✓ Dropping magnets - Session II

As a reminder, the context of this lab is to explore the impact of a magnet falling through a coil of wire.

By the end of this session, you will present to your TA and the lab section your claim and evidence about how different variables affect the measured voltage difference across a coil of wire when a magnet moves through the coil.

Learning goals

By the end of this unit, you should be able to:

- Design high-precision experiments to build models, including identifying interesting variables to test, variables to control, and ways to reduce uncertainty and systematics.
- Manage time by conducting pilot experiments, plotting as you go, and reflecting on the measurements and data throughout.
- Motivate all research questions, conclusions, and interpretations with supporting data.
- Provide positive and constructive feedback when evaluating peers' work.

✓ Setup the Notebook

Run the code cell below to mount your Google Drive and load the `utilities.ipynb` file as in previous weeks.

```
from google.colab import drive
drive.mount('/content/drive')

#Fill in the appropriate directory info in the ``...``
%run "/content/drive/My Drive/.../utilities.ipynb"
```

Reminder: Magnets should be seen and not heard. Please use one of the rubber buckets to catch the magnet.

✓ Iterating and extending

Remind yourself of your claim from last session. This session, you should be testing more variables, improving your methods, and building towards a collective model:

- Use your evidence to propose several possible models for whether and how your variable(s) affects aspects of the signal and compare your data to each model.
- Justify each model that you develop using your previously collected data.
- Use the model(s) to make a prediction(s) about a new result and design and carry out investigations to test those predictions.
- Iteratively build a body of evidence that rules out possibilities and provides support for other possibilities.

Document this process in the space below as a continuous train of thought -- more like a journal or diary than a lab report -- and analyze data **as you go**.

[Your ongoing train of thought documentation of your various investigations should keep getting created here and below]

#Create as many of these as necessary

✓ Lab Checkout

At the end of the second session, you will give a two to three minute presentation about your investigations to the whole section. In your presentation, you should provide:

- a clear claim (whether a positive, negative, or null result)
- your evidence in support of that claim,
- any evidence that contradicts that claim.

These presentations will serve as the lab checkouts. Document your claim and evidence below.

[Your response here]

Circuit set up

Your TA will draw a circuit diagram on the board to represent the set up for the lab. In the diagram, you should only see two circuit components: a coil and an oscilloscope. The coil is connected directly to the oscilloscope so that the oscilloscope reads the voltage difference across the coil.

Oscilloscope settings

- Use the **Scale** knobs to change the scale for the horizontal axis (time) and vertical axis (voltage). The separation between the major grid lines is given on the bottom in the colors corresponding to each channel. These are good things to keep note of in your lab notes!
 - The magnet takes less than a second to fall, so the time divisions should be on the order of milliseconds (50 ms).
 - The height of the voltage peak is on the order of 100 mV so voltage divisions should be 50 mV.

- You can also adjust the position of the signal with the **Position** knobs.
- The oscilloscope will need to be set to observe and freeze the signal when the magnet falls through the coil. First, we need to tell it when to *trigger*.
 - Triggering is the process of starting a "sweep" of the oscilloscope. The oscilloscope waits for the voltage difference to pass through a triggering voltage before beginning a new sweep.
 - We want the triggering voltage to be high enough to avoid triggering on noise but low enough to detect the induced voltage difference from the test.
 - The triggering voltage is adjusted via the knob labeled **Trigger**.
 - The oscilloscope allows you to set various properties associated with the trigger. Start with the trigger type set to **Edge** and the trigger mode set (second page of the trigger menu) to **Normal**.
- Second, we need the signal to freeze on the screen once it's been triggered:
 - For this, we'll use the **Single** button on the upper right-hand corner of the oscilloscope. Press it and make sure it's green before you conduct a test (green means it is actively measuring).
 - When the triggering voltage is reached, it should turn red and freeze the trial on the screen of the oscilloscope (red means it is no longer actively measuring).

Oscilloscope FAQs

What is this thing showing me?

The grid on the oscilloscope shows the voltage difference in the vertical direction and time in the horizontal direction. It is measuring the voltage difference between the ends of the wires that you connect to each Channel.

I can't see anything or I don't see what I expected. What do I do?

Some things to try:

- Press **Autoset**
- You may not have it set to display the channel you want. Turn on channel 1 by pressing the yellow **1** button. You might need to change **Probe 10x Voltage**,

which multiplies your measured voltage by a factor of 10, to **Attenuation 1x**.

- Still no? Repeat the previous step for Channel 2.
- Can we see a known source, such as a function generator? Hook up the oscilloscope to read the voltage difference across the function generator terminals using Channel 2 (make sure grounds are connected). Is that what you expect? If not, there may be something wrong with your circuit. Check with another group or your instructor.

How do I measure voltage differences with an oscilloscope?

- Press **Cursor** and select **Type None**. From the list, use the **Multipurpose** knob to select **Amplitude**. The **Time** button will allow you to simultaneously measure differences in time and voltage.
- Adjust *Source* to the channel that you wish to measure (either Channel 1 or Channel 2, whatever the wires from your coil are plugged into).
- Use **Cursor 1** and **Cursor 2** to measure differences in voltage and time between the two cursors. Remember to use the difference between the two cursors, not the absolute value of either cursor. We want voltage difference and don't know what either cursor is relative to on its own (we want the pressure difference, not the absolute pressure, going back to the [water pipes analogy](#)).

What I'm seeing makes no sense.

That is not a question. Regardless...

- Have you discussed an appropriate time scale with your group? Adjust the timescale manually to an order of magnitude that is appropriate for your test (e.g., how long does it take for the magnet to fall through the coil?).
- Still not sure? Go find another group who have a signal that makes sense and check what settings they have.
- *Still* not sure? Ask your TA.

How do I measure [insert measurement]?

The oscilloscope has many available tools to assist you in making different measurements. The **Multipurpose** knob and the **Math** button each include multiple capabilities that are available. Search online for the oscilloscope manual (include brand and model number) for additional information or play around and figure it out!

