

PHYSICS

HS-PS2-4: Motion and Stability: Forces and Interactions

HS-PS2-4: Use mathematical representations of Newton’s Law of Gravitation and Coulomb’s Law to describe and predict the gravitational and electrostatic forces between objects.

Clarification Statement: Emphasis is on both quantitative and conceptual descriptions of gravitational and electric fields.

Assessment Boundary: Assessment is limited to systems with two objects.

Evidence Statements: HS-PS2-4

Science & Engineering Practices	Disciplinary Core Ideas	Cross-Cutting Concepts
<p>Using Mathematics and Computational Thinking</p> <p>Mathematical and computational thinking at the 9–12 level builds on K–8 and progresses to using algebraic thinking and analysis, a range of linear and nonlinear functions including trigonometric functions, exponentials and logarithms, and computational tools for statistical analysis to analyze, represent, and model data. Simple computational simulations are created and used based on mathematical models of basic assumptions.</p> <p>Use mathematical representations of phenomena to describe explanations.</p> <p>Connections to Nature of Science</p> <p>Science Models, Laws, Mechanisms, and Theories Explain Natural Phenomena</p> <p>Theories and laws provide explanations in science.</p> <p>Laws are statements or descriptions of the relationships among observable phenomena.</p>	<p>PS2.B: Types of Interactions</p> <p>Newton’s law of universal gravitation and Coulomb’s law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects.</p> <p>Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields.</p>	<p>Patterns</p> <p>Different patterns may be observed at each of the scales at which a system is studied and can provide evidence for causality in explanations of phenomena.</p>

Connections to other DCIs in this grade-band: HS.PS3.A ; HS.ESS1.B

Articulation of DCIs across grade-bands: MS.PS2.B ; MS.ESS1.B

NJSLS- ELA: N/A

NJSLS- Math: MP.2, MP.4, HSN.Q.A.1, HSN.Q.A.2, HSN.Q.A.3, HSA.SSE.A.1, HSA.SSE.B.3

5E Model

HS-PS2-4: Use mathematical representations of Newton’s Law of Gravitation and Coulomb’s Law to describe and predict the gravitational and electrostatic forces between objects.

Engage Anticipatory Set	<p>The following PHET Colorado online simulations can be used to introduce Newton's Law of Gravitation and Coulomb's Law.</p> <p>https://phet.colorado.edu/en/simulation/gravity-force-lab</p>
Exploration Student Inquiry	<p>Gravitational Fields</p> <p>http://www.physicsclassroom.com/NGSS-Corner/Activity-Descriptions/Gravitational-Fields-Description</p> <p>If activity fails to open try using another browser</p>

Student Inquiry	<p>Coulomb's Law Interactive http://www.physicsclassroom.com/NGSS-Corner/Activity-Descriptions/Coulombs-Law</p>
<p>Explanation Concepts and Practices</p>	<p><u>In these lessons</u> Teachers Should: Introduce formal labels, definitions, and explanations for concepts, practices, skills or abilities. Students Should: Verbalize conceptual understandings and demonstrate scientific and engineering practices. Topics to Be Discussed in Teacher Directed Lessons (Disciplinary Core Ideas): PS2.B: Types of Interactions Newton’s law of universal gravitation and Coulomb’s law provide the mathematical models to describe and predict the effects of gravitational and electrostatic forces between distant objects. Forces at a distance are explained by fields (gravitational, electric, and magnetic) permeating space that can transfer energy through space. Magnets or electric currents cause magnetic fields; electric charges or changing magnetic fields cause electric fields.</p>
<p>Elaboration Extension Activity</p>	<p><u>Electrostatic and Coulomb's Law: Lab</u> http://www.myips.org/cms/lib8/IN01906626/Centricity/Domain/8123/Coulombs%20Law%20E1.pdf</p> <p><u>Related Activities</u> http://www.ck12.org/ngss/high-school-physical-sciences/motion-and-stability:-forces-and-interactions/</p>
<p>Evaluation Assessment Tasks</p>	<p>Assessment Task A: Using the two simulation activities above, teachers will evaluate the students' descriptions and predictions of electric or gravitational forces between objects.</p>