

HS-PS3-5 Energy

California Science Test—Item Content Specifications

# HS-PS3-5 Energy

Students who demonstrate understanding can:

Develop and use a model of two objects interacting through electric or magnetic fields to illustrate the forces between objects and the changes in energy of the objects due to the interaction.

[Clarification Statement: Examples of models could include drawings, diagrams, and texts, such as drawings of what happens when two charges of opposite polarity are near each other.] [*Assessment Boundary: Assessment is limited to systems containing two objects.*]

| Science and Engineering Practices | Disciplinary Core Ideas | Crosscutting Concepts |
| --- | --- | --- |
| Developing and Using Models  Modeling in 9–12 builds on K–8 and progresses to using, synthesizing, and developing models to predict and show relationships among variables between systems and their components in the natural and designed world(s).  Develop and use a model based on evidence to illustrate the relationships between systems or between components of a system. | PS3.C: Relationship Between Energy and Forces   1. When two objects interacting through a field change relative position, the energy stored in the field is changed. | Cause and Effect  Cause and effect relationships can be suggested and predicted for complex natural and human-designed systems by examining what is known about smaller scale mechanisms within the system. |

## Assessment Targets

Assessment targets describe the focal knowledge, skills, and abilities for a given three-dimensional Performance Expectation. Please refer to the Introduction for a complete description of assessment targets.

### Science and Engineering Subpractice(s)

Please refer to appendix A for a complete list of Science and Engineering Practices (SEP) subpractices. Note that the list in this section is not exhaustive.

2.1 Ability to develop models

2.3 Ability to evaluate and revise models

### Science and Engineering Subpractice Assessment Targets

Please refer to appendix A for a complete list of SEP subpractice assessment targets. Note that the list in this section is not exhaustive.

2.1.1 Ability to determine components of a scientific event, system, or design solution

2.1.2 Ability to determine the relationships among multiple components of a scientific event, system, or design solution

2.1.4 Ability to represent mechanisms, relationships, and connections to illustrate, explain, or predict a scientific event

2.3.2 Ability to revise models in light of empirical evidence to improve their explanatory and predictive power

### Disciplinary Core Idea Assessment Targets

#### PS3.C.4

* Describe electric and magnetic fields as containing energy that can be transmitted from one space to another
* Quantify the stored energy in a system as a function of the relative position of charged particles and the magnitude of their charges
* Describe changes in the energy stored in a field caused by changes in the relative positions of the interacting objects
* Describe the reduction in stored energy of a field that occurs when forces are exerted among interacting objects
* Construct electric field lines that run from positive charges to negative charges
* Construct magnetic field lines from north to south outside of a magnet and south to north inside of a magnet
* Identify (with assistance of electric field lines) the direction and magnitude of the acceleration a hypothetical charge would experience if placed in a field
* Determine (using the right-hand rule) the direction of the force exerted by a magnetic field on charged objects

### Crosscutting Concept Assessment Target(s)

CCC2 Suggest and predict cause and effect relationships for complex natural and human-designed systems by examining what is known about smaller-scale mechanisms within the system

## Examples of Integration of Assessment Targets and Evidence

Note that the list in this section is not exhaustive.

Task provides an incomplete model of two objects interacting via electric or magnetic fields that are some distance away from each other:

* Completes the model by adding new components or labeling existing components in order to quantify the change in energy associated with a stated change in the relative orientation of the two objects (2.1.1, PS3.C.4, and CCC2)

Task provides a simulation where two objects interacting via magnetic or electric forces are some distance away from each other and students are able to add electric or magnetic field lines:

* Selects or generates the appropriate field lines that represent the magnitude of stored energy at various relative positions within the system (2.1.1, PS3.C.4, and CCC2)
* Selects or generates a prediction for future acceleration (both for magnitude and for direction) of objects in the field (2.1.1, PS3.C.4, and CCC2)

Task provides a model of two objects interacting via electric or magnetic fields that is unable to help explain or predict a presented phenomenon:

* Identifies and refines existing features of the model to better explain/predict the presented phenomenon (2.3.2, PS3.C.4, and CCC2)
* Identifies and generates new features of the model that assist in explaining or predicting the presented phenomenon (2.3.2, PS3.C.4, and CCC2)
* Provides appropriate reasoning for why a suggested amendment to the model (either additions of new features or refinement of existing features) better supports an explanation or a prediction about a presented phenomenon (2.3.2, PS3.C.4, and CCC2)

## Possible Phenomena or Contexts

Note that the list in this section is not exhaustive.

* Two charged objects interact in one of the following ways:
  + When both are in fixed positions.
  + When one is in a fixed position and the other can move.
  + When both can move.
* Interactions of a magnet (e.g., disk, bar, or horseshoe) with a ferromagnetic material (e.g., iron or nickel)
* Interactions of two magnets, one in a fixed position and one that can move
* Behavior of a charged object as it moves past a magnet in a fixed position

## Common Misconceptions

Note that the list in this section is not exhaustive.

* Objects always accelerate in the direction of electric field lines.
* Positively charged objects are attracted to the north pole of magnets and negatively charged objects are attracted to the south pole.
* A magnetic field only exists outside of the magnet.

## Additional Assessment Boundaries

None listed at this time.

## Additional References

HS-PS3-5 Evidence Statement [https://www.nextgenscience.org/sites/default/files/evidence\_statement/black\_white/HS-PS3-5 Evidence Statements June 2015 asterisks.pdf](https://www.nextgenscience.org/sites/default/files/evidence_statement/black_white/HS-PS3-5%20Evidence%20Statements%20June%202015%20asterisks.pdf)

The *2016 Science Framework for California Public Schools Kindergarten through Grade 12*

Appendix 1: Progression of the Science and Engineering Practices, Disciplinary Core Ideas, and Crosscutting Concepts in Kindergarten through Grade 12 <https://www.cde.ca.gov/ci/sc/cf/documents/scifwappendix1.pdf>

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