<table>
<thead>
<tr>
<th>Conceptual Category(s)</th>
<th>Domain</th>
</tr>
</thead>
<tbody>
<tr>
<td>• Number and Quantity</td>
<td>• Quantities (N-Q)</td>
</tr>
<tr>
<td>• Algebra</td>
<td>• Seeing Structure in Expressions (A-SSE)</td>
</tr>
<tr>
<td>• Functions</td>
<td>• Creating Equations (A-CED)</td>
</tr>
<tr>
<td>• Geometry</td>
<td>• Reasoning with Equations &amp; Inequalities (A-REI)</td>
</tr>
<tr>
<td>• Physics</td>
<td>• Linear, Quadratic, &amp; Exponential Models (F-LE)</td>
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<td></td>
<td>• Modeling with Geometry (G-MG)</td>
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<td>• Properties and Principles of Matter and Energy (SC-1)</td>
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<td></td>
<td>• Properties and Principles of Force and Motion (SC-2)</td>
</tr>
<tr>
<td></td>
<td>• Processes and Interactions of the Earth’s Systems (SC-5)</td>
</tr>
<tr>
<td></td>
<td>• Scientific Inquiry (SC-7)</td>
</tr>
<tr>
<td></td>
<td>• Impact of Science, Technology, and Human Activity (SC-8)</td>
</tr>
</tbody>
</table>

| Cluster                         | • Reason Quantitatively and use units to solve problems (N-Q.1-3)     |
|                                 | • Interpret the structure of expressions (A-SSE.1)                    |
|                                 | • Create equations that describe numbers or relationships (A-CED.1, 4)|
|                                 | • Solve equations and inequalities in one variable (A-REI.3)         |
|                                 | • Construct and compare linear, quadratic, and exponential models and solve problems (F-LE.1.b) |
|                                 | • Apply geometric concepts in modeling situations (G-MG.1, G-MG.3)    |
|                                 | • Energy has a source, can be stored, and can be transferred but is conserved within a system. (SC-1.2) |
|                                 | • Forces affect motion (SC-2.2)                                       |
|                                 | • Human activity is dependent upon and affects Earth’s resources and systems (SC-5.3) |
|                                 | • Science understanding is developed through the use of science process skills, scientific knowledge, scientific investigation, reasoning, and critical thinking (SC-7.1) |
|                                 | • Advances in Technology often result in improved data collection and an increase in scientific information (SC-8.1) |
## Standards

**N-Q.1,2,3**
1. Use units as a way to understand problems and to guide the solution of multistep problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays
2. Define appropriate quantities for the purpose of descriptive modeling
3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities

**A-SSE.1a,b**
1. Interpret expressions that represent a quantity in terms of its context
   a. Interpret parts of an expression, such as terms, factors, and coefficients
   b. Interpret complicated expressions by viewing one or more of their parts as a single entity

**A-CED.1,4**
1. Create equations and inequalities in one variable and use them to solve problems
2. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations

**A-REI.3**
3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters

**F-LE.1b**
1b. Recognize situations in which one quantity changes at a constant rate per unit interval relative to another

**G-MG.1,3**
1. Use geometric shapes, their measures, and their properties to describe objects

## Learning Targets

### Unit 1: Energy and Power

#### 1.1 Mechanisms:
- Differentiate between engineering and engineering technology
- Conduct a professional interview and reflect on it in writing
- Identify and differentiate among different engineering disciplines
- Measure forces and distances related to mechanisms
- Distinguish between the six simple machines, their attributes, and components
- Calculate mechanical advantage and drive ratios of mechanisms
- Design, create, and test gear, pulley, and sprocket systems
- Calculate work and power in mechanical systems
- Determine efficiency in a mechanical system
- Design, create, test, and evaluate a compound machine design

CCSS: N-Q.1-3; A-SSE.1a,b; A-CED.1,4; A-REI.3; F-LE.1b; G-MG.1,3; 9-10.RST.4; 9-10.WHST.2; 9-10.WHST.4
SCCLE: SC2.2.F (Physical)

#### 1.2 Energy Sources:
- Identify and categorize energy sources as nonrenewable, renewable, or inexhaustible
- Create and deliver a presentation to explain a specific energy source
- Summarize and reflect upon information collected during a visit to a local utility company
- Define the possible types of power conversion
- Calculate work and power
- Demonstrate the correct use of a digital multi-meter
3. Apply geometric methods to solve design problems

| SC1.2.A | A. Forms of energy have a source, a means of transfer (work and heat), and a receiver |
| SC2.2.F | F. Work transfers energy into and out of a mechanical system |
| SC5.3.A | A. Earth’s materials are limited natural resources affected by human activity |
| SC7.1.A,D | A. Scientific inquiry includes the ability of students to formulate a testable question and explanation, and to select appropriate investigative methods in order to obtain evidence relevant to the explanation |
| SC8.1.B | B. Recognize the relationships linking technology and science |

|  | • Calculate power in a system that converts energy from electrical input to a mechanical output |
|  | • Calculate circuit resistance, current, and voltage using Ohm’s law |
|  | • Understand the advantages and disadvantages of parallel and series circuit design in an application |

**CCSS:** N-Q.1; A-CED.1.4; A-REL3; 9-10.RST.4; 9-10.WHST.2; 9-10.WHST.4  
**SCCLE:** SC1.2.A (7th Grade); SC2.2.F (Physical Science); SC5.3.A (Physical Science)  

### 1.3 Energy Applications:

- Test and apply the relationship between voltage, current, and resistance relating to a photovoltaic cell and a hydrogen fuel cell
- Experiment with a solar hydrogen system to produce mechanical power
- Design, construct, and test recyclable insulation materials
- Test and apply the relationship between R-values and recyclable insulation
- Complete calculations for conduction, R-values, and radiation

**CCSS:** A-CED.4  
**SCCLE:** SC1.2.A (7th Grade)  

### 1.4 Design Problem – Energy and Power:

- Brainstorm and sketch possible solutions to an existing design problem
- Create a decision-making matrix for a design problem
- Select an approach that meets or satisfies the constraints provided in a design brief
- Create a detailed pictorial sketch or use 3D modeling software to document the best choice, based upon the design team’s decision matrix
### Instructional Strategies

- **Classroom discussion enhanced with PowerPoint**
- **Lesson 1.1 activities:**
  - Professional interview and paper
  - Simple machine investigation
  - Construct simple and compound gear systems
  - Calculate ratios of belt and pulley systems
- **Lesson 1.2 activities:**
  - Class PowerPoint presentation on different types of energy sources
  - Visit a local utility company and write about conclusions to questions
  - Electrical circuits investigation
  - Mechanical system efficiency investigation
  - Maximizing motor power
- **Lesson 1.3 activities:**
  - Investigate solar hydrogen system
  - Project Lead the Way activities with practice problems
  - Engineering notebook documentation of student work
### Assessments/Evaluations

- Formative assessments
- Practice problems
- Activities
- Project 1.1.6 – Compound Machine Design:
  - Students work in teams to design and build a compound machine to accomplish an instructor-specified task
- Project 1.3.4 – Renewable Insulation:
  - Students work in teams to design a renewable composite insulation material
- 1.4 Design Problem – Renewable Electrical Energy Generation and Distribution:
  - Students will work in teams to design and create a renewable electrical energy generating and distribution system that uses wind, solar electric, and fuel cell energy conversion systems

### Sample Assessment Questions

### Instructional Resources/Tools

- Project Lead the Way curriculum – including:
  - PowerPoint presentations
  - activities
  - scoring guides
  - instructions
- VEX Robotics Principles of Engineering kit
- Project Lead The Way Learning Online Management System

### Literacy Connections

- Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9–10 texts and topics
- Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes
- Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience
- Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology’s capacity to link to other information and to display information flexibly and dynamically
- Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences
### Cross Curricular Connections

- **Math:**
  - Algebra
  - Geometry

- **Science:**
  - Physical Science
  - Engineering
  - Applications of Science

- **ELA:** Written reflection of professional interview

- **Technology:**
  - Use VEX robot kits to create and explore
  - Create presentations using various technology options
### Principles of Engineering

| Conceptual Category(s) | • Number and Quantity  
| | • Algebra  
| | • Geometry  
| | • Physics  
| Domain | • Vector and Matrix Quantities (N-VM)  
| | • Quantities (N-Q)  
| | • Seeing Structure in Expressions (A-SSE)  
| | • Geometric Measurement and Dimension (G-GMD)  
| | • Modeling with Geometry  
| | • Properties and Principles of Force and Motion (SC-2)  
| | • Scientific Inquiry (SC-7)  
| Cluster | • Represent and model with vector quantities (N-VM.3)  
| | • Reason Quantitatively and Use Units to Solve Problems (N-Q.1-3)  
| | • Interpret the Structure of Expressions (A-SSE.1ab)  
| | • Explain Volume Formulas and Use Them to Solve Problems (G-GMD.3)  
| | • Visualize Relationships Between Two-Dimensional and Three-Dimensional Objects (G-GMD.4)  
| | • Apply Geometric Concepts in Modeling Situations (G-MG.1, 2)  
| | • Forcresses affect motion (SC-2.2)  
| | • Science understanding is developed through the use of science process skills, scientific knowledge, scientific investigation, reasoning, and critical thinking (SC-7.1)  

### Standards

| N-VM_1 | 1. Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes (e.g., \( \mathbf{v} \), \(|\mathbf{v}|\), \(||\mathbf{v}||\), \(\mathbf{v}\))  
| N-Q_1,2,3 | 1. Use units as a way to understand problems and to guide the solution of multistep problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays  
| | 2. Define appropriate quantities for the purpose of descriptive modeling  

### Learning Targets

**Unit 2: Materials and Statics**

#### 2.1 Statics:
- Create free body diagrams of objects, identifying all forces acting on the object
- Mathematically locate the centroid of structural members
- Calculate moment of inertia of structural members
- Differentiate between scalar and vector quantities
- Identify magnitude, direction, and sense of a vector
- Calculate the X and Y components given a vector
- Calculate moment forces given a specified axis
- Use equations of equilibrium to calculate unknown forces
3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities

A-SSE.1a,b
1. Interpret expressions that represent a quantity in terms of its context
   a. Interpret parts of an expression, such as terms, factors, and coefficients
   b. Interpret complicated expressions by viewing one or more of their parts as a single entity

G-GMD.3,4
3. Use volume formulas for cylinders, pyramids, cones, and spheres to solve problems
4. Identify the shapes of two-dimensional cross-sections of three-dimensional objects, and identify three-dimensional objects generated by rotations of two-dimensional objects

G-MG.1,2
1. Use geometric shapes, their measures, and their properties to describe objects
2. Apply concepts of density based on area and volume in modeling situations

SC2.2.D
D. Newton’s Laws of Motion explain the interaction of mass and forces, and are used to predict changes in motion

SC7.1.A,B,D
A. Scientific inquiry includes the ability of students to formulate a testable question and explanation, and to select appropriate investigative methods in order to obtain evidence relevant to the explanation
B. Scientific inquiry relies upon gathering evidence from qualitative and quantitative observations
D. The nature of science relies upon communication of results and justification of explanations

- Use the method of joints strategy to determine forces in the members of a statically determinate truss

CCSS: N-VM.3
CLE: SC2.2.D (Physical)

2.2 Material Properties:
- Investigate specific material properties related to a common household product
- Conduct investigative non-destructive material property tests on selected household products. Property testing conducted to identify continuity, ferrous metal, hardness, and flexure
- Calculate weight, volume, mass, density, and surface area of selected household product
- Identify the manufacturing processes used to create the selected common household product
- Identify the recycling codes
- Promote recycling using current media trends

CCSS: N-Q.1,3; G-GMD.3,4; G-MG.1,2
CLE: SC7.1.B (Physical)

2.3 Material Testing:
- Utilize a five-step technique to solve word problems
- Obtain measurements of material samples
- Tensile test a material test sample
- Identify and calculate test sample material properties using a stress strain curve

CCSS: N-Q.1-3; A-SSE.1a,b

2.4 Design Problem – Materials and Structures:
- Brainstorm and sketch possible solutions to an existing design problem
- Create a decision-making matrix for a design problem
- Select an approach that meets or satisfies the constraints provided in a design brief
- Create a detailed pictorial sketch or use 3D modeling software to document the best choice, based upon the design team’s decision matrix
- Present a workable solution to the design problem

CCSS: N-Q.1,2; 9-10.WHST.10
SCCLE: SC7.1.A,D (Physics)

**Alignments:**
CCSS: 9-10.WHST.10; N-VM.3; N-Q.1; N-Q.2; N-Q.3; A-SSE.1a,b; G-GMD.3; G-GMD.4; G-MG.1; G-MG.2
Performance: 1.3, 1.10, 2.1, 3.4, 3.6, 3.7, 4.6
Knowledge: (CA) 1, 4 (MA) 2, 4 (SC) 2, 7
SCCLE: SC2.2.D (Physical Science); SC7.1.A,D (Physics); SC7.1.B (Physical Science)
NGSS: HS.PS1.3; HS.ETS1.3
NETS: 1b,c; 2a,d; 4b; 6a
DOK: 4

**Instructional Strategies**

- Classroom discussion enhanced with PowerPoint
- **Lesson 2.1 Activities:**
  - Career field description
  - Centroids
  - Beam deflection
  - Free body diagrams
  - Calculating force vectors
  - Calculating moments
  - Step-by-step truss system
  - Calculating truss forces
  - Truss design
- **Lesson 2.2 Activities:**
  - Product analysis
  - Manufacturing processes
  - Recycling
Principles of Engineering

- **Lesson 2.3 Activities:**
  - Stress/strain calculations
  - Tensile testing
  - Project Lead the Way activities with practice problems
  - Engineering notebook documentation of student work

<table>
<thead>
<tr>
<th>Assessments/Evaluations</th>
</tr>
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<tbody>
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<td>Formative assessments</td>
</tr>
<tr>
<td>Practice problems</td>
</tr>
<tr>
<td>Activities</td>
</tr>
<tr>
<td>2.4 Design Problem – Structural Design: Student teams will design and create a bridge utilizing West Point Bridge Designer software</td>
</tr>
</tbody>
</table>

**Sample Assessment Questions**

**Instructional Resources/Tools**

- Project Lead the Way curriculum, including:
  - PowerPoint presentations
  - activities
  - scoring guides
  - instructions
- VEX Principles of Engineering kit
- Project Lead The Way Online Learning Management System
- West Point Bridge Designer software

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</tr>
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</tr>
<tr>
<td>• Applications of Science</td>
</tr>
<tr>
<td>• ELA: Written description of career field</td>
</tr>
<tr>
<td>• Technology – Students use VEX robot kits to:</td>
</tr>
<tr>
<td>• create and explore</td>
</tr>
<tr>
<td>• design and create a bridge using West Point Bridge Software</td>
</tr>
</tbody>
</table>
Conceptual Category(s)
- Algebra
- Number and Quantity
- Physics

Domain
- Creating Equations (A-CED)
- Quantities (N-Q)
- Properties and Principles of Matter and Energy (SC-1)
- Scientific Inquiry (SC-7)
- Impact of Science, Technology, and Human Activity (SC-8)

Cluster
- Create Equations that describe numbers or relationships (A-CED.1)
- Reason Quantitatively and Use Units to Solve Problems (N-Q.3)
- Energy has a source, can be stored, and can be transferred but is conserved within a system (SC-1.2)
- Scientific understanding is developed through the use of science process skills, scientific knowledge, scientific investigation, reasoning, and critical thinking (SC-7.1)
- Advances in Technology often result in improved data collection and an increase in scientific information (SC-8.1)

Standards

A-CED.1
1. Create equations and inequalities in one variable and use them to solve problems

N-Q.3
3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities

SC1.2.A
A. Forms of energy have a source, a means of transfer, and a receiver

SC7.1.A
A. Scientific inquiry includes the ability of students to formulate a testable question and explanation, and to select appropriate investigative methods in order to obtain evidence relevant to the explanation

SC8.1.B
B. Recognize the relationships linking technology and science

Learning Targets

Unit 3: Control Systems

3.1 Machine Control
- Create detailed flow charts utilizing a computer software application
- Create control system operating programs utilizing computer software
- Create system control programs that utilize flowchart logic
- Choose appropriate inputs and output devices based on the need of a technological system
- Differentiate between the characteristics of digital and analog devices
- Judge between open and closed loop systems in order to choose the most appropriate system for a given technological problem

Board Approved 7-14-14
• Design and create a control system based on given needs and constraints

**SCCLE: SC8.1.B (Physics)**  
**CCSS: 11-12RST.3; 9-10.WHST.2; 9-10.WHST.4**

### 3.2 Fluid Power

• Identify devices that utilize fluid power  
• Identify and explain basic components and functions of fluid power devices  
• Differentiate between the characteristics of pneumatic and hydraulic systems  
• Distinguish between hydrodynamic and hydrostatic systems  
• Design, create, and test a hydraulic device  
• Design, create, and test a pneumatic device  
• Calculate values in a fluid power system utilizing Pascal’s Law  
• Distinguish between pressure and absolute pressure  
• Distinguish between temperature and absolute temperature  
• Calculate values in a pneumatic system, utilizing the perfect gas laws  
• Calculate flow rate, flow velocity, and mechanical advantage in a hydraulic system

**CCSS: A-CED.1**  
**SCCLE: SC1.2.A (Physics)**

### 3.3 Design Problem – Control Systems:

• Brainstorm and sketch possible solutions to an existing design problem  
• Create a decision-making matrix for a design problem  
• Select an approach that meets or satisfies the constraints provided in a design brief

• Create a detailed pictorial sketch or use 3D modeling software to document the best choice, based upon the design team’s decision matrix
### Principles of Engineering

- Present a workable solution to the design problem

**CCSS:** N-Q.3; 9-10.WHST.10  
**SCCLE:** SC7.1.A (Physics)

### Alignments:

**CCSS:** 11-12.RST.3; 9-10.WHST.2; 9-10.WHST.4; 9-10.WHST.10; A-CED.1; N-Q.3; 9-10.RST.4  
**Performance:** 1.2, 1.6, 3.4, 3.6, 4.5, 4.6  
**Knowledge:** (CA) 4 (MA) 4 (SC) 2, 7  
**SCCLE:** SC1.2.A; SC7.1.A; SC8.1.B (Physics)  
**NGSS:** HS-ETS1.2; HS-ETS1.3; HS.PS3.3  
**NETS:** 1b; 2d; 4b, d; 6a, c, d  
**DOK:** 4

### Instructional Strategies

- Classroom discussion enhanced with PowerPoint  
- **Lesson 3.1 Activities:**  
  - Career:  
    - demand  
    - salary  
    - education  
  - Build a VEX POE test-bed  
  - Inputs and outputs – VEX  
  - Basic outputs programming – VEX  
  - Basic inputs programming – VEX  
  - While loops and If-Else structures – VEX  
  - Variables and functions – VEX  
  - Open and closed loop systems – VEX

- **Lesson 3.2 Activities:**  
  - Fluid power applications  
  - Demonstrations:  
    - Pneumatic  
    - Hydraulic  
  - Project Lead the Way activities with practice problems  
  - Engineering notebook documentation of student work

Board Approved 7-14-14
### Assessments/Evaluations

- Formative assessments
- Practice problems
- Activities
- **Project 3.1.7 – Machine Control Design (VEX):** Students will solve specific problems using a specific procedure that includes creating:
  - multiple potential solutions
  - and testing their final solution
- **Project 3.2.3 – Pneumatic Brake Design FT:** Students will work in teams to create a braking system utilizing friction
- **Project 3.2.5 – Hydraulic Lift Design:** Students will work in teams to design hydraulic systems to help determine why the sizes of two hydraulic cylinders allow force to be increased while work remains the same
- **3.3 Design Problem – National Recreation Park Association:** Student teams will design, model, and test a device that will separate recyclable materials

### Sample Assessment Questions

- 

### Instructional Resources/Tools

- Project Lead the Way curriculum, including:
  - PowerPoint presentations
  - activities
  - scoring guides
  - instructions
- VEX Principles of Engineering kit
- Project Lead The Way Online Learning Management System
- Fischertechnik Pneumatic Components
**Literacy Connections**

- Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text
- Write informative/explanatory texts, including the narration of historical events, scientific procedures/experiments, or technical processes
- Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience
- Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences

**Cross Curricular Connections**

- Math:
  - Algebra
  - Geometry
- Science:
  - Physical Science
  - Engineering
  - Applications of Science
- ELA – Written description of:
  - career demand
  - salary
  - education
- Technology – Students will:
  - use VEX robot kits to create and explore
  - use Fischertechnik Pneumatic Components to design a brake
| Conceptual Category(s) | • Number and Quantity  
• Algebra  
• Functions  
• Geometry  
• Statistics  
• Physics |
|---|---|
| Domain | • The Real Number System (N-RN)  
• Quantities (N-Q)  
• Vector and Matrix Quantities (N-VM)  
• Seeing Structure in Expressions (A-SSE)  
• Creating Equations (A-CED)  
• Reasoning with Equations and Inequalities (A-REI)  
• Trigonometric Functions (F-TF)  
• Similarity, Right Triangles, and Trigonometry (G-SRT)  
• Modeling With Geometry (G-MG)  
• Interpreting Categorical and Quantitative Data (S-ID)  
• Making Inferences and Justifying Conclusions (S-IC)  
• Conditional Probability and the Rules of Probability (S-CP)  
• Properties and Principles of Force and Motion (SC-2)  
• Scientific Inquiry (SC-7) |
| Cluster | • Extend the properties of exponents to rational exponents (N-RN.2)  
• Reason quantitatively and use units to solve problems (N-Q.1-3)  
• Represent and model with vector quantities (N-VM.1-3)  
• Interpret the structure of expressions (A-SSE.1)  
• Create equations that describe numbers or relationships (A-CED.3, 4)  
• Solve equations and inequalities in one variable. (A-REI.3, 4)  
• Model periodic phenomena with trigonometric functions (F-TF.7)  
• Define trigonometric ratios and solve problems involving right triangles (G-SRT.6, 8)  
• Apply geometric concepts in modeling situations (G-MG.3)  
• Summarize, represent, and interpret data on a single count or measurement variable (S-ID.1-4)  
• Making inferences and justifying conclusions (S-IC.1, 2)  
• Make inferences and justify conclusions from sample surveys, experiments, and observational studies (S-IC.4)  
• Understand independence and conditional probability and use them to interpret data (S-CP.2) |
<table>
<thead>
<tr>
<th>Standards</th>
<th>Learning Targets</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>N-RN.2</strong></td>
<td><strong>Unit 4: Statistics and Kinematics</strong></td>
</tr>
<tr>
<td>2. Rewrite expressions involving radicals and rational exponents using the properties of exponents</td>
<td><strong>4.1 Statistics:</strong></td>
</tr>
<tr>
<td><strong>N-Q.1,2,3</strong></td>
<td>• Calculate the theoretical probability that an event will occur</td>
</tr>
<tr>
<td>1. Use units as a way to understand problems and to guide the solution of multi-step problems; choose and interpret units consistently in formulas; choose and interpret the scale and the origin in graphs and data displays</td>
<td>• Calculate the experimental frequency distribution of an event occurring</td>
</tr>
<tr>
<td>2. Define appropriate quantities for the purpose of descriptive modeling</td>
<td>• Apply the Bernoulli process to events that only have two distinct possible outcomes</td>
</tr>
<tr>
<td>3. Choose a level of accuracy appropriate to limitations on measurement when reporting quantities</td>
<td>• Apply AND, OR, and NOT logic to probability</td>
</tr>
<tr>
<td><strong>N-VM.1,2,3</strong></td>
<td>• Apply Bayes’ theorem to calculate the probability of multiple events occurring</td>
</tr>
<tr>
<td>1. Recognize vector quantities as having both magnitude and direction. Represent vector quantities by directed line segments, and use appropriate symbols for vectors and their magnitudes</td>
<td>• Create a histogram to illustrate frequency distribution</td>
</tr>
<tr>
<td>2. Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point</td>
<td>• Calculate the central tendency of a data array, including mean, median, and mode</td>
</tr>
<tr>
<td>3. Solve problems involving velocity and other quantities that can be represented by vectors</td>
<td>• Calculate data variation, including range, standard deviation, and variance</td>
</tr>
<tr>
<td><strong>A-SSE.1</strong></td>
<td><strong>CCSS:</strong> S-ID.1-4; S-IC.1,2,4; S-CP.2,6-9</td>
</tr>
<tr>
<td>1. Interpret expressions that represent a quantity in terms of its context</td>
<td>SCCLE: SC7.1.B (Physics)</td>
</tr>
<tr>
<td><strong>SCCLE:</strong> SC7.1.B (Physics)</td>
<td><strong>4.2 Kinematics:</strong></td>
</tr>
<tr>
<td><strong>A-SSE.1</strong></td>
<td>• Calculate distance, displacement, speed, velocity, and acceleration from data</td>
</tr>
<tr>
<td>1. Interpret expressions that represent a quantity in terms of its context</td>
<td>• Design, build, and test a vehicle that stores and releases potential energy for propulsion</td>
</tr>
<tr>
<td><strong>SCCLE:</strong> SC7.1.B (Physics)</td>
<td>• Calculate acceleration due to gravity given data from a free fall device</td>
</tr>
<tr>
<td><strong>SCCLE:</strong> SC7.1.B (Physics)</td>
<td>• Calculate the X and Y components of a projectile motion</td>
</tr>
</tbody>
</table>
3. Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or non-viable options in a modeling context

4. Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations

3. Solve linear equations and inequalities in one variable, including equations with coefficients represented by letters

4. Solve quadratic equations in one variable

7. Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context

6. Understand that by similarity, side ratios in right triangles are properties of the angles in the triangle, leading to definitions of trigonometric ratios for acute angles

8. Use trigonometric ratios and the Pythagorean Theorem to solve right triangles in applied problems

3. Apply geometric methods to solve design problems

1. Represent data with plots on the real number line

2. Use statistics appropriate to the shape of the data distribution to compare center and spread of two or more different data sets

3. Interpret differences in shape, center, and spread in the context of the data sets, accounting for possible effects of extreme data points

• Determine the angle needed to launch a projectile a specific range given the projectile’s initial velocity

CCSS: N-RN.2; N-Q.1-3; N-VM.1-3; A-SSE.1; A-CED.3,4; A-REI.3,4; F-TF.7; G-SRT.6,8; G-MG.3; S-ID.2

SCCLE: SC2.1.A,B

4.3 Design Problem – Statistics and Kinematics:

- Brainstorm and sketch possible solutions to an existing design problem
- Create a decision-making matrix for a design problem
- Select an approach that meets or satisfies the constraints provided in a design brief
- Create a detailed pictorial sketch or use 3D modeling software to document the best choice, based upon the design team’s decision matrix
- Present a workable solution to the design problem

CCSS:

SCCLE:
4. Use the mean and standard deviation of a data set to fit it to a normal distribution and to estimate population percentages

S-IC.1,2,4
I. Understand statistics as a process for making inferences about population parameters based on a random sample from that population
2. Decide if a specified model is consistent with results from a given data-generating process
4. Use data from a sample survey to estimate a population mean or proportion; develop a margin of error through the use of simulation models for random sampling

S-CP.2,6,7,8,9
2. Understand that two events A and B are independent if the probability of A and B occurring together is the product of their probabilities, and use this characterization to determine if they are independent
6. Find the conditional probability of A given B as the fraction of B’s outcomes that also belong to A, and interpret the answer in terms of the model
7. Apply the Addition Rule, P(A or B) = P(A) + P(B) − P(A and B), and interpret the answer in terms of the model
8. Apply the general Multiplication Rule in a uniform probability model, P(A and B) = P(A)P(B|A) = P(B)P(A|B), and interpret the answer in terms of the model

9. Use permutations and combinations to compute probabilities of compound events and solve problems

SC2.1.A,B
A. The motion of an object is described as a change in position, direction, and speed relative to another object
B. An object that is accelerating is speeding up, slowing down, or changing direction
### SC7.1.A,B

**A.** Scientific inquiry includes the ability of students to formulate a testable question and explanation, and to select appropriate investigative methods in order to obtain evidence relevant to the explanation.

**B.** Scientific inquiry relies upon gathering evidence from qualitative and quantitative observations.

### Alignments:

CCSS: 11-12.RST.3; 9-10.RST.4; 9-10.WHST.2; 9-10.WHST.4; 9-10.WHST.5; 9-10.WHST.6; 9-10.WHST.10; N-RN.2; N-Q.1,2,3; N-VM.1,2,3; A-SSE.1; A-CED.3,4; A-REI.3,4; F-TF.7; G-SRT.6,8; G-MG.3; S-ID.1,2,3,4; S-IC.1,2,4; S-CP.2,6,7,8,9

**Performance:** 1.1, 1.2, 1.10, 2.3, 2.6, 3.4, 3.6, 4.5, 4.6

**Knowledge:** (CA) 4 (MA) 3 (SC) 7

**GLE/CLE:** SC2.1.A,B; SC7.1.A,B

**NGSS:** HS-PS3.3

**NETS:** 1a,b; 3a; 4b; 6a

**DOK:** 4

### Instructional Strategies

- Classroom discussion enhanced with PowerPoint
- **Lesson 4.1 Activities:**
  - Career:
    - reflection
    - abstract
    - presentation
  - Data exploration
  - Candy statistics
- **Lesson 4.2 Activities:** Projectile motion
- Engineering notebook documentation of student work
### Assessments/Evaluations

- Formative assessments
- Practice problems
- Activities
- **Project 4.2.1 – Self-Propelled Vehicle Design:** Student teams design a self-powered car and gather data to determine:
  - distance
  - displacement
  - speed
  - velocity
  - acceleration
- **4.2.3 Design Problem – Ballistic Design – VEX:** Students will work in teams to innovate and make improvements to a given design using the steps in the design process

### Sample Assessment Questions

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### Instructional Resources/Tools

- Project Lead the Way curriculum, including:
  - PowerPoint presentations
  - activities
  - scoring guides
  - instructions
- VEX Principles of Engineering kit
- Project Lead The Way Online Learning Management System
- America’s Army Mountain Pass Simulation software

### Literacy Connections

- Follow precisely a complex multistep procedure when carrying out experiments, taking measurements, or performing technical tasks; analyze the specific results based on explanations in the text
- Determine the meaning of symbols, key terms, and other domain-specific words and phrases as they are used in a specific scientific or technical context relevant to grades 9–10 texts and topics
- Write informative/explanatory texts, including the narration of historical events, scientific procedures/ experiments, or technical processes
**Principles of Engineering**

- Produce clear and coherent writing in which the development, organization, and style are appropriate to task, purpose, and audience
- Develop and strengthen writing as needed by planning, revising, editing, rewriting, or trying a new approach, focusing on addressing what is most significant for a specific purpose and audience
- Use technology, including the Internet, to produce, publish, and update individual or shared writing products, taking advantage of technology’s capacity to link to other information and to display information flexibly and dynamically
- Write routinely over extended time frames (time for reflection and revision) and shorter time frames (a single sitting or a day or two) for a range of discipline-specific tasks, purposes, and audiences

### Cross Curricular Connections

- **Math:**
  - Algebra
  - Geometry
- **Science:**
  - Physical Science
  - Engineering
  - Applications of Science
- **ELA:** Written description of career field
- **Technology – Students will use:**
  - VEX robot kits to create and explore
  - America’s Army Mountain Pass Simulation Software