SEVENTH EDITION

WHEN ARE WE EVER GOING TO USE THIS STUFF?

COLLEGE MATHEMATICS FOR THE LIBERAL ARTS MAJOR



By Jim Matovina and
Ronald Yates

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PREFACE

This book represents an accumulation of material over a couple decades. At the College of Southern Nevada, Professors Jim Matovina and Ronnie Yates have been teaching liberal arts math classes, both online and in the classroom, regularly since 1996. They have written and shared their materials with each other and their colleagues over the years, and those collaborations ultimately led to the creation of this book.

Acknowledgments

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The majority of the photographs and images throughout the text were acquired from public domain sites at Wikimedia Commons and Pixabay. Other images came from the database and tools in MS Word, or were actual photographs taken by the authors.

Once again, thanks.

Jim and Ronnie

To the Instructor

This work was originally created as a textbook for the College of Southern Nevada's (CSN's) MATH 120 course, which is commonly referred to as "Liberal Arts Math." It is fun to teach, and as a terminal course, it is typically taken by students who need just one math class to earn their degrees. Since it does not satisfy any prerequisites to other courses, we are given a fair amount of flexibility in what and how we teach, and that is reflected in the survey nature of the course.

In all the material, you should stress practical applications over symbolic manipulations, but that does not mean you should totally discount the algebra. Instead, help the students learn where, when, why, and how the mathematics will help them in their lives.

To the Student

A few years ago, a class was presented with the following problem:

> A farmer looks across his field and sees pigs and chickens. If he counts 42 heads and 106 feet, how many pigs are in the field?

One student, instead of answering the question, sent an e-mail to the instructor stating, "I feel this question is unfair and misleading because pigs do not have feet. They have hooves."

In this class, and in all math classes for that matter, we are not trying to trick you. Although you will, undoubtedly, be presented with some challenging questions, be assured they are there to make you apply and extend your thought processes. Don't waste time and effort looking for technicalities that might invalidate a question. Instead, take the questions at face value, and spend your time trying to solve them.

We completely understand students taking this course are often Liberal Arts majors and/or need only this one math class in order to graduate. Not only that, but, in many cases, students often wonder why they need to take this class in the first place. All of us—yes, including your instructor—have sat in a math class at one time or another and thought, "When are we ever going to use this stuff?" Well, this is the class where we tell you.

—Jim and Ronnie

1 CONSUMER MATH

Money. It controls nearly everything in the world. Those who have it are often seen as more powerful and influential than those who do not. So, having a basic understanding of how money grows and is (or should be) spent is essential.

Understanding percentages is key to understanding how money works. Budgets are based on different percents of available money being allocated in specific ways. Sale discounts and taxes are based on the percent of cost of the items at hand. Credit cards and loans operate on interest rates, which—you guessed it—are given in percents.

The single largest purchase most people will make in a lifetime is a home. A basic understanding of mortgages and finance charges will make you a much wiser homebuyer and could easily save you tens of thousands of dollars over a 20- to 30-year period.

We could go on, but you get the picture.



1.1 On the Shoulders of Giants (Biographies and Historical References)

Historical References in This Book

Throughout this book, you will find many historical references. These fascinating glimpses into the past are there to provide a bit of a human element. Essentially, if you can appreciate some of the people and aspects that led to the development of the mathematics at hand, you can better understand the reasoning behind its existence.

For Consumer Math …

As a signer of both the Declaration of Independence and the Constitution, Benjamin Franklin is considered one of the Founding Fathers of the United States of America. His pervasive influence in the early history of the U.S. has led to his being jocularly called "the only President of the United States who was never President of the United States." Franklin's likeness is ubiquitous, and, primarily due to his keen understanding of the power of compound interest and constant advocacy for paper currency, has adorned all the variations of American $100 bills since 1928.

The Dow Jones Industrial Average (DJIA) is one of several stock market indices; it was created by nineteenth-century *Wall Street Journal* editor Charles Dow. It is an index that shows how certain stocks have traded. Dow compiled the index to gauge the performance of the industrial sector of the American stock market and, thus, the nation's economy.

On December 10, 2008, Bernard "Bernie" Madoff, a former chairman of the NASDAQ Stock Market, allegedly told his sons the asset management arm of his firm was a massive **Ponzi scheme**—as he put it, "one big lie." The following day, he was arrested and charged with a single count of securities fraud, but one that accused him of milking his investors out of $50 billion. The 71-year-old Madoff was eventually sentenced to 150 years in prison.

Benjamin Franklin



Throughout his career, **Benjamin Franklin** was an advocate for paper money. He published *A Modest Enquiry into the Nature and Necessity of a Paper Currency* in 1729, and even printed money using his own press. In 1736, he printed a new currency for New Jersey based on innovative anti-counterfeiting techniques, which he had devised. Franklin was also influential in the more restrained and thus successful monetary experiments in the Middle Colonies, which stopped deflation without causing excessive inflation.

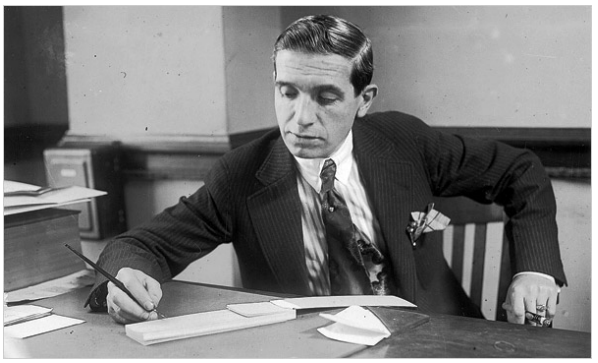
In 1785 a French mathematician wrote a parody of Franklin's *Poor Richard's Almanack* called *Fortunate Richard*. Mocking the unbearable spirit of American optimism represented by Franklin, the Frenchman wrote that Fortunate Richard left a small sum of money in his will to be used only after it had collected interest for 500 years. Franklin, who was 79 years old at the time, wrote to the Frenchman, thanking him for a great idea and telling him that he had decided to leave a bequest of 1,000 pounds (about $4,400 at the time) each to his native Boston and his adopted Philadelphia. By 1940, more than $2,000,000 had accumulated in Franklin's Philadelphia trust, which would eventually loan the money to local residents. In fact, from 1940 to 1990, the money was used mostly for mortgage loans. When the trust came due, Philadelphia decided to spend it on scholarships for local high school students. Franklin's Boston trust fund accumulated almost $5,000,000 during that same time, and was used to establish a trade school that became the Franklin Institute of Boston.

The Dow Jones Industrial Average (DJIA)

Charles Dow compiled his DJIA index to gauge the performance of the industrial sector of the American stock market. It is the second-oldest U.S. market index, after the Dow Jones Transportation Average, which Dow also created. When it was first published on May 26, 1896, the DJIA index stood at 40.94. It was computed as a direct average by adding up stock prices of its components and dividing by the number of stocks in the index. The DJIA averaged a gain of 5.3% compounded annually for the 20th century; a record Warren Buffett called "a wonderful century" when he calculated that, to achieve that return again, the index would need to reach nearly 2,000,000 by 2100. Many of the biggest percentage price moves in the DJIA occurred early in its history, as the nascent industrial economy matured. The index hit its all-time low of 28.48 during the summer of 1896.

The original DJIA was just that—the average of the prices of the stocks in the index. The current average is computed from the stock prices of 30 of the largest and most widely held public companies in the United States, but the divisor in the average is no longer the number of components in the index. Instead, the divisor, called the DJIA divisor, gets adjusted in case of splits, spinoffs, or similar structural changes to ensure that such events do not in themselves alter the numerical value of the DJIA. The initial divisor was the number of component companies, so that the DJIA was, at first, a simple arithmetic average. The present divisor, after many adjustments, is much less than 1, which means the DJIA, itself, is actually larger than the sum of the prices of the components. At the end of 2008, the value of the DJIA Divisor was 0.1255527090, and the updated value is regularly published in the *Wall Street Journal*.

Charles Ponzi and His Scheme



A **Ponzi scheme** is a fraudulent investment operation that pays returns to investors from their own money or money paid by subsequent investors, rather than from profit. Without the significant information about the investment, only a few investors are initially tempted, and usually for small sums. After a short period (typically around 30 days), the investor receives the original capital plus a large return (usually 20% or more). At this point, the investor will have more incentive to put in additional money and, as word begins to spread, other investors grab the "opportunity" to participate, with the promise of extraordinary returns. The catch is that, at some point, the promoters will likely vanish, taking all the remaining investment money with them.

The scheme is named after **Charles Ponzi**, who became notorious for using the technique after emigrating from Italy to the United States in 1903. Ponzi did not invent the scheme, but his operation took in so much money that it was the first to become known throughout the United States. Ponzi went from anonymity to being a well-known Boston millionaire in just six months after using such a scheme in 1920. He canvassed friends and associates to back his scheme, offering a 50% return on investment in 45 days. About 40,000 people invested about $15 million all together; in the end, only a third of that money was returned to them. People were mortgaging their homes and investing their life savings, and most chose to reinvest, rather than take their profits. Ponzi was bringing in cash at a fantastic rate, but the simplest financial analysis would have shown that the operation was running at a large loss. As long as money kept flowing in, existing investors could be paid with the new money. In fact, new

money was the only source Ponzi had to pay off those investors, as he made no effort to generate legitimate profits.

Ponzi lived luxuriously: he bought a mansion in Lexington, Massachusetts, with air conditioning and a heated swimming pool (remember, this was the 1920s), and brought his mother from Italy in a first-class stateroom on an ocean liner. As newspaper stories began to cause a panic run on his Securities Exchange Company, Ponzi paid out $2 million in three days to a wild crowd that had gathered outside his office. He would even canvass the crowd, passing out coffee and donuts, all while cheerfully telling them they had nothing to worry about. Many people actually changed their minds and left their money with him.

On November 1, 1920, Ponzi pleaded guilty to a single count of mail fraud before Judge Clarence Hale, who declared before sentencing, "Here was a man with all the duties of seeking large money. He concocted a scheme, which, on his counsel's admission, did defraud men and women. It will not do to have the world understand that such a scheme as that can be carried out ... without receiving substantial punishment." Ponzi was sentenced to five years in federal prison, and after three and a half years, he was released to face 22 Massachusetts state charges of larceny. He was eventually released in 1934 following other indictments, and was deported back to Italy, since he hadn't gained American citizenship. His charismatic confidence had faded, and when he left the prison gates, an angry crowd met him. He told reporters before he left, "I went looking for trouble, and I found it."

References

Benjamin Franklin Institute of Technology. "Benjamin Franklin's Legacy." http://www.bfit.edu/the-college/benjamin-franklin-s-living-legacy-/benjamin-franklin-s-legacy.

Buffet, W. "Letter to Shareholders." 2007. http://www.berkshirehathaway.com/letters/2007ltr.pdf.

Darby, M. "In Ponzi We Trust." *Smithsonian Magazine*, December 1998. http://www.smithsonianmag.com/people-places/in-ponzi-we-trust-64016168/?no-ist=&page=1.

DeLeon, C. "Divvying Up Ben: Let's Try for 200 More." *Philadelphia Enquirer*, February 7, 1993.

Dow Jones Indexes. http://www.djindexes.com.

Nash, J. R. *Bloodletters and Badmen: A Narrative Encyclopedia of American Criminals from the Pilgrims to the Present*. New York, NY: M. Evans & Company, 1995.

"Ponzi Arrested." *New York Times*, August 13, 1920.

Sullivan, A. and S. Sheffrin. *Economics: Principles in Action*. Upper Saddle River, NJ: Prentice Hall, 2003.

World Book Encyclopedia, 1978 ed., s.v. "Dow Jones Averages."

World Book Encyclopedia, 1978 ed., s.v. "Franklin, Benjamin."

Zuckoff, M. "What Madoff Could Learn from Ponzi." *Fortune,* January 13, 2009. http://archive.fortune.com/2009/01/13/news/newsmakers/ponzi.jail.fortune/index.htm?postversion=2009011312

1.2 For Sale (Percents, Markup, and Markdown)

When finding a percent of an amount or an amount that is a percent of a quantity, most people know they either need to multiply or divide by the decimal value of the percent. Unfortunately, most people can't quite remember *when* to multiply and *when* to divide. Fortunately, we can reduce all of those problems to the same equation and let our algebra skills tell us what to do.

A Brief Review of Rounding

Before we dive into the material for this course, let's take a few minutes to review how to correctly round numbers.

Rounding always involves a specified place value, and we *must* have a place value to round to. Without a specified place value, it is incorrect to assume one out of convenience.

If there is no directive to round to a specified place value, it is incorrect to do so. After all, if no place value is mentioned, we cannot assume one out of convenience.

The formal procedure for the traditional rounding of a number is as follows.

1. First, determine the round-off digit, which is the digit in the specified place value column.

2. If the first digit to the right of the round-off digit is less than 5, do not change the round-off digit, but delete all the remaining digits to its right. If you are rounding to a whole number, such as tens or hundreds, all the digits between the round-off digit and the decimal point should become zeros, and no digits will appear after the decimal point.

3. If the first digit to the right of the round-off digit is 5 or more, increase the round-off digit by 1, and delete all the remaining digits to its right. Again, if you are rounding to a non-decimal number, such as tens or hundreds, all the digits between the round-off digit and the decimal point should become zeros, and no digits will appear after the decimal point.

4. For decimals, double-check to make sure the right-most digit of the decimal falls in the place value column to which you were directed to round and there are no other digits to its right.

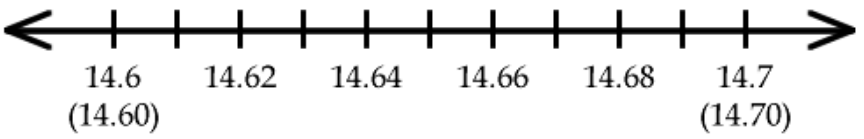
Don't Get Trapped Memorizing Instructions

We cannot let ourselves get trapped in a process of trying to memorize a set of instructions. Yes, if followed correctly, instructions can be quite valuable, but when we blindly try to stick to a formal, rigid process, we often lose sight of logic and reason. For many students, rounding numbers is a classic example of this.

If, for a second, we set aside the traditional process outlined on the previous page and understand that "rounding a number to the tenth" can be thought of as "identifying the number ending in the tenths place that is closest to the given number," we can gain a better understanding of what it means to round.

For example, if we are tasked with rounding 14.68 to the nearest tenth, we could begin by identifying the consecutive numbers ending in the tenths place (remember, for decimals, the right-most digit of the answer must fall in the stated place value) that are immediately less than and immediately greater than 14.68. Those two numbers are 14.6 and 14.7. Then, we can simply ask ourselves, "Is 14.68 closer to 14.6 or 14.7?"

If we look at a number line…



Treating 14.6 and 14.7 as 14.60 and 14.70, respectively, makes it easy to see 14.68 is closer to 14.7, than it is to 14.6. The important point to remember is the last digit of our rounded answer *must* fall in the place value to which we are rounding. In other words, the answer needs to be 14.7 and not 14.70.

EXAMPLE 1: Round 103.4736999 to the nearest tenth, hundredth, and then hundred.

Solutions For the tenth, begin by recognizing the four is in the tenths place. The seven immediately to its right indicates we are to change the four to a five, and remove the rest of the digits. Thus, rounded to the tenth, the value is 103.5.

For the hundredth, begin by recognizing the seven is in the hundredths place. The three immediately to its right indicates we are not to change the seven, and remove the rest of the digits. Thus, rounded to the hundredth, the value is 103.47.

For the hundred, begin by recognizing the one is in the hundreds place. The zero immediately to its right indicates we are not to change the one, and all the digits between the one and the decimal point are to become zeros. Thus, rounded to the hundred, the value is 100.

When to Round and When *Not* to Round

Throughout this book, and all of mathematics, for that matter, we will see many directives to "Round to the nearest hundredth (or other place value), when necessary." A very important part of that directive is the "when necessary" part. How are we supposed to know when rounding is necessary and when it isn't?

First, if we are given the absolute directive "round to the nearest hundredth"(or other place value) we MUST round to that specified place value. Keep in mind, when we are working with money, the underlying—but often unstated—directive is to round to the nearest cent.

Then we run into the "when necessary" scenario. This only applies to **non-terminating decimals**. If the decimal terminates, there usually is no need to round it. In fact, if we round it, our answer is less accurate than it could be. In other words, 1/32 = 0.03125, exactly. If we round that decimal to the hundredth, to 0.03, the value is no longer equal to 1/32. Sure, it's close, but it is NOT equal to 1/32. 0.03 is actually 3/100.

Non-terminating decimals are the ones to which we need to pay attention. If we dismiss the use of the "…" (called an "ellipsis"), it is impossible to write 1/3 as a decimal. 0.33 = 33/100, but 1/3 = 33/99. 0.33333 = 33333/100000, but 1/3 = 33333/99999. 0.333333333333333 is closer, but as soon as we stop writing 3s, we no longer have exactly 1/3. Thus, in order to save us from writing 3s indefinitely, it is necessary to round it to a specified place value.

Keep in mind; a calculator does not display an ellipsis. If you change 5/9 to a decimal, the calculator may display the "final" digit as a 6: 0.555555556. Calculators typically round to the number of digits they can display on their screens. Some calculators may just truncate the decimal to the screen size, and others may actually hold an extra three to five digits of the decimal in memory without displaying them—this is the smarter version, since a greater amount of precision leads to a greater degree of accuracy.

If the decimal terminates within three or four decimal places, there may be no need to round. If it extends past four decimal places and we have a specified place value to which to round, then go ahead and do so. Remember, though, there must be a designated place value.

One of the few exceptions to this rule involves money. As mentioned earlier, if money is involved, we should always round to the nearest cent unless we are specifically told to round to a less precise value, such as the nearest dollar.

Identifying the Parts in a Percent Problem

In simple percent problems, there is a percent, a base, and an amount. The numeric value of the **percent**, p is easy to spot—it has a % immediately after it, and for calculation purposes, the percent must be changed to its decimal equivalent. The **base**, b is the initial quantity and is associated with the word "of." The **amount**, a is the part being compared with the initial quantity and is associated with the word "is."

EXAMPLE 2: Identify the amount, base, and percent in each of the following statements. If a specific value is unknown, use the variable p, b, and a for the percent, base, and amount, respectively. Do not solve the statements; just identify the parts.

a. 65% of 820 is 533

b. What is 35% of 95?

c. 50 is what percent of 250?

Solutions

a. Percent = 65%, Base = 820, Amount = 533

b. Percent = 35%, Base = 95, Amount = a

c. Percent = p, Base = 250, Amount = 50

Solving Percent Problems Using an Equation

Always begin by identifying the percent, base, and amount in the problem, and remember that, usually, one of them is unknown. If we are given a percent in the problem, change it to a decimal for the calculation. If we are finding a percent, the calculation will result in a decimal, and we must change it to a percent for our answer.

Once we have identified the parts, we then need to recognize the basic form of the percent equation. An amount, a, is some percent, p, of a base, b. In other words, $a = pb$, where p is the decimal form of the percent.

When setting up the equation, if the a is the only unknown, find its value by simplifying the other side of the equation (by multiplying the values of p and b). If the unknown quantity is b, divide both sides of the equation by the value for p. Likewise, if the unknown quantity is p, divide both sides of the equation by the value for b.

EXAMPLE 3: What is 9% of 65?

Solution The percent is 9%, so we will use $p = 0.09$. 65 is the base, so $b = 65$. Thus, the unknown quantity is a.

$a = 0.09(65) = 5.85$

EXAMPLE 4: 72 is what percent of 900?

Solution 900 is the base, and 72 is the amount. So, $b = 900$, and $a = 72$. The unknown quantity is the percent.

$72 = p(900)$

$72/900 = p$

So, $p = 0.08$, which is 8%.

General Applied Problems Involving Percents

To solve any application problem involving a percent, a good strategy is to rewrite the problem into the form "a is p% of b." Remember, we should always begin by clearly identifying the amount, base, and percent.

EXAMPLE 5: Of the 130 flights at Orange County Airport yesterday, only 105 of them were on time. What percent of the flights were on time? Round to the nearest tenth of a percent.

Solution First, identify the base is 130 flights, and 105 is the amount we are comparing to the base. The percent is the unknown.

Then, we should recognize the simplified form of this question is "105 is what percent of 130?" This gives us the equation: $105 = p(130)$.

$105 = p(130)$

$105/130 = p = 0.8076923 \ldots = 80.76923 \ldots \%$

Rounding to the tenth of a percent, we state, "80.8% of the flights were on time."



In the above example, do notice the rounding was not done until the very end.

Sales Tax and Discounts

Sales taxes are computed as a percent of the cost of a taxable item. Then, when we find the dollar amount of the tax, we add it to the cost. **Discounts** are also computed as a percent of the original price of an item. For discounts, however, when we find the dollar amount of the discount, we deduct it from the original price. If both a discount and sales tax are involved in the same computation, we need to know which one gets applied first. In most cases, the sales tax gets computed on the discounted price. However, in some cases, we may get a discount, but will still be responsible for the taxes based on the original price—it all depends on the wording used in the situation. The latter of those two situations is usually referred to as a **rebate**. Often, rebates are given as dollar amounts, instead of percents.

Next, we need to make sure we answer the question being asked. If the question asks for the tax, we should *only* give the tax as our answer. Likewise, if the question asks for the discount, we should *only* give the amount of the discount as our answer. If the question asks for a sales price, then we need to be sure to subtract the discount from the posted price. If the question asks for the total cost of an object, we need to be sure to add the tax to the item's price.

Finally, when working with money, unless directed otherwise, we should always round to the nearest cent. Think about it. When we fill our gas tank and the total is $23.01, we have to pay that penny. Likewise, if your paycheck is for $543.13, you don't just get the $543.

Unless specifically directed to do otherwise, always round answers involving money to the nearest cent (hundredth).

EXAMPLE 6: Find the total cost of a $125 TV if the sales tax rate is 7.25%.

Solution The base cost of the TV is $125, so $b = 125$. As a decimal, $p = 0.0725$.

$a = 0.0725(125) = 9.0625$. So, to the cent, the sales tax is $9.06.

That makes the total cost of the TV $125 + $9.06 = $134.06.

EXAMPLE 7: A pair of shoes is on sale for 20% off. If the original price of the shoes was $65, what is the sale price?

Solution The base cost of the shoes is $65, so $b = 65$. $p = 0.20$.

$a = 0.2(65) = 13$. So, the discount is $13.

This makes the sale price of the shoes
$65 – $13 = $52.



By the way, in the above example, 20% is a nice number to work with. We can quickly see 10% of $65 is $6.50. Twenty percent is twice as much, so by a quick inspection, 20% of $65 is $2 \times \$6.50$, or $13. If we spot a quick inspection calculation like the one above, we definitely have a better understanding of the material at hand. If we cannot spot something like this, we can just resort to the computation shown in the example.

Percent Increase or Decrease

Another type of percent calculation we often see involves the change in percent. When studying information, it is often valuable to examine absolute changes in amounts over a period of time, as well as relative changes with respect to those amounts. The total amount something changes may be obvious, but examining the **change in percent** can often give a better overall picture of a situation or set of data.

Absolute Change is simply the difference between the beginning and ending amounts.

Percent Change, indicated with the notation $\Delta\%$, is found by the formula:

$$\Delta\% = \left(\frac{\textit{ending amount} - \textit{beginning amount}}{\textit{beginning amount}} \right) \times 100$$

Keep in mind, if an amount is increasing, the $\Delta\%$ will be positive. If the amount is decreasing, the $\Delta\%$ will be negative.

EXAMPLE 8: Smith's Shoe Store has two salesmen, Al and Bob. Al sold 250 pairs of shoes in April and 322 pairs in May. Bob, who did not work as many hours as Al, sold 150 pairs of shoes in April and 198 pairs in May. Find the amount of increase in shoe sales for each salesman, and then find the percentage by which each salesman increased his sales, to the tenth of a percent.

Solution For the change in the amounts, Al increased his sales by 72 pairs of shoes, and Bob increased his sales by 48 pairs.

For the percent of increase in the sales…

- For Al, $\Delta\% = (322 - 250)/250 \times 100 = 28.8\%$.
- For Bob, $\Delta\% = (198 - 150)/150 \times 100 = 32\%$.

In other words, even though he sold fewer pairs of shoes, Bob increased his rate of sales by a higher percent than Al.

EXAMPLE 9: Ronald Reagan's first term as President was 1981–85, and his second term was 1985–89. George H.W. Bush was President from 1989–93, and Bill Clinton was President from 1993–97, and again from 1997–2001.

The following table indicates the U.S. National Debt at the start of each of those presidential terms.

Year	Debt (in trillions)
1981	$0.9
1985	$1.6
1989	$2.6
1993	$4.0
1997	$5.3

During which presidential term did the national debt increase the greatest amount? During which term did the national debt increase at the greatest rate?

Solutions George H.W. Bush increased the National Debt by $1.4 trillion.

Ronald Reagan's first term caused a 77.8% increase in the National Debt.



Section 1.2 Exercises

For Exercises #1 through #23, round bases and amounts to the nearest hundredth, and percents to the nearest tenth of a percent, as necessary.

1. What is 10% of 58?

2. What is 140% of 35?

3. 90 is what percent of 120?

4. 120 is what percent of 90?

5. 0.13 is what percent of 5?

6. 72 is 37% of what?

7. 45 is 112% of what?

8. 16 is 0.24% of what?

9. A student correctly answered 23 out of 30 questions on a quiz. What percent is this?

10. A basketball player made 13 out of 18 free throw attempts. What percent is this?

11. A recent survey showed 78% of people thought the President was doing a good job. If 5,000 people were surveyed, how many people approved of the President's job performance?

12. A bowl of cereal contains 43 grams of carbohydrates, which is 20% of the recommended daily value of a 2,000-calorie diet. What is the total number of grams of carbohydrates in that diet?



13. A bowl of cereal contains 190 milligrams of sodium, which is 8% of the recommended daily value in a 2,000-calorie diet. What is the total number of milligrams of sodium in that diet?

14. John's monthly net salary is $3,500, and his rent payment is $805. What percent of his net monthly salary goes toward rent?

15. Jane budgets 8% of her net salary for groceries. If she spent $300 on groceries last month, what is her monthly net salary?



16. Wade wants to buy a new computer priced at $1,200. If the sales tax rate in his area is 5.75%, what will be the amount of sales tax and total cost for this computer?

17. In the bookstore, a book is listed at $24.95. If the sales tax rate is 6.5%, what will be the amount of sales tax and the total cost of the book?



18. Mike has breakfast at a local restaurant and notices the subtotal for his food and coffee is $8.98. If the sales tax is 67¢, what is the sales tax rate?



19. Nancy wants to buy a sweater that is priced at $45. If the store is running a 40% off sale, what will be the amount of the discount and the sale price of the sweater?

20. Sue finds a CD she likes that normally costs $19.99. If the CD is labeled 75% off, and the sales tax rate is 5.5% (of the sale price), what will be the total cost of the CD?

21. To deal with slumping sales, Eric's boss cut his salary by 15%. If Eric was making $52,000 per year, what will be his new annual salary?

22. Last year, Ms. Rose had 24 students in her six-grade math class. This year she has 30 students. What is the percent change of her class size?

23. A new cell phone costs $40, and last year's model cost $45. What is the percent change in the cost of this phone?



24. Is it possible for one person to be 200% taller than another person? Why or why not?

25. Is it possible for one person to be 200% shorter than another person? Why or why not?

26. Because of losses by your employer, you agree to accept a temporary 10% pay cut, with the promise of getting a 10% raise in 6 months. Will the pay raise restore your original salary?

Answers to Section 1.2 Exercises

1. 5.8
2. 49
3. 75%
4. 133.3%
5. 2.6%
6. 194.59
7. 40.18
8. 6666.67
9. The student answered 76.7% of the questions correctly.
10. The player made 72.2% of his free throws.
11. 3,900 of the people surveyed approved of the President's job performance.
12. 215 carbohydrates are recommended in that diet.
13. 2,375 milligrams of sodium are recommended in that diet.
14. 23% of John's net salary goes toward his rent.
15. Jane's monthly net salary is $3,750.
16. The sales tax is $69, and the total cost of the computer is $1,269.
17. The sales tax is $1.62, and the total cost is $26.57.
18. The sales tax rate is 7.5%.
19. The discount is $18, and the sale price is $27.
20. The total cost of the CD is $5.28.
21. Eric's new annual salary will be $44,200.
22. Ms. Rose had a 25% increase in her class size.



23. The new phone costs 11.1% less than last year's model.

24. Sure. If a child is 2 feet tall, 200% of that is 4 feet. There are plenty of 2 feet children and 6 feet adults in the world.

25. Nope. Given the previous answer, it is tempting to say yes. However, 200% of 6 feet is 12 feet. Thus, to be 200% shorter than 6 feet, you would need to be –6 feet tall (6 – 12 = –6).

26. Nope. If your original salary was $100 per week, a 10% pay cut would make your salary $90 week. Then, a 10% raise would be 10% of the $90, not the $100. That means your new salary would be $99 per week.

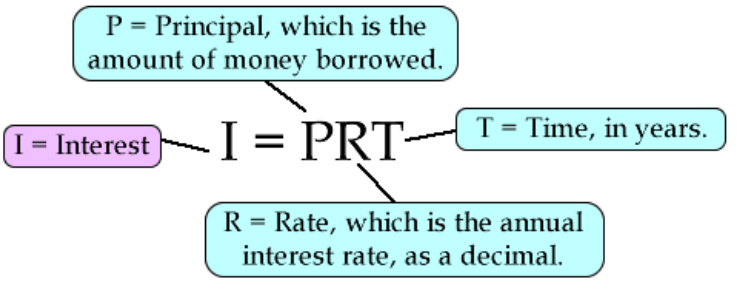
1.3 The Most Powerful Force in the Universe (Simple and Compound Interest)

Simple vs. Compound Interest

Simple interest is just that: simple. It is calculated once during the loan period and is only computed upon the principal (money borrowed) of the loan or the investment. **Compound interest**, on the other hand, is calculated several times throughout the loan period. Furthermore, each time the interest is compounded, it is then added to the existing balance for the next compounding. That means we are actually paying (or earning) interest on interest!

Keeping It Simple

Interest is a percentage of a principal amount calculated for a specified period, usually a stated number of years. Thus, the formula for simple interest is **I** = **PRT**.



- **P** stands for the principal, which is the original amount invested.
- **R** is the annual interest rate. Be sure to convert the rate to its decimal form for use in the formula.
- The time, **T**, is also referred to as the term of the loan or investment and usually stated in terms of years.

It is possible to have the rate and time stated in terms of a time period other than years. If that is the case, make sure the two values are in agreement. That is, if we are working with a monthly rate, we need to state the time period in months, as well.

Also, remember, this formula gives us the amount of interest earned, so to find the total amount, A, of the loan or investment, we have to add that interest to the original principal, $\mathbf{A = P + I}$.

EXAMPLE 1: Find the total amount returned for a 5-year investment of \$2,000 with 8% simple interest.

Solution First, find the interest. $I = \$2{,}000(0.08)(5) = \$800$. The total amount, A, returned to us is found by adding that interest to the original investment.

$A = \$2{,}000 + \$800 = \$2{,}800$

The amount returned at the end of the 5-year period will be \$2,800.

When working with simple interest calculations, we need to pay attention to the directives. Sometimes we are asked to find the total amount of an investment. Alternatively, we may be asked to find just the earned interest, the rate, or even the amount of time in question.

EXAMPLE 2: \$2,500 earned \$395 in simple interest over a 5-year period. What was the interest rate of the investment? State your answer as a percent.

Solution $I = PRT$, so, substituting the known values:
$\$395 = \$2{,}500(r)(5)$

Simplifying the right side of the equation gives us:
$\$395 = \$12{,}500(r)$

Dividing both sides by \$12,500 leads us to:
$r = \$395/\$12{,}500 = 0.0316$

This is the decimal form of the rate. As a percent, r is 3.16%.

EXAMPLE 3: How much principal must be invested at 4% simple interest for 5 years to earn $500?

Solution I = PRT, so:
$500 = P(0.04)(5)

Solving for P, we have:
$500 = P(0.2)
P = $500/0.2 = $2,500

$2,500 should be invested at 4% for 5 years in order to earn $500 in interest.

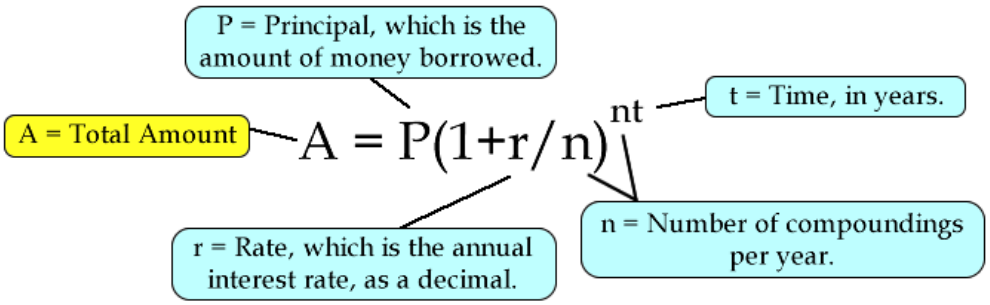
Compounding the Situation



Legend has it, a Chinese emperor was so enamored with the inventor of the game of chess, he offered the guy one wish. The inventor asked for something along the lines of one grain of rice for the first square on the chessboard, two for the second square, four for the third, eight for the fourth, and so on—doubling for each of the 64 squares on the board. Thinking it was a modest request, the emperor agreed. Of course, upon finding out the inventor would receive $2^{64} - 1 = 18{,}446{,}744{,}073{,}709{,}551{,}615$ grains of rice (more than enough to cover the surface of the earth), he had the guy beheaded.

Perhaps that story is what inspired **Albert Einstein** to refer to compound interest as the "most powerful force in the universe."

The formula for the compounded amount is $\mathbf{A = P(1+r/n)^{nt}}$.



Don't fall into the trap of trying to memorize that formula. When we attempt to memorize something, we ultimately forget it or, even worse, recall it incorrectly. If we want to be able to recall a formula correctly, we need to understand the various components of it.

For the compounded amount formula, one of the most important things to realize is, unlike the formula for simple interest, the formula returns the total amount of the investment.

The compounded amount formula returns the entire compounded amount, A. If we want to find only the interest, we need to subtract the original amount, $I = A - P$.

Just like in the simple interest formula, P stands for the principal, which is the original amount invested, and **t** stands for the time of the loan or investment stated in terms of years.

In the compounded amount formula, the interest rate, **r**, is also referred to as the **Annual Percentage Rate** (APR). Be sure to convert the APR to its decimal form for use in the formula.

Next, pay special attention to **n**, the number of compoundings per year. In most instances, this is described by using terms like monthly, annually, or quarterly. Make sure you know what each of those terms means.

Term:	Monthly	Quarterly	Semiannually	Annually
# of Times per Year:	**12**	**4**	**2**	**1**

Since **n** refers to the number of compoundings per year, **r/n** is the rate for each period. For example, if the APR is 15%, and the amount is compounded monthly, the monthly rate is 15%/12 = 1.25%. Do keep in mind, though, we must still use the APR in the formula.

We add **1** to the monthly rate to account for the interest being added to the original amount. This is similar to a sales tax computation. If an item sells for \$10, and the tax rate is 7%, the amount of the tax is \$10(0.07) = \$0.70, which would then be added to the original \$10 to get a total cost of \$10.70. Alternatively, we could compute it all in one step by multiplying \$10(1+0.07) = \$10(1.07) = \$10.70. The **(1+r/n)** in the compound amount formula is exactly like the (1+0.07) in that tax calculation we did earlier.

The exponent in the formula, **nt**, is the total number of compoundings throughout the life of the investment. That is, if the amount is compounded monthly for 5 years, there will be a total of 12(5) = 60 compoundings.

EXAMPLE 4: Find the total amount due for $2,000 borrowed at 6% Annual Percentage Rate (APR) compounded quarterly for 3 years.

Solution First, since quarterly implies four compoundings per year, **r/n** = 0.06/4 = 0.015. Then, add **1**, and raise that sum to the power that corresponds to the number of compoundings. In this case, 4 times a year for 3 years is 12. Finally, multiply by the amount borrowed, which is the principal.

$$A = \$2{,}000 \times (1 + 0.06/4)^{4\,3} = \$2{,}000 \times (1.015)^{12} = \$2{,}000 \times 1.195618 = \$2{,}391.24$$

The total amount at the end of 3 years will be $2,391.24.

Using Your Calculator

In the previous example, we were faced with a multi-step calculation. Using a scientific calculator effectively can greatly expedite the process. For the exponentiation, $(1.015)^{12}$, we could literally multiply (1.015)(1.015)(1.015) … (1.015) twelve times, but it is clearly faster to use the exponentiation key on our calculator. Depending on the calculator, the exponentiation key may look like x^y or $\wedge$. Thus, $(1.015)^{12}$ would be done on a scientific calculator as 1.015 x^y 12, and then, hit the $=$ key. For more involved computations, we can use the parentheses keys. In all, we should never have to hit the $=$ key more than once.

EXAMPLE 5: Use a calculator to compute $\$1{,}000(1 + 0.14/12)^{24}$.

Solution Literally type: 1000 $\times$ (1 $+$ 0.14 $\div$ 12) x^y 24 $=$

You should get 1,320.9871, which you will manually round to $1,320.99.

As with questions involving simple interest, when we are working with compounded amounts, we need to pay attention to the directives. Some questions may ask for the total amount returned, A, while others may just ask us to find the amount of interest, I.

EXAMPLE 6: On the day her son was born, Tricia invested $2,000 for him at a guaranteed APR of 8%, compounded monthly. How much will that investment be worth when he turns 50? How much will it be worth if he leaves it alone until he turns 65?

Solution On his 50th birthday, the investment is worth:

$A = \$2{,}000 \times (1 + 0.08/12)^{12 \cdot 50} = \$2{,}000 \times (1.00666667)^{600}$

$A = \$2{,}000 \times 53.878183179 = \$107{,}756.37$

On his 65th birthday, the investment is worth:

$A = \$2{,}000 \times (1 + 0.08/12)^{12 \cdot 65} = \$2{,}000 \times (1.00666667)^{780} = \$356{,}341.84$

EXAMPLE 7: If $1,500 is invested at 5% APR compounded annually for 10 years, how much interest is earned?

Solution The total amount, $A = \$1{,}500 \times (1 + 0.05/1)^{1 \cdot 10} = \$2{,}443.34$. Thus, the interest earned is found by subtracting the value of the original investment: $\$2{,}443.34 - \$1{,}500 = \$943.34$.

Section 1.3 Exercises

Unless specifically directed to do otherwise, always round answers involving money to the nearest cent (hundredth).

1. Find the simple interest on $12,000 for 2 years at a rate of 6% per year.

2. Find the simple interest on $25,000 for 6 months at a rate of 8.5% per year.

3. How much time is needed for $1,800 to accumulate $360 in simple interest at a rate of 10%?

4. How much time is needed for $600 to accumulate $72 in simple interest at a rate of 4%?

5. If $4,300 yields $1,290 in simple interest over 6 years, what is the annual rate?

6. If $200 yields $45 in simple interest over 3 years, what is the annual rate?

7. How much principal is needed to accumulate $354.60 in simple interest at 9% for 4 years?

8. How much principal is needed to accumulate $65,625 in simple interest at 15% for 7 years?

9. If $500 yields $40 in simple interest over 2.5 years, what is the annual rate?

10. How much time is needed for $1,250 to accumulate $375 in simple interest at a rate of 5%?

11. Find the simple interest on $900 for 18 months at a rate of 9.5% per year.

12. If $420 yields $31 in simple interest over 30 months, what is the annual rate?

13. How much time is needed for $660 to accumulate $514.80 in simple interest at a rate of 12%?

14. Find the simple interest on $1,975 for 3 1/2 years at a rate of 7.2% per year.

15. Find the interest, I, and the total amount, A, for $825 invested for 10 years at 4% APR, compounded annually.

16. Find the interest, *I*, and the total amount, *A*, for $3,250 invested for 5 years at 2% APR, compounded annually.

17. Find the interest, *I*, and the total amount, *A*, for $75 invested for 6 years at 3% APR, compounded semiannually.

18. Find the interest, *I*, and the total amount, *A*, for $1,550 invested for 7 years at 5% APR, compounded semiannually.

19. Find the interest, *I*, and the total amount, *A*, for $625 invested for 12 years at 8% APR, compounded quarterly.

20. Find the interest, I, and the total amount, A, for \$2,575 invested for 2 years at 4% APR, compounded quarterly.

21. Find the interest, I, and the total amount, A, for \$1,995 invested for 6 years at 5% APR, compounded semiannually.

22. Find the interest, I, and the total amount, A, for \$460 invested for 7 years at 6% APR, compounded quarterly.

23. To purchase a refrigerated showcase, Jamestown Florists borrowed \$8,000 for 6 years. The simple interest was \$4,046.40. What was the rate?



24. To purchase new equipment, Williams Brake Repair borrowed \$4,500 at 9.5%. The company paid \$1,282.50 in simple interest. What was the term of the loan?

25. John Doe earned $216 simple interest on a savings account at 8% over 2 years. How much was in the account?

26. Michelle is 25 and wants to retire at the age of 50. If she invests a $60,000 inheritance at 7% compounded semiannually, how much will she have when she turns 50?

27. In order to pay for college, Brooke's parents invest $20,000 in a bond that pays 8% interest compounded semiannually. How much money will there be in 18 years?

28. A couple sets aside $5,000 into a savings account that is compounded quarterly for 10 years at 9%. How much will the investment be worth at the end of 10 years?

Answers to Section 1.3 Exercises

1. $1,440
2. $1,062.50
3. 2 years
4. 3 years
5. 5%
6. 7.5%
7. $985
8. $62,500
9. 3.2%
10. 6 years
11. $128.25
12. 2.95%
13. 6.5 years (or 78 months)
14. $497.70
15. I = $396.20, A = $1,221.20
16. I = $338.26, A = $3,588.26
17. I = $14.67, A = $89.67
18. I = $640.11, A = $2,190.11
19. I = $991.92, A = $1,616.92
20. I = $213.36, A = $2,788.36
21. I = $688.05, A = $2,683.05
22. I = $237.92, A = $697.92
23. 8.43%
24. 3 years
25. $1,350
26. $335,095.61
27. $82,078.65
28. $12,175.94