

Design and Modeling (DM)

Common Core State Standards for English Language Arts

Lesson 1.1 - What Is Engineering?

Reading

Key Ideas and Details

1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text. (AS.R.1)
4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone. (AS.R.4)
7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words. (AS.R.7)

Text Types and Purposes

4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (AS.W.4)
6. Use technology, including the Internet, to produce and publish writing and to interact and collaborate with others. (AS.W.6)
7. Conduct short as well as more sustained research projects based on focused questions, demonstrating understanding of the subject under investigation. (AS.W.7)
8. Gather relevant information from multiple print and digital sources, assess the credibility and accuracy of each source, and integrate the information while avoiding plagiarism. (AS.W.8)
9. Draw evidence from literary or informational texts to support analysis, reflection, and research. (AS.W.9)

Comprehension and Collaboration

2. Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. (AS.SL.2)
4. Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience. (AS.SL.4)
5. Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. (AS.SL.5)

Conventions of Standard English

1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. (AS.L.1)
2. Demonstrate command of the conventions of Standard English capitalization, punctuation, and spelling when writing. (AS.L.2)
6. Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression. (AS.L.6)

Lesson 1.2 - Design Process

Reading

Key Ideas and Details

1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text. (AS.R.1)
7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words. (AS.R.7)

Text Types and Purposes

2. Write informative/explanatory texts to examine and convey complex ideas and information clearly and accurately through the effective selection, organization, and analysis of content. (AS.W.2)
4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (AS.W.4)

Comprehension and Collaboration

1. Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively. (AS.SL.1)
2. Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. (AS.SL.2)

Conventions of Standard English

1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. (AS.L.1)
2. Demonstrate command of the conventions of Standard English capitalization, punctuation, and spelling when writing. (AS.L.2)
6. Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression. (AS.L.6)

Lesson 1.3 - Measurement

Reading

Key Ideas and Details

1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text. (AS.R.1)

Text Types and Purposes

4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (AS.W.4)

Conventions of Standard English

1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. (AS.L.1)
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Lesson 1.4 - Sketching and Dimensioning

Reading

Key Ideas and Details

1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text. (AS.R.1)
4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone. (AS.R.4)

Text Types and Purposes

4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (AS.W.4)

Conventions of Standard English

1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. (AS.L.1)
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6. Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression. (AS.L.6)

Lesson 1.5 - Designing for Production

Reading

Key Ideas and Details

1. Read closely to determine what the text says explicitly and to make logical inferences from it; cite specific textual evidence when writing or speaking to support conclusions drawn from the text. (AS.R.1)
4. Interpret words and phrases as they are used in a text, including determining technical, connotative, and figurative meanings, and analyze how specific word choices shape meaning or tone. (AS.R.4)
7. Integrate and evaluate content presented in diverse formats and media, including visually and quantitatively, as well as in words. (AS.R.7)
10. Read and comprehend complex literary and informational texts independently and proficiently. (AS.R.10)

Text Types and Purposes

4. Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience. (AS.W.4)

Comprehension and Collaboration

1. Prepare for and participate effectively in a range of conversations and collaborations with diverse partners, building on others' ideas and expressing their own clearly and persuasively. (AS.SL.1)
2. Integrate and evaluate information presented in diverse media and formats, including visually, quantitatively, and orally. (AS.SL.2)
4. Present information, findings, and supporting evidence such that listeners can follow the line of reasoning and the organization, development, and style are appropriate to task, purpose, and audience. (AS.SL.4)
5. Make strategic use of digital media and visual displays of data to express information and enhance understanding of presentations. (AS.SL.5)

Conventions of Standard English

1. Demonstrate command of the conventions of standard English grammar and usage when writing or speaking. (AS.L.1)
2. Demonstrate command of the conventions of Standard English capitalization, punctuation, and spelling when writing. (AS.L.2)
6. Acquire and use accurately a range of general academic and domain-specific words and phrases sufficient for reading, writing, speaking, and listening at the college and career readiness level; demonstrate independence in gathering vocabulary knowledge when considering a word or phrase important to comprehension or expression. (AS.L.6)

Standards for Technological Literacy

Lesson 1.1 - What Is Engineering?

Students will develop an understanding of the characteristics and scope of technology.

6-8

- F. New products and systems can be developed to solve problems or to help do things that could not be done without the help of technology. (1.6-8.F)
- G. The development of technology is a human activity and is the result of individual and collective needs and the ability to be creative. (1.6-8.G)
- H. Technology is closely linked to creativity, which has resulted in innovation. (1.6-8.H)

Students will develop an understanding of the relationships among technologies and the connections between technology and other fields of study.

6-8

- D. Technological systems often interact with one another. (3.6-8.D)
- F. Knowledge gained from other fields of study has a direct effect on the development of technological products and systems. (3.6-8.F)

Students will develop an understanding of the cultural, social, economic, and political effects of technology.

6-8

- D. The use of technology affects humans in various ways, including their safety, comfort, choices, and attitudes about technology's development and use. (4.6-8.D)
- F. The development and use of technology poses ethical issues. (4.6-8.F)
- G. Economic, political, and cultural issues are influenced by the development and use of technology. (4.6-8.G)

Students will develop an understanding of the role of society in the development and use of technology.

6-8

- D. Throughout history, new technologies have resulted from the demands, values, and interests of individuals, businesses, industries, and societies. (6.6-8.D)
- E. The use of inventions and innovations has led to changes in society and the creation of new needs and wants. (6.6-8.E)

Lesson 1.2 - Design Process

Students will develop an understanding of the attributes of design.

6-8

- E. Design is a creative planning process that leads to useful products and systems. (8.6-8.E)
- F. There is no perfect design. (8.6-8.F)
- G. Requirements for design are made up of criteria and constraints. (8.6-8.G)

Students will develop an understanding of engineering design.

6-8

- F. Design involves a set of steps, which can be performed in different sequences and repeated as needed. (9.6-8.F)
- G. Brainstorming is a group problem-solving design process in which each person in the group presents his or her ideas in an open forum. (9.6-8.G)

Students will develop the abilities to apply the design process.

6-8

- H. Apply a design process to solve problems in and beyond the laboratory-classroom. (11.6-8.H)
- I. Specify criteria and constraints for the design. (11.6-8.I)

Lesson 1.3 - Measurement

Students will develop an understanding of the role of society in the development and use of technology.

6-8

- D. Throughout history, new technologies have resulted from the demands, values, and interests of individuals, businesses, industries, and societies. (6.6-8.D)
- E. The use of inventions and innovations has led to changes in society and the creation of new needs and wants. (6.6-8.E)

Students will develop an understanding of the influence of technology on history.

6-8

- D. The specialization of function has been at the heart of many technological improvements. (7.6-8-D)
- E. The design and construction of structures for service or convenience have evolved from the development of techniques for measurement, controlling systems, and the understanding of spatial relationships. (7.6-8-E)

Students will develop the abilities to use and maintain technological products and systems.

6-8

- H. Use information provided in manuals, protocols, or by experienced people to see and understand how things work. (12.6-8.H)

Students will develop the abilities to assess the impact of products and systems.

6-8

- F. Design and use instruments to gather data. (13.6-8.F)

Lesson 1.4 - Sketching and Dimensioning

Students will develop the abilities to apply the design process.

6-8

- J. Make two-dimensional and three-dimensional representations of the designed solution. (11.6-8.J)

Students will develop an understanding of and be able to select and use information and communication technologies.

6-8

- K. The use of symbols, measurements, and drawings promotes a clear communication by providing a common language to express ideas. (17.6-8.K)

Lesson 1.5 - Designing for Production

Students will develop an understanding of the attributes of design.

6-8

- G. Requirements for design are made up of criteria and constraints. (8.6-8.G)

Students will develop an understanding of engineering design.

6-8

- F. Design involves a set of steps, which can be performed in different sequences and repeated as needed. (9.6-8.F)
- G. Brainstorming is a group problem-solving design process in which each person in the group presents his or her ideas in an open forum. (9.6-8.G)
- H. Modeling, testing, evaluating, and modifying are used to transform ideas into practical solutions. (9.6-8.H)

Students will develop an understanding of the role of troubleshooting, research and development, invention and innovation, and experimentation in problem solving.

6-8

- F. Troubleshooting is a problem-solving method used to identify the cause of a malfunction in a technological system. (10.6-8.F)
- G. Invention is a process of turning ideas and imagination into devices and systems. Innovation is the process of modifying an existing product or system to improve it. (10.6-8.G)
- H. Some technological problems are best solved through experimentation. (10.6-8.H) 9-12
- I. Research and development is a specific problem-solving approach that is used intensively in business and industry to prepare devices and systems for the marketplace. (10.9-12.I)
- J. Technological problems must be researched before they can be solved. (10.9-12.J)

Students will develop the abilities to apply the design process.

6-8

- H. Apply a design process to solve problems in and beyond the laboratory-classroom. (11.6-8.H)
- I. Specify criteria and constraints for the design. (11.6-8.I)
- J. Make two-dimensional and three-dimensional representations of the designed solution. (11.6-8.J)
- K. Test and evaluate the design in relation to pre-established requirements, such as criteria and constraints, and refine as needed. (11.6-8.K)
- L. Make a product or system and document the solution. (11.6-8.L)

Students will develop the abilities to use and maintain technological products and systems.

6-8

- H. Use information provided in manuals, protocols, or by experienced people to see and understand how things work. (12.6-8.H)
- J. Use computers and calculators in various applications. (12.6-8.J)

Students will develop an understanding of and be able to select and use information and communication technologies.

6-8

- H. Information and communication systems allow information to be transferred from human to human, human to machine, and machine to human. (17.6-8.H)
- K. The use of symbols, measurements, and drawings promotes a clear communication by providing a common language to express ideas. (17.6-8.K)

Next Generation Science Standards

Lesson 1.1 - What Is

Engineering? Lesson 1.2 - Design

Process

Middle School

Engineering Design

1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. (MS.ETS1.1)
2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. (MS.ETS1.2)

Lesson 1.3 - Measurement

Lesson 1.4 - Sketching and Dimensioning

Lesson 1.5 - Designing for Production

Middle School

Engineering Design

1. Define the criteria and constraints of a design problem with sufficient precision to ensure a successful solution, taking into account relevant scientific principles and potential impacts on people and the natural environment that may limit possible solutions. (MS.ETS1.1)
2. Evaluate competing design solutions using a systematic process to determine how well they meet the criteria and constraints of the problem. (MS.ETS1.2)
3. Analyze data from tests to determine similarities and differences among several design solutions to identify the best characteristics of each that can be combined into a new solution to better meet the criteria for success. (MS.ETS1.3)
4. Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved. (MS.ETS1.4)

Common Core State Standards for Mathematical Practice (6- 8)

Lesson 1.1 - What Is

Engineering? Lesson 1.2 - Design

Process Lesson 1.3 -

Measurement

Grade 6

Ratios and Proportional Relationships

Understand ratio concepts and use ratio reasoning to solve problems.

- 3. Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations. (6.RP.A.3)
- 3.d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities. (6.RP.A.3d)

Lesson 1.4 - Sketching and Dimensioning

Grade 6

Ratios and Proportional Relationships

Understand ratio concepts and use ratio reasoning to solve problems.

- 3. Use ratio and rate reasoning to solve real-world and mathematical problems, e.g., by reasoning about tables of equivalent ratios, tape diagrams, double number line diagrams, or equations. (6.RP.A.3)
- 3.d. Use ratio reasoning to convert measurement units; manipulate and transform units appropriately when multiplying or dividing quantities. (6.RP.A.3d)

Grade 7

Ratios and Proportional Relationships

Analyze proportional relationships and use them to solve real-world and mathematical problems.

1. Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. For example, if a person walks $\frac{1}{2}$ mile in each $\frac{1}{4}$ hour, compute the unit rate as the complex fraction $\frac{1/2}{1/4}$ miles per hour, equivalently 2 miles per hour. (7.RP.A.1)

The Number System

Apply and extend previous understandings of operations with fractions to add, subtract, multiply, and divide rational numbers.

1. Apply and extend previous understandings of addition and subtraction to add and subtract rational numbers; represent addition and subtraction on a horizontal or vertical number line diagram. (7.NS.A.1)
- 1.b. Understand $p + q$ as the number located a distance $|q|$ from p , in the positive or negative direction depending on whether q is positive or negative. Show that a number and its opposite have a sum of 0 (are additive inverses). Interpret sums of rational numbers by describing real-world contexts. (7.NS.A.1b)
2. Solve real-world and mathematical problems involving the four operations with rational numbers. (7.NS.A.3)

Geometry

Draw, construct, and describe geometrical figures and describe the relationships between them.

1. Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale. (7.G.A.1)
2. Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle. (7.G.A.2)

Grade 8

Geometry

Understand congruence and similarity using physical models, transparencies, or geometry software.

1. Verify experimentally the properties of rotations, reflections, and translations: (8.G.A.1)
 - 1.a. Lines are taken to lines, and line segments to line segments of the same length. (8.G.A.1a)
 - 1.c. Parallel lines are taken to parallel lines. (8.G.A.1c)

Lesson 1.5 - Designing for Production

Grade 6

The Number System

Apply and extend previous understandings of numbers to the system of rational numbers.

5. Understand that positive and negative numbers are used together to describe quantities having opposite directions or values (e.g., temperature above/below zero, elevation above/below sea level, credits/debits, positive/negative electric charge); use positive and negative numbers to represent quantities in real-world contexts, explaining the meaning of 0 in each situation. (6.NS.C.5)
6. Understand a rational number as a point on the number line. Extend number line diagrams and coordinate axes familiar from previous grades to represent points on the line and in the plane with negative number coordinates. (6.NS.C.6)
 - 6.a. Recognize opposite signs of numbers as indicating locations on opposite sides of 0 on the number line; recognize that the opposite of the opposite of a number is the number itself, e.g., $-(-3) = 3$, and that 0 is its own opposite. (6.NS.C.6a)
 - 6.b. Understand signs of numbers in ordered pairs as indicating locations in quadrants of the coordinate plane; recognize that when two ordered pairs differ only by signs, the locations of the points are related by reflections across one or both axes. (6.NS.C.6b)
 - 6.c. Find and position integers and other rational numbers on a horizontal or vertical number line diagram; find and position pairs of integers and other rational numbers on a coordinate plane. (6.NS.C.6c)
8. Solve real-world and mathematical problems by graphing points in all four quadrants of the coordinate plane. Include use of coordinates and absolute value to find distances between points with the same first coordinate or the same second coordinate. (6.NS.C.8)

Geometry

Solve real-world and mathematical problems involving area, surface area, and volume.

3. Draw polygons in the coordinate plane given coordinates for the vertices; use coordinates to find the length of a side joining points with the same first coordinate or the same second coordinate. Apply these techniques in the context of solving real-world and mathematical problems. (6.G.A.3)
4. Represent three-dimensional figures using nets made up of rectangles and triangles, and use the nets to find the surface area of these figures. Apply these techniques in the context of solving real-world and mathematical problems. (6.G.A.4)

Grade 7

Geometry

Draw, construct, and describe geometrical figures and describe the relationships between them.

1. Solve problems involving scale drawings of geometric figures, including computing actual lengths and areas from a scale drawing and reproducing a scale drawing at a different scale. (7.G.A.1)
2. Draw (freehand, with ruler and protractor, and with technology) geometric shapes with given conditions. Focus on constructing triangles from three measures of angles or sides, noticing when the conditions determine a unique triangle, more than one triangle, or no triangle. (7.G.A.2)
3. Describe the two-dimensional figures that result from slicing three-dimensional figures, as in plane sections of right rectangular prisms and right rectangular pyramids. (7.G.A.3)

Solve real-life and mathematical problems involving angle measure, area, surface area, and volume.

4. Know the formulas for the area and circumference of a circle and use them to solve problems; give an informal derivation of the relationship between the circumference and area of a circle. (7.G.B.4)
6. Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms. (7.G.B.6)

Grade 8

Geometry

Understand congruence and similarity using physical models, transparencies, or geometry software.

1. Verify experimentally the properties of rotations, reflections, and translations: (8.G.A.1)
 - 1.a. Lines are taken to lines, and line segments to line segments of the same length. (8.G.A.1a)
 - 1.b. Angles are taken to angles of the same measure. (8.G.A.1b)
 - 1.c. Parallel lines are taken to parallel lines. (8.G.A.1c)
2. Understand that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations; given two congruent figures, describe a sequence that exhibits the congruence between them. (8.G.A.2)
3. Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates. (8.G.A.3)
4. Understand that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations; given two similar two-dimensional figures, describe a sequence that exhibits the similarity between them. (8.G.A.4)