# Grade 8

**Standard 1**

## Number Sense and Computation

**CORE STANDARD**

**Number Sense and Computation**

***Integer Exponents***

Use the laws of integer exponents and evaluate expressions with negative integer exponents. Use scientific notation for small numbers.

*[Standard Indicators: 8.1.1, 8.1.2, 8.1.3]*

***Square Roots***

Use irrational numbers. Calculate square roots. Use the inverse relationship between squares and square roots.

*[Standard Indicators: 8.1.4, 8.1.5]*

8.1.1 Interpret calculator or computer displays of numbers given in scientific notation and read, write, compare and solve problems using decimals in scientific notation.

Example: Polaris is $4.077 \times 10^{15}$ km from Earth. There are $9.461 \times 10^{12}$ km in a light year. Find the distance from Earth to Polaris in light years.

8.1.2 Recognize positive integer powers as repeated multiplication. Recognize negative integer powers as repeated division or multiplication by the multiplicative inverse.

Example: Write $2^{-3}$ as a fraction.

8.1.3 Use the laws of exponents for integer exponents and evaluate expressions with negative integer exponents.

Examples:

- Write $2^2 \times 2^3$ as $(2 \times 2)\ (2 \times 2 \times 2)$ and then as a single power of 2. Explain your process.
- Evaluate $6^{-3} / 6^{2.}$ Explain your process.

8.1.4 Identify, compare and order irrational numbers.

Example: Estimate the square root of $\sqrt{18}$ to the nearest tenth. Plot the square root on a number line.

8.1.5 Calculate square roots of perfect squares, estimate square roots of numbers less than 1,000, and use the inverse relationship between squares and square roots.

Example: Explain how you can find the length of the hypotenuse of a right triangle with legs that measure 5 cm and 12 cm.

8.1.6 Solve percent, ratio and proportion problems.

- Find average rates.
- Express one quantity as a percent of another.
- Compare two quantities by percent.
- Use percents greater than 100 percent.
- Increase or decrease a quantity by a given percent.
- Find the original amount for a given percent increase or decrease.
- Solve problems involving percents, ratios and proportions.
- Solve problems involving simple and compound interest.

  Example: You leave $100 in each of three bank accounts paying 5 percent interest per year. One account pays simple interest, one pays interest compounded annually, and the third pays interest compounded quarterly. Use a spreadsheet to find the amount of money in each account after one, two, three, 10 and 20 years. Compare the results in the three accounts and explain how compounding affects the balance in each account.

**Standard 2**

# Algebra and Functions

**CORE STANDARD**

**Algebra and Functions**

***Solving Equations and Inequalities***

Write and solve multi-step equations and inequalities in one variable.

*[Standard Indicator: 8.2.1]*

***Linear Functions***

Use linear functions and linear equations to represent, analyze and solve problems. Translate among tables, equations, verbal expressions and graphs.

*[Standard Indicators: 8.2.4, 8.2.5, 8.2.6, 8.2.8]*

8.2.1 Write and solve linear equations and inequalities, interpret the solution or solutions in their context, and verify the reasonableness of the results.

Example: As a salesperson, you are paid $50 per week plus $3 per sale. This week you want your pay to be at least $100. Write an inequality for the number of sales you need to make, solve it and check that your answer is reasonable.

8.2.2 Solve equations and formulas for a specified variable.

Example: Solve $5(x + 2) = 10 + 5$

8.2.3 Simplify algebraic expressions involving powers.

Example: Expand $3(2x + 5)^2$

8.2.4 Identify and graph linear functions and identify lines with positive and negative slopes.

Example: Draw the graphs of $y = 2x - 1$, $y = 3x - 1$, $y = -2x - 1$ and $y = -3x - 1$. Find the slope of each graph. What do you notice?

8.2.5 Find the slope of a linear function given the equation. Write the equation of a line given the slope and any point on the line.

Example: Write an equation of the line with slope 2 and containing the point (1, -2). What is the *y*-intercept for this line?

8.2.6 Translate among tables, equations, verbal expressions and graphs of linear functions and recognize in ($y = mx + b$) that $m$ is the rate of change and $b$ is the vertical intercept of the graph.

Example: Write a formula for the perimeter of a square as a function of its side length. Construct a table of values for this function. Draw the graph of this function.

8.2.7 Identify functions as linear or nonlinear and contrast their characteristics from tables, graphs and equations.

Example: Graph $y = x^2 + 2$ and $y = x + 2$ on the same coordinate plane. How does the graph of $y = x^2 + 2$ differ from the graph of $y = x + 2$?

8.2.8 Use linear functions and linear equations to represent, analyze and solve problems.

Example: Corey is hosting a birthday party for a friend at a park shelter. The cost to rent the shelter is $50 plus $2 per person. Write a function to represent the situation. Find the total cost if 35 people attend.

**Standard 3**

# Geometry and Measurement

**CORE STANDARD**

**Geometry and Measurement**

***Constructions and Properties of Shapes***

Perform basic compass and straightedge constructions: constructions of angle and segment bisectors, copies of segments and angles, and perpendicular segments. Justify the constructions. Identify properties of geometric objects.

*[Standard Indicators: 8.3.1, 8.3.2]*

***Pythagorean Theorem***

Use the Pythagorean Theorem and its converse to calculate lengths of line segments.

*[Standard Indicator: 8.3.3]*

***Rates***

Solve simple problems involving rates and derived measurements like speed and density. Express these measurements in a given unit in terms of other units within the same measurement system.

*[Standard Indicators: 8.3.4, 8.3.8]*

### *Solids*

Find and use the surface areas and volumes of cones, spheres and pyramids. Use scale factors to find areas and volumes of similar figures.

*[Standard Indicators: 8.3.5, 8.3.6]*

8.3.1 Perform basic compass and straightedge constructions: angle and segment bisectors, copies of segments and angles, and perpendicular segments. Describe and justify the constructions.

Example: Explain the procedures used to construct the three angle bisectors of a triangle.

8.3.2 Identify, define and describe properties of three-dimensional geometric objects, describe how two or more figures intersect in a plane or in space, and visualize or describe the cross section of a solid.

Example: Find two lines in your classroom that are not parallel and yet do not meet.

8.3.3 Explain why the Pythagorean Theorem is valid using a variety of methods and use the Pythagorean Theorem and its converse to calculate lengths of line segments.

Example: A square piece of glass 7 feet on each side must be delivered through a doorway. Can the glass fit through the doorway that is 3 feet wide and 6.5 feet tall? Explain your thinking. Make a scale drawing on grid paper to solve the problem.

8.3.4 Solve simple problems involving rates and other derived measurements — including problems involving speed, uniform speed, average speed and density — by applying the concept of proportionality to measurement in different contexts. Express measurements in a given unit or in terms of other units of the same type.

Example: A car travels at 60 mph for 20 minutes and then at 48 miles an hour for 10 minutes. What is the average speed in miles per hour for this trip? Explain your answer.

8.3.5 Use scale factors to find the area and volume of similar figures.

Example: Calculate the volume and surface area of cubes with sides 1 cm, 2 cm, 3 cm, etc. Make a table of your results and describe any patterns in the table.

8.3.6 Find and use the surface area and volume of cones, spheres and pyramids.

Example: A prism has as its base a right triangle with the shorter sides of length 6 and 8 feet. Its height is 14 feet and the non-triangular faces are rectangles. Find the surface area of the prism.

8.3.7 Estimate and compute the area of irregular two-dimensional shapes and the volume of irregular three-dimensional objects by breaking them down into more basic geometric objects.

Example: Find the volume of a doghouse that has a rectangular space that is 3 ft long by 2 ft wide by 5 ft high and has a triangular roof that is 1.5 ft higher than the walls of the house.

8.3.8 Solve problems involving conversions within the same measurement system. Estimate the measure of an object in one system given the measure of that object in another system and the approximate conversion factor.

Example: The area of a hall is 40 square yards. What is the area in square feet?

## Standard 4
# Data Analysis and Probability

**CORE STANDARD**

**Data Analysis and Probability**

***Evaluating Claims, Selecting Samples and Analyzing Bias***

Identify claims based on statistical data and in simple cases evaluate the reasonableness of the claims. Identify different methods of selecting samples. Analyze the strengths and weaknesses of each method and the possible bias in samples or displays.

*[Standard Indicators: 8.4.1, 8.4.2]*

***Analyzing Data***

Use mean, median, mode, upper and lower quartiles, and range of data to compare data sets. Organize and display data to analyze central tendencies of data. Investigate effects of change in data values on the measures of the central tendency of the set of data. Display data in scatter plots and informally find lines of best fit.

*[Standard Indicators: 8.4.3, 8.4.5]*

***Simple Experiments***

Compute probabilities of events from simple experiments with equally probable outcomes.

*[Standard Indicator: 8.4.7]*

8.4.1 Identify claims based on statistical data and in simple cases evaluate the reasonableness of the claims. Design a study to investigate the claim.

Example: A study shows that teenagers who use a certain brand of toothpaste have fewer cavities than those using other brands. Describe how you can test this claim in your school.

8.4.2 Identify different methods of selecting samples. Analyze the strengths and weaknesses of each method and the possible bias in samples or displays.

Example: Describe possible bias in the following survey: A local television station has a daily call-in poll. Viewers of the morning and noon newscasts are asked to call one telephone number to answer “yes” and a different telephone number to answer “no.” The results are reported on the five-o’clock newscast.

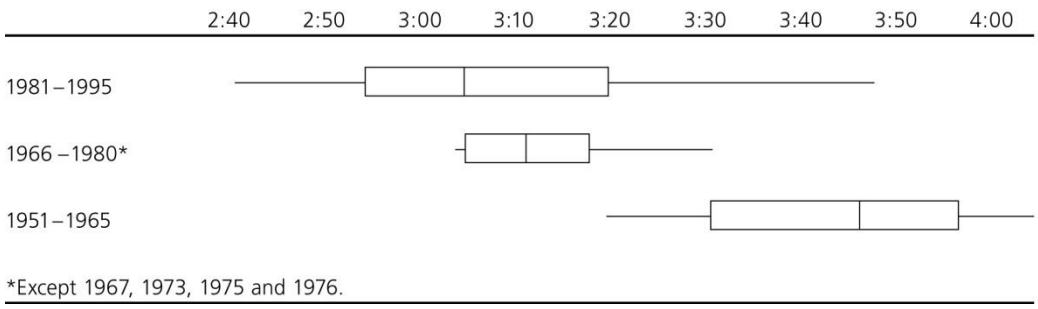
8.4.3 Use mean, median, mode, upper and lower quartiles, and range to compare data sets. Organize and display data to highlight important features such as the range and how

the data is spread around a central value. Investigate what happens to the display when some of the data values are changed.

Example: Arrange a set of test scores in increasing order and find the lowest and highest scores, the median, and the upper and lower quartiles.

8.4.4 Analyze, interpret and display data in box-and-whisker plots.

Example: The box-and-whisker plots below show winning times (hours: minutes) for the Indianapolis 500 race in selected years:




In the years from 1951 to 1965, the slowest time was 3 hours 57 minutes. Explain how the slowest time changed in the years from 1951 to 1995. How did the winning times change during that period? How did the median times change in the same period?

8.4.5 Display two-variable data in scatter plots and describe how the data points are distributed. If the pattern appears to be linear, draw a line that appears to best fit the data and write the equation of that line.

Example: Survey some of the students at each grade level in your school to ask them how much time they spend on homework. Plot the grade level and time of each student as a point (grade, time) on a scatter diagram. Describe and justify any relationship between grade and time spent on homework.

8.4.6 Describe and apply the addition rule for probabilities for simple events that are mutually exclusive and for simple events that are not.

Example: Amy and Bill were each asked to roll two six-sided dice and add the numbers shown. Amy wins if the sum is odd. Bill wins if the sum is six, seven or eight. Who is more likely to win? Show your work.

8.4.7 Compute probabilities of events from simple experiments with equally probable outcomes Use methods like organized lists, tree diagrams and area models.

Example: A six-sided die is rolled, and a spinner with equal sections A, C, D and E is spun. Find the probability of rolling a 3 and spinning a vowel.

## PROCESS STANDARDS

Indiana's Academic Standards for Mathematics describe the key content of each grade level and course, and students must develop conceptual understanding of this content.

The American Diploma Project noted that, “beyond acquiring procedural mathematical skills with their clear methods and boundaries, students need to master the more subjective skills of reading, interpreting, representing and ‘mathematicizing’ a problem” (p. 55).

The National Council of Teachers of Mathematics has described five Process Standards that “highlight ways of acquiring and using content knowledge” (p. 29). The following Process Standards must be addressed throughout the learning and teaching of Indiana’s Academic Standards for Mathematics in all grade levels in mathematics.

**Problem Solving**

- Build new mathematical knowledge through problem solving.
- Solve problems that arise in mathematics and in other contexts.
- Apply and adapt a variety of appropriate strategies to solve problems.
- Monitor and reflect on the process of mathematical problem solving.

**Reasoning and Proof**

- Recognize reasoning and proof as fundamental aspects of mathematics.
- Make and investigate mathematical conjectures.
- Develop and evaluate mathematical arguments and proofs.
- Select and use various types of reasoning and methods of proof.

**Communication**

- Organize and consolidate mathematical thinking through communication.
- Communicate mathematical thinking coherently and clearly to peers, teachers and others.
- Analyze and evaluate the mathematical thinking and strategies of others.
- Use the language of mathematics to express mathematical ideas precisely.

**Connections**

- Recognize and use connections among mathematical ideas.
- Understand how mathematical ideas interconnect and build on one another to produce a coherent whole.
- Recognize and apply mathematics in contexts outside of mathematics.

**Representation**

- Create and use representations to organize, record and communicate mathematical ideas.
- Select, apply and translate among mathematical representations to solve problems.
- Use representations to model and interpret physical, social and mathematical phenomena.

In addition, estimation, mental computation and technology are areas that need to be addressed at all grade levels in mathematics.

**Estimation and Mental Computation**

- Know and apply appropriate methods for estimating the results of computations.

- Round numbers to a specified place value.
- Use estimation to decide whether answers are reasonable.
- Decide when estimation is an appropriate strategy for solving a problem.
- Determine appropriate accuracy and precision of measurements in problem situations.
- Use properties of numbers and operations to perform mental computation.
- Recognize when the numbers involved in a computation allow for a mental computation strategy.

**Technology**

- Technology should be used as a tool in mathematics education to support and extend the mathematics curriculum.
- Technology can contribute to concept development, simulation, representation, communication and problem solving.
- The challenge is to ensure that technology supports, but is not a substitute for, the development of skills with basic operations, quantitative reasoning and problem-solving skills.
    - Graphing calculators should be used to enhance middle school and high school students' understanding and skills.
    - The focus must be on learning mathematics and using technology as a tool rather than as an end unto itself.

**References**

American Diploma Project (2004). *Ready or not: Creating a high school diploma that counts.* Washington, DC: Achieve, Inc.

National Council of Teachers of Mathematics (2000). *Principles and Standards for School Mathematics.* Reston VA: author.