

WORD NETWORKS ON WORDLOCK™

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Wordlock™, a combination lock using words instead of numbers, was created by Todd Basche, a Silicon Valley executive. Sold by Staples for \$5.98 (in blue or black) or \$3.90 (in orange), it consists of five independently-rotating rings, yielding one hundred thousand different positions, any one of which the user can select. Because words are more easily remembered than numbers, he inscribed four of the rings with ten different letters each, and the fifth with nine different letters and a blank, allowing the user to pick either a four-letter or a five-letter word (left column):

M A T C H	M A S O N
J O C S S	J U N T A
L E I N	L O C I
S L E E K	S T A L E
A I S Y L	A L L A Y
C H D A D	C H I N K
D U L L Y	D I T C H
B R A I N	B E R Y L
E N R T A	E N D E D
T T N O E	T R E S S

With the default factory setting (left column), four of the ten combinations can be simultaneously read off as words. Three of these, MATCH, BRAIN, and SLEEK, must have been deliberately created to reside on the three raised sections of the rings, but DULLY was probably an afterthought. However, Basche could have rearranged the non-raised letters on the rings to spell THINE (or TENSE), ENROL, CODAS and LIST, for a total of seven out of ten words.

Rearranging all the letters on the rings, could Basche have created a full ten words? In other words, can ten mutually non-crashing words be found which use the specified letters on the various rings? (Two words are non-crashing if they have no common letters in the same position, such as sTraw and oTher or hoUse and brUnt.) The answer is yes—ten words from the Merriam-Webster Pocket Dictionary are given in the right column above. More generally, a set of seventeen mutually non-crashing Pocket Dictionary words can be found on page 211 of the author's book *Making the Alphabet Dance*.

Basche apparently consulted letter-frequency tables to select the letters on the rings. The commonest ten first letters for four-letter words in the Pocket Dictionary are SBPTCLDMFR, and for five-letter ones, SCBAPTFGMD--so why did he select J and E for the first ring in preference to P and F? In the fourth ring, Y is rarely found in five-letter words and is less common than nine other letters (SETLDKNMR) ending four-letter ones; R would have been a better choice. The top ten Pocket Dictionary letters terminating five-letter words are EYTRDLNHKS, but he wisely included S in his set of nine because of noun plurals and verb present tenses. However, he should have substituted T for the relatively rare A, and (possibly) R for H or K.

The most interesting wordplay possibility for Wordlock™ is found in the word ladder—the successive transformation of one word into another by changing a single letter (i.e., by rotating a

single ring). The thousand-plus Pocket Dictionary words present on the rings of the lock can be sorted into various word networks, in which any word can be converted to any other word by successive single-letter changes. It is remarkable that more than 90 per cent of all possible words lie in a single network; in fact, the largest network not connected to the main network consists of only six words! The five-letter part of the main network is displayed in sections at the end of this article, with all connections to the four-letter part of the network (too tangled to diagram) shown.

In theory, any word in the main network can be transformed to a word with different letters in every position in a maximum of five steps (such as crane-crank-crack-crick-click-slick). The reality is that many more steps are usually needed. Consider, for example, CHILD to MIRTH. The shortest connection is apparently 25 steps:

CHILD-chill-shill-still-stall-stalk-stank-shank-thank-than-that-teat-test-lest-last-mast-
mart-Mars-marsh-march-match-batch-bitch-birch-birth-MIRTH

Can it be done in 24 or fewer steps? More important, can one locate another pair of words for which the shortest possible connection is greater than 25? Each pair of words in the network has a shortest-possible-connection number; the largest such number for any pair of words in the network is called the *span* of the network.

The four-letter part of the main network contains the densest cluster of words. This is evinced by the fact that the span of the four-letter network appears to be only 10, as given for example by

-duly-dull-doll-moll-molt-moat-coat-chat-chit-
JULY CHIC
-jury-bury-burn-turn-tern-teen-then-thin-chin-

Note that DUTY to CHIC has the same span.

Interestingly, only four of the ten non-crashing words presented earlier are in the main network. A typical connection (not necessarily the shortest) is

CHINK-clink-slink-stink-stick-stack-stalk-STALE
STALE-state-slate-slat-seat-meat-melt-malt-mart-Mars-marsh-march-match-batch-bitch-DITCH
DITCH-bitch-batch-match-march-marsh-Mars-mart-mare-tare-tarn-tern-teen-then-thee-tree-trees-
TRESS

LOCO is connected only with LOCI, and ALLAY with ALLOY-ALLEY-ALLAH; the other four are isolanos (i.e., have no connecting words in the Pocket Dictionary).

THREE is the only cardinal, TENTH and NINTH the only ordinals, BORON the only element, MAINE the only state, and ARIES the only sign of the Zodiac. However, there exist three out of the twelve months, MARCH, JUNE and JULY, which are connectable. How about connecting CHINA, CHILE and MALTA (which have one-step connections to words in the network)? Or opposites such as THICK and THIN (an easy one-step via THINK), or EARLY and LATE? Alas, one cannot connect BLESS and CURSE, DIRTY and CLEAN, SATAN and ALLAH, or BIRTH and DEATH!

Partially-capitalized words connect with the four-letter network

Boldface words transfer five-letter words in the first network to five-letter words in the second

When three words are joined by equal signs, one can go directly from word 1 to word 3

When three vertical words are separated by underlines, one can go directly from word 1 to word 3

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                stein-stain-slain
                    staid blain          trail
SHINY THINe-THANK          brain=drain=train
SHINe-THINe                braid
seine |          briny          BRAND-BRANs-BRASs
      |          |          | BRAYs |
brace trine-trite brine blank-bland BRATs |
      |          |          |          |          |
trace-trice drink-brink-blink-blind BRASH
track-trick-----brick          |          crash-clash-slash
      |          brisk          blend-bleed crass-class
      |          |          |          |          cress-----chess
      |          |          |          |          tress-dress
      |          |          |          |          |
      |          |          |          |          |
thick          |          |          |          |
      |          |          |          |          |
CHICK          |          |          |          |
check          |          |          |          |
cheek-----creek---|-----creed          |          dries-dried
                        triad          creel          |          tries-tried
                        trial          |          |          |          cries-cried
                        |          |          |          |          Aries
                        |          |          |          |          ARIAs-alias
drill-trill          |          |          |          |          array-arras
drily
daily-DAISy
dally=====DULLY=====DOLLY
manly          |          |          |          |          JELLY-jolly
EARLY-MARLy-madly |          |          |          |          BILLY=BULLY=BELLY
      badly TALLY |          |          |          |          BELLe-belie
      sadly-sally=SILLY=sully
                        SALTy-SILTy-surly=CURLY=burly
Malay-MALTy

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crate-crane          THINK
crank-crack-crick---CHINK-CHINa
CLANK-clack-click---clink
      black |          |
      slack-slick---slink
      snack |slice |
shank-shack |          |
stand-stank-stack-stick---stink
      |
scaly-scald |
scale |
shale---|---shall-shell
state-stale=stalk=stall |
SLATe stile-----still-shill
elate-----elite          chill-child

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Transfers

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black to blank
shank to thank
think to thank
think to thick
think to thine
chink to chick
click to chick
crick to chick
crick to trick
crack to track
clink to blink

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milch
 mulch
 lunch=bunch=munch
 lurch | beech-leech
 larch bench=belch=beach=leach=teach
 MARSh-march LEASh
 match=catch=batch LEASe=cease=TEASe
 bitch-ditch chase
 birch
 mirth-birth
 berth

 metal-medal-modal-MODEl-MOTEl canal-banal-basal-basil
 | basin
 coral-moral-mural basis
 BASEs

 steed-steel baste=CASTe=taste-tasty-TESTy
 stead |
 steak-steal
 sneak CONEy-money
 mosey
 MASSy=MOSSy=MESSy=MUSSy
 sassy BOSSy MUSTy-MISTy-MINTy
 sissy LUSTy

 Allah-allay=alley=alloy moron-boron-baron=baton=bacon

 sense=dense=tense-terse decal-decay-decoy
 delay

Note that the *steed* network is the largest one not connected with the main network.