

Anderson Junior College
 2012 H2 JC2 Physics
 17 Electromagnetic Induction

What Happens when You Drop a Magnet Through A Coil?

Let us find out through the help of an applet and this helpful worksheet =)

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Steps to download the applet as follows:

Step 1. Log into IVLE

Step 2. At your workspace, click on “Lesson Plan Batch_1112_H2_Physics Lesson Plan 1”

Step 3. Click on Topic 26

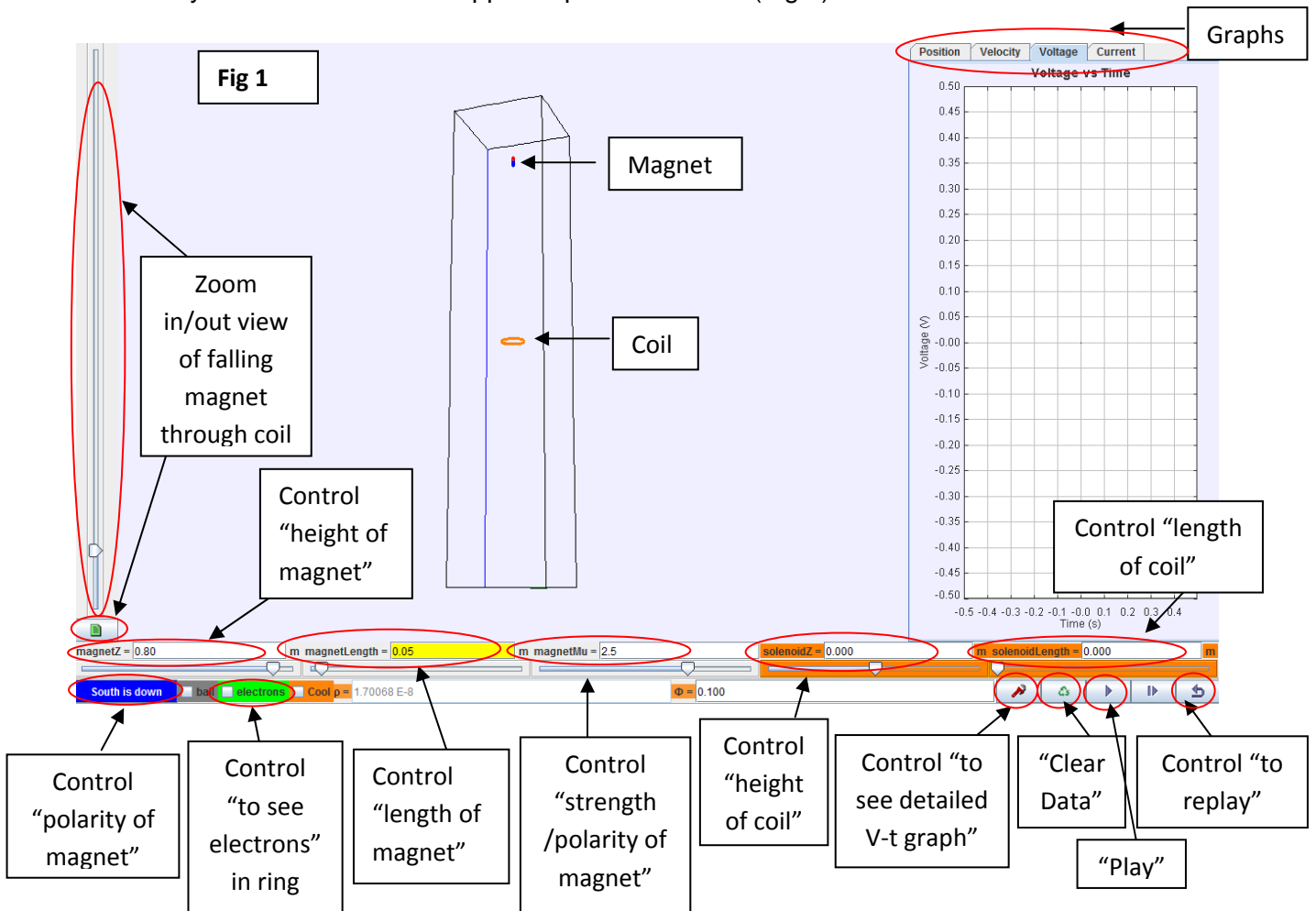
Step 4. Click to see the applet “ejs_MagnetFallingweexmlcoil2”



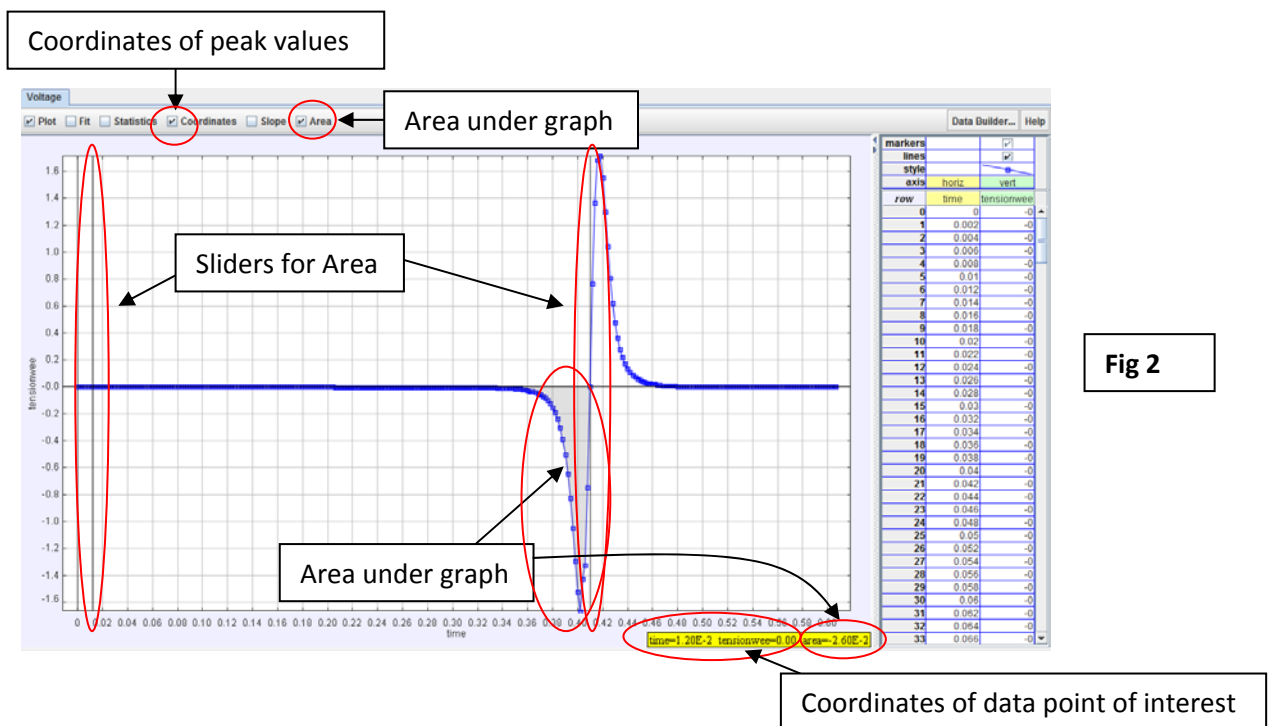
Step 5: Download and save into your computer.

Step 6: Run the executable file to start the applet.

Now, let us familiarise ourselves with the controls/functions of the applet which we will be using in the activity. A screenshot of the applet is provided below (Fig 1).






- **Zoom-in/zoom-out view** of the magnet and coil – leftmost “vertical” control or leftmost bottom box for checking.
- **To change the orientation of your view of the magnet and coil**, eg get the top view of ring, you can click anywhere around the region of the magnet or coil, hold on and then move your cursor.
- “Horizontal” controls near bottom of screen (from L to R)
 - **height of magnet** – 1st (magnetZ) control,
 - **length of magnet** – 2nd (magnetLength) control,
 - **strength and polarity of magnet** – 3rd (magnetMu) control ,
 - **height of the coil** – 4th (coilZ) control &
 - **length of coil/solenoid** – 5th (solenoidLength) control.
- **4 graphs (s-t, v-t, V-t and I-t)** of the magnet as it falls through the coil are plotted as you drop the magnet. The graphs are located on the right hand side. You can click on the relevant tab to see the desired graph.
- Last row of controls at bottom of screen (from L to R)
 - **polarity of magnet** – bottom left “South is down” or “North is down” tab
 - **view electrons in coil** – check “electrons” box and the movement of the numbered electrons can be seen
 - **Detailed V-t graph with coordinate values and area under the graph** – “probe” icon located at the bottom left. Upon clicking it, you will see Fig 2 as shown below.
 - **Fig 2**
 - **Coordinates** – check “coordinates” box and put your cursor on the data point you are interested in. Read off the coordinates located at the bottom right yellow portion.
 - **Area under graph** – check “area” box and using your cursor, click on the “sliders” located at the left and right of the graph and slide them till the two sliders enclose the area of interest. The enclosed area will be shaded. You can read off the enclosed area located at the bottom right yellow portion.



Now, you are ready to start!! =)

(A) Dropping a Magnet through a Coil

- 1) Set the magnet height to 0.80, magnet length to 0.05, magnet strength to 2.50, fix coil's height and coil's length to be 0.00. (You may want to check the "bottom view" button  to see magnet and coil from the far view)
- 2) Click on the "play" button  to drop magnet through the coil.
- 3) Click on the "probe"  icon to obtain the detailed V-t graph.
- 4) Sketch the graph (known as Graph 1) that you obtain.

- 5) Check on the "coordinate" box and bring your cursor to the peaks of Graph 1.
 - Record the peak values of the induced e.m.f.
 - Are the induced peak e.m.f of the same magnitude? Why/why not?




Coordinates: _____ & _____
Why/why not? _____

- 6) (i) Check on the "area" box and record the values of the areas under Graph 1.
Areas: _____ & _____

(ii) Calculate the difference in the areas under Graph 1. Explain your results.

Difference in areas: _____

Comment _____

- 7) Check on the "electrons" button , click the "restart" button  and then "play" button  to observe the movement of free charges (which have been numbered for easy reference) in the ring as the magnet enters and leaves the coil.

State the direction for the movement of charges when



- Magnet is entering the coil _____
- Magnet is leaving the coil _____

Explain why there is a movement of electrons

Explain why there is a change in direction of movement of electrons when magnet enters versus when it leaves the coil.

(B) Changing Polarity of Magnet, Keeping All Other Variables Constant

8) Change the **polarity of magnet** by clicking on the “South is down” **South is down** tab to change to **“North is down”** **North is down** while keeping magnet height as 0.80, magnet length as 0.05, magnet strength 2.50 and coil’s height and length to be 0.00.

- Click “clear data” button  and click “reset” button . **[IMPORTANT]**
- Repeat steps (1) to (4) to obtain sketch of Graph 2.
- Note the difference between the shapes of Graph 1 & Graph 2 and explain for the difference.

Difference btw Graph 1 & Graph 2

Explanation

(C) Changing Height of Magnet, Keeping All Other Variables Constant

9) Now, change polarity of magnet back to that in step (1), ie “South is down” **South is down** tab. **Change the height of magnet to 0.20**, while keeping magnet length as 0.05, magnet strength as 2.50 and coil’s height and length as 0.00.

Click “clear data” button  and click “reset” button . **[IMPORTANT]**

Repeat steps (2) to (6) to obtain

- (i) a sketch of Graph 3,
- (ii) coordinates of the peak values,
- (iii) areas under Graph 3 and difference in these areas.
- (iv) Explain the differences between Graph 1 & Graph 3 for
 - the peak values and
 - the difference in areas under the two graphs.

For Graph 3
Coordinates

Areas

Difference in area

Difference btw Graph 1 & Graph 3

Explanation

(D) Changing Length of Magnet, Keeping All Other Variables Constant

10) Now, reset the height of magnet to 0.80 and keeping the polarity as "South is down"

South is down, magnet's strength as 2.50 and coil's height and length as 0.00, set the **length of the magnet to 0.60**.

Click "clear data" button  and click "reset" button . **[IMPORTANT]**

- Repeat steps (2) to (4) to obtain a sketch of Graph 4.
- Note the difference between the shapes of Graph 1 & Graph 4 and explain for the difference.

Difference btw Graph 1 & Graph 4

Explanation

(E) Changing Length of Coil (ie Solenoid), Keeping All Other Variables Constant

11) Now, reset the length of magnet back to 0.05 and keeping the height of magnet as 0.80, magnet strength as 2.50, polarity as "South is down" **South is down** and coil's height and length as 0.00, **set the length of the coil to 0.740** (ie becomes a solenoid in this case).

Click "clear data" button  and click "reset" button . **[IMPORTANT]**

- Repeat steps (2) to (4) to obtain a sketch of Graph 5.
- Note the difference in the shapes of Graph 1 & Graph 5 and explain for the difference.
- Note the similarity in the shapes of Graph 4 & Graph 5 and explain for the similarity.

Difference btw Graph 1 & Graph 5

Explanation (Graph 1 versus Graph 5)

Similarity btw Graph 1 & Graph 5

Explanation (Graph 4 versus Graph 5)

12) Congratulations! You have come to the end of the activity. Through the series of Electromagnetic Induction lecture that is upcoming, you will be able to understand the reasons of your observations. Stay tune!! =D