Transitional Colorado Assessment Program (TCAP) Assessment Framework

Mathematics – Grade 9

The assessment frameworks specify the content that will be eligible for assessment in the 2012 and 2013 TCAP by aligning the assessment objectives from the Colorado Model Content Standards (old standards) with the Colorado Academic Standards (new standards). TCAP supports the transition to the CAS during the next two years as a gradual approach to statewide measuring of student achievement of the new standards.

Please remember that the TCAP frameworks, and thus TCAP, are not inclusive of **all** of the Colorado Academic Standards (CAS). **Districts should, however, still transition to the full range of the new standards as the complete set of CAS will be considered eligible content for inclusion in the new 2014 assessment.**

The frameworks are organized as indicated in the table below:

Standard	Indicates the broad knowledge skills that all students should be acquiring in Colorado schools at grade level. Each standard is assessed every year.		
Benchmark	Tactical descriptions of the knowledge and skills students should acquire by each grade level assessed by the TCAP.		
Assessment Objective	**CAS Alignment Code**	**CAS Expectation Text**	**Comment**
Specific knowledge and skills eligible for inclusion on TCAP for each grade level.	Provides the code(s) from the Colorado Academic Standards (CAS) that correspond(s) to the assessment objective.	Provides the text from the CAS which correspond(s) to the assessment objective.	Provides clarifying information.

The following may assist in understanding the revised frameworks:

- As the new standards are mastery based, any assessment objective that is aligned to a standard or a mathematical practice from the Colorado Academic Standards at the relevant grade level or below is eligible for assessment on the TCAP.
- A CAS may be aligned to multiple assessment objectives. To ensure a reasonable document length per grade, some instances of multiple CAS alignments have been omitted.

- Some assessment objectives, or parts of assessment objectives, do not explicitly align with the CAS but will still be assessed. Where this occurs, it is noted with language such as "this will continue to be assessed." The concepts from these assessment objectives are also compiled in a table at the bottom of each framework for easy reference. The purpose of continuing to assess non-CAS aligned objectives is to ensure the reliability and comparability of the TCAP to prior year's assessments.

- Assessment objectives and parts of assessment objectives that will no longer be assessed have been struck through and are included in the revised frameworks for purposes of comparison to the prior frameworks only.

- A key to the CAS Alignment Code can be by following this link: http://www.cde.state.co.us/cdeassess/UAS/AdoptedAcademicStandards/CAS_Reference_system.pdf

The revised frameworks directly build off of the work done on the original Colorado Student Assessment Program (CSAP) frameworks and reflect a joint endeavor between the Office of Assessment, Research and Evaluation and the content specialists from the Office of Academic and Instructional Support.

Standard 1	Students develop number sense and use numbers and number relationships in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 1	Demonstrate meanings for real numbers, absolute value, and scientific notation using physical materials and technology in problem-solving situations.		
Assessment Objective	**CAS Alignment Code**	**CAS Expectation Text**	**Comment**
a. Compare and order sets of rational numbers and common irrational numbers ($\sqrt{2}$, $\sqrt{5}$, and π).	MA10-GR.8-S.1-GLE.1-EO.c	Use rational approximations of irrational numbers to compare the size of irrational numbers, locate them approximately on a number line diagram, and estimate the value of expressions. (CCSS: 8.NS.2)	
	MA10-GR.6-S.1-GLE.3-EO.c.ii	Write, interpret, and explain statements of order for rational numbers in real-world contexts. (CCSS: 6.NS.7b)	
b. Recognize and use equivalent representations of real numbers in a variety of forms including scientific notation, radicals, and other irrational numbers such as π.	MA10-GR.8-S.1-GLE.1-EO.c	Use rational approximations of irrational numbers to compare the size of irrational numbers, locate them approximately on a number line diagram, and estimate the value of expressions. (CCSS: 8.NS.2)	
	MA10-GR.8-S.1-GLE.1-EO.d.	Apply the properties of integer exponents to generate equivalent numerical expressions. (CCSS: 8.EE.1)	
	MA10-GR.8-S.1-GLE.1-EO.g	Use numbers expressed in the form of a single digit times a whole-number power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. (CCSS: 8.EE.3)	
	MA10-GR.8-S.1-GLE.1-EO.h	Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. (CCSS: 8.EE.4)	
	MA10-GR.HS-S.1-GLE.1-EO.a.ii	Rewrite expressions involving radicals and rational exponents using the properties of exponents. (CCSS: N-RN.2)	

Standard 1	Students develop number sense and use numbers and number relationships in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 1	Demonstrate meanings for real numbers, absolute value, and scientific notation using physical materials and technology in problem-solving situations.		
c. Use very large and very small numbers in real life situations to solve problems (for example, understanding the size of the national debt).	MA10-GR.8-S.1-GLE.1-EO.g	Use numbers expressed in the form of a single digit times a whole-number power of 10 to estimate very large or very small quantities, and to express how many times as much one is than the other. (CCSS: 8.EE.3)	
	MA10-GR.8-S.1-GLE.1-EO.h (i-ii)	Perform operations with numbers expressed in scientific notation, including problems where both decimal and scientific notation are used. (CCSS: 8.EE.4) i. Use scientific notation and choose units of appropriate size for measurements of very large or very small quantities. (CCSS: 8.EE.4) ii. Interpret scientific notation that has been generated by technology. (CCSS: 8.EE.4)	

Standard 1	Students develop number sense and use numbers and number relationships in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 2	Develop, test, and conjectures about the properties of number systems and sets of numbers.		
Assessment Objective	**CAS Alignment Code**	**CAS Expectation Text**	**Comment**
a. Verify and apply the properties of the operation “to the power of”.	MA10-GR.8-S.1-GLE.1-EO.d	Apply the properties of integer exponents to generate equivalent numerical expressions. (CCSS: 8.EE.1)	
	MA10-GR.HS-S.1-GLE.1-EO.a.ii	Rewrite expressions involving radicals and rational exponents using the properties of exponents. (CCSS: N-RN.2)	

Standard 1	Students develop number sense and use numbers and number relationships in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 3	Use number sense to estimate and justify the reasonableness of solutions to problems involving real numbers.		
Assessment Objective	**CAS Alignment Code**	**CAS Expectation Text**	**Comment**
a. Use number sense to estimate and justify the reasonableness of solutions to problems involving rational numbers and common irrational numbers (for example, circumference, area of a circle, and Pythagorean Theorem).	MA10-GR.7-S.2-GLE.2-EO.b	Apply properties of operations to calculate with numbers in any form, convert between forms as appropriate, and assess the reasonableness of answers using mental computation and estimation strategies. (CCSS: 7.EE.3)	
	MA10-GR.7-S.4-GLE.2-EO.a	State the formulas for the area and circumference of a circle and use them to solve problems. (CCSS: 7.G.4)	
	MA10-GR.8-S.4-GLE.2-EO.b	Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions. (CCSS: 8.G.7)	

Standard 2	Students use algebraic methods to explore, model, and describe patterns and functions involving numbers, shapes, data, and graphs in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 1	Model real world phenomena (for example, distance-versus-time relationships, compound interest, amortization tables, mortality rates) using functions, equations, inequalities, and matrices.		
Assessment Objective	**CAS Alignment Code**	**CAS Expectation Text**	**Comment**
a. Model real world phenomena involving linear and non-linear relationships using multiple representations of rules that can take the form of recursive processes, functions, equations, or inequalities.	MA10-GR.HS-S.2-GLE.2-EO.a (i-iii)	Construct and compare linear, quadratic, and exponential models and solve problems. (CCSS: F-LE) i. Distinguish between situations that can be modeled with linear functions and with exponential functions. (CCSS: F-LE.1) 1. Prove that linear functions grow by equal differences over equal intervals, and that exponential functions grow by equal factors over equal intervals. (CCSS: F-LE.1a) 2. Identify situations in which one quantity changes at a constant rate per unit interval relative to another. (CCSS: F-LE.1b) 3. Identify situations in which a quantity grows or decays by a constant percent rate per unit interval relative to another. (CCSS: F-LE.1c) ii. Construct linear and exponential functions, including arithmetic and geometric sequences, given a graph, a description of a relationship, or two input-output pairs. (CCSS: F-LE.2) iii. Use graphs and tables to describe that a quantity increasing exponentially eventually exceeds a quantity increasing linearly, quadratically, or (more generally) as a polynomial function. (CCSS: F-LE.3)	
	MA10-GR.HS-S.2-GLE.4-EO.a.i	Create equations and inequalities in one variable and use them to solve problems. (CCSS: A-CED.1)	

Standard 2	Students use algebraic methods to explore, model, and describe patterns and functions involving numbers, shapes, data, and graphs in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 2	Represent functional relationships using written explanations, tables, equations, and graphs and describe the connections among these representations.		
Assessment Objective	**CAS Alignment Code**	**CAS Expectation Text**	**Comment**
a. Represent functional relationships using written explanations, tables, equations, and graphs, and describe the connections among these representations.	MA10-GR.8-S.2-GLE.3-EO.a.iii	Compare properties of two functions each represented in a different way (algebraically, graphically, numerically in tables, or by verbal descriptions). (CCSS: 8.F.2)	
	MA10-GR.8-S.2-GLE.3-EO.b	Use functions to model relationships between quantities. (CCSS: 8.F)	
b. Convert from one functional representation to another.	MA10-GR.8-S.2-GLE.3-EO.b (i-vi)	Use functions to model relationships between quantities. (CCSS: 8.F) i. Construct a function to model a linear relationship between two quantities. (CCSS: 8.F.4) ii. Determine the rate of change and initial value of the function from a description of a relationship or from two (*x, y*) values, including reading these from a table or from a graph. (CCSS: 8.F.4) iii. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values. (CCSS: 8.F.4) iv. Describe qualitatively the functional relationship between two quantities by analyzing a graph. (CCSS: 8.F.5) v. Sketch a graph that exhibits the qualitative features of a function that has been described verbally. (CCSS: 8.F.5) vi. Analyze how credit and debt impact personal financial goals (PFL)	

Standard 2	Students use algebraic methods to explore, model, and describe patterns and functions involving numbers, shapes, data, and graphs in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 2	Represent functional relationships using written explanations, tables, equations, and graphs and describe the connections among these representations.		
c. Interpret a graphical representation of a real-world situation.	MA10-GR.HS-S.2-GLE.1-EO.b	Interpret functions that arise in applications in terms of the context. (CCSS: F-IF)	
	MA10-GR.8-S.2-GLE.3-EO.b.iv	Describe qualitatively the functional relationship between two quantities by analyzing a graph. (CCSS: 8.F.5)	
	MA10-GR.8-S.3-GLE.1-EO.b	Describe patterns such as clustering, outliers, positive or negative association, linear association, and nonlinear association. (CCSS: 8.SP.1)	
Standard 2	Students use algebraic methods to explore, model, and describe patterns and functions involving numbers, shapes, data, and graphs in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 3	Solve problems involving functional relationships using graphing calculators and/or computers as well as appropriate paper-and-pencil techniques.		
Assessment Objective	**CAS Alignment Code**	**CAS Expectation Text**	**Comment**
a. Solve problems involving functions and relations using calculators, graphs, tables, and algebraic methods.	MA10-GR.8-S.2-GLE.3-EO.b (i-vi)	Use functions to model relationships between quantities. (CCSS: 8.F) i. Construct a function to model a linear relationship between two quantities. (CCSS: 8.F.4) ii. Determine the rate of change and initial value of the function from a description of a relationship or from two (*x, y*) values, including reading these from a table or from a graph. (CCSS: 8.F.4) iii. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values. (CCSS: 8.F.4) iv. Describe qualitatively the functional relationship between two quantities by analyzing a graph. (CCSS: 8.F.5) v. Sketch a graph that exhibits the qualitative features of a function that has been described verbally. (CCSS: 8.F.5) vi. Analyze how credit and debt impact personal financial goals (PFL)	

Standard 2	Students use algebraic methods to explore, model, and describe patterns and functions involving numbers, shapes, data, and graphs in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 3	Solve problems involving functional relationships using graphing calculators and/or computers as well as appropriate paper-and-pencil techniques.		
b. Solve simple systems of equations using algebraic, graphical or numeric methods.	MA10-GR.8-S.2-GLE.2-EO.b (i-iii)	Analyze and solve pairs of simultaneous linear equations. (CCSS: 8.EE.8) i. Explain that solutions to a system of two linear equations in two variables correspond to points of intersection of their graphs, because points of intersection satisfy both equations simultaneously. (CCSS: 8.EE.8a) ii. Solve systems of two linear equations in two variables algebraically, and estimate solutions by graphing the equations. Solve simple cases by inspection. (CCSS: 8.EE.8b) iii. Solve real-world and mathematical problems leading to two linear equations in two variables. (CCSS: 8.EE.8c)	
c. Solve equations with more than one variable for a given variable (for example, solve for p in 1= prt or for r in C=2πr).	MA10-GR.HS-S.2-GLE.4-EO.a.iv.	Rearrange formulas to highlight a quantity of interest, using the same reasoning as in solving equations. (CCSS: A-CED.4)	

Standard 2	Students use algebraic methods to explore, model, and describe patterns and functions involving numbers, shapes, data, and graphs in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 4	Analyze and explain the behaviors, transformations, and general properties of types of equations and functions (for example, linear, quadratic, exponential).		
Assessment Objective	**CAS Alignment Code**	**CAS Expectation Text**	**Comment**
a. Identify and interpret x- and y- intercepts in the context of a problem.	MA10-GR.HS-S.2-GLE.1-EO.b	Interpret functions that arise in applications in terms of the context. (CCSS: F-IF)	
	MA10-GR.HS-S.2-GLE.1-EO.b.i	For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. ★ (CCSS: F-IF.4)	
	MA10-GR.HS-S.2-GLE.2-EO.b.i	Interpret the parameters in a linear or exponential function in terms of a context. (CCSS: F-LE.5)	
b. Using a graph, identify the maximum and minimum value within a given domain.	MA10-GR.HS-S.2-GLE.1-EO.b	Interpret functions that arise in applications in terms of the context. (CCSS: F-IF)	
	MA10-GR.HS-S.2-GLE.1-EO.b.i	For a function that models a relationship between two quantities, interpret key features of graphs and tables in terms of the quantities, and sketch graphs showing key features given a verbal description of the relationship. ★ (CCSS: F-IF.4)	
c. Analyze the effects of change in the leading coefficient and/or the vertical translation (for example, given $y = kx + c$ and $y = kx^2 + c$, how do changes in k and/or c affect the graphs?	MA10-GR.HS-S.2-GLE.1-EO.e	Build new functions from existing functions. (CCSS: F-BF)	
	MA10-GR.HS-S.2-GLE.1-EO.e.i	Identify the effect on the graph of replacing $f(x)$ by $f(x) + k$, $k\,f(x)$, $f(kx)$, and $f(x + k)$ for specific values of k, and find the value of k given the graphs. (CCSS: F-BF.3)	
	MA10-GR.HS-S.2-GLE.1-EO.e.ii	Experiment with cases and illustrate an explanation of the effects on the graph using technology.	

Standard 2	Students use algebraic methods to explore, model, and describe patterns and functions involving numbers, shapes, data, and graphs in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 5	Interpret algebraic equations and inequalities geometrically and describe geometric relationships algebraically.		
Assessment Objective	**CAS Alignment Code**	**CAS Expectation Text**	**Comment**
a. Graph solutions to equations and inequalities in one-and two-dimensions and determine solutions.	MA10-GR.HS-S.2-GLE.4-EO.a.iii	Represent constraints by equations or inequalities, and by systems of equations and/or inequalities, and interpret solutions as viable or nonviable options in a modeling context. (CCSS: A-CED.3)	
	MA10-GR.HS-S.2-GLE.4-EO.e.iii	Graph the solutions to a linear inequality in two variables as a half-plane (excluding the boundary in the case of a strict inequality), and graph the solution set to a system of linear inequalities in two variables as the intersection of the corresponding half-planes. (CCSS: A-REI.12)	
b. Express the perimeter, area and volume relationships of geometric figures algebraically.	MA10-GR.6-S.4-GLE.1-EO.a (i-ii)	Develop and apply formulas and procedures for area of plane figures i. Find the area of right triangles, other triangles, special quadrilaterals, and polygons by composing into rectangles or decomposing into triangles and other shapes. (CCSS: 6.G.1) ii. Apply these techniques in the context of solving real-world and mathematical problems. (CCSS: 6.G.1)	
	MA10-GR.6-S.4-GLE.1-EO.b (i-iii)	Develop and apply formulas and procedures for volume of regular prisms. i. Find the volume of a right rectangular prism with fractional edge lengths by packing it with unit cubes of the appropriate unit fraction edge lengths. (CCSS: 6.G.2) ii. Show that volume is the same as multiplying the edge lengths of a rectangular prism. (CCSS: 6.G.2) iii. Apply the formulas $V = l\ w\ h$ and $V = b\ h$ to find volumes of right rectangular prisms with fractional edge lengths in the context of solving real-world and mathematical problems. (CCSS: 6.G.2)	
	MA10-GR.8-S.4-GLE.2-EO.d	State the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems. (CCSS: 8.G.9)	

Standard 3	Students use data collection and analysis, statistics, and probability in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 1	Design and conduct a statistical experiment to study a problem, and interpret and communicate the results using the appropriate technology (for example, graphing calculators, computer software).		
Assessment Objective	**CAS Alignment Code**	**CAS Expectation Text**	**Comment**
a. Identify factors which may have affected the outcome of a survey (for example, ~~biased questions or~~ collection methods).	MA10-GR.7-S.3-GLE.1-EO.a (i-iv)	Use random sampling to draw inferences about a population. (CCSS: 7.SP) i. Explain that generalizations about a population from a sample are valid only if the sample is representative of that population. (CCSS: 7.SP.1) ii. Explain that random sampling tends to produce representative samples and support valid inferences. (CCSS: 7.SP.1) iii. Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. (CCSS: 7.SP.2) iv. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions. (CCSS: 7.SP.2)	The CAS only refers to methods of data collection that may affect the outcome of a survey.
b. Using large populations, formulate hypothesis, draw conclusions, and make convincing arguments based on data analysis.	MA10-GR.7-S.3-GLE.1-EO.a (i-iv)	Use random sampling to draw inferences about a population. (CCSS: 7.SP) i. Explain that generalizations about a population from a sample are valid only if the sample is representative of that population. (CCSS: 7.SP.1) ii. Explain that random sampling tends to produce representative samples and support valid inferences. (CCSS: 7.SP.1) iii. Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. (CCSS: 7.SP.2) iv. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions. (CCSS: 7.SP.2)	

Standard 3	Students use data collection and analysis, statistics, and probability in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 1	Design and conduct a statistical experiment to study a problem, and interpret and communicate the results using the appropriate technology (for example, graphing calculators, computer software).		
c. Select and use an appropriate display to represent and describe a set of data (for example, scatter plot, line graph and histogram).	MA10-GR.6-S.3-GLE.1-EO.d (i-ii and 1-4)	Summarize and describe distributions. (CCSS: 6.SP) i. Display numerical data in plots on a number line, including dot plots, histograms, and box plots. (CCSS: 6.SP.4) ii. Summarize numerical data sets in relation to their context. (CCSS: 6.SP.5) 1. Report the number of observations. (CCSS: 6.SP.5a) 2. Describe the nature of the attribute under investigation, including how it was measured and its units of measurement. (CCSS: 6.SP.5b) 3. Give quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered. (CCSS: 6.SP.5c) 4. Relate the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered. (CCSS: 6.SP.5d)	This is related to the standard for mathematical practice, "Use appropriate tools strategically."
	MA10-GR.8-S.3-GLE.1-EO.a	Construct and interpret scatter plots for bivariate measurement data to investigate patterns of association between two quantities. (CCSS: 8.SP.1)	

Standard 3	Students use data collection and analysis, statistics, and probability in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 2	Analyze statistical claims for erroneous conclusions or distortions.		
Assessment Objective	**CAS Alignment Code**	**CAS Expectation Text**	**Comment**
~~a. Analyze a graph, table, or summary for misleading characteristics.~~			This is not explicitly in the CAS.
b. Recognize the misuse of statistical data in written arguments.	MA10-GR.7-S.3-GLE.1-EO.a (i-iv)	Use random sampling to draw inferences about a population. (CCSS: 7.SP) i. Explain that generalizations about a population from a sample are valid only if the sample is representative of that population. (CCSS: 7.SP.1) ii. Explain that random sampling tends to produce representative samples and support valid inferences. (CCSS: 7.SP.1) iii. Use data from a random sample to draw inferences about a population with an unknown characteristic of interest. (CCSS: 7.SP.2) iv. Generate multiple samples (or simulated samples) of the same size to gauge the variation in estimates or predictions. (CCSS: 7.SP.2)	The CAS only refers to misuse associated with sampling methods.
c. Describe how data can be interpreted in more than one way or be used to support more than one position in a debate.	MA10-GR.6-S.3-GLE.1-EO.d.ii (1-4)	Summarize numerical data sets in relation to their context. (CCSS: 6.SP.5) 1. Report the number of observations. (CCSS:6.SP.5a) 2. Describe the nature of the attribute under investigation, including how it was measured and its units of measurement. (CCSS: 6.SP.5b) 3. Give quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered. (CCSS: 6.SP.5c) 4. Relate the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered. (CCSS: 6.SP.5d)	This part of the standard for mathematical practice, "Construct viable arguments and critique the reasoning of others."

Standard 3	Students use data collection and analysis, statistics, and probability in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 3	Fit curves to scatter plots using informal methods or appropriate technology to determine the strength of the relationship between two data sets and to make predictions.		
Assessment Objective	**CAS Alignment Code**	**CAS Expectation Text**	**Comment**
a. Fit curves to scatter plots using informal methods or appropriate technology to make predictions about the data.	MA10-GR.8-S.3-GLE.1-EO.c	For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line. (CCSS: 8.SP.2)	
	MA10-GR.HS-S.3-GLE.1-EO.b.ii	Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. (CCSS: S-ID.6)	
	MA10-GR.HS-S.3-GLE.1-EO.b.ii.1	Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models. (CCSS: S-ID.6a)	
b. Fit curves to scatter plots using informal methods or appropriate technology to determine the type (positive, negative, or non-existent) of relationship between two data sets.	MA10-GR.8-S.3-GLE.1-EO.c	For scatter plots that suggest a linear association, informally fit a straight line, and informally assess the model fit by judging the closeness of the data points to the line. (CCSS: 8.SP.2)	
	MA10-GR.HS-S.3-GLE.1-EO.b.ii (1)	Represent data on two quantitative variables on a scatter plot, and describe how the variables are related. (CCSS: S-ID.6) 1. Fit a function to the data; use functions fitted to data to solve problems in the context of the data. Use given functions or choose a function suggested by the context. Emphasize linear, quadratic, and exponential models. (CCSS: S-ID.6a)	

Standard 3	Students use data collection and analysis, statistics, and probability in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 4	Draw conclusions about distributions of data based on analysis of statistical summaries (for example, the combination of mean and standard deviation, and differences between the mean and median).		
a. Determine, analyze, and use measure of central tendency (such as mean, median, and ~~mode~~) and measures of variability (such as range and quartiles) in problem-solving situations.	MA10-GR.6-S.3-GLE.1-EO.d (i-ii and 1-4)	Summarize and describe distributions. (CCSS: 6.SP) i. Display numerical data in plots on a number line, including dot plots, histograms, and box plots. ii. Summarize numerical data sets in relation to their context. (CCSS: 6.SP.5) 1. Report the number of observations. (CCSS: 6.SP.5a) 2. Describe the nature of the attribute under investigation, including how it was measured and its units of measurement. (CCSS: 6.SP.5b) 3. Give quantitative measures of center (median and/or mean) and variability (interquartile range and/or mean absolute deviation), as well as describing any overall pattern and any striking deviations from the overall pattern with reference to the context in which the data were gathered. (CCSS: 6.SP.5c) 4. Relate the choice of measures of center and variability to the shape of the data distribution and the context in which the data were gathered. (CCSS: 6.SP.5d)	Mode is not in the CAS.
~~b. Use averages (including averages per trial, expected value) to draw conclusions about distributions of data (for example, if there are 10 people with one five dollar bill and one dollar bill in their wallets and they each randomly place one of the bills in a donation box, what will be the average amount of money donated per person?).~~			This is not explicitly in the CAS.

Standard 3	Students use data collection and analysis, statistics, and probability in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 5	Use experimental and theoretical probability to represent and solve problems involving uncertainty (for example, the chance of playing professional sports if a student is a successful high school athlete).		
Assessment Objective	**CAS Alignment Code**	**CAS Expectation Text**	**Comment**
a. Determine the probability of an identified event using the sample space.	MA10-GR.7-S.3-GLE.2-EO.d (i-iv)	Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation. (CCSS: 7.SP.8) i. Explain that the probability of a compound event is the fraction of outcomes in the sample space for which the compound event occurs. (CCSS: 7.SP.8a) ii. Represent sample spaces for compound events using methods such as organized lists, tables and tree diagrams. (CCSS: 7.SP.8b) iii. For an event described in everyday language identify the outcomes in the sample space which compose the event. (CCSS: 7.SP.8b) iv. Design and use a simulation to generate frequencies for compound events. (CCSS: 7.SP.8c)	
b. Make predictions using theoretical probability in real-world problems.	MA10-GR.7-S.3-GLE.2-EO.c (i-iii)	Develop a probability model and use it to find probabilities of events. (CCSS: 7.SP.7) Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy. (CCSS: 7.SP.7) Develop a uniform probability model by assigning equal probability to all outcomes, and use the model to determine probabilities of events. (CCSS: 7.SP.7a) Develop a probability model (which may not be uniform) by observing frequencies in data generated from a chance process. (CCSS: 7.SP.7b)	

Standard 3	Students use data collection and analysis, statistics, and probability in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 5	Use experimental and theoretical probability to represent and solve problems involving uncertainty (for example, the chance of playing professional sports if a student is a successful high school athlete).		
c. Use a model (list, tree diagram, area model) to determine theoretical probabilities to solve problems involving uncertainty.	MA10-GR.7-S.3-GLE.2-EO.c (i-iii)	Develop a probability model and use it to find probabilities of events. (CCSS: 7.SP.7) i. Compare probabilities from a model to observed frequencies; if the agreement is not good, explain possible sources of the discrepancy. (CCSS: 7.SP.7) ii. Develop a uniform probability model by assigning equal probability to all outcomes, and use the model to determine probabilities of events. (CCSS: 7.SP.7a) iii. Develop a probability model (which may not be uniform) by observing frequencies in data generated from a chance process. (CCSS: 7.SP.7b)	
	MA10-GR.7-S.3-GLE.2-EO.d (i-iv)	Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation. (CCSS: 7.SP.8) i. Explain that the probability of a compound event is the fraction of outcomes in the sample space for which the compound event occurs. (CCSS: 7.SP.8a) ii. Represent sample spaces for compound events using methods such as organized lists, tables and tree diagrams. (CCSS: 7.SP.8b) iii. For an event described in everyday language identify the outcomes in the sample space which compose the event. (CCSS: 7.SP.8b) iv. Design and use a simulation to generate frequencies for compound events. (CCSS: 7.SP.8c)	

Standard 3	Students use data collection and analysis, statistics, and probability in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 6	Solve real-world problems with informal use of combinations and permutations (for example, determining the number of possible meals at a restaurant featuring a given number of side dishes).		
a. Solve real-world problems with informal use of combinations and permutations (for example, determining the number of possible meals at a restaurant featuring a given number of side dishes).	MA10-GR.7-S.3-GLE.2-EO.d (i-iv)	Find probabilities of compound events using organized lists, tables, tree diagrams, and simulation. (CCSS: 7.SP.8) i. Explain that the probability of a compound event is the fraction of outcomes in the sample space for which the compound event occurs. (CCSS: 7.SP.8a) ii. Represent sample spaces for compound events using methods such as organized lists, tables and tree diagrams. (CCSS: 7.SP.8b) iii. For an event described in everyday language identify the outcomes in the sample space which compose the event. (CCSS: 7.SP.8b) iv. Design and use a simulation to generate frequencies for compound events. (CCSS: 7.SP.8c)	

Standard 4	Students use geometric concepts, properties, and relationships in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 1	Find and analyze relationships among geometric figures using transformations (for example, reflections, translations, rotations, dilations) in coordinate systems.		
Assessment Objective	**CAS Alignment Code**	**CAS Expectation Text**	**Comment**
a. Find and analyze relationships among geometric figures using transformation (for example, reflections, translation, rotations, dilation) in coordinate systems.	MA10-GR.8-S.4-GLE.1-EO.a	Verify experimentally the properties of rotations, reflections, and translations. (CCSS: 8.G.1)	
	MA10-GR.8-S.4-GLE.1-EO.b	Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates. (CCSS: 8.G.3)	
	MA10-GR.8-S.4-GLE.1-EO.c	Demonstrate that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations. (CCSS: 8.G.2)	
	MA10-GR.8-S.4-GLE.1-EO.d	Given two congruent figures, describe a sequence of transformations that exhibits the congruence between them. (CCSS: 8.G.2)	
	MA10-GR.8-S.4-GLE.1-EO.e	Demonstrate that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations. (CCSS: 8.G.4)	
	MA10-GR.8-S.4-GLE.1-EO.f	Given two similar two-dimensional figures, describe a sequence of transformations that exhibits the similarity between them. (CCSS: 8.G.4)	
	MA10-GR.8-S.4-GLE.1-EO.g	Use informal arguments to establish facts about the angle sum and exterior angle of triangles, about the angles created when parallel lines are cut by a transversal, and the angle-angle criterion for similarity of triangles. (CCSS: 8.G.5)	

Standard 4	Students use geometric concepts, properties, and relationships in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 2	Derive and use methods to measure perimeter, area, and volume of regular and irregular geometric figures.		
a. Solve problems involving perimeter, area, and volume of regular and irregular geometric figures.	MA10-GR.7-S.4-GLE.2-EO.d	Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms. (CCSS: 7.G.6)	
	MA10-GR.8-S.4-GLE.2-EO.d	State the formulas for the volumes of cones, cylinders, and spheres and use them to solve real-world and mathematical problems. (CCSS: 8.G.9)	
	MA10-GR.3-S.4-GLE.2-EO.c	Solve real world and mathematical problems involving perimeters of polygons. (CCSS: 3.MD.8)	
b. Use the Pythagorean Theorem to solve real-world problems.	MA10-GR.8-S.4-GLE.2-EO.b	Apply the Pythagorean Theorem to determine unknown side lengths in right triangles in real-world and mathematical problems in two and three dimensions. (CCSS: 8.G.7)	

Standard 4	Students use geometric concepts, properties, and relationships in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 3	Make and test conjectures about geometric shapes and their properties, incorporating technology where appropriate.		
Assessment Objective	**CAS Alignment Code**	**CAS Expectation Text**	**Comment**
a. Make and test conjectures about geometric shapes and their properties (for example, parallelism, perpendicularity, similarity, congruence, symmetry).	MA10-GR.8-S.4-GLE.2-EO.a	Verify experimentally the properties of rotations, reflections, and translations. (CCSS: 8.G.1)	
	MA10-GR.8-S.4-GLE.2-EO.b	Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates. (CCSS: 8.G.3)	
	MA10-GR.8-S.4-GLE.2-EO.c	Demonstrate that a two-dimensional figure is congruent to another if the second can be obtained from the first by a sequence of rotations, reflections, and translations. (CCSS: 8.G.2)	
	MA10-GR.8-S.4-GLE.2-EO.d	Given two congruent figures, describe a sequence of transformations that exhibits the congruence between them. (CCSS: 8.G.2)	
	MA10-GR.8-S.4-GLE.2-EO.e	Demonstrate that a two-dimensional figure is similar to another if the second can be obtained from the first by a sequence of rotations, reflections, translations, and dilations. (CCSS: 8.G.4)	
	MA10-GR.8-S.4-GLE.2-EO.f	Given two similar two-dimensional figures, describe a sequence of transformations that exhibits the similarity between them. (CCSS: 8.G.4)	
	MA10-GR.8-S.4-GLE.2-EO.g	Use informal arguments to establish facts about the angle sum and exterior angle of triangles, about the angles created when parallel lines are cut by a transversal, and the angle-angle criterion for similarity of triangles. (CCSS: 8.G.5)	
b. Use coordinate geometry to solve problems involving shapes and their properties.	MA10-GR.8-S.4-GLE.1-EO.b	Describe the effect of dilations, translations, rotations, and reflections on two-dimensional figures using coordinates. (CCSS: 8.G.3)	
	MA10-GR.5-S.4-GLE.2-EO.a	Graph points on the coordinate plane to solve real-world and mathematical problems. (CCSS: 5.G)	

Standard 5	Students use a variety of tools and techniques to measure, apply the results in problem-solving situations, and communicate the reasoning used in solving these problems.		
Benchmark 1	Measure quantities indirectly using techniques of algebra, geometry, or trigonometry.		
Assessment Objective	**CAS Alignment Code**	**CAS Expectation Text**	**Comment**
~~a. Use appropriate measurements to solve problems indirectly (for example, find the height of a flagpole using similar triangles.~~			This is not explicitly in 9th grade or below in the CAS
b. Use measurement to solve real-world problems involving rate of change (for example, distance traveled using rate and time).	MA10-GR.8-S.2-GLE.3-EO.b (i-vi)	Use functions to model relationships between quantities. (CCSS: 8.F) i. Construct a function to model a linear relationship between two quantities. (CCSS: 8.F.4) ii. Determine the rate of change and initial value of the function from a description of a relationship or from two (*x, y*) values, including reading these from a table or from a graph. (CCSS: 8.F.4) iii. Interpret the rate of change and initial value of a linear function in terms of the situation it models, and in terms of its graph or a table of values. (CCSS: 8.F.4) iv. Describe qualitatively the functional relationship between two quantities by analyzing a graph. (CCSS: 8.F.5) v. Sketch a graph that exhibits the qualitative features of a function that has been described verbally. (CCSS: 8.F.5) vi. Analyze how credit and debt impact personal financial goals (PFL)	
	MA10-GR.7-S.1-GLE.1-EO.a	Analyze proportional relationships and use them to solve real-world and mathematical problems.(CCSS: 7.RP)	

Standard 5	Students use a variety of tools and techniques to measure, apply the results in problem-solving situations, and communicate the reasoning used in solving these problems.		
Benchmark 1	Measure quantities indirectly using techniques of algebra, geometry, or trigonometry.		
c. Describe how changing one attribute of a shape affects its angle measure, perimeter, circumference, area, surface area and volume.	MA10-GR.7-S.4-GLE.2-EO.d	Solve real-world and mathematical problems involving area, volume and surface area of two- and three-dimensional objects composed of triangles, quadrilaterals, polygons, cubes, and right prisms. (CCSS: 7.G.6)	
	MA10-GR.7-S.1-GLE.1-EO.b	Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. (CCSS: 7.RP.1)	

Standard 5	Students use a variety of tools and techniques to measure, apply the results in problem-solving situations, and communicate the reasoning used in solving these problems.		
Benchmark 2	Select and use appropriate tools and techniques to measure quantities in order to achieve specified degrees of precision, accuracy and error (or tolerance) of measurements.		
Assessment Objective	**CAS Alignment Code**	**CAS Expectation Text**	**Comment**
a. Select and use appropriate tools and techniques to measure quantities in order to achieve specified degrees of precision, accuracy, and error (or tolerance) of measurements.			This is part of the standard for mathematical practices, “Use appropriate tools strategically” and “Attend to precision”. Students should be familiar with the language “relative error”.

Standard 6	Students link concepts and procedures as they develop and use computational techniques, including estimation, mental arithmetic, paper-and-pencil, calculators, and computers, in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 1	Use ratios, proportions, and percents in problem-solving situations.		
a. Use ratios, proportions, and percents in problem-solving situations that involve rational numbers.	MA10-GR.7-S.1-GLE.1-EO.a	Analyze proportional relationships and use them to solve real-world and mathematical problems.(CCSS: 7.RP)	
	MA10-GR.7-S.1-GLE.1-EO.b	Compute unit rates associated with ratios of fractions, including ratios of lengths, areas and other quantities measured in like or different units. (CCSS: 7.RP.1)	
	MA10-GR.7-S.1-GLE.1-EO.c (i-iv)	Identify and represent proportional relationships between quantities. (CCSS: 7.RP.2) i. Determine whether two quantities are in a proportional relationship. (CCSS: 7.RP.2a) ii. Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships. (CCSS: 7.RP.2b) iii. Represent proportional relationships by equations. (CCSS: 7.RP.2c) iv. Explain what a point (x, y) on the graph of a proportional relationship means in terms of the situation, with special attention to the points (0, 0) and (1, r) where r is the unit rate. (CCSS: 7.RP.2d)	
	MA10-GR.7-S.1-GLE.1-EO.d (i-ii)	Use proportional relationships to solve multistep ratio and percent problems. (CCSS: 7.RP.3) i. Estimate and compute unit cost of consumables (to include unit conversions if necessary) sold in quantity to make purchase decisions based on cost and practicality (PFL) ii. Solve problems involving percent of a number, discounts, taxes, simple interest, percent increase, and percent decrease (PFL)	
b. Convert from one set of units to another using proportions (for example, feet/minute to miles/hour).	MA10-GR.6-S.1-GLE.1-EO.c.viii	Use ratio reasoning to convert measurement units	

Standard 6	Students link concepts and procedures as they develop and use computational techniques, including estimation, mental arithmetic, paper-and-pencil, calculators, and computers, in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 1	Use ratios, proportions, and percents in problem-solving situations.		
c. Apply direct variation to problem-solving situations.	MA10-GR.7-S.1-GLE.1-EO.c (i-iv)	Identify and represent proportional relationships between quantities. (CCSS: 7.RP.2) i. Determine whether two quantities are in a proportional relationship. (CCSS: 7.RP.2a) ii. Identify the constant of proportionality (unit rate) in tables, graphs, equations, diagrams, and verbal descriptions of proportional relationships. (CCSS: 7.RP.2b) iii. Represent proportional relationships by equations. (CCSS: 7.RP.2c) iv. Explain what a point (x, y) on the graph of a proportional relationship means in terms of the situation, with special attention to the points (0, 0) and (1, r) where r is the unit rate. (CCSS: 7.RP.2d)	

Standard 6	Students link concepts and procedures as they develop and use computational techniques, including estimation, mental arithmetic, paper-and-pencil, calculators, and computers, in problem-solving situations and communicate the reasoning used in solving these problems.		
Benchmark 2	Select and use appropriate algorithms for computing with real numbers in problem-solving situations and determine whether the results are reasonable.		
Assessment Objective	**CAS Alignment Code**	**CAS Expectation Text**	**Comment**
a. Apply appropriate computational methods to solve multi-step problems involving rational numbers.	MA10-GR.7-S.1-GLE.2-EO.c	Solve real-world and mathematical problems involving the four operations with rational numbers. (CCSS: 7.NS.3)	
	MA10-GR.8-S.1-GLE.1-EO.d	Apply the properties of integer exponents to generate equivalent numerical expressions. (CCSS: 8.EE.1)	

Note: Some assessment objectives or parts of assessment objectives are not contained within the Colorado Academic Standards at or below this grade level but will continue to be assessed by the TCAP in 9th grade. The concepts from these objectives are reflected in the table below.

Grade 9 Mathematics	Relevant Assessment Objective(s)
Understand the meaning of the words “relative error”	5.2a