Indiana Mathematics

Quantitative Reasoning: Grades 9, 10, 11, 12

Adopted 2020

Process Standards For Mathematics

1. **Make sense of problems and persevere in solving them.** PS.1
2. **Reason abstractly and quantitatively.** PS.2
3. **Construct viable arguments and critique the reasoning of others.** PS.3
4. **Model with mathematics.** PS.4
5. **Use appropriate tools strategically.** PS.5
6. **Attend to precision.** PS.6
7. **Look for and make use of structure.** PS.7
8. **Look for and express regularity in repeated reasoning.** PS.8

Numeracy

1. **Represent quantities in equivalent forms (fractions, decimals, and percentages) to investigate and describe quantitative relationships and solve real-world problems in a variety of contexts. Compare the size of numbers in different forms arising in authentic real-world contexts, such as growth expressed as a fraction versus as a percentage. Interpret the meaning of numbers in different forms, such as the meaning of a fraction or the meaning of a percentage greater than 100 and its validity in a given context. Recognize incorrect or deceptive uses of fractions, decimals, or percentages.** QR.N.1
2. **Solve problems involving calculations with percentages and interpret the results, such as calculating percentage rates or differentiating between a discount of 30% and two consecutive discounts of 15%. Calculate relative change and explain how it differs from absolute change. Recognize incorrect or deceptive uses of percentages.** QR.N.2
3. **Interpret numbers in different forms in terms of authentic contexts to solve real-world problems, such as interpreting a growth rate less than 1%. Compare and precisely communicate with numbers in different forms (including words, fractions, decimals, standard notation, and scientific notation), such as comparing relative and absolute changes in quantities.** QR.N.3

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4. **Compare magnitudes of numbers in context, such as the population of the US compared to the population of the world. Perform such comparisons when numbers are in different forms (including words, fractions, decimals, standard notation, and scientific notation).** QR.N.4

5. **Perform accurate and efficient calculations using large and small numbers in different forms, to an appropriate precision, with and without technology. Include calculations in context, such as ratios representing water use per capita for a large population.** QR.N.5

6. **Use estimation skills, and know why, how, and when to estimate results. Identify and use numeric benchmarks for estimating calculations (e.g., using 25% as an estimate for 23%). Identify and use contextual benchmarks for comparison to other numbers (e.g., using the US population as a benchmark to evaluate reasonableness of statistical claims or giving context to numbers). Check for reasonableness using both types of benchmarks.** QR.N.6

7. **Use dimensional analysis to convert between units of measurements and to solve problems involving multiple units of measurement, such as converting between currencies, calculating the cost of gasoline to drive a given car a given distance, or calculating dosages of medicine.** QR.N.7

Ratio and Proportional Reasoning

1. **Solve real-life problems requiring interpretation and comparison of complex numeric summaries which extend beyond simple measures of center, such as problems requiring interpreting and/or comparing weighted averages, indices, coding, and ranking. Evaluate claims based on complex numeric summaries.** QR.P.1

2. **Understand and communicate percentages as rates per 100, and identify uses and misuses of percentages related to a proper understanding of the base in real-world and mathematical problems.** QR.P.2

3. **Solve real-life problems requiring interpretation and comparison of various representations of ratios, (i.e. fractions, decimals, rate, and percentages), such as problems that involve non-standard ratios (e.g., media and risk reporting) or part-to-part versus part-to-whole ratios taken from meaningful context.** QR.P.3

4. **Analyze growth and decay using absolute and relative change and make comparisons using absolute and relative difference.** QR.P.4

5. **Distinguish between proportional and non-proportional situations, and, when appropriate, apply proportional reasoning, such as when solving for an unknown quantity in proportional situations; solving real-life problems requiring conversion of units using dimensional analysis; or applying scale factors to perform indirect measurements (e.g., maps, blueprints, concentrations, dosages, and densities). Recognize when proportional techniques do not apply.** QR.P.5

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Determine the constant of proportionality in proportional situations (both real-life and mathematical), leading to a symbolic model for the situation (i.e. an

	equation based upon a rate of change, y = kx). QR.P.6
Modeling	1. Analyze and critique mathematical models and be able to describe their limitations, including distinguishing between correlation and causation and determine whether interpolation and/or extrapolation are appropriate. QR.M.1
	2. Use models, including models created with spreadsheets or other tools, to estimate solutions to contextual questions, such as functional models to estimate future population or spreadsheets to model financial applications (e.g. credit card debt, installment savings, amortization schedules, mortgage and other loan scenarios). Identify patterns and identify how changing parameters affect the results. QR.M.2
	3. Choose and create, with and without technology, linear, exponential, logistic, or periodic models and curves of best fit for bivariate data sets. Use the models to answer questions and draw conclusions or make decisions, addressing limitations and long-term ramifications of chosen models when appropriate. Recognize when a change in model is needed. QR.M.3
	4. Analyze real-world problem situations and use variables to construct and solve equations involving one or more unknown or variable quantities to answer questions about the situations, such as creating spreadsheet formulas to calculate prices based on percentage mark-up or solving formulas for specified values. Demonstrate understanding of the meaning of a solution. Identify when there is insufficient information given to solve a problem. QR.M.4
	5. Apply geometric concepts to model situations and solve problems such as those arising in art, architecture, and other fields. QR.M.5
	6. The student uses a variety of network models represented graphically to organize data in quantitative situations, make informed decisions, and solve problems, such as in scheduling or routing situations that can be modeled using different methods, e.g., vertex-edge graphs using critical paths, Euler paths, or minimal spanning trees. QR.M.6
Probabilistic Reasoning to Assess Risk	1. Determine the nature and number of elements in a finite sample space to model the outcomes of real-world events using counting techniques, and build the sample space by making lists, tables, or tree diagrams. QR.PR.1
	2. Determine the number of ways an event may occur using the Fundamental Counting Principle. QR.PR.2
	3. Evaluate the validity of claims based on empirical, theoretical, and subjective probabilities. Draw conclusions or make decisions related to risk, pay-off, expected value, and false negatives/positives in various probabilistic contexts. QR.PR.3
	Use data displays and models, such as two-way tables, tree diagrams, Venn diagrams, and area models, to determine probabilities (including conditional

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probabilities) and use these probabilities to make informed decisions. QR.PR.4

Statistics

1. Analyze statistical information from studies, surveys, and polls (including when reported in condensed form or using summary statistics) to make informed judgments as to the validity of claims or conclusions, such as when interpreting and comparing the results of polls using margin of error. QR.S.1
2. Identify limitations, strengths, or lack of information in studies, including data collection methods (e.g. sampling, experimental, observational) and possible sources of bias, and identify errors or misuses of statistics to justify particular conclusions. QR.S.2
3. Create (with and without technology) and use visual displays of real world data, such as charts, tables and graphs. QR.S.3
4. Interpret and analyze visual representations of data, and describe strengths, limitations, and fallacies of various graphical displays. QR.S.4
5. Read, interpret, and make decisions about data summarized numerically using measures of center and spread, in tables, and in graphical displays (line graphs, bar graphs, scatterplots, and histograms), e.g., explain why the mean may not represent a typical salary; explain the difference between bar graphs and histograms; critique a graphical display by recognizing that the choice of scale can distort information. QR.S.5
6. Summarize, represent, and interpret data sets on a single count or measurement variable using plots and statistics appropriate to the shape of the data distribution to represent it. QR.S.6
7. Compare center, shape, and spread of two or more data sets and interpret the differences in context. QR.S.7
8. Use properties of distributions, including uniform and normal distributions, to analyze data and answer questions. QR.S.8
9. Recognize when data are normally distributed and use the mean and standard deviation of the data to fit it to a normal distribution. QR.S.9