

WordsWorth Times [Under construction]

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Play is the work of the child. – Jean Piaget (or was it Friedrich Froebel?)

When tools become toys, then work becomes play. – Bernie De Koven

Among my tools and toys for learning and teaching are games. I blend them with other tools and toys in the hope of reaching that magical moment when a child leaps up and exclaims, "I understand!" – Laran Stardrake

Grab your favorite dictionary and play **WordsWorth Times**, one of the games in our WordsWorth system of math and word games that began with **WordsWorth Plus**. We'll show you how to calculate the **WordsWorth of a word** and suggest WordsWorth activities for you, your family, and your friends to try. As you play, you'll learn about **reverses, palindromes, semordnilaps, permutations, and anagrams**.

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As our reference for the words you'll see, we use our favorite dictionaries:

- *The Official Scrabble Players Dictionary*, Fourth Edition. Copyright (c) 2005. ISBN-13: 978-0-87779-929-0. ISBN-10: 0-87779-929-6.
- The Internet dictionary Dictionary.com (<http://dictionary.reference.com/>)
- The Internet version of *Merriam-Webster's Collegiate Dictionary*. Merriam-Webster Online – Dictionary (www.m-w.com/).

Let's play!

WordsWorths of 2-Letter Words

Assign a **letter score** to each letter in the alphabet, A through Z, as follows:

| | | | | | | | | |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| A = 1 | B = 2 | C = 3 | D = 4 | E = 5 | F = 6 | G = 7 | H = 8 | I = 9 |
| J = 10 | K = 11 | L = 12 | M = 13 | N = 14 | O = 15 | P = 16 | Q = 17 | R = 18 |
| S = 19 | T = 20 | U = 21 | V = 22 | W = 23 | X = 24 | Y = 25 | Z = 26 | |

Lowercase letters (a, b, c, ..., z) have the same letter scores as their uppercase counterparts.

| | | | | | | | | |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| a = 1 | b = 2 | c = 3 | d = 4 | e = 5 | f = 6 | g = 7 | h = 8 | i = 9 |
| j = 10 | k = 11 | l = 12 | m = 13 | n = 14 | o = 15 | p = 16 | q = 17 | r = 18 |
| s = 19 | t = 20 | u = 21 | v = 22 | w = 23 | x = 24 | y = 25 | z = 26 | |

The **WordsWorth of a word** is the product of the letter scores of the word's letters. Here are the WordsWorths of the 2-letter words *ah* and *ha*:

- The letter score of the letter *a* is 1.
- The letter score of the letter *h* is 8.
- The WordsWorth of the word *ah* is $1 \times 8 = 8$.
- The WordsWorth of the word *ha* is $8 \times 1 = 8$.

$$\begin{array}{|c|} \hline a \\ \hline 1 \\ \hline \end{array} \times \begin{array}{|c|} \hline h \\ \hline 8 \\ \hline \end{array} = \begin{array}{|c|} \hline ah \\ \hline 8 \\ \hline \end{array}$$

$$\begin{array}{|c|} \hline h \\ \hline 8 \\ \hline \end{array} \times \begin{array}{|c|} \hline a \\ \hline 1 \\ \hline \end{array} = \begin{array}{|c|} \hline ha \\ \hline 8 \\ \hline \end{array}$$

The words *ah* and *ha* are **reverses** of each other. The word *ha* is the reverse of *ah* which, of course, is the reverse of *ha*. If two different dictionary words are reverses of each other, they are **semordnilaps**. Here's another pair of semordnilaps:

| | | | | |
|--|---|---|---|----|
| Reverse <i>ah</i> to get <i>ha</i>. | | | | |
| | a | a | a | |
| ah | h | h | h | ha |

- The WordsWorth of the word *no* is $14 \times 15 = 210$.
- The WordsWorth of the word *on* is $15 \times 14 = 210$.

| | | | | |
|--|---|---|---|----|
| Reverse <i>no</i> to get <i>on</i>. | | | | |
| | n | n | n | |
| no | o | o | o | on |

Multiplication is a **commutative operation**, so $14 \times 15 = 15 \times 14$. Semordnilaps have the same letters and the same letter scores, so they have the same WordsWorth.

Next, *tra la*, *tra la*, are 2-letter words that are not semordnilaps.

- The WordsWorth of the word *be* is $2 \times 5 = 10$.
- The WordsWorth of the word *hi* is $8 \times 9 = 72$.

$$\begin{array}{|c|} \hline b \\ \hline 2 \\ \hline \end{array} \times \begin{array}{|c|} \hline e \\ \hline 5 \\ \hline \end{array} = \begin{array}{|c|} \hline be \\ \hline 10 \\ \hline \end{array}$$

Your Turn #1

Use mental math, paper and pencil math, great guesses, or a calculator to do the following WordsWorth activities. Complete the sentences and answer the questions.

a = 1 b = 2 c = 3 d = 4 e = 5 f = 6 g = 7 h = 8 i = 9
 j = 10 k = 11 l = 12 m = 13 n = 14 o = 15 p = 16 q = 17 r = 18
 s = 19 t = 20 u = 21 v = 22 w = 23 x = 24 y = 25 z = 26

1. The letter score of the letter *a* is _____ and the letter score of *m* is _____.
2. The WordsWorth of *am* is $1 \times 13 =$ _____.
3. The WordsWorth of *ma* is $13 \times 1 =$ _____.
4. The WordsWorth of *at* is $1 \times$ _____ = _____.
5. The WordsWorth of *pi* is _____ $\times 9 =$ _____.
6. The WordsWorth of *oh* is _____ $\times 8 =$ _____.
7. What is the WordsWorth of *ho*?
8. What is the WordsWorth of *it*?

Answers

1. The letter score of the letter *a* is 1 and the letter score of *m* is 13.
2. The WordsWorth of *am* is $1 \times 13 = 13$.

am and *ma* are semordnilaps
3. The WordsWorth of *ma* is $13 \times 1 = 13$.
4. The WordsWorth of *at* is $1 \times 20 = 20$.
5. The WordsWorth of *pi* is $16 \times 9 = 144$.
6. The WordsWorth of *oh* is $15 \times 8 = 120$.
7. In #6, you calculated the WordsWorth of *oh*. The words *oh* and *ho* are semordnilaps and have the same WordsWorth: $15 \times 8 = 8 \times 15 = 120$.
8. The WordsWorth of *it* is $9 \times 20 = 180$. A semordnilap of *it* is *ti* of do, re, mi, fa, sol, la, ti, do fame, so the WordsWorth of *ti* is also 180.

Your Turn #2

Given a number, is it the WordsWorth of a 2-letter word? Is there a 2-letter word that has a WordsWorth equal to 12? The product of the letter scores of the word must equal 24, so each letter score must be less than 24. What letters have letter scores that are less than 20?

- We found *la* ($12 \times 1 = 12$) and *Al* ($1 \times 12 = 12$), which are semordnilaps. *Al* is the chemical symbol for aluminum. *AL* is also the abbreviation for *Alabama*. You decide whether or not to allow abbreviations and chemical symbols.

Boldly plunge onward and do these friendly activities. Here is the handy list of letter scores.

a = 1 b = 2 c = 3 d = 4 e = 5 f = 6 g = 7 h = 8 i = 9
 j = 10 k = 11 l = 12 m = 13 n = 14 o = 15 p = 16 q = 17 r = 18
 s = 19 t = 20 u = 21 v = 22 w = 23 x = 24 y = 25 z = 26

- In your dictionary, what 2-letter word has a WordsWorth equal to 14?
- In your dictionary, what 2-letter word has a WordsWorth equal to 72?
- In your dictionary, what pair of semordnilaps have a WordsWorth equal to 65?
- The WordsWorth of a 2-letter word is greater than or equal to what number?
- The WordsWorth of a 2-letter word is less than or equal to what number?

Answers

- In our dictionary, we found *an* ($1 \times 14 = 15$).
- In our dictionary, we found *hi* ($8 \times 9 = 72$).
- In our dictionary, we found *em* ($5 \times 13 = 65$) and *me* ($13 \times 5 = 65$).
- A letter score is greater than or equal to 1, so the WordsWorth of a 2-letter word is greater than or equal to $1 \times 1 = 1$.
- A letter score is less than or equal to 26, so the WordsWorth of a 2-letter word is less than or equal to $26 \times 26 = 676$.

WordsWorths of 3-Letter Words

Let's calculate the WordsWorths of 3-letter words. The object of this activity is to find the WordsWorth of a word, not to practice multiplying numbers, so we think a calculator is an appropriate tool for this task. Here again is the handy table of letter scores.

| | | | | | | | | |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| a = 1 | b = 2 | c = 3 | d = 4 | e = 5 | f = 6 | g = 7 | h = 8 | i = 9 |
| j = 10 | k = 11 | l = 12 | m = 13 | n = 14 | o = 15 | p = 16 | q = 17 | r = 18 |
| s = 19 | t = 20 | u = 21 | v = 22 | w = 23 | x = 24 | y = 25 | z = 26 | |

We'll calculate the WordsWorths of some 3-letter words:

- The WordsWorth of *dad* is $4 \times 1 \times 4 = 16$.
- The WordsWorth of *mom* is $13 \times 15 \times 13 = 2,535$.
- The WordsWorth of *elf* is $5 \times 12 \times 6 = 360$.
- The WordsWorth of *cat* is $3 \times 1 \times 20 = 60$.
- The WordsWorth of *owl* is $15 \times 23 \times 12 = 4,140$.

| | | | | | | |
|---|---|---|---|---|---|-----|
| d | × | a | × | d | = | dad |
| 4 | | 1 | | 1 | | 16 |

The word *dad* is a **palindrome**. It reads the same left to right or right to left. The word *mom* is also a palindrome. The reverse of *mom* is *mom*.

| | | | | |
|--|---|---|---|-----|
| Reverse <i>mom</i> to get <i>mom</i>. | | | | |
| mom | m | m | m | mom |
| | o | o | o | |
| | m | m | m | |

You can arrange the letters of *cat* to get *act*, so these words are **anagrams** of each other. Multiplication is a **commutative operation**, so *cat* and *act* have the same WordsWorth:

| | | | |
|--|----|-----|---|
| Arrange <i>act</i> to get <i>cat</i>. | | | |
| act | a | c | t |
| | ct | a | t |
| | | cat | |

- Multiplication is commutative: $3 \times 1 \times 20 = 1 \times 3 \times 20 = 60$.

You can arrange the letters of *owl* to get *low*, so these words are anagrams and have the same WordsWorth.

- Multiplication is commutative: $15 \times 23 \times 12 = 12 \times 15 \times 23 = 4,140$.

The words *alp*, *lap*, and *pal* are anagrams. Two of these, *lap* and *pal* are also semordnilaps. The three words have the same letters and the same WordsWorth.

- WordsWorth of *alp*, *lap*, and *pal*: $1 \times 12 \times 16 = 12 \times 1 \times 16 = 16 \times 1 \times 12 = 192$.

Your Turn #3

Use mental math, paper and pencil math, great guesses, base-10 blocks, or a calculator to do the following WordsWorth activities. Complete the sentences and answer the questions.

a = 1 b = 2 c = 3 d = 4 e = 5 f = 6 g = 7 h = 8 i = 9
 j = 10 k = 11 l = 12 m = 13 n = 14 o = 15 p = 16 q = 17 r = 18
 s = 19 t = 20 u = 21 v = 22 w = 23 x = 24 y = 25 z = 26

1. The WordsWorth of *aha* is $1 \times 8 \times 1 = \underline{\hspace{2cm}}$.
2. The WordsWorth of *fun* is $6 \times 21 \times \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$.
3. The WordsWorth of *joy* is $\underline{\hspace{2cm}} \times \underline{\hspace{2cm}} \times \underline{\hspace{2cm}} = \underline{\hspace{2cm}}$.
4. What is the WordsWorth of *not*?
5. The words *pot* and *top* are anagrams and semordnilaps, so they share the same WordsWorth. What is that WordsWorth?
6. The words *art*, *rat*, and *tar* are anagrams. *Rat* and *tar* are also semordnilaps. What is the WordsWorth shared by *art*, *rat*, and *tar*?

Answers

1. The WordsWorth of *aha* is $1 + 8 + 1 = 8$. The word *aha* is a palindrome.
2. The WordsWorth of *fun* is $6 \times 21 \times 14 = 1,764$.
3. The WordsWorth of *joy* is $10 \times 15 \times 25 = 3,750$.
4. What is the WordsWorth of *not*? $14 \times 15 \times 20 = 4,200$. This is also the WordsWorth of *ton*.
5. The WordsWorth shared by *pot* and *ton* is $16 \times 15 \times 20 = 20 \times 15 \times 16 = 4,800$.
6. The WordsWorth of *art*, *rat*, and *tar* is 360.

WordsWorth of *art* = $1 \times 18 \times 20 = 360$.

WordsWorth of *rat* = $18 \times 1 \times 20 = 360$.

WordsWorth of *tar* = $20 \times 1 \times 18 = 360$.

Your Turn #4

Is a given number the WordsWorth of a 3-letter word? Is there a 3-letter word that has a WordsWorth equal to 12? The sum of the letter scores of the word must equal 13, so each letter score must be less than 12.

- We found *ala*, which is a palindrome. Its WordsWorth is $1 \times 12 \times 1 = 12$.
- We also found *cad* ($3 \times 1 \times 4 = 12$).

Onward! Amaze and delight yourself and others by doing these word-friendly activities. Here is the handy list of letter scores.

| | | | | | | | | |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| a = 1 | b = 2 | c = 3 | d = 4 | e = 5 | f = 6 | g = 7 | h = 8 | i = 9 |
| j = 10 | k = 11 | l = 12 | m = 13 | n = 14 | o = 15 | p = 16 | q = 17 | r = 18 |
| s = 19 | t = 20 | u = 21 | v = 22 | w = 23 | x = 24 | y = 25 | z = 26 | |

1. In your dictionary, what 3-letter word has a WordsWorth equal to 2?
2. In your dictionary, what 2-letter word has a WordsWorth equal to 6?
3. In your dictionary, what 2-letter word has a WordsWorth equal to 15?
4. The WordsWorth of a 3-letter word is greater than or equal to what number?
5. The WordsWorth of a 3-letter word is less than or equal to what number?

Answers

1. In our dictionary, we found *aba* ($1 \times 2 \times 1$) and *baa* ($2 \times 1 \times 1 = 2$). *Baa* is the sound made by Mary's little lamb and other lambs on Gaia (Mother Earth). An *aba* is a garment worn by men in the Middle East, also a fabric made from the hair of camels and goats. *Aba* and *baa* are anagrams and *aba* is a palindrome. Play WordsWorth and improve your vocabulary!
2. In our dictionary, we found *cab* ($3 \times 1 \times 2 = 6$).
3. In our dictionary, we found *ace* ($1 \times 3 \times 5 = 15$).
4. A letter score is greater than or equal to 1, so the WordsWorth of a 3-letter word is greater than or equal to $1 \times 1 \times 1 = 1$.
5. A letter score is less than or equal to 26, so the WordsWorth of a 2-letter word is less than or equal to $26 \times 26 \times 26 = 17,576$.

WordsWorths 1 to 26

For each number from 1 to 26, find words (the more the better) that have a **WordsWorth** equal to the number. Your word may have 2 letters, 3 letters, 4 letters, or more letters..

a = 1 b = 2 c = 3 d = 4 e = 5 f = 6 g = 7 h = 8 i = 9
 j = 10 k = 11 l = 12 m = 13 n = 14 o = 15 p = 16 q = 17 r = 18
 s = 19 t = 20 u = 21 v = 22 w = 23 x = 24 y = 25 z = 26

| | | | |
|----|---|----|---|
| 1 | 2 | 3 | 4 |
| 5 | | 6 | |
| 7 | | 8 | |
| 9 | | 10 | |
| 11 | | 12 | |
| 13 | | | |
| 14 | | | |
| 15 | | | |
| 16 | | | |
| 17 | | | |
| 18 | | | |
| 19 | | | |
| 20 | | | |
| 21 | | | |
| 22 | | | |
| 23 | | | |
| 24 | | | |
| 25 | | | |
| 26 | | | |

Investigations

Most of the work and play in WordsWorth is **thinking**: knowing words, browsing a dictionary to learn more words, thinking about the questions, and devising strategies for finding answers – most enjoyable, we think. People are well equipped to do this type of work and play.

Some of the work is ho-hum tedious: looking up letter scores and multiplying them to get the WordsWorth. A calculator is a handy tool for this task. Using a number-crunching tool to do the calculating gives you more time to do the thinking.

Here are investigations that occurred to us.

In your dictionary:

1. What 2-letter word has the smallest WordsWorth?
2. What 2-letter word has the largest WordsWorth?
3. What 3-letter word has the smallest WordsWorth?
4. What 3-letter word has the largest WordsWorth?
5. What 4-letter word has the smallest WordsWorth?
6. What 4-letter word has the largest WordsWorth?
7. What n -letter word (you choose the value of n) has the smallest WordsWorth?
8. What n -letter word (you choose the value of n) has the largest WordsWorth?
9. What is the first word (alphabetically) that has a WordsWorth equal to 53?
10. What is the last word (alphabetically) that has a WordsWorth equal to 53?
11. What is the first word (alphabetically) that has a WordsWorth equal to 100?
12. What is the last word (alphabetically) that has a WordsWorth equal to 100?
13. What is the first word (alphabetically) that has a WordsWorth equal to W (you choose the value of W)?
14. What is the last word (alphabetically) that has a WordsWorth equal to W (you choose the value of W)?
15. In the entire dictionary, what word has the largest WordsWorth?

16. What is the shortest word (fewest letters) that has a WordsWorth equal to 52?
17. What is the longest word (most letters) that has a WordsWorth equal to 52?
18. What is the shortest word (fewest letters) that has a WordsWorth equal to 78?
19. What is the longest word (most letters) that has a WordsWorth equal to 78?
20. What is the shortest word (fewest letters) that has a WordsWorth equal to W (you choose the value of W)?
21. What is the longest word (most letters) that has a WordsWorth equal to W (you choose the value of W)?

The WordsWorth of *ratio* is 63 and *ratio* has five letters. The ratio of the WordsWorth of *ratio* to the number of letters in *ratio* is $63 / 5 = 12.6$.

- $(\text{WordsWorth of } ratio) / (\text{number of letters in } ratio) = 63 / 5 = 12.6$.
22. What 2-letter word has the smallest WordsWorth to number of letters ratio? What is the ratio?
 23. What 2-letter word has the largest WordsWorth to number of letters ratio? What is the ratio?
 24. What 3-letter word has the smallest WordsWorth to number of letters ratio? What is the ratio?
 25. What 3-letter word has the largest WordsWorth to number of letters ratio? What is the ratio?
 26. What 4-letter word has the smallest WordsWorth to number of letters ratio? What is the ratio?
 27. What 4-letter word has the largest WordsWorth to number of letters ratio? What is the ratio?
 28. What n -letter word (you choose the value of n) has the smallest WordsWorth to number of letters ratio? What is the ratio?
 29. What n -letter word (you choose the value of n) has the largest WordsWorth to number of letters ratio? What is the ratio?
 30. In the entire dictionary, what word with five or more letters has the smallest WordsWorth to number of letters ratio? What is the ratio?
 31. In the entire dictionary, what word with five or more letters has the largest WordsWorth to number of letters ratio? What is the ratio?

Glossary

anagram A word made by changing the order of the letters of another word. You can change the order of the letters in *cat* to get *act*. You can change the order of the letters of *art* to get *rat* or *tar*. We found hundreds of anagrams on the Internet. Here are some we liked:

- alp lap pal
- ate eat eta tea
- arts rats star tars tsar
- abode adobe
- loops pools sloop spool
- merit miter timer remit
- capers pacers parsec spacer scrape

Anagrams can be phrases as well as single words. Here are two that we like:

- Anagram of *wizard*: rad wiz
- Anagram of *eleven plus two*: twelve plus one

For lots of anagram fun, visit these Internet sites:

- Internet Anagram Server (www.wordsmith.org/anagram/)
- Brendan's On-Line Anagram Generator (www.mbhs.edu/~bconnell/cgi-bin/anagram.cgi?)

commutative In his excellent book, *Algebra the Easy Way*, Douglas Downing calls this the order-doesn't-make-a-difference property of mathematical operations. Addition and multiplication of real numbers are commutative operations. If you add two numbers, it doesn't make any difference in what order you add them. The result is the same. If you multiply two numbers, it doesn't make any difference in what order you multiply them. The result is the same.

- Addition is a commutative operation: If a and b are numbers, then $a + b = b + a$.
- Multiplication is a commutative operation: If a and b are numbers, then $a \times b = b \times a$.

It works for three numbers or more numbers. If a , b , and c are numbers, then

- $a + b + c = a + c + b = b + a + c = b + c + a = c + a + b = c + b + a$.
- $a \times b \times c = a \times c \times b = b \times a \times c = b \times c \times a = c \times a \times b = c \times b \times a$.

palindrome A word that reads the same backward and forward, such as *aha*, *toot*, and *radar*. There are also numbers that are palindromes, such as 77, 454, 3003, and 12345678987654321. Clever people have constructed palindromes that are phrases, sentences, paragraphs, poems, et cetera, et cetera.

- Three-letter palindromes: bib dad did gag hah mom oho pep wow
- Four-letter palindromes: deed noon peep sees toot
- Five-letter palindromes: civic level madam radar refer rotor

If you'd like to sample a proliferation of palindromes, pop on over to these Internet sites:

- Introduction : what is a palindrome ? (www.worldofnumbers.com/intro.htm)
- What are palindromes? (http://fun-with-words.com/palin_explain.html).

permutation An arrangement, or ordering, of a set of objects. In WordsWorth, a permutation is an arrangement of letters in a word or in any string of letters.

- There are two permutations of *ab*: *ab* and *ba*.
- There are six permutations of *abc*: *abc*, *acb*, *bac*, *bca*, *cab*, and *cba*. One of these permutations is a word: *cab*.
- There are six permutations of *aet*: *aet*, *ate*, *eat*, *eta*, *tae*, and *tea*. Four of these permutations are words: *ate*, *eat*, *eta*, and *tea*. These words are anagrams. The words *ate* and *eta* are semordnilaps.

The letter *a* appears twice in *aha*, so the number of distinct permutations of *aha* is less than six. There are three distinct permutations: *aha*, *aah*, and *haa*.

reverse A word or non-word obtained by reversing the order of the letters in a given word. For example, the reverse of *hobbit* is *tibboh*, which is not a word in our dictionary. The reverse of *now* is *won*, which is a word. If the reverse of a word is a different word, the two words are **semordnilaps** of each other.

The reverse of *aha* is *aha*, which is the same word. If the reverse of a word is the same word, the word is a **palindrome**.

semordnilap A word that is the **reverse** of a different word. If you read a word backward and get a different word, then the two words are semordnilaps. Here are some semordnilaps:

- Two-letter semordnilaps: *ah* and *ha*, *eh* and *he*, *em* and *me*, *it* and *ti*.
- Three-letter semordnilaps: *are* and *era*, *not* and *ton*, *pot* and *top*, *saw* and *was*.
- Four-letter semordnilaps: *doom* and *mood*, *loop* and *pool*, *moor* and *room*.
- 11-letter semordnilaps: *palindromes* and *semordnilap*. Aha! The word *semordnilap* is the word *palindromes* spelled backward.

A semordnilap is a special type of **anagram**. If a word is a semordnilap, then it is an anagram. The converse is not true: a word may be an anagram, but not be a semordnilap. The words *alp*, *lap*, and *pal* are anagrams. *Lap* and *pal* are also semordnilaps. However, *alp* and *lap* are not semordnilaps, and *alp* and *pal* are not semordnilaps.

Two-Letter Words

All 2-letter words in *The Official Scrabble® Players Dictionary* are listed at

- MidZine – Scrabble – All 2-Letter Words
<http://www.msoworld.com/mindzine/news/proprietary/scrabble/features/all2s.html>

aa, ab, ad, ae, ag, ah, ai, al, am, an, ar, as, at, aw, ax, ay, ba, be, bi, bo, by, de, do, ed, ef, eh, el, em, en, er, es, et, ex, fa, go, ha, he, hi, hm, ho, id, if, in, is, jo, ka, la, li, lo, ma, me, mi, mm, mo, mu, my, na, ne, no, nu, od, oe, of, oh, om, on, op, or, os, ow, ox, oy, pa, pe, pi, re, sh, si, so, ta, ti, to, uh, um, un, up, us, ut, we, wo, xi, xu, ya, ye, yo

We suggest the following subset of the 96 official Scrabble® words:

ab, ad, ah, am, an, as, at, aw, ax, ay, be, by, do, ed, eh, el, em, en, ex, fa, go, ha, he, hi, ho, id, if, in, is, la, lo, ma, me, my, no, nu, of, oh, om, on, or, ow, ox, oy, pa, pi, re, so, ta, ti, to, uh, um, up, us, we, xi, yo

Three-Letter Words

All 3-letter words in *The Official Scrabble® Players Dictionary* are listed at

- MidZine – Scrabble – All 3-Letter Words
<http://www.msoworld.com/mindzine/news/proprietary/scrabble/features/all3s.html>

From the long list at the Internet site, we selected the following 3-letter words:

- aba, abs, ace, act, add, ado, ads, adz, aft, aga, age, ago, aha, aid, ail, aim, air, ala, alb, ale, all, alp, alt, amp, and, ant, any, ape, apt, arc, are, arf, ark, arm, art, ash, ask, asp, ass, ate, auk, awe, awl, awn, axe, aye
- baa, bad, bag, bah, bam, ban, bap, bar, bas, bat, bay, bed, bee, beg, bel, bet, bey, bib, bid, big, bin, bio, bit, biz, boa, bob, bod, bog, boo, bop, bot, bow, box, boy, bra, bro, brr, bub, bud, bug, bum, bun, bur, bus, but, buy, bye
- cab, cad, cam, can, cap, car, cat, caw, cay, cee, cel, chi, cob, cod, cog, col, con, coo, cop, cot, cow, coy, cry, cub, cud, cue, cup, cur, cut
- dab, dad, dam, day, deb, dee, den, dew, did, die, dig, dim, din, dip, dit, doc, doe, dog, don, dot, dry, dub, dud, due, dug, dun, duo, dup, dye
- ear, eat, ebb, eel, egg, ego, eke, elf, elk, ell, elm, emu, end, eon, era, ere, erg, err, ess, eta, eve, ewe, eye
- fad, fag, fan, far, fat, fax, fed, fee, fen, few, fey, fez, fib, fid, fie, fig, fin, fir, fit, fix, flu, fly, fob, foe, fog, fop, for, fox, fro, fry, fun, fur
- gab, gag, gal, gap, gar, gas, gat, gay, gee, gel, gem, get, gig, gin, gnu, gob, god, goo, got, gum, gun, gut, guy, gym, gyp

- had, hag, hah, ham, has, hat, haw, hay, heh, hem, hen, hep, her, het, hew, hex, hey, hic, hid, him, hip, his, hit, hmm, hod, hoe, hog, hop, hot, how, hub, hue, hug, huh, hum, hun, hup, hut, hyp
- ice, ick, icy, ids, iff, ifs, ilk, ill, imp, ink, inn, ion, ire, irk, its, ivy
- jab, jag, jam, jar, jaw, jay, jet, jib, jig, job, joe, jog, jot, joy, jug, jut
- keg, ken, key, kid, kin, kit, koi
- lab, lad, lag, lam, lap, lat, law, lax, lay, lea, led, lee, leg, lei, let, lid, lie, lip, lit, lob, log, loo, lop, lot, low, lox, lug, lux, lye
- mac, mad, man, map, mar, mat, maw, max, may, men, met, mew, mid, mil, mix, mob, mod, mol, mom, moo, mop, mow, mud, mug, mum,
- nab, nag, nah, nap, nay, nee, net, new, nib, nil, nip, nit, nix, nod, nor, not, now, nth, nub, nun, nut
- oaf, oak, oar, oat, obi, odd, ode, off, oft, ohm, oho, oil, old, ole, one, ooh, opt, orb, orc, ore, ort, our, out, ova, owe, owl, own
- pad, pal, pan, pap, par, pas, pat, paw, pax, pay, pea, pec, pee, peg, pen, pep, per, pet, pew, phi, pic, pie, pig, pin, pip, pit, pix, ply, pod, poi, pom, pop, pot, pow, pox, pro, pry, psi, pub, pug, pun, pup, pus, put
- rad, rag, rah, raj, ram, ran, rap, rat, raw, ray, reb, rec, red, ref, rep, rev, rex, rho, rib, rid, rig, rim, rip, rob, roc, rod, roe, rom, rot, row, rub, rue, rug, rum, run, rut
- sac, sad, sag, sap, sat, saw, sax, say, sea, sec, see, seg, set, sew, sex, she, shh, shy, sic, sim, sin, sip, sir, sis, sit, six, ski, sky, sly, sob, sod, sol, son, sop, sos, sot, sou, sow, sox, soy, spa, spy, sty, sub, sue, sum, sun, sup
- tab, tad, tag, tam, tan, tao, tap, tar, tat, tau, tax, tea, tee, ten, tet, the, tho, thy, tic, tie, til, tin, tip, tis, tit, toe, tog, tom, ton, too, top, tor, tot, tow, toy, try, tsk, tub, tug, tun, tut, tux, two
- ugh, uke, ump, urn, use
- vac, van, vat, vee, veg, vet, vex, via, vie, vim, vis, vow, vox,
- wad, wag, wan, war, was, wax, way, web, wed, wee, wet, who, why, wig, win, wit, wiz, woe, wok, won, woo, wow, wry
- yah, yak, yam, yap, yaw, yea, yen, yep, yes, yet, yew, yin, yip, yon, you, yuk, yup
- zag, zap, zed, zee, zen, zig, zip, zit, zoo

Teacher Talk

WordsWorth Times is part of our system of word and math games that includes the following games:

- WordsWorth Plus. The letter scores are the same as in WordsWorth Times, but you add them to get the WordsWorth of a word. The right stuff for grades 1 and 2, we think. Play WordsWorth Plus slowly over a an entire school year or two or more.
- WordsWorth Scrabble[®] Scores. Use the letter scores in the game of Scrabble[®].
- WordsWorth Go for Zero. Letter scores are a = 1, b = -2, c = 3, d = -4, and so on to y = 25, z = -26. The object of the game is to find words that have a WordsWorth equal to zero. For example, the WordsWorth of *baa* is $(-2) + 1 + 1 = 0$. Under construction.
- WordsWorth Times is the game described in this unit. You multiply letter scores to obtain the WordsWorth of a word.
- WordsWorth Prime Time. The letter scores are a = 1 and b through z equal to the first 25 prime numbers. Under construction.
- Et cetera, et cetera – the system is growing

Elsewhere in this document, you'll find lists of 2-letter words and 3-letter words selected from *The Official Scrabble[®] Players Dictionary*. You can find these word lists on the Internet at:

- MidZine – Scrabble – All 2-Letter Words
<http://www.msoworld.com/mindzine/news/proprietary/scrabble/features/all2s.html>
- MidZine – Scrabble – All 3-Letter Words
<http://www.msoworld.com/mindzine/news/proprietary/scrabble/features/all3s.html>

We selected all of the 2-letter words and a subset of the 3-letter words. We also made a shorter list of 2-letter words. For more words, we recommend our favorite dictionaries:

As our reference for the words you'll see, we use our favorite dictionaries:

- *The Official Scrabble Players Dictionary*, Fourth Edition. Copyright (c) 2005. ISBN-13: 978-0-87779-929-0. ISBN-10: 0-87779-929-6.
- The Internet dictionary Dictionary.com (<http://dictionary.reference.com/>)
- The Internet version of *Merriam-Webster's Collegiate Dictionary*. Merriam-Webster Online – Dictionary (www.m-w.com/).

You can make word lists that have the right stuff for your students. For grades 1 and 2, it might be handy to have a list of words constructed from the first nine letters, *a* through *i*, which have letter scores 1 through 9.

a = 1 b = 2 c = 3 d = 4 e = 5 f = 6 g = 7 h = 8 i = 9

We perused *The Official Scrabble® Players Dictionary* and selected words having two to six letters using only the letters *a* through *i*.

- Two-letter words: ad, ah, be, fa, ha, he, if
- Three-letter words: ace, add, aga, age, aha, aid, baa, bad, bag, bah, bed, bee, beg, bib, bid, big, cab, cad, dab, dad, deb, did, die, dig, ebb, egg, fad, fee, fid, fie, fig, gab, gag, gee, gig, had, hag, hah, heh, hic, hid, ice
- Four-letter words: ache, acid, aide, babe, bade, bead, beef, bide, cafe, cage, cede, chad, chic, dada, dead, deaf, deed, dice, died, each, edge, egad, face, fade, feed, fief, fife, gaff, gibe, head, hide, high, iced, idea
- Five-letter words: abide, adage, badge, beach, beech, beige, cache, cadge, chafe, chaff, chide, chief, decaf, fiche, hedge
- Six-letter words: acacia, acidic, addend, babied, baddie, bagged, bedbug, behead, biggie, caddie, cicada, decade, decide, deface, efface, feedbag, gagged

Most of the work and play in WordsWorth is **thinking**: knowing words, browsing a dictionary to learn more words, thinking about the questions, and devising strategies for finding answers to questions and investigations. People are well equipped to do this type of work and play.

Some of the work is ho-hum tedious: looking up letter scores and adding them to get the WordsWorth. Appropriate number crunching tools include mental math, paper and pencil math, base-10 blocks, and calculators. Imagine first grade students starting with base-10 blocks, and then moving to mental math and paper and pencil math as their skills improve by playing WordsWorth.

| Word | Base-10 blocks | WordsWorth + | WordsWorth + |
|-----------|--------------------|-------------------|--------------|
| <i>ad</i> | ■ + ■■■■■ | ■■■■■ | 6 |
| <i>hi</i> | ■■■■■■■ + ■■■■■■■■ | ————■■■■■■■ | 17 |
| <i>me</i> | ————■■■ + ■■■■■ | ————■■■■■■■■■ | 18 |
| <i>to</i> | ———— + —————■■■■■ | ———— ————■■■■■ | 35 |

Do you play Scrabble®? If yes, you know that you play with tiles that have letters and letter scores. Good idea, we thought, so we made a page of WordsWorth Letter Score Tiles. Copy the page to stiff paper and cut along the lines to make a set of WordsWorth tiles.

In this document, we start the easy way with WordsWorths of 2-Letter Words and WordsWorths of 3-Letter Words. We introduce reverses, semordnilaps, palindromes, permutations, and anagrams. Because addition is a commutative operation, words that have the same letters have the same WordsWorth.

Investigations. Questions 1 to 6 ask you to find words with a specified number of letters (2, 3, or 4) that have the smallest and largest WordsWorth in **your dictionary**. Questions 7 and 8 suggest that you choose the number of letters in the word.

We definitely don't know the answers to our questions in your dictionary. In *The Official Scrabble® Player's Dictionary*, the 2-letter word with the smallest WordsWorth is AA (WW+ = 2), rough cindery lava. The 2-letter word with largest WordsWorth might be XU (WW = 45), a monetary unit in Vietnam. Is that too far out? How about YO (WW = 40). Will you allow use of the 2-letter and 3-letter word lists in this activity, or would you rather have students start from scratch without a word list?

Questions 9 through 14 ask you to find the alphabetically first and last words that have a given WordsWorth. We arbitrarily and capriciously picked WordsWorths of 53 for questions 9 and 10, and 100 for questions 11 and 12. Try other vales. This can be a labor-intensive investigation!

Question 15 asks you to find the word that has the largest WordsWorth in your entire dictionary. If every student brings in one candidate word a week for several weeks, maybe you will find it.

Questions 16 through 21 ask you to find the shortest word (fewest letters) and longest word (most letters) that have a specified WordsWorth. We think that *abracadabra* is a good candidate for the longest word that has a WordsWorth equal to 52. But we could be wrong.

If we were looking for the longest word with a WordsWorth of 18, we think that *acacia* is a great candidate. You can keep this activity going as long as you want by picking different target WordsWorths.

Questions 22 to 31 ask you to calculate the ratio of a word's WordsWorth to the number of letters in the word. Students who have answers to questions 1 through 6 can them to answer these questions. Here are candidates for 2-letter and 3-letter words with the smallest and largest ratios.

Two-letter word, smallest and largest ratios: *aa* and *xu*?

- (WordsWorth of *aa*) / (number of letters in *aa*) = $2 / 2 = 1$
- (WordsWorth of *xu*) / (number of letters in *xu*) = $45 / 2 = 22.5$

Three-letter word, smallest and largest ratios: *baa* and *wry*?

- (WordsWorth of *baa*) / (number of letters in *baa*) = $4 / 3 = 1.333$
- (WordsWorth of *wry*) / (number of letters in *wry*) = $66 / 3 = 22$

That leads up to questions 30 and 31. What words with five or more letters have the smallest and largest ratios in the entire dictionary? We're looking.

Variations – Under Construction

Play WordsWorth with Scrabble® letter scores.

| | | | | | | | | |
|-------|-------|-------|-------|-------|-------|-------|--------|-------|
| A = 1 | B = 3 | C = 3 | D = 2 | E = 1 | F = 4 | G = 2 | H = 4 | I = 1 |
| J = 8 | K = 5 | L = 1 | M = 3 | N = 1 | O = 1 | P = 3 | Q = 10 | R = 1 |
| S = 1 | T = 1 | U = 1 | V = 4 | W = 4 | X = 8 | Y = 4 | Z = 10 | |

Play WordsWorth Go for Zero. The letter scores are alternately positive and negative.

| | | | | | | | | |
|---------|---------|---------|---------|---------|---------|---------|---------|---------|
| a = 1 | b = -2 | c = 3 | d = -4 | e = 5 | f = -6 | g = 7 | h = -8 | i = 9 |
| j = -10 | k = 11 | l = -12 | m = 13 | n = -14 | o = 15 | p = -16 | q = 17 | r = -18 |
| s = 19 | t = -20 | u = 21 | v = -22 | w = 23 | x = -24 | y = 25 | z = -26 | |

The object of the game is to find words that have a WordsWorth equal to zero.

- *baa*: $(-2) + 1 + 1 = 0$
- *man*: $13 + 1 + (-14) = 0$
- *toe*: $(-20) + 15 + 5 = 0$

WordsWorth Prime Time. The letter scores are 1 and the first 25 prime numbers.

| | | | | | | | | |
|--------|--------|--------|--------|--------|--------|--------|--------|--------|
| a = 1 | b = 2 | c = 3 | d = 5 | e = 7 | f = 11 | g = 13 | h = 17 | i = 19 |
| j = 23 | k = 29 | l = 31 | m = 37 | n = 41 | o = 43 | p = 47 | q = 53 | r = 59 |
| s = 61 | t = 67 | u = 71 | v = 73 | w = 79 | x = 83 | y = 89 | z = 97 | |

The **WordsWorth Times** of a word is the product of the letter scores.

That's all, folks – except for the WordsWorth Letter Score Tiles on the next page. Farewell.

| WordsWorth Letter Score Tiles | | | |
|--|---|--|---|
| A = 1 ▪ | B = 2 ▪▪ | C = 3 ▪▪▪ | D = 4 ▪▪▪▪ |
| E = 5 ▪▪▪▪▪ | F = 6 ▪▪▪▪▪▪ | G = 7 ▪▪▪▪▪▪▪ | H = 8 ▪▪▪▪▪▪▪▪ |
| I = 9 ▪▪▪▪▪▪▪▪▪ | J = 10 ————— | K = 11 ————— ▪ | L = 12 ————— ▪▪ |
| M = 13 ————— ▪▪▪ | N = 14 ————— ▪▪▪▪ | O = 15 ————— ▪▪▪▪▪ | P = 16 ————— ▪▪▪▪▪▪ |
| Q = 17 ————— ▪▪▪▪▪▪▪ | R = 18 ————— ▪▪▪▪▪▪▪▪ | S = 19 ————— ▪▪▪▪▪▪▪▪▪ | T = 20 ————— ————— |
| U = 21 ————— ————— ▪ | V = 22 ————— ————— ▪▪ | W = 23 ————— ————— ▪▪▪ | X = 24 ————— ————— ▪▪▪▪ |
| Y = 25 ————— ————— ▪▪▪▪▪ | Z = 26 ————— ————— ▪▪▪▪▪▪ | | |