

GRADES

10-12

BUILD
CONFIDENCE.
ONE REP
AT A TIME.

$$P(A) = \frac{1}{6}$$

Muscle Math Mania

★ STATISTICS & PROBABILITY ★

STRONGER SKILLS. EVERY SINGLE REP.



MASTER
STATISTICS
CONCEPTS



THINK
CRITICALLY



BUILD
CONFIDENCE



MAKE SENSE
OF DATA



SOLVE
STEP BY STEP

SKILLS YOU NEED.
REPS YOU
CONTROL.

How to Use This Book

Every lesson has the same five parts, in the same order, on one page: a WARM-UP REP to wake up the skill, COACH NOTES that teach it, a CHECK YOUR FORM box with the mistake people actually make, a WORKED EXAMPLE done in full, and TRY IT for you.

After each lesson comes its worksheet. Every worksheet problem is different from every other worksheet problem in the book — nothing is padded to fill a page.

The last page of each worksheet ends with two CHALLENGE problems. They are extra rather than a replacement for the set above them, and they tend to ask you to work backwards, or to put two steps together, rather than to repeat the one just practiced.

Every unit then ends with a UNIT REVIEW that draws on all of its lessons at once. A review is allowed to ask something you have already met — meeting it again, out of order and away from the lesson that taught it, is the point.

Most of Statistics & Probability is symbolic, but when a graph or diagram is there it is part of the problem, not decoration. The values shown on it are given to you; anything marked with a question mark is what you are being asked to find.

The symbols are the standard ones you will meet in any statistics course: σ and μ for a population's standard deviation and mean, $\bar{x}$ and $\hat{p}$ for a sample's mean and proportion, $\Phi(z)$ for the standard normal table, and r^2 for the coefficient of determination.

Numbers are exact unless a question tells you to round. Every question that does ask asks for two decimal places, so an answer like 0.81568 is not an oversight — it is the exact value, and the working that produced it is exact too.

Every answer is in the back, grouped by unit. Check yourself after each block rather than at the end — a mistake caught early is one page of practice, and a mistake caught late is the whole unit.

WHAT THIS BOOK ASSUMES YOU ALREADY HAVE

Comfort with Algebra 1: solving linear equations, factoring quadratics, the laws of exponents, and graphing lines. All of it is taught in earlier Muscle Math Mania books. This book uses those skills constantly and does not re-teach them.

Contents

UNIT 1 — Introduction to Statistics and Data	7
1.1 Individuals and Variables	8
1.2 Categorical vs. Quantitative Variables	11
1.3 Discrete vs. Continuous	14
1.4 Levels of Measurement	17
1.5 Reading a Data Table	20
<i>Unit 1 Review</i>	23
UNIT 2 — Sampling and Experimental Design	25
2.1 Population, Sample, Parameter, Statistic	26
2.2 Sampling Methods	29
2.3 Bias in Sampling	32
2.4 Observational Studies vs. Experiments	35
2.5 Control, Randomization, Replication	38
2.6 Explanatory and Response Variables	41
<i>Unit 2 Review</i>	44
UNIT 3 — Displaying Categorical Data	46
3.1 Frequency and Relative-Frequency Tables	47
3.2 Bar Charts	50
3.3 Pie (Circle) Charts	53
3.4 Two-Way Tables and Marginal Frequencies	56
3.5 Conditional Relative Frequencies	59
<i>Unit 3 Review</i>	62
UNIT 4 — Displaying Quantitative Data	64
4.1 Dotplots	65
4.2 Stem-and-Leaf Plots	68
4.3 Frequency Distributions	71
4.4 Histograms	74
4.5 Cumulative Frequency and Ogives	77
4.6 Choosing the Right Display	80
<i>Unit 4 Review</i>	83
UNIT 5 — Measures of Center	85
5.1 The Mean	86
5.2 The Median	89
5.3 The Mode	92
5.4 Weighted Mean	95
5.5 Mean vs. Median; Resistance	98
<i>Unit 5 Review</i>	101

UNIT 1

Introduction to Statistics and Data

Individuals, Variables, and the Kinds of Data They Produce

Statistics is the science of learning from data. Before any calculation, a statistician asks two questions: who are the individuals being studied, and what variables are being recorded about them? Every table you will meet is individuals in rows and variables in columns.

Not all data is the same kind. A variable can be categorical (a label) or quantitative (a number you can do arithmetic on), and a quantitative variable can be discrete (counted) or continuous (measured). Knowing the kind decides every display and summary that follows.

BY THE END OF THIS UNIT YOU CAN

- Identify individuals and variables in a dataset
- Tell categorical variables from quantitative ones
- Tell discrete quantitative variables from continuous ones
- Classify a variable's level of measurement
- Read values from a data table

1.1 Individuals and Variables

WARM-UP REP

1. A data table has one row per student in a class and one column per variable. The table has 32 rows and 3 columns. How many data values does it hold?

2. A data table has one row per customer at a store and one column per variable. The table has 19 rows and 4 columns. How many data values does it hold?

3. A dataset records 8 variables for each of 14 players on a team. How many variables are in the dataset?

COACH NOTES

An individual is one member of the group being studied — a person, a car, a city. A variable is a characteristic recorded about each individual. Data is organized with one individual per row and one variable per column.

The number of data values a table holds is simply the number of individuals times the number of variables — rows times columns.

CHECK YOUR FORM

Individuals are the ROWS (who is studied), variables are the COLUMNS (what is recorded). Do not confuse the count of one for the other.

WORKED EXAMPLE

A data table has one row per customer at a store and one column per variable. The table has 31 rows and 4 columns. How many data values does it hold?

Step 1: Data values fill the table: one per individual per variable.

Step 2: $31 \text{ individuals} \times 4 \text{ variables} = 124 \text{ values}$.

Step 3: Answer: 124.

Answer: 124

TRY IT

1. A dataset records 3 variables for each of 13 cities in a survey. How many individuals are in the dataset?

2. A dataset records 5 variables for each of 10 patients in a study. How many variables are in the dataset?

Worksheet 1.1: Individuals and Variables

Part 1 of 2

- 1.** A dataset records 7 variables for each of 12 trees in a park. How many variables are in the dataset?

SET A

- 2.** A data table has one row per student in a class and one column per variable. The table has 13 rows and 7 columns. How many data values does it hold?

SET A

- 3.** A data table has one row per household in a town and one column per variable. The table has 8 rows and 5 columns. How many data values does it hold?

SET A

- 4.** A dataset records 3 variables for each of 20 customers at a store. How many variables are in the dataset?

SET A

- 5.** A dataset records 3 variables for each of 26 households in a town. How many variables are in the dataset?

SET B

- 6.** A dataset records 3 variables for each of 18 households in a town. How many individuals are in the dataset?

SET B

Worksheet 1.1: Individuals and Variables

Part 2 of 2

- 7.** A dataset records 7 variables for each of 15 cars in a lot.
SET B How many variables are in the dataset?

- 8.** A dataset records 8 variables for each of 12 songs on a playlist.
SET B How many individuals are in the dataset?

- 1.** A dataset records 7 variables for each of 18 cars in a parking lot. Then 2 more cars are added and 3 more variables are recorded for every car. How many data values does the dataset hold now?
CHALLENGE

- 2.** A dataset about the students in a class holds 310 data values in all, with 10 variables recorded for each student. How many students must the dataset include?
CHALLENGE

1.2 Categorical vs. Quantitative Variables

WARM-UP REP

1. A researcher records the letter grade (A-F) of each student in a class. Is this variable categorical or quantitative?

2. A researcher records the goals scored in a season of each runner in a race. Is this variable categorical or quantitative?

3. A researcher records the medal won (gold/silver/bronze) of each player on a team. Is this variable categorical or quantitative?

COACH NOTES

A categorical variable records which group an individual falls into — eye color, team name, letter grade. A quantitative variable records a number that measures or counts something — height, goals scored, income.

The test: would averaging the values make sense? You can average heights; you cannot average eye colors. A number used only as a label (a jersey number, a ZIP code) is categorical, not quantitative.

CHECK YOUR FORM

Ask whether arithmetic on the values means anything. Jersey numbers and ZIP codes are labels — categorical — even though they look like numbers.

WORKED EXAMPLE

A researcher records the height in centimeters of each patient in a study. Is this variable categorical or quantitative?

Step 1: Ask whether averaging the values would mean anything.

Step 2: The height in centimeters is quantitative: it is a number that measures or counts, so arithmetic on it is meaningful.

Step 3: Answer: Quantitative.

Answer: Quantitative

TRY IT

1. A researcher records the home ZIP code of each customer at a store. Is this variable categorical or quantitative?

2. A researcher records the chart position (1st/2nd/3rd) of each song on a playlist. Is this variable categorical or quantitative?

Worksheet 1.2: Categorical vs. Quantitative Variables

Part 1 of 2

- 1.** A researcher records the brand of phone of each player on a team. Is this variable categorical or quantitative?
SET A

- 2.** A researcher records the model year of each car in a lot. Is this variable categorical or quantitative?
SET A

- 3.** A researcher records the finish time in minutes of each runner in a race. Is this variable categorical or quantitative?
SET A

- 4.** A researcher records the team name of each runner in a race. Is this variable categorical or quantitative?
SET A

- 5.** A researcher records the books read this year of each customer at a store. Is this variable categorical or quantitative?
SET B

- 6.** A researcher records the favorite music genre of each customer at a store. Is this variable categorical or quantitative?
SET B

Worksheet 1.2: Categorical vs. Quantitative Variables

Part 2 of 2

- 7.** A researcher records the number of vehicles owned of each household in a town. Is this variable categorical or quantitative?
SET B

- 8.** A researcher records the number of public parks of each city in a survey. Is this variable categorical or quantitative?
SET B

- 1.** A reporter says the number of texts sent in a day by each teenager is categorical because the answers fall into groups like 0, 1, or 2. Is this variable actually categorical or quantitative?
CHALLENGE

- 2.** A reporter says the team number of each robot is a quantitative variable because it is written as a number. Is this variable actually categorical or quantitative?
CHALLENGE

Answer Key — Unit 1: Introduction to Statistics and Data

Lesson 1.1 — Warm-Up

- 96
- 76
- 8

Lesson 1.1 — Try It

- 13
- 5

Worksheet 1.1

- 7
- 91
- 40
- 3
- 3
- 18
- 7
- 12

Lesson 1.1 — Challenge

- 200
- 31

Lesson 1.2 — Warm-Up

- Categorical
- Quantitative
- Categorical

Lesson 1.2 — Try It

- Categorical
- Categorical

Worksheet 1.2

- Categorical
- Quantitative
- Quantitative
- Categorical
- Quantitative
- Categorical
- Quantitative
- Quantitative

Lesson 1.2 — Challenge

- Quantitative
- Categorical

Lesson 1.3 — Warm-Up

- Continuous
- Discrete
- Continuous

Lesson 1.3 — Try It

- Discrete
- Discrete

Worksheet 1.3

- Discrete
- Discrete
- Continuous
- Discrete
- Discrete
- Continuous
- Continuous
- Discrete

Lesson 1.3 — Challenge

- Discrete
- Continuous

Lesson 1.4 — Warm-Up

- Nominal
- Ratio
- Interval

Lesson 1.4 — Try It

- Ratio
- Ratio

Worksheet 1.4

- Ordinal
- Nominal
- Nominal
- Ratio
- Nominal
- Ratio
- Interval

- Ratio

Lesson 1.4 — Challenge

- Interval
- Ordinal

Lesson 1.5 — Warm-Up

- 26
- 43
- 11

Lesson 1.5 — Try It

- 39
- 4

Worksheet 1.5

- 3
- 12
- 24
- 39
- 33
- 3
- 4
- 18

Lesson 1.5 — Challenge

- 10
- 3

Unit 1 Review

- 25
- Interval
- 40
- Quantitative
- Continuous
- 24
- Ratio
- 6
- Categorical
- Continuous



THAT WAS THE WARM-UP.

Ready for the full workout?

The Statistics & Probability Workbook · Grades 10-12

WHAT'S IN THE FULL BOOK

- 84 lessons across 15 units
- Real data in every graph and table
- Normal distribution, regression, probability, inference
- Full answer key, grouped by unit

Paperback on Amazon · Instant-download PDF

musclemathmania.com/workbooks

These pages are taken unchanged from the full workbook, so page numbers and answer-key references point to the complete book. This sample is free to print for your own household. Muscle Math Mania workbooks are practice material; no grades, scores or placement are promised.