M11.A Numbers and Operations

**ASSESSMENT ANCHOR**

M11.A.1 Demonstrate an understanding of numbers, ways of representing numbers, relationships among numbers and number systems.

**ELIGIBLE CONTENT**

- M11.A.1.1 Represent and/or use numbers in equivalent forms (e.g., integers, fractions, decimals, percents, square roots, exponents and scientific notation).
- M11.A.1.1.1 Find the square root of an integer to the nearest tenth using either a calculator or estimation.
- M11.A.1.1.2 Express numbers and/or simplify expressions using scientific notation (including numbers less than 1).
- M11.A.1.1.3 Simplify square roots. (e.g., $\sqrt{24} = 2\sqrt{6}$)

**EXAMPLE ITEMS**

- The diameter of a red blood cell, in inches, is $3 \times 10^{-4}$. This expression is the same as which of the following numbers?
  
  A. 0.00003  
  B. 0.0003  
  C. 0.003  
  D. 3,000  
  E. 30,000  

  (NAEP)

- $\frac{6 \times 10^3}{3 \times 10^2} =$
  
  A. $0.5 \times 10^2$  
  B. $2 \times 10^2$  
  C. $2 \times 10^{0.6}$  
  D. $0.5 \times 10^{-2}$  
  E. $2 \times 10^{-2}$  

  (NAEP)

**Reference:**

- 2.1.11.A Model and compare values of irrational and complex numbers.
- 2.1.11.D Use exponential, scientific, and calculator notation to represent any rational number.
- 2.1.8.B Represent and use numbers in equivalent forms (e.g., integers, fractions, decimals, percents, exponents, scientific notation, square roots, absolute values).
- 2.1.11.B Use factoring to create equivalent forms of polynomials.
ASSESSMENT ANCHOR
M11.A.1 Demonstrate an understanding of numbers, ways of representing numbers, relationships among numbers and number systems.

ELIGIBLE CONTENT
M11.A.1.2 Apply number theory concepts to show relationships between real numbers in problem solving settings.
M11.A.1.2.1 Find the Greatest Common Factor (GCF) and/or the Least Common Multiple (LCM) for sets of monomials.

EXAMPLE ITEMS

Reference:

2.1.11.E Apply the concepts of prime and composite polynomials to determine GCFs (Greatest Common Factor) and LCMs (Least Common Multiple) of polynomials.
ASSESSMENT ANCHOR
M11.A.1 Demonstrate an understanding of numbers, ways of representing numbers, relationships among numbers and number systems.

ELIGIBLE CONTENT

M11.A.1.3 Estimate the value of an irrational number.

M11.A.1.3.1 Locate/identify irrational numbers at the approximate location on a number line.

M11.A.1.3.2 Compare and/or order any real numbers (rational and irrational may be mixed).

EXAMPLE ITEMS

Reference:

2.11.A Model and compare values of irrational and complex numbers.
### ASSESSMENT ANCHOR

**M11.A.2** Understand the meanings of operations, use operations and understand how they relate to each other.

### ELIGIBLE CONTENT

- **M11.A.2.1** Apply ratio and/or proportion in problem-solving situations.
- **M11.A.2.1.1** Solve problems using operations with rational numbers including rates and percents (single and multi-step and multiple procedure operations) (e.g., distance, work and mixture problems, etc.).
- **M11.A.2.1.2** Solve problems using direct and inverse proportions.
- **M11.A.2.1.3** Identify and/or use proportional relationships in problem solving settings.

### EXAMPLE ITEMS

- Mr. Morris is making a dollhouse with toy furniture. He uses 0.5 inches to represent 1 foot. What would be the dimensions of a toy table representing a table 6 feet long, 3 feet wide and 30 inches high?
  - A. 3 inches long, 1.25 inches wide and 1.5 inches high
  - B. 3 inches long, 1.5 inches wide and 1.25 inches high
  - C. 12 inches long, 6 inches wide and 5 inches high
  - D. 3 inches long, 1.5 inches wide and 15 inches high

* (Pennsylvania Department of Education)

**Reference:**

- **2.1.8.C** Use ratio and proportion to model relationships between quantities.

- **2.2.8.B** Add, subtract, multiply, and divide different kinds and forms of rational numbers including integers, decimal fractions, percents, and proper and improper fractions.

- **2.2.11.C** Evaluate numerical expressions that include the four basic operations and operations of powers and roots, reciprocals, opposites, and absolute values.
ASSESSMENT ANCHOR
M11.A.2 Understand the meanings of operations, use operations and understand how they relate to each other.

ELIGIBLE CONTENT

M11.A.2.2 Use exponents, roots and/or absolute value to solve problems.

M11.A.2.2.1 Simplify/evaluate expressions involving positive and negative exponents, roots and/or absolute value (may contain all types of real numbers - exponents should not exceed power of 10).

M11.A.2.2.2 Simplify/evaluate expressions involving multiplying with exponents (e.g. $x^6 \times x^7 = x^{13}$), powers of powers (e.g., $(x^6)^7 = x^{42}$) and powers of products $(2x^3)^3 = 8x^9$ (positive exponents only).

EXAMPLE ITEMS

Reference:

2.2.11.C Evaluate numerical expressions that include the four basic operations and operations of powers and roots, reciprocals, opposites, and absolute values.

2.1.11.D Use exponential, scientific, and calculator notation to represent any rational number.

2.1.11.F Understand the concepts of exponential and logarithmic forms and use the inverse relationships between exponential and logarithmic expression to determine unknown quantities in equations.
ASSESSMENT ANCHOR
M11.A.3 Compute accurately and fluently and make reasonable estimates.

ELIGIBLE CONTENT

M11.A.3.1 Apply the order of operations in computation and in problem-solving situations.

M11.A.3.1.1 Simplify/evaluate expressions using the order of operations to solve problems (any rational numbers may be used).

EXAMPLE ITEMS

Reference:

2.2.8.C Use the order of operations to evaluate numerical expressions.

2.2.11.C Evaluate numerical expressions that include the four basic operations and operations of powers and roots, reciprocals, opposites, and absolute values.
ASSESSMENT ANCHOR
M11.A.3 Compute accurately and fluently and make reasonable estimates.

ELIGIBLE CONTENT
M11.A.3.2.1 Use estimation to solve problems.

EXAMPLE ITEMS

• At the start of the month, the counter on the copy machine read 6,583. At the end of the month, it read 82,110. The copies cost $1 \frac{1}{3}$ cents a piece. What was the approximate total cost of the copies for this month?
  
  A. $10,000.00  
  B. $2,200.00  
  * C. $1,000.00  
  D. $200.00  

  (Pennsylvania Department of Education)

• Mrs. Ditters and her daughter went to lunch. Their bill came to $27.29. If a fair tip is between 15 and 20 percent, what would be a fair tip to leave their waiter?

  A. $2.00  
  B. $2.72  
  * C. $5.00  
  D. $20.00  

  (Pennsylvania Department of Education)

• The entire circle shown below represents a total of 2,675 radios sold. Of the following, which is the best approximation of the number of radios represented by the shaded sector of the circle?

  B. 70  
  * C. 275  
  D. 985  
  E. 25880  
  F. 98420  

  (NAEP)

Reference:

2.2.8.D Estimate the values of irrational numbers and the results from calculations with basic operations of fractions and percents and check the reasonableness of those estimates.

2.2.7.D Estimate solutions of problems involving calculations with basic operations of whole numbers, decimals, fractions, or mixed numbers and check the reasonableness of those estimates.
ASSESSMENT ANCHOR
M11.B.1 Demonstrate an understanding of measurable attributes of objects and figures, and the units, systems and processes of measurement.

ELIGIBLE CONTENT

Not assessed at grade 11.

EXAMPLE ITEMS
ASSESSMENT ANCHOR
M11.B.2 Apply appropriate techniques, tools and formulas to determine measurements.

M11.B.2.1 Use and/or compare measurements of angles.

ELIGIBLE CONTENT
M11.B.2.1.1 Measure and/or compare angles in degrees (up to 360°) (protractor must be provided or drawn).

**EXAMPLE ITEMS**

Given: \( a \parallel b, c \parallel d \)

If \( m \angle 1 = 2x + 16 \) and \( m \angle 2 = x + 14 \), then what is the value of \( x \)?

A. \(-10\)

* B. \(-2\)

C. \(2\)

D. \(10\)

(Pennsylvania Department of Education)

Reference:

2.3.8.C Calculate volume, surface area, and degrees of angles; calculate circumference and area of circles, and use a measurement formula to solve for a missing quantity.

2.3.11.C Use properties of geometric figures and measurement formulas to solve for a missing quantity (e.g., the measure of a specific angle created by parallel lines and a transversal).

2.3.5.B Select and use appropriate instruments and units for measuring quantities to a specified level of accuracy.
ASSESSMENT ANCHOR
M11.B.2 Apply appropriate techniques, tools and formulas to determine measurements.

M11.B.2.2 Use and/or develop procedures to determine or describe measures of perimeter, circumference, area, surface area and/or volume. (May require conversions within the same system.)

ELIGIBLE CONTENT
M11.B.2.2.1 Calculate the surface area of prisms, cylinders, cones, pyramids and/or spheres. Formulas are provided on the reference sheet.

M11.B.2.2.2 Calculate the volume of prisms, cylinders, cones, pyramids and/or spheres. Formulas are provided on the reference sheet.

M11.B.2.2.3 Estimate area, perimeter or circumference of an irregular figure.

M11.B.2.2.4 Find the measurement of a missing length given the perimeter, circumference, area or volume.

EXAMPLE ITEMS
- The inside rail of a running track consists of a rectangle with a semicircle at each end as shown in the figure below. Find the approximate area surrounded by the track rail.

![Diagram of a running track rail]

A. 1200 m²
B. 2456 m²
C. 1514 m²
D. 160 m²

(Pennsylvania Department of Education)

Reference:
2.3.8.C Calculate volume, surface area, and degrees of angles; calculate circumference and area of circles, and use a measurement formula to solve for a missing quantity.

2.3.11.C Use properties of geometric figures and measurement formulas to solve for a missing quantity (e.g., the measure of a specific angle created by parallel lines and a transversal).

2.3.5.C Calculate perimeter and area, and sums and differences of measurements.

2.3.7.C Use measurement formulas to calculate volume, area, and perimeter and to calculate circumference and area of circles.

2.3.7.F Estimate and verify measurements of length, perimeter, area, volume, capacity, temperature, time, weight, and angles.
ASSESSMENT ANCHOR
M11.B.2 Apply appropriate techniques, tools and formulas to determine measurements.

ELIGIBLE CONTENT

M11.B.2.3 Describe how a change in one dimension of a figure (2 or 3 dimensional) affects other measurements of that figure.

M11.B.2.3.1 Describe how a change in the linear dimension of a figure affects its perimeter, circumference, area or volume.

- How does changing the length of the radius of a circle affect the circumference of the circle?
- How does changing the length of the edge of a cube affect the volume of the cube?
- How does changing the length of the base of a triangle affect the area of the triangle?

EXAMPLE ITEMS

Reference:

2.3.11.E Describe how a change in the value of one variable in a formula affects the value of the measurement.
**ASSESSMENT ANCHOR**

**M11.C.1** Analyze characteristics and properties of two- and three-dimensional geometric shapes and demonstrate understanding of geometric relationships.

<table>
<thead>
<tr>
<th>ELIGIBLE CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>M11.C.1.1</strong> Identify and/or use the properties of a radius, diameter and/or tangent of a circle (given numbers should be whole.)</td>
</tr>
<tr>
<td><strong>M11.C.1.2</strong> Identify and/or use the properties of arcs, semicircles, inscribed angles and/or central angles.</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>EXAMPLE ITEMS</th>
</tr>
</thead>
<tbody>
<tr>
<td><em>Reference:</em></td>
</tr>
<tr>
<td><strong>2.9.8.A</strong> Name, describe and apply geometric relations for 1-dimensional shapes and 2-dimensional shapes and 3-dimensional solids.</td>
</tr>
<tr>
<td><strong>2.9.11.A</strong> Create justifications for arguments related to geometric relations.</td>
</tr>
</tbody>
</table>
ASSESSMENT ANCHOR

M11.C.1  Analyze characteristics and properties of two- and three-dimensional geometric shapes and demonstrate understanding of geometric relationships.

ELIGIBLE CONTENT

M11.C.1.2  Recognize and/or apply properties of angles, triangles and quadrilaterals.

M11.C.1.2.1  Identify and/or use properties of triangles (e.g., medians, altitudes, angle bisectors, side/angle relationships, Triangle Inequality Theorem).

M11.C.1.2.2  Identify and/or use properties of quadrilaterals (e.g., parallel sides, diagonals, bisectors, congruent sides/angles and supplementary angles).

M11.C.1.2.3  Identify and/or use properties of isosceles and equilateral triangles.

EXAMPLE ITEMS

- Which picture provides enough information to prove that the figure is a parallelogram?

A  
6  
30°  
6

B  
4

C  
60°  
120°

D  
25°

(Pennsylvania Department of Education)

Reference:

2.9.8.A  Name, describe and apply geometric relations for 1-dimensional shapes and 2-dimensional shapes and 3-dimensional solids.

2.9.11.A  Create justifications for arguments related to geometric relations.
ASSESSMENT ANCHOR

M11.C.1 Analysis characteristics and properties of two- and three-dimensional geometric shapes and demonstrate understanding of geometric relationships.

ELIGIBLE CONTENT

M11.C.1.3 Use properties of congruence, correspondence and similarity in problem-solving settings involving two- and three-dimensional figures.

M11.C.1.3.1 Identify and/or use properties of congruent and similar polygons or solids.

EXAMPLE ITEMS

- Given that the triangles shown are congruent, find the value of x.

\[
\begin{align*}
x + 3 & = 5x - 2 \\
5x & = x + 5 \\
4x & = 5 \\
x & = \frac{5}{4}
\end{align*}
\]

A. \(\frac{5}{4}\)  
B. -1  
C. 8  
D. -\(\frac{3}{2}\)

(Pennsylvania Department of Education)

Reference:

2.9.8.A Name, describe and apply geometric relations for 1-dimensional shapes and 2-dimensional shapes and 3-dimensional solids.

2.9.11.B Use arguments based on transformations to establish congruence or similarity of 2-dimensional shapes.
ASSESSMENT ANCHOR
M11.C.1  Analyze characteristics and properties of two- and three- dimensional geometric shapes and demonstrate understanding of geometric relationships.

ELIGIBLE CONTENT
M11.C.1.4  Solve problems involving right triangles using the Pythagorean Theorem.
M11.C.1.4.1  Find the measure of a side of a right triangle using the Pythagorean Theorem (Pythagorean Theorem included on the reference sheet).

EXAMPLE ITEMS
- Find the length of segment AB in the figure below.

![Figure](image)

NOTE: Figure is NOT drawn to scale.

A. 8  
B. 13  
C. 14  
D. 15

Reference:

2.10.11.A Identify, create, and solve practical problems involving right triangles using the trigonometric functions and the Pythagorean Theorem.
ASSESSMENT ANCHOR
M11.C.2 Identify and/or apply concepts of transformations or symmetry.

ELIGIBLE CONTENT

Not assessed at grade 11.

EXAMPLE ITEMS
ASSESSMENT ANCHOR

M11.C.3 Locate points or describe relationships using the coordinate plane.

ELIGIBLE CONTENT

M11.C.3.1 Solve problems using analytic geometry.

M11.C.3.1.1 Calculate the distance and/or midpoint between 2 points on a number line or on a coordinate plane (formula provided on the reference sheet).

M11.C.3.1.2 Relate slope to perpendicularity and/or parallelism (limit to linear algebraic expressions; slope formula provided on the reference sheet).

EXAMPLE ITEMS

- What is the distance between the points (2,10) and (-4,2) in the xy-plane?
  
  A. 6
  B. 8
  C. 10
  D. 14
  E. 18

  (NAEP)

- What is the distance between the midpoint of MN and the midpoint of PQ shown above?
  
  A. 18 cm
  B. 24 cm
  C. 26 cm
  D. 28 cm
  E. 30 cm

  (NAEP)

Reference:

2.9.8.C Plot ordered pairs and 2-dimensional shapes that satisfy given conditions on a 2-dimensional coordinate system.

2.9.7.C Identify on a 2-dimensional coordinate system the location of points with rational number coordinates; plot in a two-dimensional coordinate system a point represented by an ordered pair of rational numbers.

2.9.11.C Use techniques from coordinate geometry to establish properties of lines, shapes, and solids.
**ASSESSMENT ANCHOR**

M11.D.1 Demonstrate an understanding of patterns, relations and functions.

### ELIGIBLE CONTENT

<table>
<thead>
<tr>
<th>M11.D.1.1</th>
<th>Analyze and/or use patterns or relations.</th>
</tr>
</thead>
<tbody>
<tr>
<td>M11.D.1.1.1</td>
<td>Analyze a set of data for the existence of a pattern and represent the pattern algebraically and/or graphically.</td>
</tr>
<tr>
<td>M11.D.1.1.2</td>
<td>Determine if a relation is a function given a set of points or a graph.</td>
</tr>
<tr>
<td>M11.D.1.1.3</td>
<td>Identify the domain, range or inverse of a relation (may be presented as ordered pairs or a table).</td>
</tr>
</tbody>
</table>

### EXAMPLE ITEMS

- Which of the following best describes the pattern 4, 8, 12, …?
  - A. \( 1 + n, 4 + n, 8 + n, \ldots \)
  - B. \( n^2, n^3, n^4, \ldots \)
  - C. \( n, 2n, 3n, \ldots \)
  - D. \( n, \frac{n}{2}, \frac{n}{3}, \ldots \)  

- What is the next term in the sequence below?
  - 1, 8, 27, 64, …
  - A. 5
  - B. 25
  - C. 96
  - D. 125

- If this pattern of dot-figures is continued, how many dots will be in the 100th figure?
  - A. 100
  - B. 101
  - C. 199
  - D. 200
  - E. 201

*Reference:*

2.8.11.C Recognize, describe and generalize patterns using sequences and series to predict long-term outcomes.

2.8.8.C Find the missing elements and recognize, describe, and extend patterns to include linear, exponential, and simple quadratic equations.
2.8.11.D Demonstrate an understanding and apply properties of functions (domain, range, inverses) and characteristics of families of functions (linear, polynomial, rational, trigonometric, exponential, logarithmic).

2.8.11.E Use combinations of symbols and numbers to create expressions, equations, and inequalities in two or more variables, systems of equations and inequalities, and functional relationships that model problem situations.
M11.D Algebraic Concepts

ASSESSMENT ANCHOR

M11.D.2 Represent and/or analyze mathematical situations using numbers, symbols, words, tables and/or graphs.

ELIGIBLE CONTENT

M11.D.2.1 Write, solve and/or graph linear equations and inequalities using various methods.

M11.D.2.1.1 Solve compound inequalities and/or graph their solution sets on a number line (may include absolute value inequalities).

M11.D.2.1.2 Identify or graph functions, linear equations or linear inequalities on a coordinate plane.

M11.D.2.1.3 Write, solve and/or apply a linear equation (including problem situations).

M11.D.2.1.4 Write and/or solve systems of equations using graphing, substitution and/or elimination (limit systems to 2 equations).

M11.D.2.1.5 Solve quadratic equations using factoring (integers only – not including completing the square or the Quadratic Formula).

EXAMPLE ITEMS

- If \( f(x) = 5x - 3 \) and \( f(x) = 7 \), what is the value of \( x \)?
  A.  -3
  B.  2
  C.  5
  D.  7

- If \( f(x) = \frac{2x + 1}{3} \) and \( g(x) = 2x^2 + 2 \), then \( f(g(2)) = \)
  A.  3
  B.  5
  C.  7
  D.  7 \( \frac{1}{3} \)
  E.  16 \( \frac{1}{3} \)

Reference: (Kentucky Department of Education)

2.8.11.B Evaluate and simplify algebraic expressions and solve and graph linear, quadratic, exponential, and logarithmic equations and inequalities, and solve and graph systems of equations and inequalities.

2.8.8.D Create a table or graph from a functional rule.

2.8.11.E Use combinations of symbols and numbers to create expressions, equations, and inequalities in two or more variables, systems of equations and inequalities, and functional relationships that model problem situations.

2.8.11.F Interpret the results of solving equations, inequalities, systems of equations, and inequalities in the context of the situation that motivated the model.
### ASSESSMENT ANCHOR
M11.D.2 Represent and/or analyze mathematical situations using numbers, symbols, words, tables and/or graphs.

<table>
<thead>
<tr>
<th>ELIGIBLE CONTENT</th>
</tr>
</thead>
<tbody>
<tr>
<td>M11.D.2.2 Simplify expressions involving polynomials.</td>
</tr>
<tr>
<td><strong>M11.D.2.2.2</strong> Factor algebraic expressions, including difference of squares and trinomials (trinomials limited to the form $ax^2+bx+c$ where $a$ is not equal to 0).</td>
</tr>
<tr>
<td><strong>M11.D.2.2.3</strong> Simplify algebraic fractions.</td>
</tr>
</tbody>
</table>

### EXAMPLE ITEMS

**Reference:**

2.8.11.B Evaluate and simplify algebraic expressions and solve and graph linear, quadratic, exponential, and logarithmic equations and inequalities, and solve and graph systems of equations and inequalities.
ASSESSMENT ANCHOR
M11.D.3  Analyze change in various contexts.

ELIGIBLE CONTENT
M11.D.3.1  Describe and/or determine change.

M11.D.3.1.1  Identify, describe and/or use constant or varying rates of change.

M11.D.3.1.2  Determine how a change in one variable relates to a change in a second variable (e.g., y=4/x, if x doubles, what happens to y?).

EXAMPLE ITEMS

- Yearly college tuition increased from $16,000 in 1996 to $20,000 in the year 2000. What is the annual rate of increase?
  
  A. 2.5%
  B. 5.7%
  C. 8%
  D. 20%

  (Pennsylvania Department of Education)

- A certain culture of 5,000 bacteria triples every 43 minutes. Let B = the number of bacteria t minutes after the start of the count. Which equation models the situation?
  
  A. B = 5000 + 43t
  B. B = 43t^2 + 5000
  C. B = 5000 • 3^{43t/43}
  D. B = 5000 + 3 • 43t

  (Pennsylvania Department of Education)

Reference:

2.11.8.B  Describe the concept of unit rate, ratio, and slope in the context of rate of change.

2.11.5.B  Describe the relationship between rates of change and another variable (e.g., time, temperature).

2.8.8.D  Create a table or graph from a functional rule.
ASSESSMENT ANCHOR
M11.D.3 Analyze change in various contexts.

M11.D.3.2 Compute and/or use the slope of a line.

ELIGIBLE CONTENT
M11.D.3.2.1 Apply the formula for the slope of a line to solve problems (formula given on reference sheet).
M11.D.3.2.2 Given the graph of the line, 2 points on the line, or the slope and a point on a line, write or identify the linear equation in point-slope, standard and/or slope-intercept form.
M11.D.3.2.3 Compute the slope and/or y-intercept represented by a linear equation or graph.

EXAMPLE ITEMS

• Look at the line that is graphed below.

Which of these equations describes the line?
★ A. \( y = -2x + 6 \)
B. \( y = -\frac{1}{2}x + 6 \)
C. \( y = \frac{1}{2}x + 6 \)
D. \( y = 2x + 6 \)

(Massachusetts Department of Education)

Reference:
2.11.8.B Describe the concept of unit rate, ratio, and slope in the context of rate of change.
2.9.11.A Create justifications for arguments related to geometric relations.
2.8.8.D Create a table or graph from a functional rule.
2.11.8.B Describe the concept of unit rate, ratio, and slope in the context of rate of change.
ASSESSMENT ANCHOR
M11.D.4 Describe or use models to represent quantitative relationships.

ELIGIBLE CONTENT
M11.D.4.1 Interpret and/or use linear, quadratic and/or exponential functions and their equations, graphs or tables.
M11.D.4.1.1 Match the graph of a given function to its table or equation.

EXAMPLE ITEMS

- The figure above shows the graph of \( y = f(x) \). Which of the following could be the graph of \( y = |f(x)| \)?
- The table below shows a linear relationship between \( x \) and \( y \).

<table>
<thead>
<tr>
<th>( x )</th>
<th>-2</th>
<th>-1</th>
<th>0</th>
<th>1</th>
<th>2</th>
</tr>
</thead>
<tbody>
<tr>
<td>( y )</td>
<td>5</td>
<td>3</td>
<td>1</td>
<td>-1</td>
<td>-3</td>
</tr>
</tbody>
</table>

Which of these graphs shows this relationship?

A.  

B.  

C.  *  

D.  

E.  

(NAEP)

Reference:

2.8.5.D Determine a functional rule from a table or graph.
2.8.8.D Create a table or graph from a functional rule.
2.11.8.B Describe the concept of unit rate, ratio, and slope in the context of rate of change.
2.8.11.E Use combinations of symbols and numbers to create expressions, equations, and inequalities in two or more variables, systems of equations and inequalities, and functional relationships that model problem situations.
ASSESSMENT ANCHOR
M11.E.1  Formulate or answer questions that can be addressed with data and/or organize, display, interpret or analyze data.

ELIGIBLE CONTENT
M11.E.1.1  Appropriately display and/or use data in problem-solving settings.
M11.E.1.1.1  Create and/or use appropriate graphical representations of data, including box-and-whisker plots, stem-and-leaf plots or scatter plots.
M11.E.1.1.2  Analyze data and/or answer questions based on displayed data (box-and-whisker plots, stem-and-leaf plots or scatter plots).

EXAMPLE ITEMS

<table>
<thead>
<tr>
<th>Year</th>
<th>Number of Traffic Deaths in Pennsylvania</th>
</tr>
</thead>
<tbody>
<tr>
<td>1990</td>
<td>205</td>
</tr>
<tr>
<td>1991</td>
<td></td>
</tr>
<tr>
<td>1992</td>
<td>191</td>
</tr>
<tr>
<td>1993</td>
<td>184</td>
</tr>
</tbody>
</table>

The above relationship is linear. Predict the number of highway deaths in the year 2005.
A. 93
*B. 100
C. 107
D. 114  

(Pennsylvania Department of Education)

• Look at the box-and-whisker plot below. What range of values contains 50% of the data?

| 10 | 11 | 12 | 13 | 14 | 15 | 16 | 17 | 18 | 19 | 20 | 21 | 22 | 23 | 24 | 25 |

A. 10 – 20
B. 13 – 25
*C. 17 – 25
D. 17 – 20  

(Pennsylvania Department of Education)

Reference:

2.6.8.B  Organize and display one-variable data using appropriate data display, such as stem-and-leaf and box-and-whisker plots, and two variable data with scatterplots.

2.6.8.D  Compare data sets graphically using double-bar and double-line graphs and numerically using mean, median, mode, range, and quartiles.

2.6.5.E  Determine the reasonableness of a statement based on a comparison to data displayed in a graph and summarized by numerical measures.

2.6.5.D  Compare data using multiple categories displayed in a graph.
2.6.5.B Use pictures, tallies, tables, charts, bar graphs, line graphs, diagrams, and graphs to organize, display, and analyze data.

2.6.11.A Design and conduct an experiment using random sampling.
ASSESSMENT ANCHOR

M11.E.2 Select and/or use appropriate statistical methods to analyze data.

M11.E.2.1 Use measures of central tendency to describe a set of data.

M11.E.2.1.1 Calculate or select the appropriate measure of central tendency (mean, mode or median) of a set of data given or represented on a table, line plot or stem-and-leaf plot.

M11.E.2.1.2 Calculate and/or interpret the range, quartiles and interquartile range of data.

M11.E.2.1.3 Describe how outliers affect measures of central tendency.

ELIGIBLE CONTENT

EXAMPLE ITEMS

- 12  | 9
- 13  | 3, 6, 7, 7
- 14  | 1, 1, 1, 1, 3, 4, 4, 6, 9, 9
- 15  | 0, 0, 0, 1, 2, 4, 6, 7, 8, 8, 9
- 16  | 1, 6, 7

What is the median of the data recorded on the stem-and-leaf plot?

A. 149
B. 149.5
C. 149.6
D. 150

(Pennsylvania Department of Education)

Reference:

2.6.11.C Select or calculate the appropriate measure of central tendency, calculate and apply the interquartile range for one-variable data, and construct a line of best fit and calculate its equation for two-variable data.

2.6.5.C Calculate mean and range, identify the median and the mode of a set of data, and use these quantities to describe the data.

2.6.8.E Determine the effect of extreme values on numerical summaries and calculate estimates based on survey results or graphs.
ASSESSMENT ANCHOR
M11.E.3  Understand and/or apply basic concepts of probability or outcomes.

ELIGIBLE CONTENT
M11.E.3.1  Apply probability and/or odds to practical situations.

M11.E.3.1.1  Find probabilities for independent, dependent or compound events and represent as a fraction, decimal or percent).

M11.E.3.1.2  Find, convert and/or compare the probability and/or odds of a simple event.

EXAMPLE ITEMS

• If the odds are 3 to 5 that a vehicle randomly selected from a parking lot is a truck, what is the probability that it is not a truck?
  
  A. 3 to 5  
  B. 5 to 3  
  C.  \frac{5}{8}  
  \text{**D.} \frac{6}{8}  

  (Pennsylvania Department of Education)

• The chance of rain is \frac{2}{3}. What are the odds against rain occurring?

  A. 2 to 3  
  \text{**B.} 3 to 2  
  C. \frac{3}{8}  
  D. \frac{2}{5}  

  (Pennsylvania Department of Education)

• The nine chips shown above are placed in a sack and then mixed up. Madeline draws one chip from this sack. What is the probability that Madeline draws a chip with an even number?

  A. \frac{1}{9}  
  B. \frac{2}{9}  
  \text{**C.} \frac{4}{9}  
  D. \frac{1}{2}  
  E. \frac{4}{5}  

  (NAEP)

Reference:

2.7.8.A  Calculate the probability of an event involving “and”, “or” or “not”.

2.7.11.C  Compare odds and probability.

2.7.11.E  Use probability to make judgments about the likelihood of various outcomes.
ASSESSMENT ANCHOR

M11.E.3  Understand and/or apply basic concepts of probability or outcomes.

ELIGIBLE CONTENT

M11.E.3.2  Apply counting techniques in problem-solving settings.

M11.E.3.2.1  Determine the number of permutations and/or combinations or apply the fundamental counting principle. (Formula provided on the reference sheet).

EXAMPLE ITEMS

- A contractor is building 5 different model homes on 5 adjacent lots on one side of a street. If 1 house is to be built on each lot, how many different arrangements of the 5 houses are possible?

  ★  A. 120  
  B. 60  
  C. 25  
  D. 10  
  E. 5

(NAEP)

Reference:

2.7.8.C  Determine the number of **combinations** and **permutations** for an event.
ASSESSMENT ANCHOR
M11.E.4  Develop and/or evaluate inferences and predictions or draw conclusions based on data or data displays.

ELIGIBLE CONTENT
M11.E.4.1  Make predictions using data displays and probability.
M11.E.4.1.1  Estimate or calculate to make predictions based on a circle, line, bar graph or given situation.
M11.E.4.1.2  Use probability to predict outcomes.

EXAMPLE ITEMS
• From a shipment of 500 batteries, a sample of 25 was selected at random and tested. If 2 batteries in the sample were found to be dead, how many dead batteries would be expected in the entire shipment?
  
  A. 10
  B. 20
  C. 30
  ∗ D. 40
  E. 50

(NAEP)

Reference:

2.7.11.A  Use probability to predict the likelihood of an outcome in an experiment.

2.7.11.E  Use probability to make judgments about the likelihood of various outcomes.

2.6.5.E  Determine the reasonableness of a statement based on a comparison to data displayed in a graph and summarized by numerical measures.
ASSESSMENT ANCHOR
M11.E.4  Develop and evaluate inferences and predictions or draw conclusions based on data or data displays.

ELIGIBLE CONTENT
M11.E.4.2  Analyze and/or interpret data on a scatter plot and/or use a scatter plot to make predictions.
M11.E.4.2.1  Draw, find and/or write an equation for a line of best fit for a scatter plot.
M11.E.4.2.2  Make predictions using the equations or graphs of best-fit lines of scatter plots.

EXAMPLE ITEMS
• The annual maintenance cost of an appliance is given by the regression equation $y = 12.5x + 19.2$, where $y$ represents the total maintenance cost and $x$ represents the age of the appliance in years. Rounded to the nearest dollar, what is the expected maintenance cost of a 14-year-old appliance?

A. $ 33  
B. $156  
*C. $194  
D. $281  
(Pennsylvania Department of Education)

• Which of the given equations most closely represents the line of best fit for the scatter plot given below?

A. $y = 2x + 8$  
*B. $y = \frac{1}{2}x + 8$  
C. $y = -\frac{1}{2}x + 8$  
D. $y = -2x + 8$  
(Pennsylvania Department of Education)

Reference:
2.6.11.E  Make predictions based on lines of best fit or draw conclusions on the value of a variable in a population based on the results of a sample.

2.6.5.B  Use pictures, tallies, tables, charts, bar graphs, line graphs, diagrams, and graphs to organize, display, and analyze data.

2.6.5.E  Determine the reasonableness of a statement based on a comparison to data displayed in a graph and summarized by numerical measures.