Louisiana Believes

2021-2022 Louisiana Pacing Guidance
OpenSciEd Grade 6 Forces at a Distance

This document contains the OpenSciEd Forces at a Distance storyline with Louisiana-specific pacing suggestions. Adaptations have been made with permission under Creative Commons 4.0 licensing. Making any changes, including the ones suggested in this document, is not recommended if this is the first time implementing the unit. Teachers and instructional leaders are best placed to make pacing decisions that meet the needs of their individual students and unique school settings and may or may not choose to use these suggestions. In any setting, deep learning through authentic engagement with all three dimensions of the Louisiana Student Standards for Science for all students should be emphasized over covering content and should inform any decisions made with regard to pacing.

This guidance document is considered a “living” document as we believe that teachers and other educators will find ways to improve the document as they use it. Please send feedback to STEM@la.gov so that we may use your input when updating this guide.

Updated January 4, 2022

DEPARTMENT of EDUCATION
Louisiana Believes

Highlighted text contains Louisiana-specific pacing suggestions.

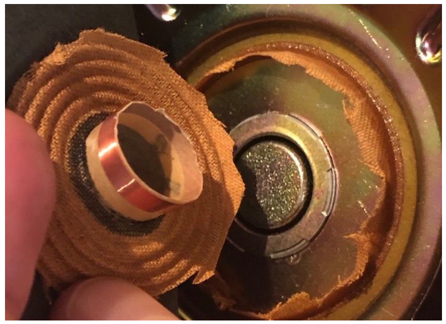
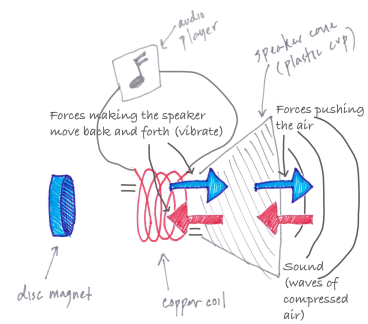
UNIT STORYLINE

How can a magnet move another object without touching it?

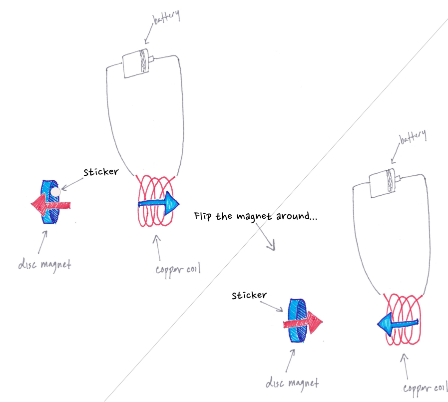
If condensing is needed, combine Days 2 & 3 by conducting Parts 6 & 7 together. Begin Part 8 on Day 1, complete for Home Learning, and follow the addtional suggestions below.

How students will engage with each of the phenomena

HANDS-ON/ LAB ACTIVITIES | VIDEOS OR IMAGES | DATA SETS | READINGS | COMPUTER INTERACTIVES

Lesson Question	Phenomena or Design Problem	What we do and figure out	How we represent it
LESSON 1 4 days **What causes a speaker to vibrate?** Anchoring Phenomenon Parts 9-14 can be completed on Day 4. If needed, have students submit addtional investigation ideas for home learning.	 *A speaker system with a magnet and a coil of wire moves back and forth without the parts touching.*	We dissect a store bought speaker and then build a homemade speaker. We develop an initial model to describe how interactions between parts of a speaker system cause sound without touching each other. Finally, we generate questions for our Driving Question Board (DQB) using a cause-effect scaffold that we will return to throughout the unit. We figure out: • A speaker is a system with parts that include a magnet, a coil of wire, and a speaker cone. • When the coil of wire is connected to a sound source, the speaker cone vibrates to produce sound, but only when a magnet is brought very near to the wire. • The magnet and the coil of wire do not need to be touching to make the speaker cone vibrate.	 Navigation from the end of Lesson 1 can be combined with the beginning of Lesson 2.

⇓ **Navigation to Next Lesson:** We identified the magnet and the coil as important parts of the system. In our next lesson, we can spend some time making observations of magnets and coils to find out more.

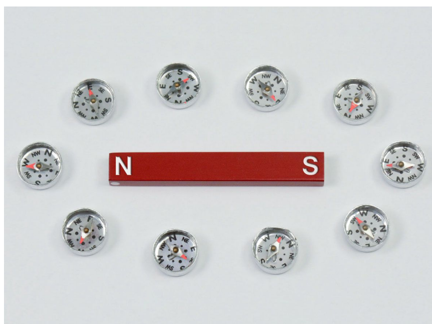
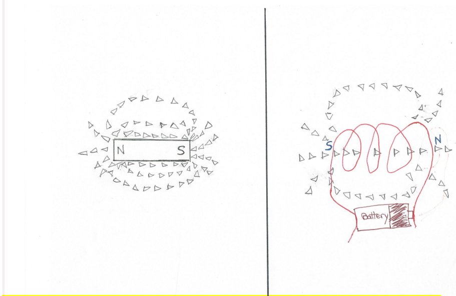
Lesson Question	Phenomena or Design Problem	What we do and figure out	How we represent it
LESSON 2 2 days **What can a magnet pull or push without touching?** Investigation	 *A magnet interacts with metal but not with copper unless it is connected to a battery.*	We experiment with magnets, coils and other metal objects to establish that while certain metals do interact with magnets, including other magnets, the copper coil does not. We notice force pairs between the magnet and the coil only when the coil is hooked up to a battery. We figure out: • There are forces between the magnet and the coil when the coil is connected to the battery. • Just like in a system with two magnets, we can get both pushes and pulls (repulsive and attractive forces) between the magnet and the connected coil. • Just like in a system with two magnets, we can get the connected coil of wire and the magnet to switch the type of force they are producing (attractive vs. repulsive) if we flip the orientation of either one of them. • When the connected coil of wire or the magnet move, they have kinetic energy.	

If condensing is needed and students seem to have a great deal of prior knowledge about magnets, Part 2 can be conducted a bit more quickly followed by a quick navigation to Part 6 and the Building Understanding Discussions (Parts 3 & 7) can be combined following Part 6.

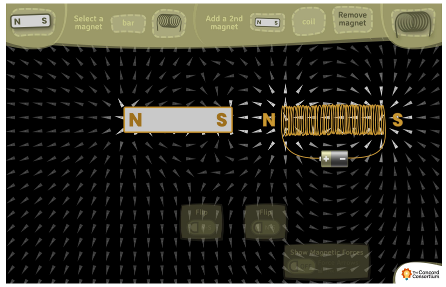
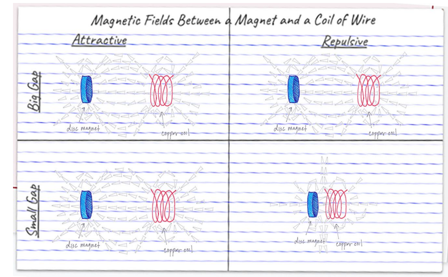
⇓ **Navigation to Next Lesson:** We know from our Broken Things unit and our Sound unit that contact forces transfer energy during collisions. We want to know where the energy of the moving coil came from if the parts of the speaker are not touching.

Lesson Question	Phenomena or Design Problem	What we do and figure out	How we represent it
LESSON 3 1 day **How does energy transfer between things that are not touching?** Investigation	 *When we block the air between two magnets or remove it altogether, magnets still exhibit the same interactions when they get close to each other.*	We are wondering how energy could transfer between parts of the speaker when the parts aren't touching. We think the energy might be transferring through the air. We write two hypotheses that predict the cause-and-effect relationships we would observe if energy transferred between magnets through the air. We figure out: • The energy that makes magnets move when they get close to each other does not get transferred through air.	

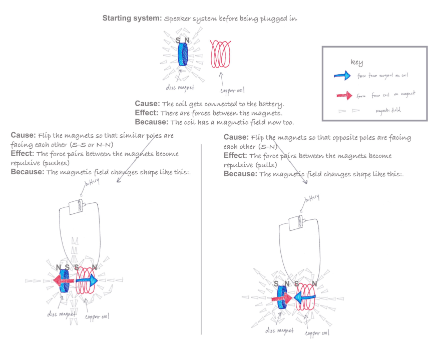
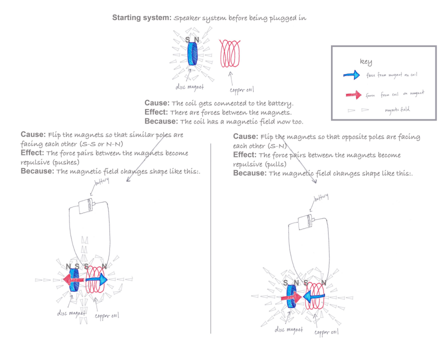
⇓ **Navigation to Next Lesson:** We use evidence from two whole-class investigations to show that our hypotheses about the role of air are false. We aren't sure what's going on in the space between two magnets, and we decide we need some new ways to visualize what is going on in that space.

Lesson Question	Phenomena or Design Problem	What we do and figure out	How we represent it
LESSON 4 4 days **What can we figure out about the invisible space around a magnet?** Investigation	 *When we place test objects like iron filings or compasses near a magnet we see patterns in the direction that they move that we can model with diagrams and computer interactives.*	We wonder about the space around a magnet that seems to push and pull on certain things. We learn that this space is called a *magnetic field*. We decide to investigate the field with test objects, like iron filings and compasses. We learn what the magnetic field looks like and that the field is not the same in every location around a magnet. We figure out: • The space around a magnet has a particular 3-dimensional shape, which we call a *magnetic field*. • Test objects, like small bits of iron and compasses, are affected by the magnet if placed inside the magnetic field. • Test objects show us that the magnetic field is not the same in every location around the magnet and seems to weaken and disappear as you move farther away from the magnet. • Electromagnets also have a magnetic field, and if the wire is made into a coil, the magnetic field is similar to that of a bar magnet. • Forces in the field have a direction - out of or away from the north pole and into or toward the south pole	 If condensing is needed, begin Part 3 discussion during the Part 2 demonstration, combine the discussions in Parts 4 & 5 and complete the investigation in Part 7 on Day 1. Finish with Part 8 and assigning home learning. Begin Day 2 by combining navigation in Parts 9 & 10 and complete the rest of the lesson as written.

⇓ **Navigation to Next Lesson:** We wonder how the magnetic field responds when there are two magnets or a magnet and a coil of wire that are near each other.

Lesson Question	Phenomena or Design Problem	What we do and figure out	How we represent it
LESSON 5 1 day **How does the magnetic field change when we add another magnet to the system?** Investigation 	 *When we add a second magnet to the computer interactive, the shape of the magnetic field changes depending on the orientation of the magnets to one another.*	We use a computer interactive to simulate the fields between a magnet and a coil for both attractive and repulsive forces at two different distances apart. We make diagrammatic models of the fields and come to consensus around how to represent the fields. We figure out: • When we look at the magnetic field around two magnets (or a magnet and a coil of wire), the magnetic field looks different than if we are looking at only one magnet. • When the forces are attractive (i.e., S-N or N-S), then the magnetic field connects in the middle with a line of pointers pointing in the same direction. • When the forces are repulsive (i.e., S-S or N-N), then the pointers curve away from each other in the middle. • It was hard to tell what happens when we move the magnet and the coil closer together.	

⇓ **Navigation to Next Lesson:** In our investigations throughout Lessons 2-5, we figured out that invisible magnetic fields are responsible for the interactions we saw between the magnet and the electromagnet in the speaker. Next time, we want to pause and put together some of our ideas to explain how this happens, which will also help us determine if there is anything else about how the speaker system works that we still need to figure out.

Lesson Question	Phenomena or Design Problem	What we do and figure out	How we represent it
LESSON 6 3 days **How can we use magnetic fields to explain interactions at a distance between the magnet and the coil?** Putting Pieces Together, Problematizing 	 *In a speaker, forces transfer energy out of an invisible magnetic field and into the rest of the system, producing the movement that we observe as vibrations or sound.*	We develop an initial model to describe how forces and energy transfer in magnetic fields explain cause-and-effect relationships between parts of a speaker system (magnet and coil of wire). We ask questions about how interactions between the magnet and the coil of wire cause sound without those parts touching each other. We figure out: • Forces in an invisible magnetic field produce the movement we observe between a magnet and an electromagnet without touching. • Flipping either magnet so that like poles are facing will change the magnetic field shape so that there will be repulsive forces between them. • Flipping either magnet so that opposite poles are facing will change the magnetic field shape so that there will be attractive forces between them.	

⇓ **Navigation to Next Lesson:** We still have a lot of gaps in our model that we want to investigate, mostly around the electromagnet. How does it work? And how does it produce both pushes and pulls when it is connected to a music player instead of a battery? When we modeled the magnetic field for a big gap versus a small gap, the field changed, but we don't know exactly what this means in real life. We have some ideas. We want to push magnets closer together and observe the effect in real life.

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<tr><th>Lesson Question</th><th>Phenomena or Design Problem</th><th>What we do and figure out</th><th>How we represent it</th></tr>
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LESSON 7

1 day

How does changing the distance between two magnets affect the amount of energy transferred out of the field?

Investigation

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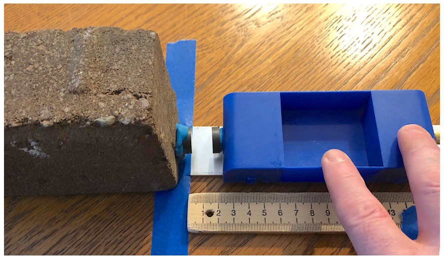

A cart on a track with a magnet on it is repelled by another magnet mounted to a bumper and moves away from the bumper magnet after the cart is brought near it and then released.

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We plan and carry out an investigation using a cart on a track to determine how changing the distance between two magnets that experience repulsive forces between them affects the energy transferred in a magnetic field between them. We use our results to explain how changing the distance between two magnets affects the amount of energy transferred into and out of the magnetic field. We figure out:

- When two magnets have repulsive forces between them and they are brought close together, kinetic energy is transferred into the magnets when they are released and they move back apart.
- When two magnets have attractive forces between them and they are moved apart, kinetic energy is transferred into the magnets when they are released and they move back together.
- Changing the distance between two magnets changes the amount of energy that can be transferred into and out of a magnetic field.

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⇓ **Navigation to Next Lesson:** We think energy might be transferring out of a battery into the electromagnet. But the speaker doesn't have a battery; it is connected to a music player. We aren't sure if those are the same thing or how they are related. We want to investigate that part of the system next.

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LESSON 8

3 days

How does the energy transferred from a battery to a wire coil compare to the energy transferred from a computer to a speaker?

Investigation

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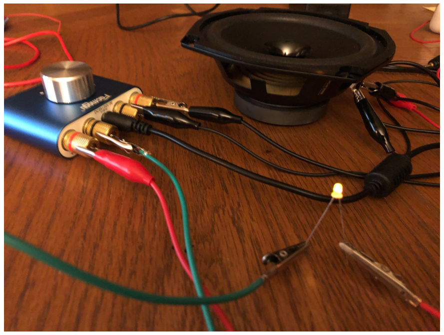

A speaker, a wire coil, an incandescent lightbulb, and a bicolor LED respond to an electric current provided by a battery vs. a sound app on a computer in some ways that are similar and some ways that are different.

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We vary the volume and frequency of sounds being produced by a sound generator on a computer and observe the effects. We gather information using various materials including light bulbs to help explain how changes in the electric current produced by the computer results in changes to a magnetic field within the speaker system. We figure out:

- More batteries in the circuit give more current, which transfers more energy, and results in stronger forces.
- Electric current changes direction when you flip the battery in a circuit.
- Electric current from a music player can change direction.
- The frequency of the changes in current determines the pitch of the sound (previous idea from the Sound Unit)
- Current that flips direction causes the poles of the electromagnet to flip.
- When the poles flip, the direction of forces (attractive vs. repulsive) flips in the field produced by the electromagnet.

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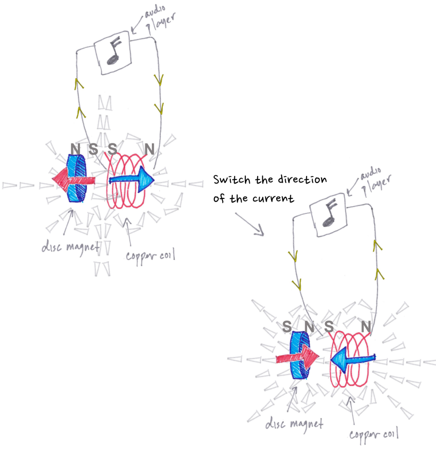

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⇓ **Navigation to Next Lesson:** We are ready to put our energy related ideas together to update our models to help explain our speaker system further.

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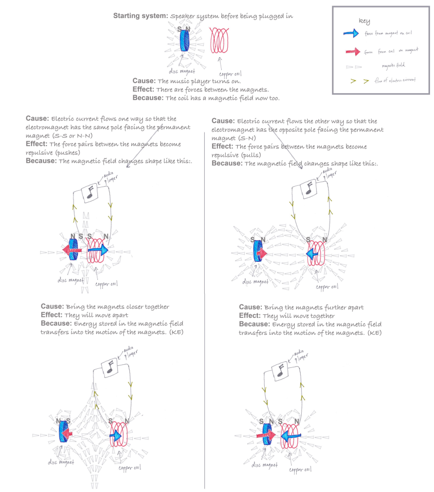
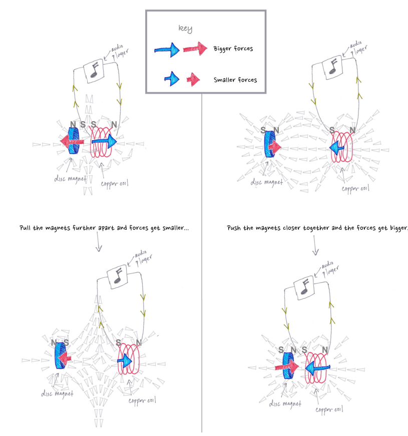
Lesson Question	Phenomena or Design Problem	What we do and figure out	How we represent it
LESSON 9 3 days **How do the magnet and the electromagnet work together to move the speaker?** Putting Pieces Together If streamlining is needed and students are able to move through Part 2 more quickly, Parts 3 & 5 can be combined to make consensus model on Day 1.	 *In a speaker, forces transfer energy out of an invisible magnetic field into the rest of the system, producing the movement that we observe as vibrations or sound.* Parts 6, 7, & 8 can be completed on Day 2 by reducing time spent on each activity by a few minutes.	We add to our list the cause-and-effect relationships. Then we construct a classroom consensus model to explain these relationships and how they work together to produce the patterns of movement we see in the speaker. After a brainstorm and a reading jigsaw, we wonder what we could do to make magnetic forces strong enough to lift trains and cars. We figure out: • Changing the current in the electromagnet changes the poles of the electromagnet and the shape of the magnetic field. • This will alternately produce force pairs between the magnet and the coil of wire that push them apart (repulsive force) and pull them together (attractive force), creating a vibration. • Energy is transferred into the magnetic field by the electric current flowing through the electromagnet and stored until it is converted into kinetic energy that transfers out of the system as sound energy.	

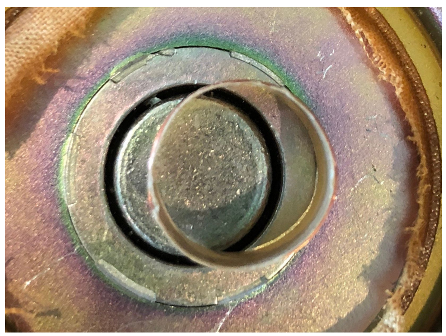
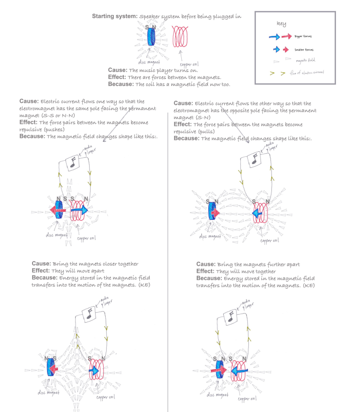
⇓ **Navigation to Next Lesson:** We learned about some very large applications for electromagnets. But our electromagnets can barely move a paper clip! We revised some of the questions on our DQB about the strength of magnetic forces that we want to investigate next in order to figure out how these very big devices can work.

Lesson Question	Phenomena or Design Problem	What we do and figure out	How we represent it
LESSON 10 3 days **How does distance affect the strength of force pairs in a magnetic field?** Investigation	 *When we change the distance between two magnets, the force pairs between them (attractive or repulsive) get stronger when they are closer together.*	We co-design and then carry out an investigation using a digital scale to test the relationship between distance and magnetic force. We analyze graphs to determine the relationship between distance and magnetic force between two magnets. We figure out: • The magnetic field around a magnet (and thus an electromagnet) gets stronger when it is closer to another magnet, which means that the force between two magnets will be stronger as the magnets get closer together. • The force with which a magnet pulls or pushes on something attracted to it or repelled by it is dependent on the distance between the magnet and the object or between two magnets. • Where magnets are in relation to each other determines how much potential energy is in the system.	

⇓ **Navigation to Next Lesson:** We have a lot more questions about what causes changes in the strength of magnetic forces. We want to divide and conquer to answer those questions through investigations.

Lesson Question	Phenomena or Design Problem	What we do and figure out	How we represent it
LESSON 11 3 days **What else determines the strength of the force pairs between two magnets in a magnetic field?** Investigation	 *When we increase the size of a permanent magnet, increase the number of coils in an electromagnet, or increase the current in an electromagnet, we make the forces between magnets stronger.*	We plan and carry out an investigation to produce data to support a hypothesis about what factors cause changes in the strength of magnetic forces. We figure out: • Magnetic forces can vary in strength across a field, and the whole field can get stronger and bigger when you make the magnet stronger. • Bigger magnets have stronger magnetic fields around them than smaller magnets of the same material, which means that the forces between two magnets will be stronger. • You can increase the current or the number of coils to get a stronger magnetic field around an electromagnet, which means that the forces between a magnet and an electromagnet will be stronger.	

⇓ **Navigation to Next Lesson:** We have figured out so much that we are ready to take stock of where we have been. We will also have an assessment for this unit where you will have an opportunity to demonstrate how much you have figured out about forces at a distance, designing investigations, and cause-effect relationships.

Lesson Question	Phenomena or Design Problem	What we do and figure out	How we represent it
LESSON 12 2 days **What cause-effect relationships explain how magnetic forces at a distance make things work?** Putting Pieces Together	 *In a speaker, forces transfer energy out of an invisible magnetic field into the rest of the system, producing the movement that we observe as vibrations or sound.*	We took stock of how far we have come and applied our new ideas about the strength of forces to both the speaker and the other electromagnet applications we have considered. We revisited the DQB one last time to answer our remaining questions. Finally, we took an assessment. We figured out these ideas: • Forces transfer energy into and out of a magnetic field. • The amount of energy stored in the field depends on the strength of the forces (which are affected by several factors) and the arrangement of the magnets in the field. • Phenomena (like increasing the strength of magnetic forces) can have more than one cause.	

LESSONS 1-12
30 days total