

If found, please return to:



# 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

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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 HOPKIN 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 O's 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	coffee cake	2346	drum	2631	evolution
1144	aerosol	1425	avocado	1666	cognitive	2351	dryer	2632	exam
1145	aesthetic	1426	awareness	2111	cohabitate	2352	deviously	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	aghost	1442	backpack	2123	couch	2364	duffel	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	egerness	2656	family
1213	alarmclock	1454	basket	2135	crumble	2416	earlobe	2661	fanfare
1214	albatross	1455	bathtrobe	2136	crystal	2421	esael	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	culprit	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	egg nog	3124	feudalist
1241	ambulance	1522	borough	2163	cynicism	2444	egomaniac	3125	feverish
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3414 naughty	3655 junkyard	4336 mayonnaise	4621 opaquely	5262 ragweed
3415 hazelnut	3656 juror	4341 moaning	4622 opera	5263 railroad
3416 headband	3661 justifying	4342 mobilize	4623 opium	5264 rampantly
3421 hedgehog	3662 juvenile	4343 moccasin	4624 opossum	5265 rancidity
3422 hefty	3663 kabob	4344 modify	4625 opponent	5266 rarity
3423 heinously	3664 kamikaze	4345 moisture	4626 optical	5311 raspberry
3424 helmet	3665 kangaroo	4346 molecule	4631 opulently	5312 ravishing
3425 hemoglobin	3666 karate	4351 momentum	4632 oscillator	5313 rearrange
3426 henceforth	4111 kayak	4352 monastery	4633 osmosis	5314 rebuilt
3431 herbs	4112 keepsake	4353 moonshine	4634 ostrich	5315 receipt
3432 hesitation	4113 kennel	4354 mortuary	4635 otherwise	5316 reentry
3433 hexagon	4114 kerosene	4355 mosquito	4636 ought	5321 refinery
3434 hubcap	4115 ketchup	4356 motorcycle	4641 outhouse	5322 register
3435 huddling	4116 khaki	4361 mousetrap	4642 ovation	5323 rehydrate
3436 huff	4121 kickstand	4362 movie	4643 oven	5324 reimburse
3441 hugeness	4122 kilogram	4363 mower	4644 owlish	5325 rejoicing
3442 hullabaloo	4123 kimono	4364 mozzarella	4645 oxford	5326 rekindle
3443 human	4124 kingdom	4365 muckiness	4646 oxidize	5331 relic
3444 hunter	4125 kiosk	4366 mudflow	4651 oxygen	5332 remote
3445 hurricane	4126 kissing	4411 mugshot	4652 oyster	5333 renovator
3446 hushing	4131 kite	4412 mule	4653 ozone	5334 reopen
3451 hyacinth	4132 kleenex	4413 mummy	4654 pacemaker	5335 reporter
3452 hybrid	4133 knapsack	4414 mundane	4655 padlock	5336 request
3453 hydrant	4134 kneecap	4415 muppet	4656 pageant	5341 rerun
3454 hygienist	4135 knickers	4416 mural	4661 pajamas	5342 reservoir
3455 hypnotist	4136 koala	4421 mustard	4662 palm	5343 retriever
3456 ibuprofen	4141 krypton	4422 mutation	4663 pamphlet	5344 reunion
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	tinSEL	6416	urchin	6566	wishbone
5451	saltshaker	5641	snowsuit	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.

## **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 physically secure. The same is true of Safari and your iCloud account, Internet Explorer and Windows Live, etc.

PasswordSafe (<https://pwsafe.org/>) and its associated mobile apps provide 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 is a 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.