PhET Faraday's Law - Grab and Release Interaction Sketch

Background

Based on feedback from user testing (see: PhET Faraday's Law - Gatech Interviews Notes), a number of issues were observed. This "Grab and Release" interaction sketch aims to address a number of these issues.

Observed Issue	Example / Remark	Grab and Release Solution
Too many alerts	Every cursor key press and release would fire location text alerts	Location text alert now fired only on release of magnet. Sonification will now be mostly uninterrupted.
Hard to concentrate on sounds and screen reader	Users often focus on the text alerts and miss the relationship between the magnet movement and the induced charge.	Sonification will now be mostly uninterrupted. Most text alerts have been removed from movement interaction loop, with the exception of a coil bump and play area edge bump alerts.
Text alerts can be out of sync with the sonification	Often when a sound event happens, like a coil bump or induced charge, text alerts report the magnets location which can create confusion or incorrect associations.	Sonification will no longer compete with most text alerts, thus avoid any confusion. Coil bumps now have a "Bumped coil" text alert.
Long alerts create cognitive load	A text alert can be very long (regardless of number of coils).	Alerts in general are now shorter and less complicated: • Removed play area location alerts. • Reduced the complexity of proximity and regions.
Long pauses in alerts causes users to stop listening	Screen readers will pause longer between sentences.	Text alerts use less periods (more commas or concatenated phrase fragments).
Coil bump sound can sometimes be ambiguous	Some users incorrectly associated the bump coil sound with a goal accomplishment (i.e. paraphrasing "I got the magnet into the coil, and that sound means I made it.").	A single text alert now fires when a coil bump occurs ("Bumped coil").
Slide key instructions are often missed	Most users did not use the slide keys.	Introduce slide key instructions on later magnet grabs (as to not compete with other instructions, and reduce cognitive load).
Not clear to some users how to begin moving the magnet	The magnet button cue wasn't strong, and located in an unintuitive spot in the PDOM.	• Better label and aria-description for better cueing ("Grab Magnet" and "Select this to move the magnet"). • Button to grab the magnet is now located in the Controls Area list with other controls.
Unclear what voltmeter does	A number of users did know what the voltmeter was for.	Alternative 1: When voltmeter is visible, a text alert is fired when a peak is reached. Alternative 2: Include a sentence in the scene summary describing the last voltage peak.
Unclear what sliding does		Sliding keys are now introduced later / scaffolded after the direction keys have been used and when the sliding will actually do something interesting. See "Text Alerts" below.

Issues not yet addressed:

Observed Issue	Example / Remark	Notes
Unclear about use of field lines	Turning on field lines has no immediate perceivable effect.	• Currently the design only updates the "Magnetic Field Lines" description as the magnet moves. • Should the field strength be added to the text alert when magnet is released?

Notes:

- how to help users replicate what they have done
- how to help users compare results
- how is it possible to track last major events?
- Conveying voltage information:
    - put a description in the PDOM, or somehow add description to the alert: use a similar 3-point description as lightbulb
        - "small / big / very big" "negative" "flux / voltage / ?"
        - "voltage big positive" "big positive volts" ?
        - "small positive change" > "small change"
        - add a description in the PDOM to help with cueing of text alert
            - voltmeter described as "measures voltage changes in circuit"
            - voltmeter text alert "small positive change" (initially) > "small change"
            - "Last peak reading on voltmeter: x negative (x positive)"
- AT reads focus when released
- Tab moves focus and AT will announce label of next item. (be wary of possible confusion)
- put the coil orientation in the scene summary.

PDOM Example

Faraday's Law (h2, Scene Summary)

Example	Description Template*

Faraday's Law is an interactive sim. It changes as you play with the movable bar magnet.
 	
At the centre of the play area are a 2 loop and a 4 loop coil connected to a light bulb circuit. A voltmeter is also attached to the circuit.
 	
The two coils are sideways, each with openings on the left and right.
 	
Magnetic field is weak at the 2 loop coil, moderate magnetic field at the 4 loop coil.
 	
Grab the magnet to play.
 	
There are additional controls that change what is connected to the circuit, flip the bar magnet, and reset the sim. If needed, check out keyboard shortcuts under Sim Resources.
	"*Faraday's Law is an interactive sim. It changes as you play with the movable bar magnet.*"
	
	"*At the centre of the play area*" + **(is a 4 loop coil / are a 2 loop and a 4 loop coil)** + "*connected to a light bulb circuit.*" `/If voltmeter attached/` "*A voltmeter is also attached to the circuit.*"
	
	"The" + (**coil is / two coils are**) + *"sideways,"* + **(with / each with)** + *"openings on the left and right."*
	
	`/ If field lines visible - One coil /`
	"Magnetic field is" + **(strong / moderate / weak)** + *"at the coil."*
	
	`/ If field lines visible - Two coils with different field strengths /`
	"Magnetic field is" + **(strong / moderate / weak)** + *"at the 2 loop coil,"* + **(strong / moderate / weak)** + *"magnetic field at the 4 loop coil."*
	
	`/ If field lines visible - Two coils, same field strengths /`
	"Magnetic field is" + **(strong / moderate / weak)** + *"at both coils."*
	
	"Grab the magnet to play.
	
	There are additional controls that change what is connected to the circuit, flip the bar magnet, and reset the sim. If needed, check out keyboard shortcuts under Sim Resources."

* Emphasis added for legibility

Play Area (h2)

Bar Magnet (h3)

Example	Description Template*
Magnet above right of 2 loop coil. Magnet North pole on left South on right. (Button "Grab magnet") Once grabbed, W A S D and Arrow Keys moves magnet in 4 directions, 1 2 3 keys slides magnet different speeds left and right.	*"Magnet"* + **(magnet location)**. *"Magnet"* **+ (North / south)** + *"pole on left"* + **(South / North)** + *"on right."* **Button:** "Grab magnet" *"Once grabbed, W A S D and Arrow Keys moves magnet in 4 directions, 1 2 3 keys slides magnet different speeds left and right."*

* Emphasis added for legibility

Controls Area (h2)

- Checkbox
  - Label: "Voltmeter"
  - Aria description: "Play with or without voltmeter connected to light bulb circuit"
- Checkbox
  - Label: "Field Lines"
  - Aria description: "Hide or show magnetic field lines."
- Circuit mode
  - Aria description: "Experiment with one or two coils."
  - Radio button group
    - (Radio) 1 coil
    - (Radio) 2 coils
- Button
  - Label: "Flip magnet"
  - Aria description: "Flip North and South Poles"
- Button
  - Label: "Reset All"

Text Alerts

Event	Alert text
Grab magnet: 1st and 2nd time	*"Grabbed"* + **(magnet location)** + *", W A S D keys move in 4 directions. Press Space to release."* **Note:** See "Magnet Locations Used for Text Alerts" below
Grab magnet: 3rd time onward	*"Grabbed"* + **(magnet location)** + *". Press Space to release."*
Grab magnet: Any time after 2nd grab, and a resulting slide will pass through a coil with no coil collision. Fire this alert at most two times. *	*"Grabbed"* + **(magnet location)** + *", try 1 2 3 keys to slide different speeds left and right, press Shift to stop slide, press Space to release."*
Brightness peaks and falls off	See "Bulb Brightness and Voltmeter Text Alerts" below.
Voltage peaks and falls off	See "Bulb Brightness and Voltmeter Text Alerts" below.
Release magnet	*"Released"* + **(magnet location)**. *See "Magnet Locations Used for Text Alerts" below
Slide stop	*"Sliding stopped."* or *"Stopped"*
Bump Coil	*"Bumped coil"*
Bump Edge	*"At edge of play area."*

*It's very possible that this alert will fire and be immediately followed by brightness and voltage peak alerts. This may not be a great experience. May have to tweak this.

Bulb Brightness and Voltmeter Text Alerts

This text alert is fired when the bulb brightness or voltmeter peaks then falls off. The intent of this alert is help the user understand what is happening in the scene and reduce confusion when magnet is near a coil.

To avoid too many alerts, this alert fires only if it hasn't already been fired within a time window. In the implementation, try setting this window to 3 seconds initially. If it seems too frequent, increase the time. If it seems not frequent enough, decrease the time.

The density of the text alert is lengthier the first 3 occurrences, and becomes terser in subsequent occurrences.

Event	Just Bulb	Voltmeter visible - idea 1 (Includes both voltage and bulb)	Voltmeter visible - idea 2 (Just voltage, and omit bulb)
First 3 occurrences	"Dim bulb " "Bright bulb" "Very bright bulb "	"Low (positive / negative) voltage dim bulb." "Medium (positive / negative) voltage bright bulb." "High (positive / negative) voltage very bright bulb."	"Low (positive / negative) voltage." "Medium (positive / negative) voltage." "High (positive / negative) voltage."
After 3rd occurence	"Dim" "Bright" "Very bright"	"Low (positive / negative) dim" "Medium (positive / negative) bright" "High (positive / negative) very bright"	"Low (positive / negative)" "Medium (positive / negative)" "High (positive / negative)"

Note About 2 Loop Coil vs. 4 Loop Coil brightness / voltage

Since the 2 loop coil is smaller, the **maximum** peak brightness / voltage will only be described as: "Bright bulb" / "Medium voltage".

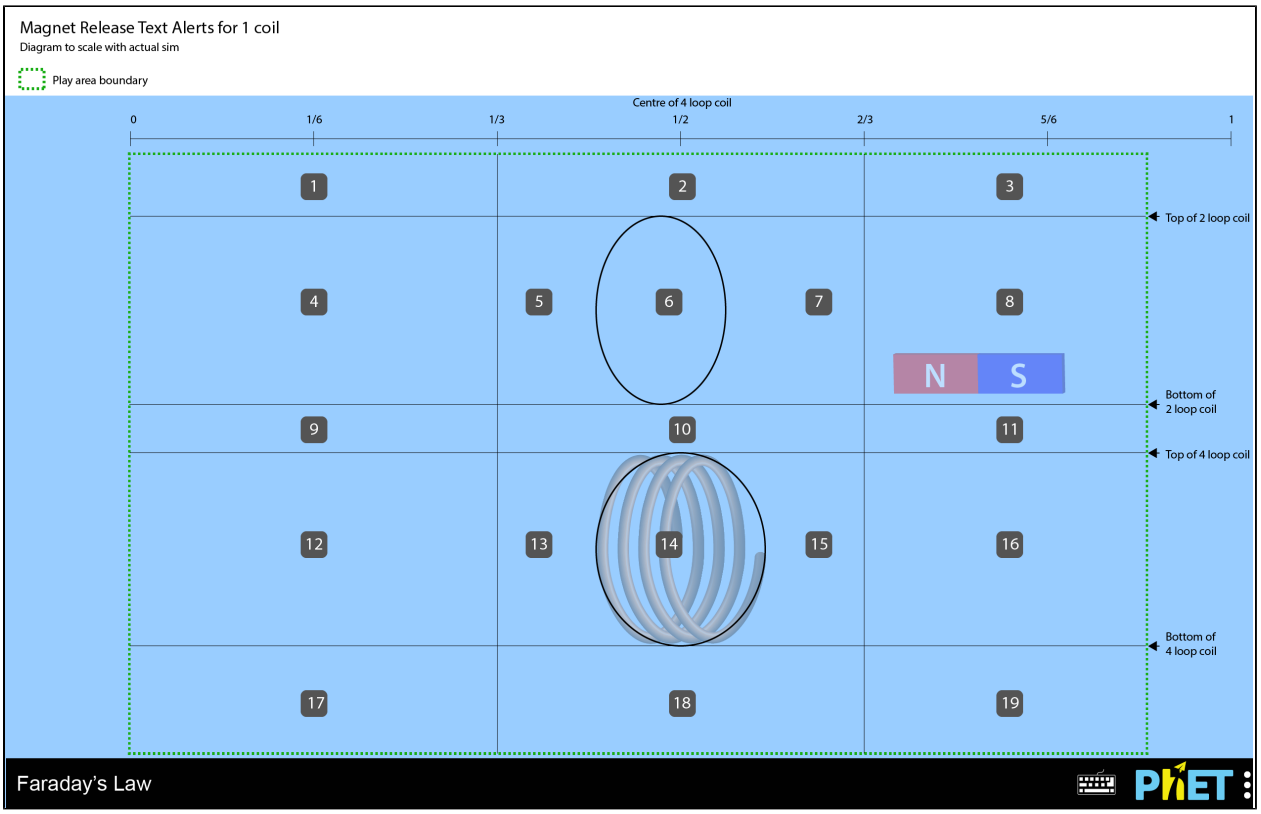
The 4 loop coil, as it is bigger, the maximum peak brightness / voltage will be described as "Very bright bulb" / "High voltage".

Magnet Locations Used for Text Alerts and PDOM Descriptions

The following diagram depicts the different magnet locations used for:

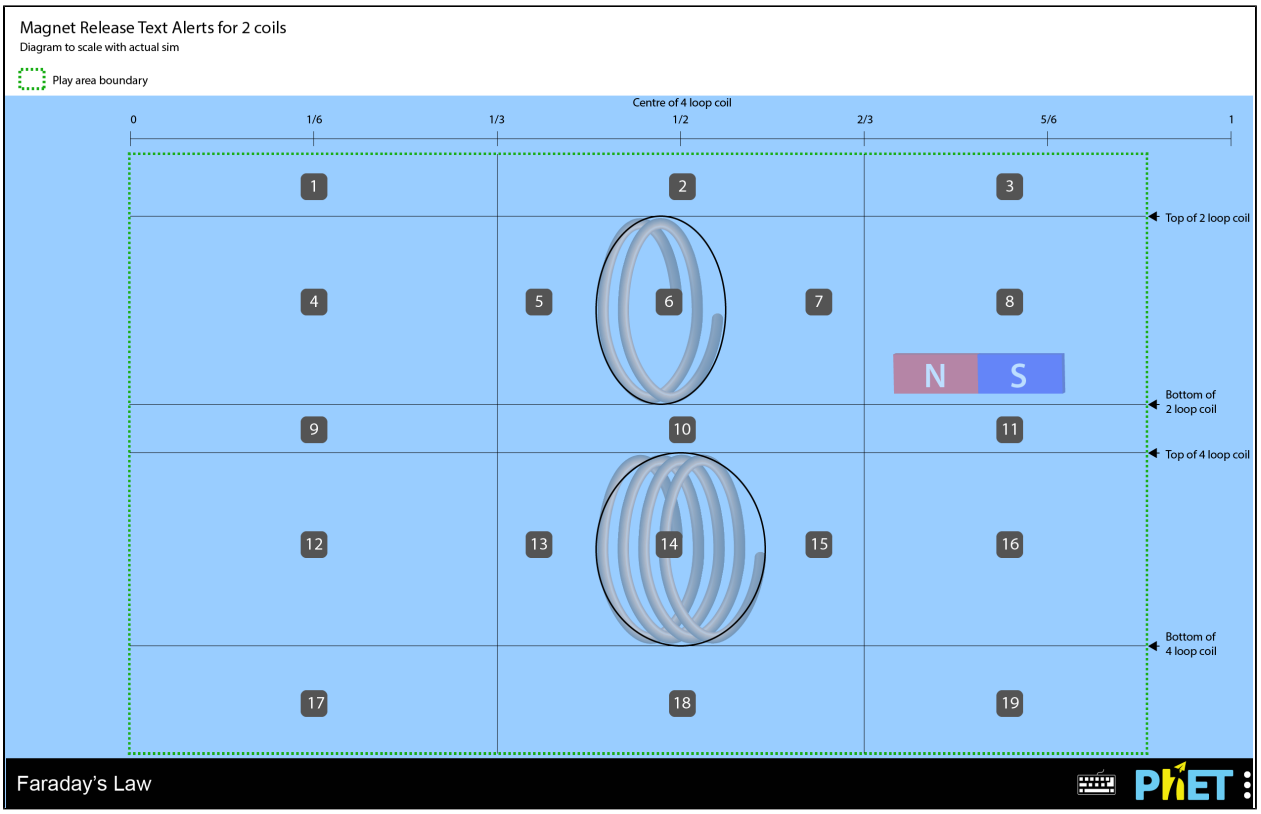
- Magnet Grab text alert
- Magnet Release text alert
- PDOM Magnet description.

Magnet Locations - One Coil



Region #	Location	Region #	Location
1, 4, 9	“above left of coil.”	15	“just right of coil.”
2, 5, 6, 7, 10	“above coil.”	16	“right of coil.”
3, 8, 11	“above right of coil.”	17	“below left of coil.”
12	“left of coil.”	18	“just below coil.”
13	“just left coil.”	19	“below right of coil.”
14	“inside coil.”		

Magnet Locations - Two Coils



Region #	Location	Region #	Location
1	“above left of 2 loop coil.”	12	"left of 4 loop coil."
2	"just above 2 loop coil"	13	"just left of 4 loop coil."
3	"above right of 2 loop coil"	14	"inside 4 loop coil."
4	"left of 2 loop coil"	15	"just right of 4 loop coil."
5	"just left of 2 loop coil"	16	"right of 4 loop coil."
6	"inside 2 loop coil"	17	"below left of 4 loop coil."
7	"just right of 2 loop coil."	18	"just below 4 loop coil."
8	"right 2 loop coil."	19	"below right of 4 loop coil."
9	"left of both coils."	11	"right of both coils."
10	"between both coils."		

Aside: Regions 9, 10, and 11 are trickier to describe succinctly. Opted for a simpler description as this alert may not happen often, and subsequent alerts will provide clarification.

Example Interaction with Text Alerts

First and Second time grabbing magnet (WASD prompt on grab)

- Pressed tab.
  - Focus moved to magnet
  - Screen reader would announce button label ("Grab magnet").
- Press enter.
  - Text alert: "Grabbed (location), W A S D keys move in 4 directions, press Space to release."
- WASD or Cursor keys pressed
  - Sonification sounds are heard
  - Bump Coil ("Bumped coil") and Bump Edge ("At edge of play area") alerts fired if occurred.
  - Changes to PDOM descriptions occur as interaction proceeds.
- Press space.
  - Text alert: "Released (location)"
  - Keyboard focus is on magnet button.
- If Tab is pressed

    - Text alert: "Released (location)"
    - Keyboard focus moves to next focusable item.

Third time on-wards (Shortened grab alert)

- Pressed tab.
    - Focus moved to magnet
    - Screen reader would announce button label ("Grab magnet").
- Press enter.
    - Text alert: "Grabbed (location). Press Space to release."
- WASD, Cursor, or 123 keys pressed
    - Sonification sounds are heard
    - Bump Coil ("Bumped coil") and Bump Edge ("At edge of play area") alerts fired if occurred.
    - Changes to PDOM descriptions occur as interaction proceeds.
- Press space.
    - Text alert: "Released (location)"
    - Keyboard focus is on magnet button.
- If Tab is pressed
    - Text alert: "Released (location)"
    - Keyboard focus moves to next focusable item.

Any time magnet is in a position where it can slide completely through the coil (Slide prompt fires at most 2 times)

- Pressed tab.
    - Focus moved to magnet
    - Screen reader would announce button label ("Grab magnet") and associated aria-describedby text ("Select this to move the magnet").
- Press enter.
    - Text alert: "Grabbed (location), try 1 2 3 keys to slide different speeds left and right, press Shift to stop slide, press Space to release."
- 1 2 3 keys pressed
    - Sonification sounds are heard
    - Bump Edge ("At edge of play area") alerts fired if occurred.
    - Changes to PDOM descriptions occur as interaction proceeds.
- Press shift
    - Slide stop alert: "Sliding stopped."
- Press space.
    - Text alert: "Released (location)"
    - Keyboard focus is on magnet button.
- If Tab is pressed
    - Text alert: "Released (location)"
    - Keyboard focus moves to next focusable item.