Anatomy and Architecture of a NGSS Performance Expectation

Scientific and Engineering Practices
The 8 scientific and engineering practices are the major practices that scientists employ as they investigate and build models and theories about the world, and that engineers use as they design and build systems

Crosscutting Concepts
The 7 crosscutting concepts are concepts that bridge disciplinary boundaries, thus have explanatory value throughout much of science and engineering

Disciplinary Core Ideas
The disciplinary core ideas have broad importance across multiple sciences or engineering disciplines or are a key organizing concept of a single discipline. There are 44 of these core ideas across the areas of Life Sciences, Physical Science, Earth and Space Sciences, and Engineering, Technology, and Applications of Science

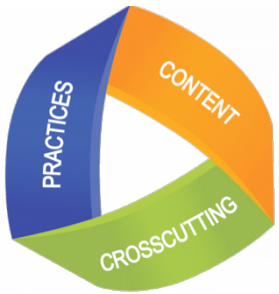
MS-PS2-2.
Grade Level/Band | DCI | PE#

Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object. [Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.] [*Assessment Boundary: Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.*]

Title and Code

Performance Expectations

Performance expectations specify what students should know, understand, and be able to do. They also illustrate how students engage in scientific practices to develop a better understanding of the essential knowledge. These expectations support targeted instruction and assessment by providing tasks that are measurable and observable.



Foundation Boxes

Scientific and Engineering Practices

Disciplinary Core Ideas

Crosscutting Concepts

Connections Boxes

Connections to Other DCIs in grade-band

Articulation of DCIs across grade-level

Common Core State Standard Connections

MS-PS2-2 Motion and Stability: Forces and Interactions

Students who demonstrate understanding can:

MS-PS2-2. **Plan an investigation to provide evidence that the change in an object's motion depends on the sum of the forces on the object and the mass of the object.** [Clarification Statement: Emphasis is on balanced (Newton's First Law) and unbalanced forces in a system, qualitative comparisons of forces, mass and changes in motion (Newton's Second Law), frame of reference, and specification of units.] [*Assessment Boundary: Assessment is limited to forces and changes in motion in one-dimension in an inertial reference frame and to change in one variable at a time. Assessment does not include the use of trigonometry.*]

The performance expectation above was developed using the following elements from the NRC document *A Framework for K-12 Science Education*:

Planning and Carrying Out Investigations
Planning and carrying out investigations to answer questions or test solutions to problems in 6–8 builds on K–5 experiences and progresses to include investigations that use multiple variables and provide evidence to support explanations or design solutions.
- Plan an investigation individually and collaboratively, and in the design: identify independent and dependent variables and controls, what tools are needed to do the gathering, how measurements will be recorded, and how many data are needed to support a claim.

Connections to Nature of Science

Scientific Knowledge is Based on Empirical Evidence
- Science knowledge is based upon logical and conceptual connections between evidence and explanations.

PS2.A: Forces and Motion
- The motion of an object is determined by the sum of the forces acting on it; if the total force on the object is not zero, its motion will change. The greater the mass of the object, the greater the force needed to achieve the same change in motion. For any given object, a larger force causes a larger change in motion.
- All positions of objects and the directions of forces and motions must be described in an arbitrarily chosen reference frame and arbitrarily chosen units of size. In order to share information with other people, these choices must also be shared.

Stability and Change
- Explanations of stability and change in natural or designed systems can be constructed by examining the changes over time and forces at different scales.

Connections to other DCIs in this grade-band:
MS.PS3.A ; MS.PS3.B ; MS.ESS2.C

Articulation of DCIs across grade-bands:
3.PS2.A ; HS.PS2.A ; HS.PS3.B ; HS.ESS1.B

Common Core State Standards Connections:

ELA/Literacy -
RST.6-8.3 Follow precisely a multistep procedure when carrying out experiments, taking measurements, or performing technical tasks. *(MS-PS2-2)*
WHST.6-8.7 Conduct short research projects to answer a question (including a self-generated question), drawing on several sources and generating additional related, focused questions that allow for multiple avenues of exploration. (MS-PS2-2)

Mathematics -
MP.2 Reason abstractly and quantitatively. (MS-PS2-2)
6.EE.A.2 Write, read, and evaluate expressions in which letters stand for numbers. *(MS-PS2-2)*
7.EE.B.3 Solve multi-step real-life and mathematical problems posed with positive and negative rational numbers in any form, using tools strategically. Apply properties of operations to calculate with numbers in any form; convert between forms as appropriate; and assess the reasonableness of answers using mental computation and estimation strategies. *(MS-PS2-2)*
7.EE.B.4 Use variables to represent quantities in a real-world or mathematical problem, and construct simple equations and inequalities to solve problems by reasoning about the quantities. *(MS-PS2-2)*

SAN DIEGO COUNTY OFFICE OF EDUCATION

NEXT GENERATION SCIENCE STANDARDS

Abbreviations and Codes

Science and Engineering Practices (SEPs)

1. Asking questions (for science) and defining problems (for engineering)
2. Developing and using models
3. Planning and carrying out investigations
4. Analyzing and interpreting data
5. Using mathematics and computational thinking
6. Constructing explanations (for science) and designing solutions (for engineering)
7. Engaging in argument from evidence
8. Obtaining, evaluating, and communicating information

Crosscutting Concepts (CCCs)

1. Patterns
2. Cause and effect: Mechanism and explanation
3. Scale, proportion, and quantity
4. Systems and system models
5. Energy and matter: Flows, cycles, and conservation
6. Structure and function
7. Stability and change

Disciplinary Core Ideas (DCIs)

Physical Sciences
PS1: Matter and its interactions
PS2: Motion and stability: Forces and interactions
PS3: Energy
PS4: Waves and their applications in technologies for information transfer

Life Sciences
LS1: From molecules to organisms: Structures and processes
LS2: Ecosystems: Interactions, energy, and dynamics
LS3: Heredity: Inheritance and variation of traits
LS4: Biological evolution: Unity and diversity

Earth and Space Science
ESS1: Earth's place in the universe
ESS2: Earth's systems
ESS3: Earth and human activity

Engineering, Technology, and Applications of Science
ETS1: Engineering design
ETS2: Links among engineering, technology, science, and society

ELA/Literacy

R – Reading
- RL – Reading: Literature
- **RI** – Reading: Informational Text
- RF – Reading: Foundational Skills

W – Writing
SL – Speaking and Listening
L – Language
RST – Reading Science and Technical Subjects
WHST – Writing History, Science and Technical Subjects

Mathematics: K-8

CC – Counting and Cardinality
OA – Operations and Algebraic Thinking
NBT – Numbers & Operations in Base Ten
NF – Numbers & Operations-Fractions
MD – Measurement & Data
G – Geometry
RP – Ratio & Proportional Relationships
NS – The Number System
EE – Expressions & Equations
SP – Statistics & Probability
F – Functions
MP – Standards for Mathematical Practice

Mathematics: High School

Number & Quantity
N-RN – The Real Number System
N-Q – Quantities
N-CN – The Complex Number System
N-VM – Vector and Matrix Quantities

Algebra
A-SSE – Seeing Structure in Equations
A-APR – Arithmetic with Polynomials and Rational Expressions
A-CED – Creating Equations
A-REI – Reasoning with Equations and Inequalities

Functions
F-IF – Interpreting Functions
F-BF – Building Functions
F-LE – Linear, Quadratic and Exponential Models
F-TF – Trigonometric Functions

Geometry
G-CO – Congruence
G-SRT – Similarity, Right Triangles, & Trigonometry
G-C – Circles
G-GPE – Expressing Geometric Properties with Equations
G-GMD – Geometric Measurement & Dimension
G-MG – Modeling with Geometry

Statistics and Probability
S-ID – Interpreting Categorical & Quantitative Data
S-IC – Making Inferences & Justifying Conclusions
S-CP – Conditional Probability and Rules of Probability
S-MD – Using Probability to Make Decisions

Information on this document is adapted from information at nextgenscience.org and www.corestandards.org by J. Spiegel, San Diego County Office of Education.