NORTH DAKOTA DEPARTMENT OF
PUBLIC INSTRUCTION

# North Dakota
# High School State Standards

# Course IV Pathway

**July 2017**

# Overview

The North Dakota State Standards (NDSS) for Mathematics are organized by grade level in Grades K-8. At the high school level, the standards are organized by conceptual category (number and quantity, algebra, functions, geometry, modeling and probability and statistics), showing the body of knowledge students should learn in each category to be college and career ready, and to be prepared to study more advanced mathematics. As North Dakota school districts consider how to implement the high school standards, an important consideration is now the high school NDSS might be organized into courses that provide a strong foundation for post-secondary success. To address this need, the NDSS writing committee has provided a possible pathway to implement the NDSS in the traditional courses of Algebra I, Geometry, Algebra II and Course IV.

In considering this document, it is important to note the following:

1. The pathway is a model, not a mandate. It illustrates a possible approach to organize the content of the NDSS into coherent and rigorous courses that lead to college and career readiness. Districts are not expected to adopt these courses as is; rather, they may use this pathway as a starting point for developing their own.

2. All college and career ready standards have been included in the pathway. Standards with a (+) are included to increase coherence but are not necessarily expected to be addressed on high stakes assessments.

While the focus of this document is on organizing the Standards for Mathematical Content into a pathway to college and career readiness, the content standards must also be connected to the Standards for Mathematical Practice to ensure that the skills needed for alter success are developed. In particular, Modeling (defined by a * in the NDSS) is defined as both a *conceptual category* for high school mathematics and a *mathematical practice* and is an important avenue for motivating students to study mathematics, for building their understanding of mathematics, and for preparing them for future success. Development of the pathway into instructional programs will require careful attention to modeling and the mathematical practices. Assessments based on the pathway should reflect both the content and mathematical practice standards.

Strategic use of technology is expected in all work. This may include employing technological tools to assist students in forming and testing conjectures, creating graphs and data displays, as well as determining and assessing lines of fit for data. Geometric constructions may also be performed using geometric software, as well as classical tools and technology aiding in three-dimensional visualization.

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** indicates modeling standards*

# Mathematical Practices

It should be noted that throughout each course, the following **mathematical practices** from the NDSS are to be emphasized:

**1. Make sense of problems and persevere in solving them.**

Mathematically proficient students:

- Explain to themselves the meaning of a problem and looking for entry points to its solution.
- Analyze givens, constraints, relationships, and goals.
- Make conjectures about the form and meaning of the solution attempt.
- Consider analogous problems, and try special cases and simpler forms of the original problem.
- Monitor and evaluate their progress and change course if necessary.
- Transform algebraic expressions or change the viewing window on their graphing calculator to get information.
- Explain correspondences between equations, verbal descriptions, tables, and graphs.
- Draw diagrams of important features and relationships, graph data, and search for regularity or trends.
- Use concrete objects or pictures to help conceptualize and solve a problem.
- Check their answers to problems using a different method.
- Ask themselves, “Does this make sense?”
- Understand the approaches of others to solving complex problems.

**2. Reason abstractly and quantitatively.**

Mathematically proficient students:

- Make sense of quantities and their relationships in problem situations.
  - ✓ *Decontextualize* (abstract a given situation and represent it symbolically and manipulate the representing symbols as if they have a life of their own, without necessarily attending to their referents) and
  - ✓ *Contextualize* (pause as needed during the manipulation process in order to probe into the referents for the symbols involved).
- Use quantitative reasoning that entails creating a coherent representation of quantities, not just how to compute them.
- Know and flexibly use different properties of operations and objects.

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**3. Construct viable arguments and critique the reasoning of others.**

Mathematically proficient students:

- Understand and use stated assumptions, definitions, and previously established results in constructing arguments.
- Make conjectures and build a logical progression of statements to explore the truth of their conjectures.
- Analyze situations by breaking them into cases.
- Recognize and use counterexamples.
- Justify their conclusions, communicate them to others, and respond to the arguments of others.
- Reason inductively about data, making plausible arguments that take into account the context.
- Compare the effectiveness of plausible arguments.
- Distinguish correct logic or reasoning from that which is flawed.
  - ✓ Elementary students construct arguments using objects, drawings, diagrams, and actions.
  - ✓ Later students learn to determine domains to which an argument applies.
- Listen or read the arguments of others, decide whether they make sense, and ask useful questions.

**4. Model with mathematics.**

Mathematically proficient students:

- Apply the mathematics they know to solve problems arising in everyday life, society, and the workplace.
  - ✓ In early grades, this might be as simple as writing an addition equation to describe a situation. In middle grades, a student might apply proportional reasoning to plan a school event or analyze a problem in the community.
  - ✓ By high school, a student might use geometry to solve a design problem or use a function to describe how one quantity of interest depends on another.
- Simplify a complicated situation, realizing that these may need revision later.
- Identify important quantities in a practical situation.
- Map their relationships using such tools as diagrams, two-way tables, graphs, flowcharts and formulas.
- Analyze those relationships mathematically to draw conclusions.
- Interpret their mathematical results in the context of the situation.
- Reflect on whether the results make sense, possibly improving the model if it has not served its purpose.

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**5. Use appropriate tools strategically.**

Mathematically proficient students:

- Consider available tools when solving a mathematical problem.
- Are familiar with tools appropriate for their grade or course to make sound decisions about each of these tools.
- Detect possible errors by using estimations and other mathematical knowledge.
- Know that technology can enable them to visualize the results of varying assumptions, and explore consequences.
- Identify relevant mathematical resources and use them to pose or solve problems.
- Use technological tools to explore and deepen their understanding of concepts.

**6. Attend to precision.**

Mathematically proficient students:

- Try to communicate precisely to others.
- Use clear definitions in discussion with others and in their own reasoning.
- State the meaning of the symbols they choose, including using the equal sign consistently and appropriately.
- Specify units of measure and label axes to clarify the correspondence with quantities in a problem.
- Calculate accurately and efficiently, express numerical answers with a degree of precision appropriate for the context.
  - ✓ In the elementary grades, students give carefully formulated explanations to each other.
  - ✓ In high school, students have learned to examine claims and make explicit use of definitions.

**7. Look for and make use of structure.**

Mathematically proficient students:

- Look closely to discern a pattern or structure.
  - ✓ Young students might notice that three and seven more is the same amount as seven and three more.
  - ✓ Later, students will see 7 x 8 equals the well-remembered 7 x 5 + 7 x 3, in preparation for the distributive property.
  - ✓ In the expression $x^2 + 9x + 14$, older students can see the 14 as 2 x 7 and the 9 as 2 + 7.
- Step back for an overview and can shift perspective.
- See complicated things, such as some algebraic expressions, as single objects or composed of several objects.

**8. Look for and express regularity in repeated reasoning.**

Mathematically proficient students:

- Notice if calculations are repeated.
- Look both for general methods and for shortcuts.
- Maintain oversight of the process, while attending to the details.
- Continually evaluate the reasonableness of intermediate results.

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** indicates modeling standards*

North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Number and Quantity**
Domain: **Quantities* (Mathematical Practices 1, 4, and 6)**
Cluster: **Reason quantitatively and use units to solve problems**

HS.N-Q

| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| HS.N-Q.1*<br>Use units as a way to understand problems and to guide the solution of multi-step problems (e.g., unit analysis).<br><br>Choose and interpret units consistently in formulas.<br><br>Choose and interpret the scale and the origin in graphs and data displays. | • interpret units in the context of the problem<br><br>• use unit analysis to check the reasonability of your solution<br><br>• choose and interpret an appropriate scale given data to be represented on a graph or display | Estimations and Approximations: The Money Munchers<br><br>Leaky Faucet<br><br>Yogurt |
| **Vocabulary**<br>• unit analysis | **Annotations**<br>Example: While driving in the United Kingdom (UK), a U.S. tourist puts 60 liters of gas in his car. The gas cost is £1.28 per liter. The exchange rate is £ 0.62978 for each US $1.00. The price for a gallon of a gasoline in the United States is US $3.05. The driver wants to compare costs for the same amount and the same type of gasoline in UK and in the United States if he pays in UK Pounds. | **Notes** |

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North Dakota *HIGH SCHOOL* State Standards: *COURSE IV*
Conceptual Category: **Number and Quantity**
Domain: **Quantities* (Mathematical Practices 1, 4, and 6)**
Cluster: **Reason quantitatively and use units to solve problems**

HS.N-Q

| **Standard**<br>HS.N-Q.2*<br>Define appropriate quantities for the purpose of descriptive modeling. | **Students Can**<br>• determine an appropriate quantity to model a situation | **Resources**<br>Estimations and Approximations: The Money Munchers<br><br>Yogurt<br><br>Leaky Faucet |
|---|---|---|
| **Vocabulary**<br>• modeling | **Annotations**<br>Example: When carpeting a room, students might consider whether it is best to use square feet or square yards. When considering a remodeling project, they might choose such units as cost per room, cost per month of the project, or cost per contractor. | **Notes** |

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North Dakota *HIGH SCHOOL* State Standards: *COURSE IV*
Conceptual Category: **Number and Quantity**
Domain: **Quantities* (Mathematical Practices 1, 4, and 6)**
Cluster: **Reason quantitatively and use units to solve problems**

HS.N-Q

| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| HS.N-Q.3*<br>Choose a level of accuracy appropriate to limitations on measurement when reporting quantities. | • choose a level of accuracy appropriate to the measuring tool or situation | Estimations and Approximations: The Money Munchers<br><br>Leaky Faucet<br><br>Yogurt |
| **Vocabulary**<br>• significant digits<br>• precision: refers to how much information is conveyed by a number (in terms of the number of digits)<br>• accuracy: the degree to which a measurement conforms to the correct value or a standard | **Annotations**<br>Example: When using a ruler, students choose to report their measurements based on the precision of the ruler (e.g., to the nearest 1/16 or the nearest 1/32).<br><br>Example: If you are playing soccer and you always hit the left goal post instead of scoring, then you are not accurate; you are precise.<br><br>Example: When using a ruler, students are able to measure accurately.<br><br>Example: When calculating the cost of a road trip, students are given the cost of gasoline to the thousandths place. When reporting the cost of the trip, students determine what level of precision –to the hundredths place or to the thousandths place— is appropriate and why. | **Notes** |

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North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Number and Quantity**
Domain: **The Complex Number System**
Cluster: **Perform arithmetic operations with complex numbers**

HS.N-CN

| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.N-CN.4<br>Represent complex numbers on the complex plane in rectangular and polar form (including real and imaginary numbers).<br><br>Find moduli (absolute value) of a complex number.<br><br>Explain why the rectangular and polar forms of a given complex number represent the same number. | • represent a complex number on the complex plane in rectangular and polar form<br><br>• find moduli (absolute value) of a complex number<br><br>• explain why rectangular and polar forms of a complex number represent the same number | |
| **Vocabulary**<br>• complex plane<br>• polar form<br>• rectangular form<br>• moduli | **Annotations** | **Notes** |

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North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Number and Quantity**
Domain: **The Complex Number System**
Cluster: **Perform arithmetic operations with complex numbers**

HS.N-CN

| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.N-CN.5<br>Represent addition, subtraction, multiplication, and conjugation of complex numbers geometrically on the complex plane; use properties of this representation for computation. | • geometrically represent operations of complex numbers on the complex plane<br>• geometrically show that the conjugate of a complex number in a complex plane is the reflection over the x-axis<br>• evaluate the power of a complex number in rectangular form using the polar form of that complex number | |
| **Vocabulary**<br>• argument | **Annotations**<br>Example: $(1 - \sqrt{3}i)^3 = 8$ because $(1 - \sqrt{3}i)$ has modulus 2 and argument 120°. | **Notes** |

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North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Number and Quantity**
Domain: **The Complex Number System**
Cluster: **Use complex numbers in polynomial identities and equations**

HS.N-CN

| **Standard**<br>(+) HS.N-CN.8<br>Extend polynomial identities to the complex numbers. | **Students Can**<br>• use polynomial identities to write equivalent expressions in the form of complex numbers | **Resources** |
|---|---|---|
| **Vocabulary**<br>• polynomial identities | **Annotations**<br>Example: Rewrite $x^2 + 4$ as $(x + 2i)(x – 2i)$.<br><br>Polynomial identities include but are not limited to:<br>$(a+b)^2 = a^2 + 2ab + b^2$<br>$(a+b)(c+d) = ac + ad + bc + bd$<br>$a^2 - b^2 = (a+b)(a-b)$ (*Differences of Squares*)<br>$a^3 \pm b^3 = (a+b)(a^2 \mp ab + b^2)$ (*Sum and Differences of Cubes*)<br>$x^2 + (a+b)x + ab = (x+a)(x+b)$ | **Notes** |

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North Dakota *HIGH SCHOOL* State Standards: *COURSE IV*
Conceptual Category: **Number and Quantity**
Domain: **The Complex Number System**
Cluster**: Use complex numbers in polynomial identities and equations**

HS.N-CN

| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.N-CN.9<br>Apply the Fundamental Theorem of Algebra to determine the number of zeros for polynomial functions.<br><br>Find all solutions to a polynomial equation. | • recognize that the Fundamental Theorem of Algebra states that the number of complex solutions to a polynomial equation is equal to the degree of the polynomial<br><br>• find all solutions to a polynomial equation | |
| **Vocabulary**<br>• Fundamental Theorem of Algebra: the number of complex solutions to a polynomial equation is equal to the degree of the polynomial<br>• zeros<br>• degree | **Annotations** | **Notes** |

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North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Number and Quantity**
Domain: **Vector and Matrix Quantities**
Cluster: **Represent and model with vector quantities**

HS.N-VM

| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.N-VM.1<br>Recognize vector quantities as having both magnitude and direction.<br><br>Represent vector quantities by directed line segments and use appropriate symbols for vectors and their magnitudes (e.g., $\boldsymbol{v}$, $\lvert\boldsymbol{v}\rvert$, $\lVert\boldsymbol{v}\rVert$, $v$). | • identify a vector as a directed line segment representing magnitude and direction<br><br>• use the appropriate symbolic representation for vectors and their magnitudes | |
| **Vocabulary**<br>• vector<br>• magnitude | **Annotations** | **Notes** |

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North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Number and Quantity**
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Cluster: **Represent and model with vector quantities**

HS.N-VM

| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.N-VM.2<br>Find the components of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point. | • find the component form of a vector by subtracting the coordinates of an initial point from the coordinates of a terminal point | |
| **Vocabulary**<br>• initial point<br>• terminal point | **Annotations** | **Notes** |

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North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Number and Quantity**
Domain: **Vector and Matrix Quantities**
Cluster: **Represent and model with vector quantities**

HS.N-VM

| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.N-VM.3<br>Solve problems involving velocity and other quantities that can be represented by vectors. | • solve problems involving velocity and other quantities that can be represented by vectors | |
| **Vocabulary**<br>• velocity | **Annotations** | **Notes** |

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North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Number and Quantity**
Domain: **Vector and Matrix Quantities**
Cluster: **Perform operations on vectors**



| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.N-VM.4<br>Add and subtract vectors.<br>a. Add vectors end-to-end, component-wise, and by the parallelogram rule.<br><br>Understand that the magnitude of a sum of two vectors is typically not the sum of the magnitudes.<br><br>b. Given two vectors in magnitude and direction form, determine the magnitude and direction of their sum.<br><br>c. Understand that vector subtraction ***v*** – ***w*** is defined as ***v*** + (–***w***), where –***w*** is the additive inverse of ***w***, with the same magnitude as ***w*** and pointing in the opposite direction.<br><br>Represent vector subtraction graphically by connecting the tips in the appropriate order and use the components to perform vector subtraction. | • add and subtract vectors<br>• add vectors tip to tail, using the horizontal and vertical components, and by finding the diagonal formed by the parallelogram<br>• understand that the magnitude of a sum of two vectors is not the sum of the magnitudes unless the vectors have the same heading or direction<br>• add two vectors geometrically or algebraically to determine the magnitude and direction of the resultant<br>• subtract vectors and know that vector subtraction is defined much like subtraction of real numbers, in that ***v – w*** is the same as ***v + (–w)***, where ***–w*** is the additive inverse of ***w***; the opposite of ***w***, ***-w***, has the same magnitude but the direction of the angle differs by 180°<br>• represent vector subtraction on a graph by connecting the vectors head to tail and using the components of those vectors to find the difference | |
| **Vocabulary**<br>• resultant | **Annotations** | **Notes** |

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North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Number and Quantity**
Domain: **Vector and Matrix Quantities**
Cluster: **Perform operations on vectors**



| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.N-VM.5<br>Multiply a vector by a scalar.<br>a. Represent scalar multiplication graphically by scaling vectors and possibly reversing their direction.<br><br>Use the components to perform scalar multiplication (e.g., as $c(v_x, v_y) = (cv_x, cv_y)$).<br><br>b. Compute the magnitude of a scalar multiple $c\mathbf{v}$ using $\|\|c\mathbf{v}\|\| = \|c\|\mathbf{v}$.<br><br>Compute the direction of $c$v knowing that when $\|c\|\mathbf{v} \neq 0$, the direction of $c\mathbf{v}$ is either along $\mathbf{v}$ (for $c > 0$) or against $\mathbf{v}$ (for $c < 0$). | • multiply a vector by a scalar<br><br>• represent scalar multiplication of vectors on a graph by changing the magnitude of the vector by the factor of the given scalar; if the scalar is less than zero, the new vector's direction is opposite the original vector's direction<br><br>• represent scalar multiplication of vectors using the component form, such as $c(v_x, v_y) = (cv_x, cv_y)$<br><br>• compute the magnitude of a scalar multiple, c**v,** as the magnitude of v multiplied by the factor of the \|c\| and when c > 0, the direction is the same or when c < 0, the direction of the vector is opposite the direction of the original vector | |
| **Vocabulary**<br>• scalar<br>• scalar multiple | **Annotations** | **Notes** |

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North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Number and Quantity**
Domain: **Vector and Matrix Quantities**
Cluster: **Perform operations on matrices and use matrices in applications**

HS.N-VM

| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.N-VM.10<br>Understand that the zero and identity matrices play a role in matrix addition and multiplication similar to the role of 0 and 1 in the real numbers. The determinant of a square matrix is nonzero if and only if the matrix has a multiplicative inverse. | • identify a zero matrix and understand that it behaves in matrix addition, subtraction, and multiplication much like 0 in the real number system<br>• identify an identity matrix for a square matrix and understand that it behaves in matrix multiplication much like the number 1 in the real number system<br>• find the determinant of a square matrix, and know that it is a nonzero value if the matrix has an inverse<br>• recognize that if a matrix has an inverse, then the determinant of a square matrix is a nonzero value | |
| **Vocabulary**<br>• determinant<br>• zero matrix<br>• identity matrix<br>• inverse matrix | **Annotations** | **Notes** |

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North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Number and Quantity**
Domain: **Vector and Matrix Quantities**
Cluster: **Perform operations on matrices and use matrices in applications**

HS.N-VM

| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.N-VM.11<br>Multiply a vector (regarded as a matrix with one column) by a matrix of suitable dimensions to produce another vector.<br><br>Understand a matrix as a transformation of vectors. | • choose a matrix and use matrix multiplication to perform transformations of a vector | |
| **Vocabulary** | **Annotations** | **Notes** |
| | | |

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North Dakota *HIGH SCHOOL* State Standard: *Course IV*
Conceptual Category: **Number and Quantity**
Domain: **Vector and Matrix Quantities**
Cluster: **Perform operations on matrices and use matrices in applications**

HS.N-VM

| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.N-VM.12<br>Understand a 2 × 2 matrix as a transformation of the plane.<br><br>Interpret the absolute value of the determinant in terms of area. | • find the vector representation for two adjacent sides with the same initial point given the coordinates of the vertices of a parallelogram in the coordinate plane<br><br>• write the components of the vectors in a 2x2 matrix and find the determinant of the 2x2 matrix (the absolute value of the determinant is the area of the parallelogram; this is called the dot product of the two vectors) | |
| **Vocabulary**<br>• dot product<br>• transformation<br>• components | **Annotations** | **Notes** |

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North Dakota *HIGH SCHOOL* State Standards: *COURSE IV*
Conceptual Category: **Algebra**
Domain: **Arithmetic with Polynomials and Rational Expressions**
Cluster**: Use polynomial identities to solve problems**

HS.A-APR


| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.A-APR.5<br>Apply the Binomial Theorem for the expansion of $(x + y)^n$ in powers of $x$ and $y$ for a positive integer $n$. | • use Pascal's Triangle to determine the coefficients of the binomial expansion $(x+y)^n$<br>• apply the Binomial Theorem to find the nth term in the expansion of a binomial to a positive integer power | |
| **Vocabulary**<br>• Pascal's Triangle<br>• Binomial Theorem | **Annotations** | **Notes** |

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North Dakota *HIGH SCHOOL* State Standards: *COURSE IV*
Conceptual Category: **Algebra**
Domain: **Reasoning with Equations and Inequalities**
Cluster: **Solve equations and inequalities in one variable**

HS.A-REI


| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| HS.A-REI.4<br>Solve quadratic equations in one variable.<br><br>a. Use the method of completing the square to transform any quadratic equation in x into an equation of the form $(x – p)^2 = q$ that has the same solutions.<br><br>(+) Derive the quadratic formula from this form. | • solve quadratic equations in one variable<br>• transform a quadratic equation to an equation in the form $(x-p)^2=q$ by completing the square<br>• derive the quadratic formula by completing the square on a quadratic equation<br>• solve quadratic equations in one variable by simple inspection, taking the square root, factoring, and completing the square<br>• recognize which method of solving a quadratic equation is appropriate for a given equation<br>• explain why taking the square root of both sides of an equation can yield two solutions<br>• use the quadratic formula to solve any quadratic equation, recognizing the formula produces all complex solutions and write the solutions in the form $a \pm bi$ where $a$ and $b$ are real numbers<br>• derive the quadratic formula from the form $(x-p)^2=q$ | |
| **Vocabulary**<br>• completing the square<br>• quadratic formula | **Annotations**<br>This standard is related to HS.N-CN.7. | **Notes** |

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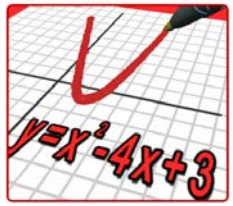
North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Algebra**
Domain: **Reasoning with Equations and Inequalities**
Cluster: **Solve systems of equations**

# HS.A-REI




| **Standard**<br>(+) HS.A-REI.8<br>Represent a system of linear equations as a single matrix equation. | **Students Can**<br>• write a system of linear equations as a single matrix equation | **Resources** |
|---|---|---|
| **Vocabulary**<br>• matrix equation | **Annotations**<br>Represent the system as a matrix equation:<br>$\begin{cases} 2x + 3y = 0 \\ x + 4y = 8 \end{cases}$<br><br>Solution: $\begin{bmatrix} 2 & 3 \\ 1 & 4 \end{bmatrix} \begin{bmatrix} x \\ y \end{bmatrix} = \begin{bmatrix} 0 \\ 8 \end{bmatrix}$ | **Notes** |

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Conceptual Category: **Algebra**
Domain: **Reasoning with Equations and Inequalities**
Cluster: **Solve systems of equations**

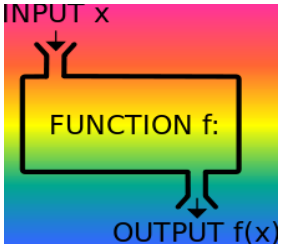
# HS.A-REI


| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.A-REI.9<br>Find the inverse of a matrix if it exists and use it to solve systems of linear equations (using technology for matrices of dimension 3 × 3 or greater). | • find the inverse of the coefficient matrix in the equation, if it exists<br>• use the inverse of the coefficient matrix to solve the system<br>• use technology for matrices with dimensions 3 × 3 or greater | |
| **Vocabulary**<br>• coefficient matrix<br>• inverse matrix | **Annotations**<br>Example: Solve using technology:<br>$\begin{bmatrix}1 & 2 & 0\\3 & 4 & -1\\5 & 7 & 2\end{bmatrix}\cdot\begin{bmatrix}a & b & c\\d & e & f\\g & h & i\end{bmatrix}=\begin{bmatrix}1 & 0 & 0\\0 & 1 & 0\\0 & 0 & 1\end{bmatrix}$ | **Notes** |

*Note:* (+) *indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics*
** indicates modeling standards*

North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Functions**
Domain: **Interpreting Functions**
Cluster: **Analyze functions using different representations**

HS.F-IF




| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| HS.F-IF.7*<br>Graph functions expressed symbolically and show key features of the graph, by hand in simple cases and using technology for more complicated cases.<br>a. (+) Graph rational functions, identifying zeros and asymptotes when suitable factorizations are available, and showing end behavior.<br>b. (+) Graph trigonometric functions, showing period, midline, phase shift and amplitude. | • graph functions expressed symbolically and show key features of the graph (graph simple cases by hand and use technology to show more complicated cases)<br>• graph rational functions, identifying zeros and asymptotes when factorable, and show end behavior<br>• graph trigonometric functions, showing period, midline, phase shift, and amplitude | |
| **Vocabulary**<br>• rational functions<br>• asymptotes<br>• trigonometric functions<br>• period<br>• midline<br>• phase shift<br>• amplitude | **Annotations** | **Notes** |

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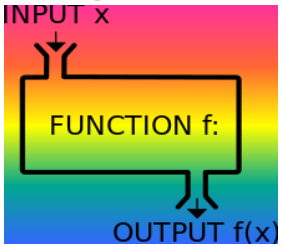
** indicates modeling standards*

North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Functions**
Domain: **Trigonometric Functions**
Cluster: **Extend the domain of trigonometric functions using the unit circle**

HS.F-TF




| **Standard**<br>HS.F-TF.2<br>Extend right triangle trigonometry to the four quadrants.<br><br>(+) Explain how the unit circle in the coordinate plane enables the extension of trigonometric functions to all real numbers, interpreted as radian measures of angles traversed counterclockwise around the unit circle. | **Students Can**<br>• use special triangles (45°-45°-90° and 30°-60°-90°) to determine the values of sine, cosine and tangent for π/3, π/4 and π/6**<br><br>• use the unit circle to express the values of sine, cosine and tangent for π-x, π+x, and 2π-x in terms of their values for x** | **Resources** |
|---|---|---|
| **Vocabulary**<br>• special triangles | **Annotations**<br>Example: Find *sin* 210° | **Notes** |

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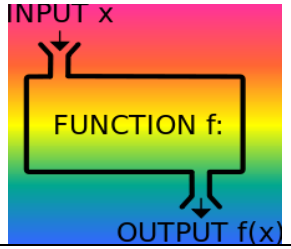
** indicates modeling standards*

North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Functions**
Domain: **Trigonometric Functions**
Cluster: **Extend the domain of trigonometric functions using the unit circle**

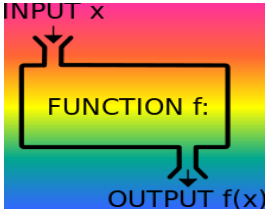
HS.F-TF




| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| HS.F-TF.3<br>Use special triangles to determine geometrically the values of sine, cosine, tangent for π/3, π/4 and π/6<br><br>(+)Use the unit circle to express the values of sine, cosine, and tangent for π-*x*, π+*x*, and 2π-*x* in terms of their values for *x*, where *x* is any real number. | • use special triangles (45°-45°-90° and 30°-60°-90°) to determine the values of sine, cosine and tangent for π/3, π/4 and π/6<br><br>• use the unit circle to express the values of sine, cosine and tangent for π-x, π+x, and 2π-x in terms of their values for x | |
| **Vocabulary**<br>• special triangles | **Annotations** | **Notes** |

*Note:* (+) *indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics*
** indicates modeling standards*

North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Functions**
Domain: **Trigonometric Functions**
Cluster: **Extend the domain of trigonometric functions using the unit circle**




| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.F-TF.4<br>Use the unit circle to explain symmetry (odd and even) and periodicity of trigonometric functions. | • use the values of the trigonometric functions derived from the unit circle to explain how trigonometric functions repeat themselves (periodicity)<br>• use the unit circle to explain that f(x) is an even function if f(-x)=f(x) for all x and that an even function is reflection symmetric over the y-axis<br>• use the unit circle to explain that f(x) is an odd function if f(-x)=-f(x) and that an odd function is symmetric with respect to the origin | |
| **Vocabulary**<br>• odd function<br>• even function<br>• periodicity | **Annotations** | **Notes** |

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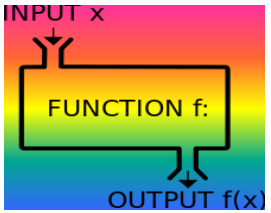
** indicates modeling standards*

North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Functions**
Domain: **Trigonometric Functions**
Cluster: **Model periodic phenomena with trigonometric functions**

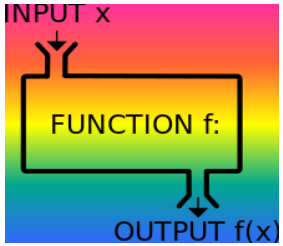



| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.F-TF.5*<br>Choose trigonometric functions to model periodic phenomena with specified amplitude, frequency, and midline. | • choose an appropriate trigonometric function to model periodic phenomena. | |
| **Vocabulary**<br>• periodic<br>• amplitude<br>• frequency<br>• midline | **Annotations** | **Notes** |

*Note:* (+) *indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics*
** indicates modeling standards*

North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Functions**
Domain: **Trigonometric Functions**
Cluster: **Model periodic phenomena with trigonometric functions**

HS.F-TF

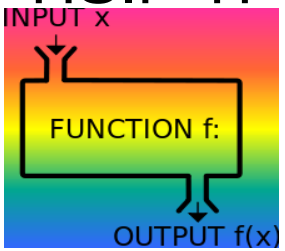



| **Standard**<br>(+) HS.F-TF.6<br>Understand that restricting a trigonometric function to a domain on which it is always increasing or always decreasing allows its inverse to be constructed. | **Students Can**<br>• determine that when the domain of a trigonometric function is restricted such that the function is always increasing or decreasing, the inverse of the function can be constructed | **Resources** |
|---|---|---|
| **Vocabulary**<br>• inverse function | **Annotations** | **Notes** |

*Note:* (+) *indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics*
** indicates modeling standards*

North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Functions**
Domain: **Trigonometric Functions**
Cluster: **Model periodic phenomena with trigonometric functions**

HS.F-TF

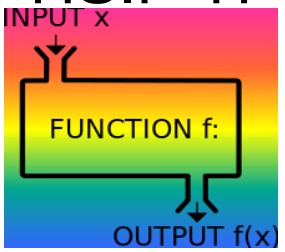



| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.F-TF.7*<br>Use inverse functions to solve trigonometric equations that arise in modeling contexts; evaluate the solutions using technology, and interpret them in terms of the context. | • use the inverse functions to solve trigonometric equations that arise in real-world situations<br>• use technology to evaluate the solutions to the inverse trigonometric functions<br>• interpret solutions in terms of the context | |
| **Vocabulary** | **Annotations** | **Notes** |
| | | |

*Note:* (+) *indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics*
** indicates modeling standards*

North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Functions**
Domain: **Trigonometric Functions**
Cluster: **Prove and apply trigonometric identities**

HS.F-TF

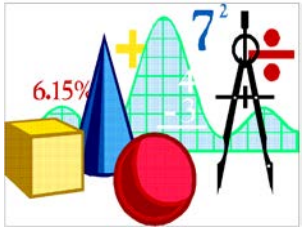



| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.F-TF.9<br>Know and apply the addition and subtraction formulas for sine, cosine, and tangent. | • know the addition and subtraction formulas sin(α±β), cos(α±β) and tan(α±β)<br><br>• use the addition and subtraction formulas for sine, cosine, and tangent to solve problems such as sin(105°) or cos(π/12) | |
| **Vocabulary**<br>• addition identities<br>• subtraction identities | **Annotations** | **Notes** |

*Note:* (+) *indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics*
** indicates modeling standards*

North Dakota *HIGH SCHOOL* State Standards: *COURSE IV*
Conceptual Category: **Geometry**
Domain: **Similarity, Right Triangles, Trigonometry**
Cluster: **Apply trigonometry to general triangles**

# HS.G-SRT

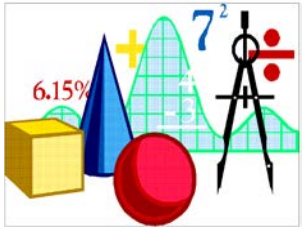



| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.G-SRT.9<br>Derive the formula $A = \frac{1}{2}ab\sin(C)$ for the area of a triangle by drawing an auxiliary line from a vertex perpendicular to the opposite side. | • for a triangle that is not a right triangle, draw an auxiliary line from a vertex, perpendicular to the opposite side and derive the formula $A = \frac{1}{2}ab\sin(C)$, for the area of a triangle, using the fact that the height of the triangle is $h = a\sin(C)$ | |
| **Vocabulary**<br>• vertex<br>• auxiliary line | **Annotations** | **Notes** |

*Note:* (+) *indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics*
** indicates modeling standards*

North Dakota *HIGH SCHOOL* State Standards: *COURSE IV*
Conceptual Category: **Geometry**
Domain: **Similarity, Right Triangles, Trigonometry**
Cluster: **Apply trigonometry to general triangles**

# HS.G-SRT




| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.G-SRT.10*<br>Solve unknown sides and angles of non-right triangles using the Laws of Sines and Cosines. | • use the Law of Sines and Cosines to solve unknown sides and angles of non-right triangles<br>• use the Laws of Sines and Cosines to solve real world problems | |
| **Vocabulary**<br>• Law of Sines<br>• Law of Cosines | **Annotations** | **Notes** |

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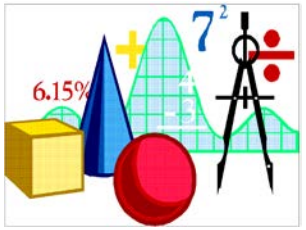
** indicates modeling standards*

North Dakota *HIGH SCHOOL* State Standards: *COURSE IV*
Conceptual Category: **Geometry**
Domain: **Similarity, Right Triangles, and Trigonometry**
Cluster: **Apply trigonometry to general triangles**

# HS.G-SRT

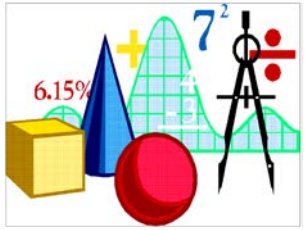



| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.G-SRT.11*<br>Understand and apply the Law of Sines and the Law of Cosines to find unknown measurements in context. | • apply any method to find unknown measurements in right triangles<br>• apply the Laws of Sines and Cosines to find unknown measurements in non-right triangles | |
| **Vocabulary** | **Annotations** | **Notes** |
| | | |

*Note:* (+) *indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics*
** indicates modeling standards*

North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Geometry**
Domain: **Expressing Geometric Properties with Equations**
Cluster: **Understand and use conic sections**






| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| HS.G-GPE.1<br>Derive the equation of a circle of given center and radius.<br><br>Derive the equation of a parabola given a focus and directrix.<br><br>(+) Derive the equations of ellipses and hyperbolas given foci, using the fact that the sum or difference of distances from the foci is constant. | • derive the equation of a circle of given center and radius<br><br>• derive the equation of a parabola given a focus and directrix<br><br>• given the foci, derive the equations of ellipses and hyperbolas | |
| **Vocabulary**<br>• ellipse<br>• hyperbola<br>• foci<br>• directrix | **Annotations** | **Notes** |

*Note:* (+) *indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics*
** indicates modeling standards*

North Dakota *HIGH SCHOOL* State Standards: *COURSE IV*
Conceptual Category: **Statistics and Probability**
Domain: **Making Inferences and Justifying Conclusions***
Cluster**: Make inferences and justify conclusions from sample surveys, experiments, and observational studies**

HS.S-IC


| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.S-IC.4*<br>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. | • use sample means and sample proportions to estimate population values<br><br>• conduct simulations of random sampling to gather sample means and sample proportions, explain what the results mean about variability in a population, and use results to calculate margins of error for these estimates | Interpreting Statistics: A Case of Muddying the Waters<br><br>Resource: Progressions for the Common Core State Standards HS Statistics & Probability |
| **Vocabulary**<br>• margin of error<br>• random sampling | **Annotations** | **Notes** |

*Note:* (+) *indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics*
** indicates modeling standards*

North Dakota *HIGH SCHOOL* State Standards: *COURSE IV*
Conceptual Category: **Statistics and Probability**
Domain: **Conditional Probability and Rules of Probability***
Cluster: **Use the rules of probability to compute probabilities of compound events in a uniform probability model**

HS.S-CP


| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| HS.S-CP.9*<br>Use permutations and combinations to determine the number of outcomes in terms of the model.<br><br>(+)Use permutations and combinations to compute probabilities of compound events and solve problems. | • identify situations as appropriate for use of a permutation or combination to calculate probabilities<br><br>• determine the number of outcomes in a model using permutations or combinations<br><br>• use permutations and combinations in conjunction with other probability methods to calculate probabilities of compound events and solve problems | Resource: Progressions for the Common Core State Standards HS Statistics & Probability |
| **Vocabulary**<br>• permutation<br>• combination<br>• compound events | **Annotations**<br>Example: Given a football team of 60 athletes, what is the probability that the star quarterback and star linebacker are not chosen for drug testing?<br>$\frac{{}_{58}C_2}{{}_{60}C_2} \approx 0.934 \approx 93.4\%$ | **Notes** |

*Note:* (+) *indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics*
** indicates modeling standards*

North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Statistics and Probability**
Domain: **Using Probability to Make Decisions***
Cluster: **Calculate expected values and use them to solve problems**

HS.S-MD


| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.S-MD.1*<br>Define a random variable for a quantity of interest by assigning a numerical value to each event in a sample space.<br><br>Graph the corresponding probability distribution using the same graphical displays as for data distributions. | • define what a random variable is and explain the properties of a random variable<br><br>• given a probability situation (theoretical or empirical), be able to define a random variable, assign probabilities to its sample space, create a table and graph of the distribution of the random variable | Resource: Progressions for the Common Core State Standards HS Statistics & Probability |
| **Vocabulary**<br>• random variable<br>• theoretical probability<br>• empirical probability<br>• probability distribution | **Annotations** | **Notes** |

*Note:* (+) *indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics*
** indicates modeling standards*

North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Statistics and Probability**
Domain: **Using Probability to Make Decisions***
Cluster: **Calculate expected values and use them to solve problems**

HS.S-MD


| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.S-MD.2*<br>Calculate the expected value of a random variable; interpret it as the mean of the probability distribution. | • calculate and interpret in context the expected value of a random variable as the mean of the probability distribution | Evaluating Statements About Probability<br><br>Resource: Progressions for the Common Core State Standards HS Statistics & Probability |
| **Vocabulary**<br>• expected value<br>• mean | **Annotations** | **Notes** |

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** indicates modeling standards*

North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Statistics and Probability**
Domain: **Using Probability to Make Decisions***
Cluster: **Calculate expected values and use them to solve problems**

HS.S-MD


| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.S-MD.3*<br>Develop a probability distribution for a random variable defined for a sample space in which theoretical probabilities can be calculated; find the expected value. | • develop a theoretical probability distribution and find the expected value | Evaluating Statements About Probability<br><br>Resource: Progressions for the Common Core State Standards HS Statistics & Probability |
| **Vocabulary** | **Annotations**<br>Example: Find the theoretical probability distribution for the number of correct answers obtained by guessing on all five questions of a multiple-choice test where each question has four choices, and find the expected value. | **Notes** |

*Note:* (+) *indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics*
** indicates modeling standards*

North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Statistics and Probability**
Domain: **Using Probability to Make Decisions***
Cluster: **Calculate expected values and use them to solve problems**

HS.S-MD


| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.S-MD.4*<br>Develop a probability distribution for a random variable defined for a sample space in which probabilities are assigned empirically; find the expected value. | • develop an empirical probability distribution and find the expected value | Evaluating Statements About Probability<br><br>Resource: Progressions for the Common Core State Standards HS Statistics & Probability |
| **Vocabulary** | **Annotations**<br>Example: Find a current data distribution on the number of TV sets per household in the United States, and calculate the expected number of sets per household. How many TV sets would you expect to find in 100 randomly selected households? | **Notes** |

*Note:* (+) *indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics*
** indicates modeling standards*

North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Statistics and Probability**
Domain: **Using Probability to Make Decisions***
Cluster: **Use probability to evaluate outcomes of decisions**

HS.S-MD


| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.S-MD.5*<br>Weigh the possible outcomes of a decision by assigning probabilities to payoff values and finding expected values.<br><br>a. Find the expected payoff for a game of chance.<br><br>b. Evaluate and compare strategies on the basis of expected values. | • set up a probability distribution for a random variable representing payoff values in a game of chance<br><br>• find the expected payoff for a game of chance<br><br>• based on expected values develop a strategy to make informed decisions | Evaluating Statements About Probability<br><br>Resource: Progressions for the Common Core State Standards HS Statistics & Probability |
| **Vocabulary**<br>• expected payoff | **Annotations**<br>Example: Find the expected winnings from a state lottery ticket or a game at a fast-food restaurant.<br><br>Example: Compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident. | **Notes** |

*Note:* (+) *indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics*
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North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Statistics and Probability**
Domain: **Using Probability to Make Decisions***
Cluster: **Use probability to evaluate outcomes of decisions**

HS.S-MD


| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.S-MD.6*<br>Use probabilities to make fair decisions (e.g., drawing by lots, using a random number generator). | • use expected values to help make good decisions<br>• use expected values to compare long term benefits of several situations | Evaluating Statements About Probability<br><br>Resource: Progressions for the Common Core State Standards HS Statistics & Probability |
| **Vocabulary** | **Annotations**<br>Example: Find the expected winnings from a state lottery ticket or a game at a fast-food restaurant.<br><br>Example: Compare a high-deductible versus a low-deductible automobile insurance policy using various, but reasonable, chances of having a minor or a major accident. | **Notes** |

*Note:* (+) *indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics*
** indicates modeling standards*

North Dakota *HIGH SCHOOL* State Standards: *Course IV*
Conceptual Category: **Statistics and Probability**
Domain: **Using Probability to Make Decisions***
Cluster: **Use probability to evaluate outcomes of decisions**

HS.S-MD


| **Standard** | **Students Can** | **Resources** |
|---|---|---|
| (+) HS.S-MD.7*<br>Analyze decisions and strategies using probability concepts (e.g., product testing, medical testing, pulling a hockey goalie at the end of a game). | • use probability concepts to analyze decisions made and strategies used in real-life situations | Resource: Progressions for the Common Core State Standards HS Statistics & Probability |
| **Vocabulary** | **Annotations** | **Notes** |
| | | |

*Note:* (+) *indicates additional mathematics that students should learn in order to take advanced courses such as calculus, advanced statistics, or discrete mathematics*
** indicates modeling standards*