INTRODUCTION

In Grade 8 mathematics, students continue to build on what they have already learned and are introduced to several new concepts. While working through different topics, students reinforce their understanding of Social and Emotional Learning (SEL) skills, using applications and activities from each content area.

CONTENT

Students will build on the mathematics they learned in Grade 7. They will cover previous content in greater depth and with wider applications. New topics are added in some areas.

Topics under **Number Concepts** include the real number system, which is made up of all rational and irrational numbers. Work in this area includes square roots and scientific notation. Ratios, rates, and proportions are also presented.

Students continue to work with **Number Operations** involving operations with ratios, proportions, and percent as well as the addition, subtraction, multiplication, and division of rational numbers.

Under **Financial Literacy**, students work with financial planning and budgets. This chapter also involves the use of credit cards, loyalty programs and foreign currency transactions.

Students will continue to work with **Equations and Inequalities.** Various forms of first-degree equations and inequalities are included.

The section on **Measurement** includes work with the Pythagorean Theorem as well as additional applications with perimeter, area, surface area, volume, and capacity. The area and circumference of circles are also dealt with in this chapter.

Geometric and Spatial Sense deals with properties of triangles and quadrilaterals. Transformations, tessellations, and 3-D rod designs are included.

The chapters on **Data and Probability** continue work with samples and populations, as well as displaying and interpreting data. Work is extended with independent and dependent events and sample spaces.

The section covering each content area includes a concise description of the concept, followed by examples with clear step-by-step solutions. Students are then provided with questions that range from easy to advanced. Each chapter ends with a test. Answers to all exercises and chapter tests are provided.

SOCIAL EMOTIONAL LEARNING

Social and emotional skills (SES) are important when working with mathematics. Learning can be enriched when students are taught social and emotional skills that include self-awareness. These skills are enhanced in mathematics through the development of problem-solving tactics and the selection of appropriate tools and strategies in approaching a problem. As content areas are taught in this course, it is recommended that the series of activities and questions provided be incorporated into the instructional sequence where appropriate.

Chapter 11 goes into more details on these skills and includes examples with answers or explanations. Each set of examples is followed by a set of exercises.

Communicating

By using numbers, symbols, pictures, graphs, diagrams, and words, you can express mathematical ideas and understanding. This can be done orally, visually, and in writing. This process is called **communicating.** It is important that you are able to communicate to express, describe, explain, and apply mathematical ideas in several different ways. Using this as a tool should help you in creating and interpreting relationships.

Representing

We **represent** mathematical ideas and relationships with the use of drawings, physical models, equations, charts, and graphs. Being able to represent mathematical ideas in different ways and making connections among them to solve problems are important skills.

Connecting and Relating

Relating mathematical concepts to each other is called **Connecting**. It also includes making mathematical connections to the real world.

Reasoning, Proving, and Reflecting

Reasoning involves an understanding about the relationships that apply to numbers, shapes, or operations. It could be thought of as systematic thinking. In applying this skill, you will make use of all your other mathematical skills.

CODING

Learning how computers follow instructions is an important part of **coding** in mathematics. It involves writing a set of instructions that a computer understands in order to get a specific outcome. In Grade 8, we continue to build on your knowledge of coding. We will focus on creating efficient code through the use of loops and other control structures. We will build on the use of sub-programs to simplify programs. Chapter 12 goes into more detail and includes activities related to coding based on content in other chapters in the book.

CHAPTER 1
NUMBER CONCEPTS

1.1 Rational and Irrational Numbers

Rational Numbers

A **rational number** is any number that can be written in the form $\frac{a}{b}$ where a and b are integers and b ≠ 0. This includes the natural numbers (the counting numbers: 1, 2, 3, …), the whole numbers (add 0 to the counting numbers to get 0, 1, 2, 3, …), and integers (add the negatives of counting numbers to the set to get ..., -2, -1, 0, 1, 2, …). Natural, whole, and integer numbers are rational since each can be written in the form $\frac{a}{b}$ ($1 = \frac{1}{1} = \frac{2}{2}$, $-3 = \frac{-3}{1}$, $0 = \frac{0}{4}$).

Examples of Rational Numbers:

All fractions and mixed numbers, both positive and negative

Examples: $\frac{2}{3}, \frac{-3}{4}, \frac{5}{2}, -3\frac{1}{4}$ (note: $\frac{0}{7} = 0$ is rational, but $\frac{7}{0}$ is **not rational** since it is not defined when the denominator equals 0).

All integers

Examples: -11, -3, 0, 1, 5, 68

All terminating and repeating decimals, both positive and negative

Examples: 0.8, -0.32, $0.\overline{3}$, $7.\overline{12}$

Irrational Numbers

A number that cannot be written as the quotient ($\frac{a}{b}$) of two integers is called an **irrational number**.

Examples of Irrational Numbers:

Numbers that are roots of whole numbers that cannot be simplified to obtain a rational number

Examples: $\sqrt{2}, \sqrt{5}, \sqrt{11}$ ($\sqrt{9}$ is rational since it is equal to 3.)

Numbers whose decimal representation does not repeat in a pattern

Examples: 0.1357421… ($0.\overline{3}$ is rational since it repeats a pattern and is equal to $\frac{1}{3}$.)

Special numbers such as π

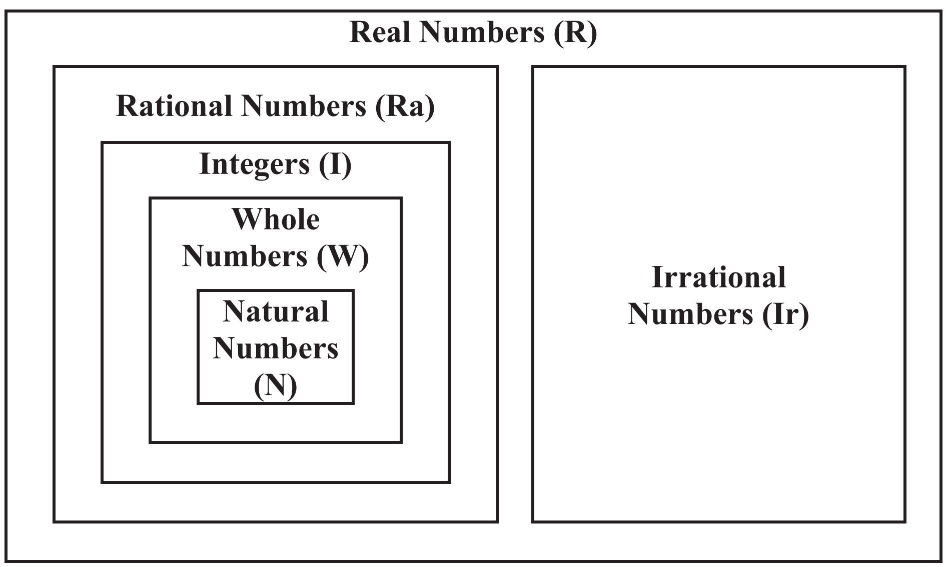
Real Numbers

Real numbers consist of the set of all rational and all irrational numbers.

The set of rational numbers includes the following:

1. Natural numbers: N = $\{1, 2, 3, 4, \ldots\}$
   These are the counting numbers.
2. Whole numbers: W = $\{0, 1, 2, 3, 4, \ldots\}$
   Whole numbers include the set of natural numbers plus 0.
3. Integers: I = $\{\ldots -3, -2, -1, 0, 1, 2, 3, 4, \ldots\}$
   Integers include the set of whole numbers and their negatives.
4. Rational numbers: Ra
   Rational numbers include all of the above plus any other number that can be written in the form $\frac{a}{b}$, b ≠ 0.

The diagram below shows the relationship among the sets of numbers discussed so far.



Identifying Rational and Irrational Numbers

Rational numbers can be shown in several different formats.

1. Natural numbers, whole numbers, and integers

   Examples: 2, -23, 0, 5001, -673

2. Fractions, mixed numbers, or improper fractions

   Examples: $\frac{2}{7}$, $-\frac{3}{5}$, $1\frac{1}{4}$, $\frac{7}{5}$, $-2\frac{1}{10}$, $-\frac{8}{3}$

3. Decimals (terminating or repeating)

   Examples: 0.8, -0.25, $0.22\overline{3}$, $2.\overline{61}$

Examples with Solutions

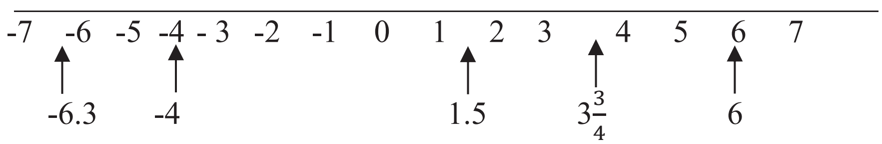
1. Put a check mark (√) if the number belongs to the set of numbers

	Number	N	W	I	Ra	R
1.	3	√	√	√	√	√
2.	-10			√	√	√
3.	$\frac{11}{3}$				√	√
4.	0.9				√	√
5.	$0.\overline{7}$				√	√
6.	π					√
7.	$1\frac{5}{8}$				√	√
8.	1.25				√	√
9.	0		√	√	√	√
10.	$\sqrt{9}$	√	√	√	√	√

Note: N = Natural Numbers, W = Whole Numbers, I = Integers, Ra = Rational Numbers, R = Real Numbers

Comparing and Ordering Rational Numbers

Each rational number corresponds to a point on the number line. Several examples are shown below.



Numbers **increase** in magnitude as you go from left to right on the line.

Examples: $1 < 3$, $2.1 < 4$; $-7 < -6$; and $2 > 1.8$; $-3 > -5$; $-1 > -10.5$

To compare the magnitudes of rational numbers where one is written in decimal and the other in common fraction form, write both either in decimal or else in common fraction form and then compare.

Examples with Solutions

1. Compare 0.1 with $\frac{3}{20}$.

   Convert both to fractions first. Change 0.1 to $\frac{1}{10}$. The common denominator is 20, so $\frac{1}{10} = \frac{2}{20}$.

   $\frac{2}{20} < \frac{3}{20}$ or $0.1 < \frac{3}{20}$

2. Compare 3.15 with $3\frac{1}{11}$.

   Convert both to decimals first. Change $3\frac{1}{11}$ to a decimal $\rightarrow 3.\overline{09}$.

   $3.15 > 3.\overline{09}$ or $3.15 > 3\frac{1}{11}$.

Exercises 1.1

Put a check mark (√) if the number belongs to the set of numbers

	Number	N	W	I	Ra	R
1.	7					
2.	-18					
3.	$\frac{7}{8}$					
4.	0.36					
5.	$0.\overline{5}$					
6.	$\sqrt{6}$					

7. Locate the following numbers on the number line: 3.1, $2\frac{5}{8}$, $-\frac{13}{12}$, $-\sqrt{6}$, $-\sqrt{16}$

-4 -3 -2 -1 0 1 2 3 4

8. Write the following numbers in order from smallest to largest.

a. –0.57, -0.507, -5.07, -5.70

b. 3.4, $-\frac{11}{3}$, -3.4, -3.5

c. $-\frac{3}{8}$, $-\frac{2}{3}$, - 0.6, -0.4

9. Put the correct symbol (>, =, <) between each pair of numbers.

a. 0.15 ☐ $\frac{7}{40}$

b. -1.8 ☐ $-\frac{9}{5}$

c. -2.8 ☐ $-\frac{13}{5}$

Exciting Extras

10. Write each term in common fraction form (as a quotient of two integers).

a. 0.17

b. $-0.\overline{5}$

c. $-1\frac{2}{3}$

d. 3.07

11. Which rational number is greater?

a. $-0.\overline{6}$ or -0.6?

b. -0.25 or $-\frac{1}{3}$?

c. $-\frac{2}{3}$ or $-\frac{4}{5}$?

1.2 Percentage

A percentage is a part of a whole. It can be thought of as parts out of 100. The symbol % means $\frac{\square}{100}$ or out of 100.

If we have 28 parts out of 100, we could write this as a fraction such as $\frac{28}{100}$ (28 out of 100, with 100 being the whole part). We also could have written this as the decimal, 0.28 (with the 28 representing the number of hundredths). The following all represent the same percentage: 28%, 0.28, or $\frac{28}{100}$.

We can have a percentage that is more than 100%. For example, if you got every question correct on a test out of 100 and received 20 bonus marks, you would receive 120% on the test.

Written as a fraction it would be $\frac{120}{100}$, or 120 out of 100. As a decimal, it would be 1.20.

Percentages can also be fractions. For example, we can have a half of a percent. It would be one half out of 100 or $\frac{1}{2}$%. This could also be written as 0.5%.

When a number is written in the form $\frac{a}{b}$, such as $\frac{2}{3}$, it can represent different meanings, depending on the context or situation in which it is used.

As a fraction:	2 parts out of 3 2 is the number of parts and 3 is the whole.
As a rate:	\$2 earned for every 3 hours worked The unit would be dollars per hour.
As a ratio:	2 units of rock for every 3 units of sand The ratio of rock to sand would be 2 to 3.
As a quotient:	2 would be divided by 3 If 2 pies are to be divided among 3 friends, each of them would get $\frac{2}{3}$ of a pie.
As a probability:	2 wins for every 3 games played The chance of winning a particular game would be 2 out of 3 or $\frac{2}{3}$.

As shown, numbers can be written in different forms (integer, ratio, common fraction, decimal fraction, percent) depending on their use in specific situations. Numbers have the same value when written in equivalent forms.

Ratio	1 : 2	These all have the same value, but one form is more suitable than another, depending on their use.
Fraction	$\frac{1}{2}$	
Decimal	0.5	
Percentage	50%	

For the ratios, the second number indicates the number of parts in the whole, so 1 : 2 means that we are comparing 1 part to the whole that contains 2 parts.

Examples of Writing Numbers in Different Forms

Ratio to a Fraction

1. 2 : 5 $\rightarrow \frac{2}{5}$ (2 : 5 means we are looking at 2 parts out of a total of 5 parts.)
2. 7 : 5 $\rightarrow \frac{7}{5}$

Fraction to a Ratio

3. $\frac{2}{3} \rightarrow$ 2 : 3
4. $\frac{10}{6}$ = reduced to $\frac{5}{3} \rightarrow$ 5 : 3
5. $1\frac{7}{8}$ = written as an improper fraction $\frac{15}{8} \rightarrow$ 15 : 8

Fraction to a Decimal

6. $\frac{2}{5} = 0.4$ (divide 2 by 5)
7. $\frac{7}{5} = 1.4$ (divide 7 by 5)
8. $\frac{2}{3} = 0.\overline{6}$ (divide 2 by 3 to get a repeating decimal)
9. $\frac{5}{3} = 1.\overline{6}$ (divide 5 by 3 to get a repeating decimal)
10. $1\frac{7}{8} = 1.875$ (divide 7 by 8)

<u>Decimal to a Fraction</u>

11. $0.7 = \frac{7}{10}$ (since 7 is in the tenths place)

12. $2.37 = 2\frac{37}{100}$ or $\frac{237}{100}$ (since 37 is in the hundredths place)

13. $0.125 = \frac{125}{1000} = \frac{1}{8}$ (since 125 is in the thousandths place and fraction is reduced)

14. $0.\overline{3} = \frac{1}{3}$ (since $0.\overline{1} = \frac{1}{9}$, $0.\overline{2} = \frac{2}{9}$ and $0.\overline{3} = \frac{3}{9}$ to be reduced)

15. $0.004 = \frac{4}{1000} = \frac{1}{250}$ (since 4 is in the thousandths place to be reduced)

16. 0.25 = 25% (To make a decimal a portion out of 100, move the decimal 2 to the <u>right</u>.)

17. 0.375 = 37.5% or $37\frac{1}{2}\%$

18. 1.6 = 160%

19. 8.875 = 887.5% or $887\frac{1}{2}\%$

20. $4.\overline{3} = 433.\overline{3}\%$ or $433\frac{1}{3}\%$

<u>Percentage to a Decimal</u>

21. 35% = 0.35 (Since percentage is out of a 100, move the decimal 2 to the <u>left</u>.)

22. 0.4% = 0.004

23. 513% = 5.13

24. 2.7% = 0.027

25. $66.\overline{6}\% = 0.\overline{6}$

CHAPTER 12
CODING

Coding at the Grade 8 Level

In Grade 8, we continue to focus on writing efficient code through the use of loops and other control structures, as well as creating sub-programs to further simplify more complex programs.

The examples and exercises in this chapter will rely on your knowledge of other topics that we explored in previous chapters. We recommend that you complete those chapters before doing this chapter on coding.

This chapter provides explanations, examples, and practice questions that do not require the use of a computer or other technology. It also includes references to some optional online resources and tools where you can practice writing your own code using a free coding platform. Internet access will be needed to participate in the optional online part of this chapter.

The free coding platform that is used is called *Scratch.* This program makes use of coding blocks that you can drag and drop to create your own code and execute it on the screen.

It is okay if access to the Internet is not possible, as all the topics are covered directly in this book. You will probably enjoy this unit more if you are able to create your own code and test it online.

Scratch is part of the MIT Media Lab and is free to use. (https://scratch.mit.edu)

12.1 Writing Efficient Code

Whether we are writing code that is designed to produce a single outcome, or writing complex conditional statements, it's important to make our code as efficient as possible.

Writing efficient code can be accomplished through the use of **control structures** like **loops** when we have repeating events, and **nested events** when we have a loop that repeats (a loop inside another loop). This will make our code much more efficient which means the computer will execute the code more quickly.

Another strategy for creating efficient code is by creating **sub-programs**. Sub-programs are separate smaller programs that can be added into more complex programs whenever they are needed. By creating sub-programs for the more common and repeated components, we can then reduce the amount of code in our main program because we can simply insert a command that tells the computer to execute this sub-program whenever we need it.

If we want the computer to only execute certain parts of the code based on certain conditions, then we can use **conditional statements**. Using conditional statements also allows us to produce a range of outcomes based on a set of conditions.

Example: Examine the following series of letters.

A B C A B C A B C

We could write some simple code to produce this series of letters and it might look something like the following.

```
Write the letter A
Write the letter B
Write the letter C
Write the letter A
Write the letter B
Write the letter C
Write the letter A
Write the letter B
Write the letter C
```

Is this code the most efficient code for producing that series of letters? If you look at the series of letters, you will notice there is a pattern that keeps repeating. The letters "A B C" are repeating in sequence a total of 3 times.

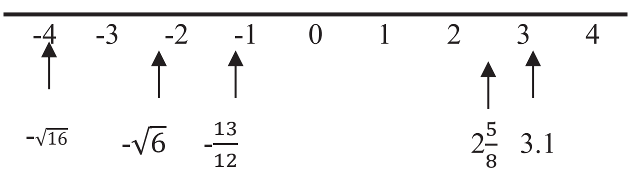
ANSWERS TO EXERCISES AND CHAPTER TESTS

CHAPTER 1

Exercises 1.1 (page 6)

		Set of Numbers				
	No.	**N**	**W**	**I**	**Ra**	**R**
1.	7	√	√	√	√	√
2.	-18			√	√	√
3.	$\frac{7}{8}$				√	√
4.	0.36				√	√
5.	$0.\overline{5}$				√	√
6.	$\sqrt{6}$					√

7.



8. a) -5.70, -5.07, -0.57, -0.507
b) $-\frac{11}{3}$, -3.5, -3.4, 3.4 **c)** $-\frac{2}{3}$, -0.6, -0.4, $-\frac{3}{8}$
9. a) < **b)** = **c)** < **10. a)** $\frac{17}{100}$ **b)** $-\frac{5}{9}$ **c)** $-\frac{5}{3}$
d) $3\frac{7}{100} = \frac{307}{100}$ **11. a)** -0.6 It is to the right of $-0.\overline{6}$ on the number line. b) -0.25
c) $-\frac{2}{3}$ (change to $-\frac{10}{15}$ and $-\frac{12}{15}$)

Exercises 1.2 (page 11)

1.	Ratio	Fraction	Decimal	Percentage
a)	3 : 8	$\frac{3}{8}$	0.375	37.5%
b)	39 : 100	$\frac{39}{100}$	0.39	39%
c)	11 : 3	$\frac{11}{3}$	3..$\overline{6}$	366.$\overline{6}$%
d)	51 : 10	$5\frac{1}{10}$	5.1	510%
e)	1 : 2000	$\frac{1}{2000}$	0.0005	0.05%
f)	1 : 2	$\frac{1}{2}$	0.5	50%
g)	17 : 20	$\frac{17}{20}$	0.85	85%
h)	7 : 5	$\frac{7}{5}$	1.4	140%
i)	1 : 4	$\frac{1}{4}$	0.25	25%
j)	5 : 13	$\frac{5}{13}$	0.3846…	38.46%

Exercises 1.3 (page 13)
1. a) 9 **b)** 11 **c)** -12 **2. a)** 2.6 **b)** 5.3

3.	Estimated Value	Calculator Value
a)	2.2	2.236067978
b)	4.5	4.472135955
c)	6.2	6.244997998

4.	Estimated Value	Calculator Value
a)	28.3	28.33725463
b)	2.8	2.8284271
c)	8.9	8.9442719

5. b **6. a)** rational **b)** irrational
c) irrational **d)** rational **e)** irrational

Exercises 1.4 (page 16)
1. a) 50 : 75 or 2 : 3 or $\frac{2}{3}$ **b)** 4 : 12 : 8 or 1 : 3 : 2 **c)** 80 : 160 or 1 : 2 or $\frac{1}{2}$ **d)** 1 : 3
2. a) 40 words/min **b)** 60 km/h
c) \$0.15/egg **d)** 2 slices/person
e) 500 sheets/package **3. a)** \$7.50 **b)** 2520
c) 560 words **d)** 16 h **e)** $66.\overline{6}$ kg **f)** 608 km
g) 70 points **h)** 73.5 **i)** \$3.43 **j)** 31.5 h
4. a) 7 for \$3.85 **b)** 8 for \$1.89
c) \$105 for 12h **d)** same unit cost **e)** 6-pack
5. \$0.85

Exercises 1.5 (page 20)
1. a) 5 **b)** 8 **c)** 4 **d)** 3 **e)** 2 **f)** 3 **g)** 1 **h)** -5
i) -3 **j)** -2 **k)** -1 **2. a)** 7.65×10^5
b) 8.72×10^7 **c)** 8.34×10^3 **d)** 4.36×10^3
e) 6.58×10^2 **f)** 3.71×10^{-3} **g)** 6.72×10^{-7}
h) 1.59×10^{-2} **i)** 1.99×10^{-1} **j)** 3.65×10^{-4}
3. a) 381 **b)** 529 000 **c)** 0.0368
d) 0.000 004 17 **e)** 5790 **4. a)** 5.23×10^4
b) 8.76×10^6 **c)** 3.25×10^0 **d)** 1.70×10^2
e) 3.16×10^{-5}

Exercises 1.6 (page 24)
1. 1.21 **2.** 0.125 **3.** 2.25 **4.** -0.001 **5.** $\frac{27}{125}$
6. 0.32 **7.** -0.027 **8.** $\frac{1}{256}$ **9.** $\frac{5}{2}$ **10.** -2.31525

Chapter 1 Test (page 25)

Set of Numbers

		N	W	I	Ra	R
1.	- 3			x	x	x
2.	$\sqrt{5}$					x
3.	1.3				x	x

4. and 5.

$-\sqrt{5}$ $2\frac{2}{3}$

-6 -5 -4 -3 -2 -1 0 1 2 3 4 5 6

6. $-\frac{3}{5}$, -0.4, 0.6, $\sqrt{5}$, $2\frac{3}{8}$

	Ratio	Fraction	Decimal	Percent
7.	7 : 5	$1\frac{2}{5}$	1.4	140%
8.	1 : 6	$\frac{1}{6}$	$0.1\overline{6}$	$16.\overline{6}$%
9.	4 : 25	$\frac{4}{25}$	0.16	16%
10.	44 : 125	$\frac{44}{125}$	0.352	35.2%
11.	8 : 9	$\frac{8}{9}$	$0.\overline{8}$	$88.\overline{8}$%

12. 5.5 **13.** \$0.00772/ml **14.** 8 for \$6.45 by about \$0.02375 per bar **15.** 96 kg **16.** 4.53×10^4 **17.** 3.85×10^{-3} **18.** 8370 **19.** 0.0526

CHAPTER 2

Exercises 2.1 (page 32)
1. a) 0.346 9 **b)** 8.356 **c)** 5.216 **d)** 79.35 **e)** 6.278 3 **f)** 2.157 9 **2. a)** 3469 **b)** 835.6 **c)** 5 216 000 **d)** 7935 **e)** 62 783 **f)** 2 157 900 **3. a)** 0.002 85 **b)** 0.721 **c)** 0.049 **d)** 0.006 38 **e)** 0.082 3 **f)** 0.599

Exercises 2.2a (page 35)
1. a) $\frac{19}{5}$ **b)** $\frac{21}{8}$ **c)** $\frac{7}{4}$ **d)** $\frac{29}{6}$ **2. a)** $8\frac{1}{2}$ **b)** $7\frac{2}{3}$ **c)** $5\frac{5}{8}$ **d)** $2\frac{2}{7}$ **3. a)** $\frac{1}{4}$ **b)** $\frac{3}{8}$ **c)** $\frac{3}{16}$ **d)** $\frac{3}{10}$ **4.** 6 **5.** 72 cm

Exercises 2.2b (page 37)
1. a) $\frac{9}{11}$ **b)** $\frac{5}{6}$ **c)** $\frac{1}{2}$ **d)** $4\frac{3}{5}$ **e)** $6\frac{7}{13}$ **f)** $\frac{4}{9}$ **2. a)** $\frac{3}{4}$ **b)** $\frac{5}{6}$ **c)** $\frac{17}{20}$ **d)** $\frac{11}{12}$ **e)** $\frac{15}{28}$ **f)** 9 **3. a)** $\frac{1}{8}$ **b)** $\frac{2}{15}$ **c)** $\frac{1}{12}$ **d)** $\frac{1}{10}$ **e)** $\frac{3}{100}$ **f)** 11 **4. a)** 9 **b)** $9\frac{11}{12}$ **c)** $10\frac{13}{24}$ **d)** $6\frac{7}{12}$ **5. a)** $4\frac{13}{15}$ pages **b)** $24\frac{1}{2}$ cm

Exercises 2.2c (page 41)
1. a) $\frac{1}{9}$ **b)** $\frac{2}{15}$ **c)** $\frac{10}{21}$ **d)** 4 **e)** $2\frac{1}{2}$ **f)** $\frac{5}{8}$ **g)** $\frac{3}{14}$ **h)** $\frac{1}{2}$ **i)** $\frac{2}{5}$ **j)** 18 **k)** 32 **l)** 4 **2. a)** $46\frac{1}{2}$ hours **b)** 88 m **c)** 159

Exercises 2.2d (page 45)
1. a) $\frac{1}{7}$ **b)** $\frac{8}{5}$ **c)** $\frac{3}{4}$ **d)** $\frac{5}{11}$ **e)** $-\frac{3}{2}$ **2. a)** 15 **b)** $12\frac{1}{2}$ **c)** $\frac{1}{9}$ **d)** $\frac{4}{35}$ **3. a)** 2 **b)** $\frac{2}{7}$ **c)** $2\frac{1}{2}$ **d)** $\frac{5}{9}$ **e)** $\frac{8}{9}$ **f)** $\frac{5}{6}$ **g)** $1\frac{7}{15}$ **h)** $2\frac{4}{7}$ **i)** 3 **j)** 4 **4. a)** $\frac{4}{9}$ **b)** $\frac{5}{8}$ **c)** 4 **d)** $4\frac{1}{2}$ **5. a)** $6\frac{2}{3}$ laps **b)** $\frac{1}{44}$ of an hour **c)** $151\frac{1}{2}$ ribbons

Exercises 2.3a (page 48)
1. 31 **2.** 1 **3.** 46 **4.** 49 **5.** 37 **6.** 3 **7.** 8.7 **8.** 29.65 **9.** 5.5

Exercises 2.3b (page 51)
1. a) -7 **b)** 28 **c)** 4 **d)** 14 **e)** 11 **f)** 9 **g)** -17 **h)** -12 **i)** -21 **j)** 4 **k)** -13 **l)** -1 **2. a)** -1 **b)** 6 **c)** -42 **d)** $\frac{1}{8}$ **e)** -24 **f)** 8 **g)** 54 **h)** 25 **i)** 16 **j)** -27 **k)** -3 **l)** 1 **3. a)** 3 **b)** 6 **c)** 11 **d)** 15 **e)** -1 **f)** 29 **g)** 4 **h)** 25 **i)** 5 **j)** -2 **4. a)** 9:21 p.m. **b)** gain of 4 **c)** -15°C **d)** \$3 million **e)** \$1030 **5.** -10 **6.** -4 **7. a)** 72 **b)** 36 **c)** 5625 **d)** 7

Exercises 2.3c (page 54)
1. a) -5 **b)** -5 **c)** $-\frac{1}{10}$ **d)** $6\frac{1}{4}$ **e)** $-1\frac{1}{8}$ **f)** -0.7 **2. a)** -94 **b)** 67 **c)** $\frac{1}{12}$ **d)** $7\frac{7}{8}$ **e)** $-\frac{7}{30}$ **f)** $-\frac{1}{8}$ **g)** 4.55 **3. a)** -5.975 **b)** 3.2 **c)** -4.8 **d)** -8 **e)** -4

Exercises 2.3d (page 56)
1. a) -10 **b)** 4 **c)** -3 **d)** $-\frac{2}{3}$ **e)** $\frac{4}{5}$ **f)** $-1\frac{2}{7}$ **g)** $-1\frac{1}{2}$ **h)** -24.78 **i)** 3.68 **2. a)** $-5\frac{1}{4}$ **b)** $-3\frac{15}{16}$ **c)** -0.027 **d)** 19.52 **e)** -6 **3. a)** 24 **b)** 160 **c)** 22 **d)** $-16\frac{1}{2}$ **e)** $-\frac{1}{12}$