OpenSciEd Massachusetts Standards Guidance
6th Grade: Forces at a Distance

This document is to provide guidance to Massachusetts 6th grade teachers who are implementing OpenSciEd. This guidance assumes the OpenSciEd curriculum is being implemented across grades 6-8, following the MA coherent sequence by grade level *(download)*. The following guidance identifies the MA standards addressed in the *Forces at a Distance* unit, and the most effective use of the OpenSciEd materials for 6th grade teachers.

Scope and Sequence Recommendation

It is recommended to **implement the *Forces at a Distance* OpenSciEd unit in 6th grade after the *Light & Matter* and *Sound Waves* OpenSciEd units, and before *Earth in Space***. This builds coherence with the ***Sound*** unit by extending the anchoring phenomenon from ***Sound*** and establishes a foundational understanding of fields through an explanation of magnetic fields. The concept of fields at this depth is necessary for mastery of grade 7 standards (7.MS-PS2-5). There is an opportunity to address grade 6 technology/engineering standards related to material properties and design. To best address the MA standards, the unit should be extended to include the relevant Technology/Engineering standards. Additional guidance on how to abbreviate and extend is included below. Refer to the MA coherent sequence by grade level *(download)* for the complete scope and sequence recommendation.

6th Grade Standards in *Forces at a Distance*

Standards in unit	Lessons building towards standards
6.MS-PS4-3. Present qualitative scientific and technical information to support the claim that digitized signals (sent as wave pulses representing 0s and 1s) can be used to encode and transmit information. State Assessment Boundary: Binary counting or the specific mechanism of any given device are not expected in state assessment.	Lesson 3, 7-8

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Recommendations for Addressing Standards in *Forces at a Distance*

Include, and teach all included 7th grade standards with *Forces at a Distance* as planned in the unit. The context of the electromagnet is integral to understanding the lessons that address digitized signals. **Excluding these standards would require substantial redesign of the unit, which is not recommended.**

Additional Standards in *Forces at a Distance*

Standards in unit	Lessons building towards standards
7.MS-PS2-5 **[Partial].** Use scientific evidence to argue that fields exist between objects with mass, between magnetic objects, and between electrically charged objects that exert force on each other even though the objects are not in contact. **Why partial?** *Forces at a Distance* focuses exclusively on magnetic fields from magnetic objects and induced magnetic fields from magnets or current carrying wires. Gravitational fields and electric fields are not addressed in this unit.	Lessons 1-12
7.MS-PS3-2. Develop a model to describe the relationship between the relative positions of objects interacting at a distance and their relative potential energy in the system.	Lessons 1-12

See recommendations below for addressing these 7th grade standards.

Opportunities to Address Additional MA Standards in *Forces at a Distance*

Standards in unit
6.MS-ETS2-1(MA). **[Opportunity to address]** Analyze and compare properties of metals, plastics, wood, and ceramics, including flexibility, ductility, hardness, thermal conductivity, electrical conductivity, and melting point.
6.MS-ETS2-2(MA). **[Opportunity to address]** Given a design task, select appropriate materials based on specific properties needed in the construction of a solution.
6.MS-ETS2-3(MA). **[Opportunity to partially address]** Choose and safely use appropriate measuring tools, hand tools, fasteners, and common hand held power tools used to construct a prototype. **Why partial?** It would be appropriate to use measuring tools, hand tools, and fasteners in the process of optimizing a self-made speaker prototype. The extension to this unit does not address the use of hand held power tools.
7.MS-ETS1-2. **[Opportunity to address]** Evaluate competing solutions to a given design problem using a decision matrix to determine how well each meets the criteria and constraints of the problem. Use a model of each solution to evaluate how variations in one or more design features, including size, shape, weight, or cost, may affect the function or effectiveness of the solution.

Recommendations for Extensions in *Forces at a Distance*

Extend the ***Forces at a Distance*** Unit to include the grade 6 Technology/Engineering standards. To best address **6.MS-ETS2-1(MA), 6.MS-ETS2-1(MA), 6.MS-ETS2-1(MA)** students should apply their learning from the unit, and extend the experience from building their initial speaker *(Lesson 1)* to ***establish the criteria and constraints for designing the most effective self-made speaker,*** then ***analyze properties of candidate materials through investigations,*** in order to ***design, prototype, and test different speaker designs to establish the most effective speaker design.*** Students should be able to explain, using evidence from investigations, why they chose the materials for their prototypes to optimize speaker performance.

Unit Extension	Support for coherently extending the unit
Lesson 1 **What causes a speaker to vibrate?**	Add to the Learning Plan in the Teacher Guide: **During Part 6 – Building a Homemade Speaker** • If possible, take time to capture images of students' speakers and save them so that students can refer directly back to their own speakers during the extension. If this is not possible, you can just refer back to their initial models and slides for this part of the lesson. **During Part 7 – Comparing Speakers** • Plant the initial seeds for students to think about how the parts of the home-made speaker work in comparison to the store-bought speaker. • During the "making sense of the speaker" conversation (p. 20) you can pose the question to students – how did the home-made speaker work in comparison to the store-bought speaker? Which components seemed to work well and which did not?

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Unit Extension	Support for coherently extending the unit
After the unit is complete	Tell the students that now that they understand how a speaker works, they will spend some time developing improved home-made speakers of their own. **Estimated time: 2-4 class periods**, depending on the number of design iterations. • If you have images of the students' original homemade speakers saved, distribute those. Otherwise, refer back to their initial models of the homemade speaker and the slides G-H from lesson 1. • As a class, create a list of criteria and constraints for a homemade speaker. Criteria might include: a magnet, a wire, etc. Constraints might include: a cost ceiling, size constraints, safety, etc. Students may also suggest making the speaker look nicer or to conceal the moving parts for a sleeker design. Prompt students to refer back to their own models to think about what is needed to build a speaker. • Ask students: what could we change about our initial speaker designs? Suggestions might include – different shapes, sizes, or strengths of magnets; different types of metals in the wire, using materials to cover the speaker's parts so that it looks better. Prompt them to ground their ideas in evidence from their investigations throughout the unit. Record these ideas as well. • Here you may choose to add some limitations to the criteria and constraints: depending on what materials you have available in your school. Tell students that they have many interesting ideas for improving the speaker design, but make them aware of what materials are actually available. • Provide students some time to work independently and develop a new speaker design, with the instruction that they must change at least one thing about the original design. Depending on your students' needs, you may provide a beginning template for them to start with. However they should have some freedom to choose some new materials or design configurations for the speaker. **You should take this opportunity to assess and provide feedback to students** – important features include selecting new design features based on criteria & constraints, based on reasonable evidence from the investigations throughout the unit, and within the limitations of material available. If needed, you may give students an opportunity to revise these designs based on feedback. This could also be a peer feedback opportunity. • Depending on materials available or other relevant factors to your classroom, you might decide to group students to work together on their speakers or to have them propose designs independently. • Allow students to build, test, revise and refine their designs. • You might have students explore each others' designs and use a **design matrix** to provide feedback, based on the initial criteria. A template for one is available in the *Chemical Reactions & Energy* Unit.

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