

# Record of Important Things



*Simply, people can no longer remember passwords good enough to reliably defend against dictionary attacks, and are much more secure if they choose a password too complicated to remember and then write it down. We're all good at securing small pieces of paper. I recommend that people write their passwords down on a small piece of paper, and keep it with their other valuable small pieces of paper: in their wallet.*

Bruce Schneier CTO, Resilient

Owner

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E-mail

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Mobile phone

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# Cryptographically-secure passphrases with Diceware

<p>UNCOMMON (NON-GIBBERISH) BASE WORD</p> <p>ORDER UNKNOWN</p> <p>Tr0ub4dor&amp;3</p> <p>CAPS? COMMON SUBSTITUTIONS NUMERICAL PUNCTUATION</p> <p>(YOU CAN ADD A FEW MORE BITS TO ACCOUNT FOR THE FACT THAT THIS IS ONLY ONE OF A FEW COMMON FORMATS)</p>	<p>~28 BITS OF ENTROPY</p> <p><math>2^{28} = 3 \text{ DAYS AT } 1000 \text{ GUESSES/SEC}</math></p> <p>(PLAUSIBLE ATTACK ON A WEAK REMOTE WEB SERVICE: YES, CRACKING A STOKEN HASH IS FASTER, BUT IT'S NOT WHAT THE AVERAGE USER SHOULD WORRY ABOUT.)</p> <p>DIFFICULTY TO GUESS: EASY</p>	<p>WAS IT TROMBONE? NO, TROUBADOR. AND ONE OF THE 0s WAS A ZERO?</p> <p>AND THERE WAS SOME SYMBOL...</p> <p>DIFFICULTY TO REMEMBER: HARD</p>
<p>correct horse battery staple</p> <p>FOUR RANDOM COMMON WORDS</p>	<p>~44 BITS OF ENTROPY</p> <p><math>2^{44} = 530 \text{ YEARS AT } 1000 \text{ GUESSES/SEC}</math></p> <p>DIFFICULTY TO GUESS: HARD</p>	<p>THAT'S A BATTERY STAPLE.</p> <p>CORRECT!</p> <p>DIFFICULTY TO REMEMBER: YOU'VE ALREADY MEMORIZED IT</p>

THROUGH 20 YEARS OF EFFORT, WE'VE SUCCESSFULLY TRAINED EVERYONE TO USE PASSWORDS THAT ARE HARD FOR HUMANS TO REMEMBER, BUT EASY FOR COMPUTERS TO GUESS.

## What is a Diceware passphrase?

A passphrase is a bunch of words and characters that you type in to your computer to let it know for sure that the person typing is you. Passphrases differ from passwords only in length.

Diceware is a method for picking passphrases that uses dice to select words at random from a special list. Each word in the list is preceded by a four digit number. All the digits are between one and six, allowing you to use the outcomes of four dice rolls to select a word from the list.

## Directions

- 1 Decide how many words you want in your passphrase. A five-word passphrase provides a level of security *much* higher than the passwords most people use. For NSA-proof security, use seven.
- 2 Roll all four dice at once and write the results down, reading from left to right, on a scrap paper. Make as many of these four-digit groups as you want words in your passphrase.
- 3 Flip to the word list and look up the corresponding word next to each four-digit number.
- 4 The words that you have found are your new passphrase! If you wish, roll the dice one more time to choose one word to Capitalize, and again for a digit to add to the end.
- 5 Come up with a way to remember your phrase. It might be a story, scenario, or sentence that that can remind you of the particular words you chose, in order.

## Example

Suppose you want a five-word passphrase. You will need  $5 \times 4$  or 20 dice rolls. Let's say they come out as:

1, 6, 6, 6, 5, 1, 5, 6, 5, 3, 5, 6, 3, 2, 2, 3, 5, 6, 2, and 6.

Write the results on a scrap of paper in groups of four:

1 6 6 6

5 1 5 6

5 3 5 6

3 2 2 3

5 6 2 6

You then look up each group of five rolls in the Diceware word list by finding the number in the list and writing down the word next to the number:

1666 cognitive

5156 poetic

5356 ribbon

3223 garlic

5626 smelliness

Your passphrase would then be:

cognitive poetic ribbon garlic smelliness

This passphrase is one of the 3,656,158,440,062,976 (about  $2^{51}$ ) alternatives that could have been chosen by this method.

1111 aardvark	1352 asinine	1633 chimney	2314 diploma	2555 ergonomic
1112 abandoned	1353 asleep	1634 chlorine	2315 directory	2556 erratic
1113 abbreviate	1354 asocial	1635 chopsticks	2316 dishcloth	2561 eruption
1114 abdomen	1355 asparagus	1636 chrome	2321 ditto	2562 escalator
1115 abhorrence	1356 astronaut	1641 chute	2322 dividers	2563 eskimo
1116 abiding	1361 asymmetric	1642 cilantro	2323 dizziness	2564 esophagus
1121 abnormal	1362 atlas	1643 cinnamon	2324 doctor	2565 espresso
1122 abrasion	1363 atmosphere	1644 circle	2325 dodge	2566 essay
1123 absorbing	1364 atom	1645 cityscape	2326 doll	2611 estrogen
1124 abundant	1365 atrocious	1646 civilian	2331 dominoes	2612 etching
1125 abyss	1366 attic	1651 clay	2332 donut	2613 eternal
1126 academy	1411 atypical	1652 clergyman	2333 doorstep	2614 ethics
1131 accountant	1412 auctioneer	1653 clipboard	2334 dorsal	2615 etiquette
1132 acetone	1413 auditorium	1654 clock	2335 double	2616 eucalyptus
1133 achiness	1414 augmented	1655 clubhouse	2336 downstairs	2621 eulogy
1134 acid	1415 auspicious	1656 coathanger	2341 dozed	2622 euphemism
1135 acoustics	1416 automobile	1661 cobweb	2342 drainpipe	2623 euthanize
1136 acquire	1421 auxiliary	1662 coconut	2343 dresser	2624 evacuation
1141 acrobat	1422 avalanche	1663 codeword	2344 driftwood	2625 evergreen
1142 actress	1423 avenue	1664 coexistent	2345 droppings	2626 evidence
1143 acuteness	1424 aviator	1665 coffeecake	2346 drum	2631 evolution
1144 aerosol	1425 avocado	1666 cognitive	2351 dryer	2632 exam
1145 aesthetic	1426 awareness	2111 cohabitate	2352 dubiously	2633 excerpt
1146 affidavit	1431 awhile	2112 collarbone	2353 duckling	2634 exerciser
1151 afloat	1432 awkward	2113 computer	2354 duffel	2635 exfoliate
1152 afraid	1433 awning	2114 confetti	2355 dugout	2636 exhale
1153 aftershave	1434 awoke	2115 copier	2356 dumpster	2641 exist
1154 again	1435 axially	2116 cornea	2361 duplex	2642 exorcist
1155 agency	1436 azalea	2121 cosmetics	2362 durable	2643 explode
1156 aggressor	1441 babbling	2122 cotton	2363 dustpan	2644 exquisite
1161 aghast	1442 backpack	2123 couch	2364 dutiful	2645 exterior
1162 agitate	1443 badass	2124 coverless	2365 duvet	2646 exuberant
1163 agnostic	1444 bagpipe	2125 coyote	2366 dwarfism	2651 fabric
1164 agonizing	1445 bakery	2126 coziness	2411 dwelling	2652 factory
1165 agreeing	1446 balancing	2131 crawfish	2412 dwindling	2653 faded
1166 aidless	1451 bamboo	2132 crewmember	2413 dynamite	2654 failsafe
1211 aimlessly	1452 banana	2133 crib	2414 dyslexia	2655 falcon
1212 ajar	1453 barracuda	2134 croissant	2415 eagerness	2656 family
1213 alarmclock	1454 basket	2135 crumble	2416 earlobe	2661 fanfare
1214 albatross	1455 bathrobe	2136 crystal	2421 easel	2662 fasten
1215 alchemy	1456 bazooka	2141 cubical	2422 eavesdrop	2663 faucet
1216 alfalfa	1461 blade	2142 cucumber	2423 ebook	2664 favorite
1221 algae	1462 blender	2143 cuddly	2424 eccentric	2665 feasibly
1222 aliens	1463 blimp	2144 cufflink	2425 echoless	2666 february
1223 alkaline	1464 blouse	2145 cuisine	2426 eclipse	3111 federal
1224 almanac	1465 blurred	2146 culprits	2431 ecosystem	3112 feedback
1225 alongside	1466 boatyard	2151 cup	2432 ecstasy	3113 feigned
1226 alphabet	1511 bobcat	2152 curry	2433 edged	3114 feline
1231 already	1512 body	2153 cushion	2434 editor	3115 femur
1232 also	1513 bogusness	2154 cuticle	2435 educator	3116 fence
1233 altitude	1514 bohemian	2155 cybernetic	2436 eelworm	3121 ferret
1234 aluminum	1515 boiler	2156 cyclist	2441 eerie	3122 festival
1235 always	1516 bonnet	2161 cylinder	2442 effects	3123 fettuccine
1236 amazingly	1521 boots	2162 cymbal	2443 eggnog	3124 feudalist
1241 ambulance	1522 borough	2163 cynicism	2444 egomaniac	3125 feverish
1242 amendment	1523 bossiness	2164 cypress	2445 ejection	3126 fiberglass
1243 amiable	1524 bottle	2165 cytoplasm	2446 elastic	3131 fictitious
1244 ammunition	1525 bouquet	2166 dachshund	2451 elbow	3132 fiddle
1245 annesty	1526 boxlike	2211 daffodil	2452 elderly	3133 figurine
1246 amoeba	1531 breath	2212 dagger	2453 elephant	3134 fillet
1251 amplifier	1532 briefcase	2213 dairy	2454 elfishly	3135 finalist
1252 amuser	1533 broom	2214 dalmatian	2455 eliminator	3136 fiscally
1253 anagram	1534 brushes	2215 dandelion	2456 elk	3141 fixture
1254 anchor	1535 bubblegum	2216 dartboard	2461 elliptical	3142 flashlight
1255 android	1536 buckle	2221 dastardly	2462 elongated	3143 fleshiness
1256 anesthesia	1541 buddhist	2222 datebook	2463 elsewhere	3144 flight
1261 angelfish	1542 buffalo	2223 daughter	2464 elusive	3145 florist
1262 animal	1543 bullfrog	2224 dawn	2465 elves	3146 flypaper
1263 ankle	1544 bunny	2225 daytime	2466 emancipate	3151 foamless
1264 announcer	1545 busboy	2226 dazzler	2511 embroidery	3152 focus
1265 anonymous	1546 buzzard	2231 dealer	2512 emcee	3153 foggy
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3461 icepack	4142 laboratory	4423 myriad	4664 pantyhose	5345 revolver
3462 icing	4143 ladder	4424 myspace	4665 paprika	5346 rewrite
3463 iconic	4144 lakefront	4425 myth	4666 parakeet	5351 rhapsody
3464 identical	4145 lantern	4426 nail	5111 passport	5352 rhetoric
3465 idiosyncrasy	4146 laptop	4431 namesake	5112 patio	5353 rhino
3466 idly	4151 laryngitis	4432 nanosecond	5113 pauper	5354 rhubarb
3511 igloo	4152 lasagna	4433 napkin	5114 pavement	5355 rhyme
3512 ignition	4153 latch	4434 narrator	5115 payphone	5356 ribbon
3513 iguana	4154 laundry	4435 nastiness	5116 pebble	5361 riches
3514 illuminate	4155 lavender	4436 natives	5121 peculiarly	5362 ridden
3515 imaging	4156 laxative	4441 naively	5122 pedometer	5363 rigidity
3516 imbecile	4161 lazybones	4442 navigate	5123 pegboard	5364 rimmed

5365	riptide	5555	siesta	6145	taco	6335	unpaved	6525	voicemail
5366	riskily	5556	silicon	6146	tadpole	6336	unquenched	6526	volleyball
5411	ritzy	5561	simmering	6151	taekwondo	6341	unroll	6531	voucher
5412	riverboat	5562	singles	6152	tagalong	6342	unscrewing	6532	voyage
5413	roamer	5563	sisterhood	6153	takeout	6343	untied	6533	vulnerable
5414	robe	5564	sitcom	6154	tallness	6344	unusual	6534	waffle
5415	rocket	5565	sixfold	6155	tamale	6345	unveiled	6535	wagon
5416	romancer	5566	sizable	6156	tanned	6346	unwrinkled	6536	wakeup
5421	ropelike	5611	skateboard	6161	tapestry	6351	unyielding	6541	walrus
5422	rotisserie	5612	skeleton	6162	tarantula	6352	unzip	6542	wanderer
5423	roundtable	5613	skies	6163	tastebud	6353	upbeat	6543	wasp
5424	royal	5614	skulk	6164	tattoo	6354	upcountry	6544	water
5425	rubber	5615	skylight	6165	tavern	6355	update	6545	waving
5426	rudderless	5616	slapping	6166	thaw	6356	upfront	6546	wheat
5431	rugby	5621	sled	6211	theater	6361	upgrade	6551	whisper
5432	ruined	5622	slingshot	6212	thimble	6362	upholstery	6552	wholesaler
5433	rulebook	5623	sloth	6213	thorn	6363	upkeep	6553	wick
5434	rummage	5624	slumbering	6214	throat	6364	upload	6554	widow
5435	running	5625	smartphone	6215	thumb	6365	uppercut	6555	wielder
5436	rupture	5626	smelliness	6216	thwarting	6366	upright	6556	wifeless
5441	rustproof	5631	smitten	6221	tiara	6411	upstairs	6561	wikipedia
5442	sabotage	5632	smokestack	6222	tidbit	6412	uptown	6562	wildcat
5443	sacrifice	5633	smudge	6223	tiebreaker	6413	upwind	6563	windmill
5444	saddlebag	5634	snapshot	6224	tiger	6414	uranium	6564	wipeout
5445	saffron	5635	sneezing	6225	timid	6415	urban	6565	wired
5446	sainthood	5636	sniff	6226	tinzel	6416	urchin	6566	wishbone
5451	saltshaker	5641	snusuit	6231	tiptoeing	6421	urethane	6611	wizardry
5452	samurai	5642	snugness	6232	tirade	6422	urgent	6612	wobbliness
5453	sandworm	5643	speakers	6233	tissue	6423	urologist	6613	wolverine
5454	sapphire	5644	sphinx	6234	tractor	6424	username	6614	womb
5455	sardine	5645	spider	6235	tree	6425	usher	6615	woolworker
5456	sassy	5646	splashing	6236	tripod	6426	utensil	6616	workbasket
5461	satchel	5651	sponge	6241	trousers	6431	utility	6621	wound
5462	sauna	5652	sprout	6242	trucks	6432	utmost	6622	wrangle
5463	savage	5653	spur	6243	tryout	6433	utopia	6623	wreckage
5464	saxophone	5654	spyglass	6244	tubeless	6434	utterance	6624	wristwatch
5465	scarf	5655	squirrel	6245	tuesday	6435	vacuum	6625	wrongdoing
5466	scenario	5656	statue	6246	tugboat	6436	vagrancy	6626	xerox
5511	schoolbook	5661	steamboat	6251	tulip	6441	valuables	6631	xylophone
5512	scientist	5662	stingray	6252	tumbleweed	6442	vanquished	6632	yacht
5513	scooter	5663	stopwatch	6253	tupperware	6443	vaporizer	6633	yahoo
5514	scrapbook	5664	strawberry	6254	turtle	6444	varied	6634	yard
5515	sculpture	5665	student	6255	tusk	6445	vaseline	6635	yearbook
5516	scythe	5666	stylus	6256	tutorial	6446	vegetable	6636	yesterday
5521	secretary	6111	suave	6261	tuxedo	6451	vehicle	6641	yiddish
5522	sedative	6112	subway	6262	tweezers	6452	velcro	6642	yield
5523	segregator	6113	suction	6263	twins	6453	vendor	6643	yo-yo
5524	seismology	6114	suds	6264	tyrannical	6454	vertebrae	6644	yodel
5525	selected	6115	suffocate	6265	ultrasound	6455	vestibule	6645	yogurt
5526	semicolon	6116	sugar	6266	umbrella	6456	veteran	6646	yuppie
5531	senator	6121	suitcase	6311	umpire	6461	vexingly	6651	zealot
5532	septum	6122	sulphur	6312	unarmored	6462	vicinity	6652	zebra
5533	sequence	6123	superstore	6313	unbuttoned	6463	videogame	6653	zeppelin
5534	serpent	6124	surfer	6314	uncle	6464	viewerfinder	6654	zestfully
5535	sesame	6125	sushi	6315	underwear	6465	vigilante	6655	zigzagged
5536	settler	6126	swan	6316	unevenness	6466	village	6656	zillion
5541	severely	6131	sweatshirt	6321	unflavored	6511	vinegar	6661	zipping
5542	shack	6132	swimwear	6322	ungloved	6512	violin	6662	zirconium
5543	shelf	6133	sword	6323	unhinge	6513	viperfish	6663	zodiac
5544	shirt	6134	sycamore	6324	unicycle	6514	virus	6664	zombie
5545	shovel	6135	syllable	6325	unjustly	6515	visor	6665	zookeeper
5546	shrimp	6136	symphony	6326	unknown	6516	vitamins	6666	zucchini
5551	shuttle	6141	synagogue	6331	unlocking	6521	vivacious		
5552	shyness	6142	syringes	6332	unmarked	6522	vixen		
5553	siamese	6143	systemize	6333	unnoticed	6523	vocalist		
5554	sibling	6144	tablespoon	6334	unopened	6524	vogue		

# Questions & answers regarding online security

## **Shouldn't I never write my password down?**

In today's world, major corporations are hacked every week, and distributed cracking networks can break complex passwords in record time. It's safest to use a strong, unique password for each account you hold, but this makes memorization impractical.

Once, people were told not to write passwords down, ever, but the consensus among security professionals has evolved. You're better at protecting this book than corporations are at securing their password databases.

## **Can I just pick my own words from the word list?**

No. Humans are terrible at being unpredictable, and hackers are great at exploiting predictability. The primary reason that Diceware creates secure passwords is that you have no agency in the process.

**Should I leave spaces between the words?**

Yes. It makes your passphrase more secure, *and* easier to type on a mobile phone.

**How many words should I use in my passphrase?**

The most important accounts, such as e-mail, e-commerce and financial sites, should use at least five words.

Other accounts like social media can reasonably use three words, as long as each password is used only once.

**What if I lose this book?**

The real purpose of this book is to provide you with the tools to generate strong, memorable passwords that are unbreakable by the world's most powerful computers. It need not be the only place that you record them.

**What if someone steals this book?**

If you choose to write passwords in this book, feel free to modify them in some way that is only known to you. This will prevent a casual thief from using your passwords, even if they have this book. Just be absolutely sure that you can remember what you have changed.

**Are password manager apps like 1Password safe?**

Yes, as long as the master password is strong & secure. For example, if Google Chrome is configured to store your password,

make sure that you have a strong Google password, and don't leave your account logged on computers or mobile devices that are not secure. The same is true for Safari and your iCloud account, or Internet Explorer and Windows Live.

PasswordSafe (<https://pwsafe.org/>) and its associated mobile apps are a good alternative password manager that is not tied to a web browser or e-mail account.

## **Who invented Diceware?**

Diceware was invented by Arnold G. Reinhold, a computer scientist living in Cambridge, MA. Diceware was first published to Usenet's `sci.crypt.research` on August 1st, 1995. For more information, visit <http://world.std.com/~reinhold/diceware.html>.

This book implements a simplified version developed by the Electronic Frontier Foundation (EFF) which uses only four dice and is optimized for typing on mobile phones.

## **What is the danger in re-using a password?**

Imagine that you used the same password for an online clothing store, and your e-mail provider. Months later, the clothing store is hacked and your password stolen. The hackers login to your email and find correspondence from your bank. They use the bank website to reset your online banking password, and intercept the confirmation email sent by your bank. From here, they use the bank website to order checks in your name, initiate transfers, etc.

This story illustrates why the security of your e-mail ranks above others in importance: for hackers, it can be the gateway to all of your accounts.

## **How can I find out if my password has been stolen?**

Visit <https://haveibeenpwned.com/> or a similar site, and type in your e-mail address. They track the data leaks released by hackers, and can identify which e-mail addresses were hacked, and how much data was released.

If your e-mail tests positive, immediately change the password for the sites listed **and** any sites that might have used the same password.

## **What is two-factor authentication?**

Two-factor authentication enhances your password by sending a code to your phone or another device, which you then have to type in in order to be authorized. This ensures that even if someone has your password, they also need to have your phone.

It's a good idea to set up two-factor authentication on any account linked to your bank account or credit cards.

## **What is phishing?**

Phishing is when a hacker sends you an email that appears to be from an organization you have a relationship with, but is actually a trap to get you to give up your password.

Phishing e-mails typically warn you that something is wrong with your account, and urge you to log in via a link. They can be very realistic and insidious.

Always check the URL in any e-mailed links you click, and make sure that they take you to the site you expect. Better yet, ignore links in e-mails and go directly to the website for the organization.

## What is social engineering?

Social engineering is when a hacker contacts a company you do business with and pretends to be you. Often this means telling customer service that you have lost your password, and trying to convince the representative to change it or otherwise unlock your account.

The best protection against social engineering is to avoid using easily-guessed security questions, such as your mother's maiden name. When offered an opportunity to enter such security questions, generate a Diceware password instead.

## How can I stay safe online?

Above all, practice good operational security (*opsec*). Be suspicious and careful online.

Minimize the number of accounts you open, and always choose the best account security available.

Keep track of the accounts you open, close unused accounts, and change passwords on active accounts frequently.

Prefer to shop with businesses that have strong online safeguards, and take advantage of identity protection and online shopping protection services offered by *reputable* financial services.

## What to do if I've been hacked?

The resources at [www.crashoverridenetwork.com](http://www.crashoverridenetwork.com) and [staysafeonline.org](http://staysafeonline.org) are a good starting point. They provide tools that help determine whether you have been hacked and can help regain control over your online accounts.