

# Quantitative Reasoning

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Alta Quantitative Reasoning is a 1 - 2 semester course intended for students who require quantitative literacy skills. Many students pursuing a degree that has a general education math requirement will take this course. To develop this course, Knewton used four main sources of content: OpenStax Introductory Statistics, OpenStax PreAlgebra, Washington Open Course Library, and videos from an Online Stat book developed by Rice University, University of Houston, and Tufts University, along with a team of Subject Matter Experts. The SMEs come from diverse backgrounds and are all accomplished academics in the field of Mathematics, and have experience teaching and designing Quantitative Reasoning courses. Knewton Quantitative Reasoning covers the breadth of quantitative reasoning topics and also provides the necessary depth to ensure the course is manageable and engaging for instructors and students alike.

Alta Quantitative Reasoning has two instructional sequences for every learning objective, giving students multiple opportunities to learn new concepts. Between our text, video, and original SME content, we were able to solicit ideas from Quantitative Reasoning instructors from community colleges to Ph.D- granting universities. Alta Quantitative Reasoning provides a level of academic rigor, while also promoting relevance and accessibility for students. Knewton has added current and relevant contexts and examples to instruction and assessments.

## Quantitative Reasoning | Table of Contents

### Chapter 1: Critical Thinking and Set Theory

#### 1.1 Inductive / Deductive

- Understand and use inductive reasoning
- Understand and use deductive reasoning
- Identify the premise and conclusion of an argument
- Find fallacies in an argument

#### 1.2 Estimation

- Estimate a value by rounding a whole number
- Estimate a value by rounding a decimal
- Estimate using a pie chart or bar graph

#### 1.3 Introduction to Problem Solving

- Explain Polya's four steps to solving a problem
- Solve a problem using trial and error
- Solve a problem using estimating
- Solve a problem using diagram

#### 1.4 Applications with Problem Solving Strategies

- Identify the piece of information needed to solve a problem and unnecessary information given in a problem
- Solve an application problem by applying Polya's four step procedure

#### 1.5 Sets Fundamentals

- Represent a set using a written description and the roster method
- Represent a set using set builder notation
- Identify the cardinal number for a set
- Determine if two sets are equivalent
- Determine if two sets are equal

#### 1.6 Sets Applications

- Identify subsets, universal sets, and empty sets
- Distinguish between finite and infinite sets
- Identify subsets and proper subsets using set notation
- Determine the number of subsets and proper subsets in a given set

#### 1.7 Venn Diagrams from Sets

- Illustrate the universal set, a set, and complement of a set using a Venn diagram
- Illustrate two sets using Venn diagram and set notation

#### 1.8 Venn Diagram and Set Operations

- Determine the complement of a set using Venn diagrams and proper set notation
  - Determine the intersection of two sets using Venn diagrams and set notation
  - Determine the union of two sets using Venn diagrams and set notation
-

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- Perform operations on sets
- Find the difference and cartesian product of two sets
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- Determine the cardinal number of a union of two finite sets

### 1.10 Venn Diagrams with Three Sets and Verification of Equality of Sets

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- Apply De Morgan's law using Venn diagrams
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## Chapter 2: Logic

### 2.1 Statement and Logical Connectives

- Identify and negate simple statements
- Identify and negate quantified statements
- Identify logical connectives and compound statements

### 2.2 Converting Logic Statements to English

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- Represent conditional statements in symbolic form and English
- Write biconditional statements in symbolic form and English

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- Construct a truth table for a statement with a conjunction and/or a negation and determine its truth value
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- Multiply two numbers using duplation and mediation
- Multiply two numbers using lattice multiplication
- Multiply two numbers using Napier's rods

## 3.5 Intro to Rules of Exponents and Scientific Notation

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  - Use the product rule of exponents
-

- Use the quotient rule of exponents
- Use the power rule of exponents

### 3.6 Advanced Rules of Exponents and Scientific Notation

- Simplify numerical expressions containing exponents
- Simplify expressions using the product property for exponents
- Simplify expressions using the quotient to a power property
- Simplify expressions using the power property for exponents or the product to a power property for exponents

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-

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- Convert decimals and fractions to percents

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### **Chapter 5: Probability**

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- Use and, or, and not notation to describe events
- Use conditional probability notation to describe events

#### 5.2 Basic Probability

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- Compute basic probability in a situation where there are equally-likely outcomes
- Compute probability involving and, or, and not
- Compute probability using the complement rule

#### 5.3 Independent and Mutually Exclusive Events

- Understand mutually exclusive events
- Find the conditional probabilities of independent and mutually exclusive events
- Distinguish between independent or mutually exclusive events given conditional probability information

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- Use the counting principle and the multiplication rule for independent events
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- Use the addition rule for mutually exclusive event probabilities

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- Use a contingency table to find probabilities

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- Find the number of permutations of  $n$  non-distinct objects

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- Find the number of subsets of a set

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- Compute the probability of equally likely outcomes in application

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- Compute probability involving permutations
- Compute probability involving combinations
- Use the complement rule to compute probabilities

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- Compute the probability of the union of two events
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- Distinguish between risk and odds

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### 6.1 Percent, Sales Tax, and Income Tax

- Convert between percents, decimals, and fractions
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### 6.4 Evaluating Exponential Functions

- Evaluate exponential functions
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- Calculate compound interest
- Calculate continuously compounded interest

### 6.6 Working with Compound Interest

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- Use the continuously compounding interest formula to find the new value of an account

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- Define stock terminology
- Read a stock table

### 6.9 Installment Loans and Amortization

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  - Choose the best installment loan plan
  
  - Evaluate student loan options
-

- Explain and interpret Credit scores, FICA, and federal income taxes

#### 6.10 Credit Cards and interest

- Recognize key features of credit cards
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- Determine interest to be paid on a card's next billing date

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- Calculate the annual rate of inflation
- Use the Consumer Price Index to calculate inflation rates

### **Chapter 7: Data Collection and Sampling**

#### 7.1 Overview of Statistics and Experimental Design

- Evaluate the strength of evidence against a claim about a population proportion
- Identify and describe the steps in the statistical analysis process
- Determine whether a study is observational or an experiment and appropriate use cases
- Identify components of the experimental design in a given experiment: use of a control group, use of a placebo, and blinding
- Identify confounding variables

#### 7.2 Variables and Measures of Data

- Identify explanatory and response variables in an experiment
- Define and distinguish between qualitative, quantitative, discrete, and continuous variables
- Identify levels of measurement of data

#### 7.3 Sampling Methods

- Understand the definitions of population, sample, statistic, parameter, and data

#### 7.4 Comparing Sampling Methods

- Identify and distinguish between stratified, cluster, systematic, and convenience sampling
- Determine appropriate sampling methods

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- Explain why a poor sampling plan can result in misleading conclusions
- Identify situations in which statistics can be misleading

### **Chapter 8: Graphic Displays of Data**

#### 8.1 Frequency tables

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- Construct and understand cumulative relative frequency tables for a set of data

#### 8.2 Frequency Tables and Histograms

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  - Identify and label shapes of histograms
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- Construct and understand relative frequency tables for a set of data with technology - Calculator
- Create and interpret histograms with technology - Calculator

### 8.4 Histograms and Frequency Tables with Technology - Excel

- Construct and understand frequency tables for a set of data with technology - Excel
- Construct and understand relative frequency tables for a set of data with technology - Excel
- Create and interpret histograms with technology - Excel

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### 8.8 Dot plots, Line and Bar graphs with Technology - Calculator

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- Create and interpret line and bar graphs of data with technology - Calculator

### 8.9 Dot plots, Line and Bar graphs with Technology - Excel

- Create and interpret dot plots with technology - Excel
- Create and interpret line and bar graphs of data with technology - Excel

### 8.10 Choose appropriate graphs to display data

- Choose appropriate graphs and charts to display data

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- Find the mean of a set of data
- Find the mean from a frequency table
- Find the median of a set of data
- Find the mode of a set of data

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- Identify the effect of outliers on measures of central tendency
- Determine whether the mean, median, or mode is the best measure of center for a data set

### 9.3 Distribution Shape

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  - Determine if a data set is skewed
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- Interpret the standard deviation of a set of data -v1

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- Find and interpret percentiles and quartiles of a data set
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- Standardize a normally distributed random variable
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#### 10.4 Using the Normal Distribution with Technology- Excel

- Use the normal distribution to compute probability with technology - Excel
- Use the normal distribution to compute a value for a random variable given probability - Excel
- Use the normal distribution to approximate the binomial with technology - Excel

### **Chapter 11: Linear Functions and Modeling**

#### 11.1 Solving Linear Equations

- Solve equations in one variable algebraically, variable just on one side
- Solve equations in one variable algebraically, variable on both sides
- Solve equations using cross multiplication

#### 11.2 Applying formulas

- Use a formula
  - Solve a formula for a given variable
  - Solve a formula for a specific variable
  - Use a formula to solve a geometric application
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### 11.3 Slope and Intercepts

- Plot ordered pairs in a Cartesian coordinate system
- Graph equations by plotting points
- Graph linear equations by plotting points
- Interpret slope as a rate of change
- Find the slope given a line or given two points

### 11.4 Graphing Linear Equations

- Graph linear equations using point-slope form
- Graph a line using a point and the slope
- Understand the relationship between the slope and y-intercept of a line and its equation

### 11.5 Finding Equations

- Determine a linear function using point-slope form
- Find equation of a line, in slope-intercept form, given slope and one point (point-slope formula)
- Find equation, in slope-intercept form, of a line passing through two given points

### 11.6 Working with Linear Equations

- Write the equation of a line using a point and a slope
- Write the equation of a line using two points
- Given slope and intercept, find the equation of a line and write it in standard form
- Calculate a slope in word problems

### 11.7 Graphing Special Cases

- Find the equation of vertical and horizontal lines
- Use slopes to identify parallel lines
- Use slopes to identify perpendicular lines
- Given the equations of two lines, determine whether their graphs are parallel or perpendicular

### 11.8 Linear Inequalities

- Use interval notation
- Use properties of inequalities
- Solve simple inequalities in one variable algebraically

### 11.9 Solving Linear Inequalities

- Solve an inequality using the subtraction and addition properties of inequality
- Solve an inequality using the division and multiplication properties of inequality
- Solve an inequality that requires simplification

### 11.10 Advanced Linear Inequalities

- Solve compound inequalities in one variable algebraically
- Solve a linear inequality in two variables by graphing
- Solve a compound inequality involving intersections
- Graph a linear inequality in two variables

### 11.11 Functions

- Identify domain and range from a set of ordered pairs
  - Determine whether a relation represents a function
-

- Use the vertical line test to identify functions
- Find the domain and range of a function defined by a graph

#### 11.12 Function Notation

- Understand function notation
- Evaluate a function using function notation

#### 11.13 Evaluating Functions

- Evaluate or solve a function from a table
- Evaluate or solve a function from a graph
- Represent a linear function in table form

#### 11.14 Graphs of Linear Functions

- Graph linear functions
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- Set up a linear equation to solve a real-world application
- Translate verbal expressions into mathematical expressions
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- Understand properties of linear equations
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- Graph exponential functions
- Graph an exponential function and understand its properties

#### 12.2 Relate Logarithms and Exponents

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  - Convert from exponential to logarithmic form
-

### 12.3 Evaluate Logarithmic Expressions

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- Evaluate logarithms with negative integer solutions
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- Use common logarithms
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### 12.4 Properties and Graphs of Logarithmic Functions

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- Perform an exponential regression with a calculator
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- Factor a trinomial of the form  $x^2+bx+c$  where  $c$  is positive
-

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- Factor a trinomial using trial and error
- Factor a trinomial using the 'ac' method

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- Convert between non-metric units and metric units using dimensional analysis

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### 13.10 Volume and Surface Area of Round Conventional Solids

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- Find the surface area of spheres and cylinders

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  - Determine the number of Hamilton circuits in a graph
-

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- Select the winner of an election using the pairwise comparison method

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- Determine a voting systems fairness using the head to head count criterion
- Determine a voting system's fairness using the monotonicity criterion

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- Determine a voting system's fairness using the irrelevant alternatives criterion
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#### 15.5 Apportionment Methods by Calculating Quotas

- Determine the standard quota for a state given its population
- Calculate the lower and upper quotas for a state given its population

#### 15.6 Apportionment Methods - Hamilton, Jefferson, Adam and Webster Methods

- Use Hamilton's method of determining apportionment
- Use Jefferson's method of determining apportionment
- Use Adam's method of determining apportionment
- Use Webster's method of determining apportionment

#### 15.7 Flaws of the Apportionment Methods

- Identify where the Alabama paradox occurs
- Identify where the population paradox occurs
- Identify where the new states paradox occurs
- Choose the best apportionment system for a given region

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#### 16.1 Number Theory

- Understand and identify prime and composite numbers
  - Find the GCF and LCM of two or more numbers
-

- Find the prime factorization of a number

#### 16.2 The Integers

- Understand integers and find opposites of numbers
- Order and compare integers
- Understand and evaluate absolute value
- Evaluate an absolute value expression

#### 16.3 Working with Integers

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- Understand distance in terms of absolute value
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- Find equivalent fractions
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- Multiply fractions
- Find reciprocals of fractions
- Divide fractions

#### 16.7 Combining Fractions

- Add and subtract fractions with like denominators
- Add and subtract fractions with unlike denominators
- Add or subtract fractions with a common denominator
- Add or subtract fractions with different denominators
- Add and subtract fractions in applications

#### 16.8 Sequences of Rational Numbers

- Write the terms of a sequence defined by an explicit formula

#### 16.9 Ratios and Proportions

- Solve ratio and unit rate problems
  - Understand a unit rate
  - Understand ratios
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#### 16.10 Advanced Ratios

- Solve fractional ratio problems
- Understand fractional ratios

#### 16.11 Arithmetic Sequences

- Find the common difference of an arithmetic sequence
- Write terms of an arithmetic sequence
- Write an explicit formula for an arithmetic sequence

#### 16.12 Sums of Series and Notation

- Evaluate expressions using summation notation
- Find the sum of a finite arithmetic series

#### 16.13 Geometric Sequences

- Find the common ratio of a geometric sequence
- Write terms of a geometric sequence
- Write an explicit formula for a geometric sequence
- Find the sum of a finite geometric series

#### 16.14 Slopes of Equations of lines

- Write the equation of a line parallel to a given line
  - Write the equation of a line perpendicular to a given line
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