# PRINCIPLES OF



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# DECIMALS

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# Principles

# of Decimals

# Introduction to
# PRINCIPLES OF DECIMALS

Welcome to the study of mathematics -- *Decimals*!

This math book by Textbook Publishers will be different from any other math book you have studied. Most conventional math books have pages and pages of problems to solve. This book has very few. Here is why.

Math is actually just a TOOL for you to learn an *intrinsic value*. "Intrinsic" means "something inside." An intrinsic value becomes part of your heart and mind. It becomes part of you. The intrinsic value of math is knowing how to THINK AND SELF-GOVERN. This intrinsic value will give you freedom of thought!

To help you learn how to think and self-govern, you will be creating and solving your OWN math problems. Here is why a knowledge of how to do that is so important:

1. When you create and solve your own problems, you are learning how to THINK. Math books which have worksheets created by someone else teach students how to follow instructions, but at the same time students are robbed of the ability to think and reason.

2. When you have learned how to think through math problems, you can then apply math principles in every-day life. For example, you will be able to give accurate change as a cashier, or balance your own check book. No matter what your life's profession is, you will be able to apply math intelligently. You will be GOVERNING YOURSELF.

3. When you create and solve your own math problems, you have not only learned how to think, but you will find that you learn math <u>ten times faster</u> than by filling in the blanks of someone else's problems. This fact has been proven by testing hundreds, even thousands, of students. By reasoning through each math process along the way, you will UNDERSTAND math.

4. When you create and solve your own problems, your individual attitudes of life magically appear. Students who create simple, boring problems for themselves find out that they are not motivated about math. When unmotivated students do the minimums in math, they may also be doing the minimums in other aspects of their lives as well. For them, life itself is often boring. Students who create challenging problems for themselves will excel in math and will become excited about learning to think. Their ATTITUDES about life also become motivational and exciting.

The study of Decimals is usually associated with money. Figuring amounts of money is probably the main way you will use Decimals, and this is very valuable knowledge. You will use Decimals when figuring your checkbook, your earnings, your savings, and your tithing.

Using Decimals actually combines two other divisions of math -- fractions and percents. Unlike *Fractions*, however, Decimals always work in tenths, hundredths, and thousandths. Understanding this makes them easy to work when figuring Percents.

Since you will be working with money amounts in this section, here is some interesting background about the dollar sign symbol:

# Origin of the dollar sign

## by Mark Brader

http://www.alt-usage-english.org/excerpts/fxorigin.html

It is sometimes said that the dollar sign's origin is a narrow "U" superimposed over a wide "S", "U.S." being short for "United States." [We now think this may be incorrect] and this explanation also tells why the $ sign is used both for dollars and for pesos in various countries. The explanation is not widely known, maybe because not many people would think to look for it in a book called *A History of Mathematical Notations, Volume II: Notations Mainly in Higher Mathematics* by Florian Cajori (published in 1929 and reprinted in 1952, by Open Court Press). Cajori acknowledges the "U.S." theory and a number of others, but, after examining many 18th-century manuscripts, finds that there is [not much] evidence to support those theories.

Spanish pesos were also called piastres, Spanish dollars, and pieces of eight. (The piece of eight was so called because its value was eight reales. Some countries made one-real coins by slicing pieces of eight into eight sectors; the still-current U.S. slang "two bits" for a quarter of a dollar may refer to this, although "bit" denoting any small coin -- as in "threepenny bit" -- was already in use.) The coins were circulated in many parts of the world, much as U.S. dollars are today. The coins were so well known that, when the U.S. got around to issuing its own silver coinage (U.S. dollar coins first appeared in 1794), it simply replicated the Spanish unit's weight and hence value, and even one of its names; so it was natural to use the same symbol.

Since three of the four names given above for the Spanish dollar
start with p (and pluralize with s), it was natural for
abbreviations like p and ps to be used. Sometimes ps was written
s
as P -- P with a superscript s. The superscript was a common way
of rendering abbreviated endings of words -- we see vestiges of it
today in the way some people write "10th". Now, what happens if you
write P with a superscript s *fast*, because it's part of a long
document that you have to hand-write because you can't wait for the
typewriter to be invented, let alone the word-processor? Naturally,
you join the letters. Well, now look at the top part of the
resulting symbol. There's the $ sign! Reduce the P to a single
stroke and you have the form of the $ with a double vertical; omit
it altogether and you get the single vertical.

And yes, both these forms are original. Cajori reproduces 14
$ signs from a diary written in 1776; 11 of them have the single
stroke, which was the more common form to the end of the century,
and 3 have the double stroke.

Although the $ sign originally referred to a Spanish coin, it was
the ... British -American colonists who made the transition
from ps to the new sign. (This is apparently also why we write $1
instead of 1$; it mimics the British use of the pound sign.) So,
while it did not originally refer to the U.S. dollar, the symbol
does legitimately claim its origins in that country.

Here is some interesting information about coins or "cents":

"CENT" is a small bronze coin that represents one-hundredth of a dollar. It is the coin of
smallest value in the United States and Canada. The name *cent* was first suggested by the
Revolutionary War patriot Gouverneur Morris in 1782, when he was assistant to Superintendent
of Finance Robert Morris. He may have taken th3e word from the Latin word *centum* (hundred).
The people of the United States and Canada say *penny* and *cent* to mean the same thing.

The first cent to be minted in the United States was the so-called Washington cent of 1783 [the
year America signed the Peace Treaty with England]. In 1785, Vermont and Connecticut
authorized the coinage of cents. The *Fugio* cent of 1787 was the first coin issued by authority of
the United States. In 1792, Congress authorized the establishment of a United States mint to
issue coins regularly. The first regularly issued cents from the mint, each worth a hundredth part
of a dollar, were issued in 1793. Half cents also were issued until 1857, two-cent pieces from
1864 to 1873, and three-cent pieces from 1851-1889.

The weight and metal content of the cent have changed many times. But in 1864 the law
provided that the cent contain 95 per cent copper and 5 per cent tin and zinc, and weight 48
grains (3 grams). Any number of cents has been legal tender since 1933. *(World Book
Encyclopedia,* 1979 edition, Volume 3, page 260)

# Introduction to Decimals

The word "decimal" comes from the Latin word *"decimus"* which means "tenth." It might help you remember its meaning by associating "dec" with <u>dec</u>ade (ten years) or <u>dec</u>athlon (ten sports events). Also, the tenth month of the year used to be <u>Dec</u>ember.

Decimals are used when:
    (1) you write dollars and cents
    (2) you convert fractions
    (3) you write out "checks" from the bank

You will enjoy the Learning Exercises in this section as you practice applying decimals to math. Memorize the three parts of a decimal as shown in the example.

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**PRINCIPLE #1**

# DECIMALS HAVE THREE PARTS.

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**EXAMPLE**

**3.1**

| 3 | . | 1 |
|---|---|---|
| Whole Number | Decimal Point | Decimal Portion |

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**Learning Exercise**

Write twelve decimal numbers.

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## Decimal Positions

When writing decimals, remember that the numbers to the LEFT of the decimal are whole numbers. The numbers to the RIGHT of the decimal are less than one.

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**PRINCIPLE #2**

# THE POSITION OF A DIGIT IN A DECIMAL DETERMINES THE DIGIT'S "PLACE VALUE."

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### EXAMPLE

Here is how the number "fifty-two and sixty-five hundredths" (or fifty-two dollars and sixty-five cents) is shown on the **"place value" chart:**

| Hundreds | Tens | Ones | • | Tenths | Hundredths | Thousandths |
|----------|------|------|---|--------|------------|-------------|
|          |      |      |   |        |            |             |

|      | fifty | - | two |   | and |   | sixty | - | five hundredths |
|------|-------|---|-----|---|-----|---|-------|---|-----------------|
|      | 5     |   | 2   |   | •   |   | 6     |   | 5               |

($52.65)

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### Learning Exercise

Draw your own Decimal "Place Value Chart" as shown. Write five decimal numbers on the Chart. Then write the numbers as dollars and cents.

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You have probably noticed that decimals are easier to visualize when you think of them in terms of dollars and cents. In our previous example, the decimal 52.65 probably made more sense to you when it was written like this: $52.65.

If you were to write this amount in word phrases, it would appear like this: Fifty-two dollars and sixty-five cents. However, if the amount was a simple decimal figure, it would be written: Fifty-two and sixty-five hundredths (as shown on the place value chart).

The digits to the <u>left</u> of the decimal point are read and written the same as whole numbers *(fifty-two)*. The digits to the <u>right</u> of the decimal point *(sixty-five hundredths)* end with "ths", to indicate they are <u>part of the whole</u>. The decimal point is indicated by the word "and."

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### PRINCIPLE #3

# THERE IS A CORRECT WAY TOWRITE DECIMALS IN WORD PHRASES.

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### EXAMPLES

4.3  =  four and three tenths

83.25  =  eighty-three and twenty-five hundredths

.332  =  three hundred thirty-two thousandths

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### Learning Exercise

Write five decimal numbers in digits, and then write them in words.

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# Rounding Decimals

When a number is to be rounded to the nearest tenth, hundredth, or thousandth, etc., the next number to the right is also rounded. All the other digits to the right are dropped. Remember that if a digit is five or more, the rounded number is increased by "one."

It also might be helpful to remember that a *tenth* will be *one* digit to the right of the decimal because the number ten has *one zero*. Hundredths are *two* digits to the right, because the number one hundred has *two zeros*, and so on.

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### PRINCIPLE #4

# THE PRINCIPLE OF ROUNDING DECIMALS IS THE SAME AS ROUNDING WHOLE NUMBERS.

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### EXAMPLE

Round 63.8723 to the nearest tenth.

63.8723 = Eight is the digit representing the nearest tenth.
Seven is the number to be rounded.
Drop the 2 and the 3.
63.87 = Since seven is larger than 5, this will change the 8 to 9.

**ANSWER:** 63.8723 rounded to the nearest tenth is 63.9

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### Learning Exercise

Write ten decimal numbers and round them to the nearest tenth.

---

**\* Optional Review #1 \***

# *REVIEW #1*

<div style="border:1px solid black;">

## Can you answer these questions?

</div>

( Try to remember without looking back! )

1. What are the three parts of a decimal?

    a.

    b.

    c.

2. Label the boxes in the place value chart below, for decimals.

| | | | | | | |
|---|---|---|---|---|---|---|
| | | | | | | |

Place the following decimals in their appropriate place value chart boxes above.

    73.96          27.851          382.74

3. Write the following decimals in word phrases:

    a. 81.532

    b. 472.26

    c. 77.65

4. Round the following decimals to the nearest tenth:

    a. 27.8973

    b. 54.217

    c. 35.24

5. Round the following decimals to the nearest hundredth:

    a. 98.573

    b. 59.685

    c. 36.8271

When adding several decimal numbers together, it is very important to place the numbers in straight columns. Graph paper helps to keep the columns straight so the decimals always line up.

Then all you have to do is add the column as if there were no decimals. In your answer, put the decimal point directly below the decimal points in the column, as shown in the example below.

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**PRINCIPLE #5**

# TO ADD DECIMALS, WRITE THE NUMBERS SO THAT THE DECIMAL POINTS LINE UP VERTICALLY.

---

**EXAMPLES**

```
  5. 4 9            0 0 6
     3 3          3.7 8 6 4
  1. 9            5.0 1
  7. 7 2          8.8 0 2 4
 15. 4 4         17.6 0 4 8
```

---

**Learning Exercise**

Create and solve ten addition problems using decimals.

## PRINCIPLE #6

# TO <u>SUBTRACT</u> DECIMALS, WRITE THE NUMBERS SO THAT THE DECIMAL POINTS LINE UP VERTICALLY.

### EXAMPLES

$$
\begin{array}{r} 6.698 \\ -3.1 \\ \hline 3.598 \end{array}
\qquad
\begin{array}{r} 94.33 \\ -62.21 \\ \hline 32.12 \end{array}
\qquad
\begin{array}{r} 9.67 \\ -.43 \\ \hline 9.24 \end{array}
$$

### Learning Exercise

Create and solve ten subtraction problems using decimals.

## PRINCIPLE #7

# WHEN THE SUBTRAHEND HAS MORE NUMBERS THAN THE MINUEND, WRITE <u>EXTRA ZEROS</u> IN THE MINUEND.

### EXAMPLE

$$
\begin{array}{r} 7.23 \\ -\ 2.19664 \\ \hline \end{array}
\qquad
\begin{array}{r} 7.23000 \\ -\ 2.19664 \\ \hline \end{array}
\qquad
\begin{array}{r} {}^{1\,2\,9\,9\,10} \\ 7.23000 \\ -\ 2.19664 \\ \hline 5.03336 \end{array}
$$

### Learning Exercise

Create and solve five subtraction problems
which require borrowing from additional zeros .

\* Optional Review #2 \*

# REVIEW #2

## Can you answer these questions?

1. Add the following decimals:

a.     26.837
      816.53
        6.7
   +  .15

b.       6.10
     98.279
  +   .82

c.     537.9018
      2.108
     16.73
  +     .62

d.     281.29
       .16
  +   2.68

2. Add the following sets of decimals:   2.815,   67.238, and .0893.     285.96, .0034, and 28.813.

3. Subtract the following decimals:

a    481.967
  -    26.478

b.     26.1
  -    8.276

c.     6.2
  -    .3084

d.     6801.4290
  -    593.287

4. Subtract the following sets of decimals:   26.08 minus 2.0158.     627.73261 minus 5.083.

## PRINCIPLE #8

# DECIMALS ARE MULTIPLIED THE SAME WAY AS WHOLE NUMBERS, WITH THE DECIMAL POINT PLACED IN THE PRODUCT.

**EXAMPLES**

| 367 | 490 | 559.3 |
|---|---|---|
| x .2 | x .5 | x 3 |
| 73. 4 | 245.0 | 1,677.9 |

**Learning Exercise**

Create and solve ten multiplication problems, using a decimal in one factor.

## PRINCIPLE #9

# THE NUMBER OF DECIMAL PLACES IN THE PRODUCT IS THE SUM OF THE NUMBER OF DIGITS TO THE *RIGHT* OF THE DECIMAL IN <u>BOTH FACTORS</u>.

## EXAMPLES

1. Two decimal places:

```
  25.3            25.3            25.3  ⟩ (two digits
 x 2.2           x 2.2           x 2.2  ⟩  on the right)
  506             506             506
                  506             506
                                 55.66  (two decimal
                                         places)
```

2. Five decimal places:

```
 2.631           2.631           2.631  ⟩ (five digits
 x .72           x .72           x .72  ⟩  on the right)
 5262            5262            5262
                 18417           18417
                               1.89432  (five decimal
                                         places)
```

## Learning Exercise

Create and solve five multiplication problems, using decimals in both factors.

## PRINCIPLE #10

# WHEN THE PRODUCT DOES NOT HAVE ENOUGH NUMBERS FOR THE DECIMAL PLACE, WRITE IN ADDITIONAL ZEROS.

---

### EXAMPLE

```
  0.052              0.052
x   .02            x   .02
                   0.00104
```

---

### Learning Exercise

Create five multiplication problems which require
additional zeros in the product.

## PRINCIPLE #11

# TO MULTIPLY A DECIMAL BY DIGITS ENDING WITH ONE OR MORE ZEROS, MOVE THE DECIMAL POINT TO THE <u>RIGHT</u> THE SAME NUMBER OF PLACES AS THERE ARE <u>ZEROS</u>.

### EXAMPLES

5.9782 multiplied by ten　　=　　59.782 (1 decimal place to the right)

5.9782 multiplied by one hundred　　=　　597.82 (2 decimal places to the right)

5.9782 multiplied by one thousand　　=　　5978.2 (3 decimal places to the right)

(Remember: If there are not enough digits, add zeros):

3.2 multiplied by 100 = 320.

### Learning Exercise

Create five problems multiplying decimals by 10s, 100s, or more.

## Decimal "Powers"

You will recall in the section on whole numbers, you could increase a number by writing a small digit above and to the right the original number called an "exponent." (Ten to the fourth power, for example is written $10^4$.) You can do this with decimals, too. The procedure to remember is that you move the decimal to the <u>right</u> the same number of places as the exponent.

See the examples below.

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**PRINCIPLE #12**

# WHEN MULTIPLYING DECIMALS, "POWERS" CAN BE WRITTEN AS <u>EXPONENTS.</u>

---

**EXAMPLES**

$4.8834 \times 10^1 = 48.834$    (one place to the right)

$4.8834 \times 10^2 = 488.34$    (two places to the right)

$4.8834 \times 10^3 = 4883.4$    (three places to the right)

$4.8834 \times 10^4 = 48834.$    (four places to the right)

$4.8834 \times 10^5 = 488340.$    (five places to the right)

---

**Learning Exercise**

Create and solve five multiplication problems using decimals and exponents.

---

**\* Optional Review #3 \***

# REVIEW #3

## Can you answer these questions?

( Try to remember without looking back! )

1. Multiply the following decimals:

a.  .034
    x   .2
    _____

b.  .305
    x  .25
    _____

c.  4.06
    x  .014
    _____

d.  .342
    x  2.5
    _____

e.  .547
    x  .01
    _____

f.  6.38
    x  .04
    _____

g.  9.54
    x  1.7
    _____

h.  .695
    x  3.1
    _____

2. Place the decimal between the proper digits in the following "powers" problems.

a.  $336.8194 \times 10^1$ = 3 3 6 8 1 9 4

b.  $27.56304 \times 10^3$ = 2 7 5 6 3 0 4

c.  $9634.63740 \times 10^4$ = 9 6 3 4 6 3 7 4 0

d.  $754.8159 \times 10^2$ = 7 5 4 8 1 5 9