CODEX 32

Imagine you had a magic wand that could turn your bitcoin into dust so that no dragons could steal them. Now imagine that you had a magical potion, one drop of which would turn your only a few specks of that dust back into the original, complete bitcoin.

The **Shamir Secret Sharing Scheme** (SSSS) is a mechanism to split a secret (S) into many "shares", such that the original secret can be reconstructed from only a fraction of them. In SSSS, users choose a threshold value k, (typically 2 or 3). They then generate k-many shares and compute an additional number of derived shares (up to 31 in total). The original secret can then be reconstructed from any k of the total shares like magic!

Bitcoin private keys are ultimately derived from a really large random number that we need to keep secret. SSSS enables users to split up that secret into many shares that can be better hidden for safekeeping. Shares of the secret can be written down on separate sheets of paper, and stored in different places. If any one share is lost or destroyed, the owner can still reconstruct their secret because more shares are available.

Of course, when you copy or transfer keys, especially by hand, it's always possible that errors occur. In this scheme, the **codex32** checksum is computed as a part of each share, so that you can be sure that the integrity of your shares is intact. The checksum is an error-detection method that computes a unique numerical value based on the contents of a message, and is sent along with the message to be verified against it.

The **codex32** book is named after the error-correcting code proposed within it, a powerful checksum, uniquely designed to be computable *without the use of electronic computers*. Instead of using computers, the eccentric readers of Codex 32 can generate secrets, and compute checksums entirely by hand. Using dice and the provided paper computers called volvelles (a technology used by medieval astronomers) you too can weld the timeless power of ciphers and hidden secrets.

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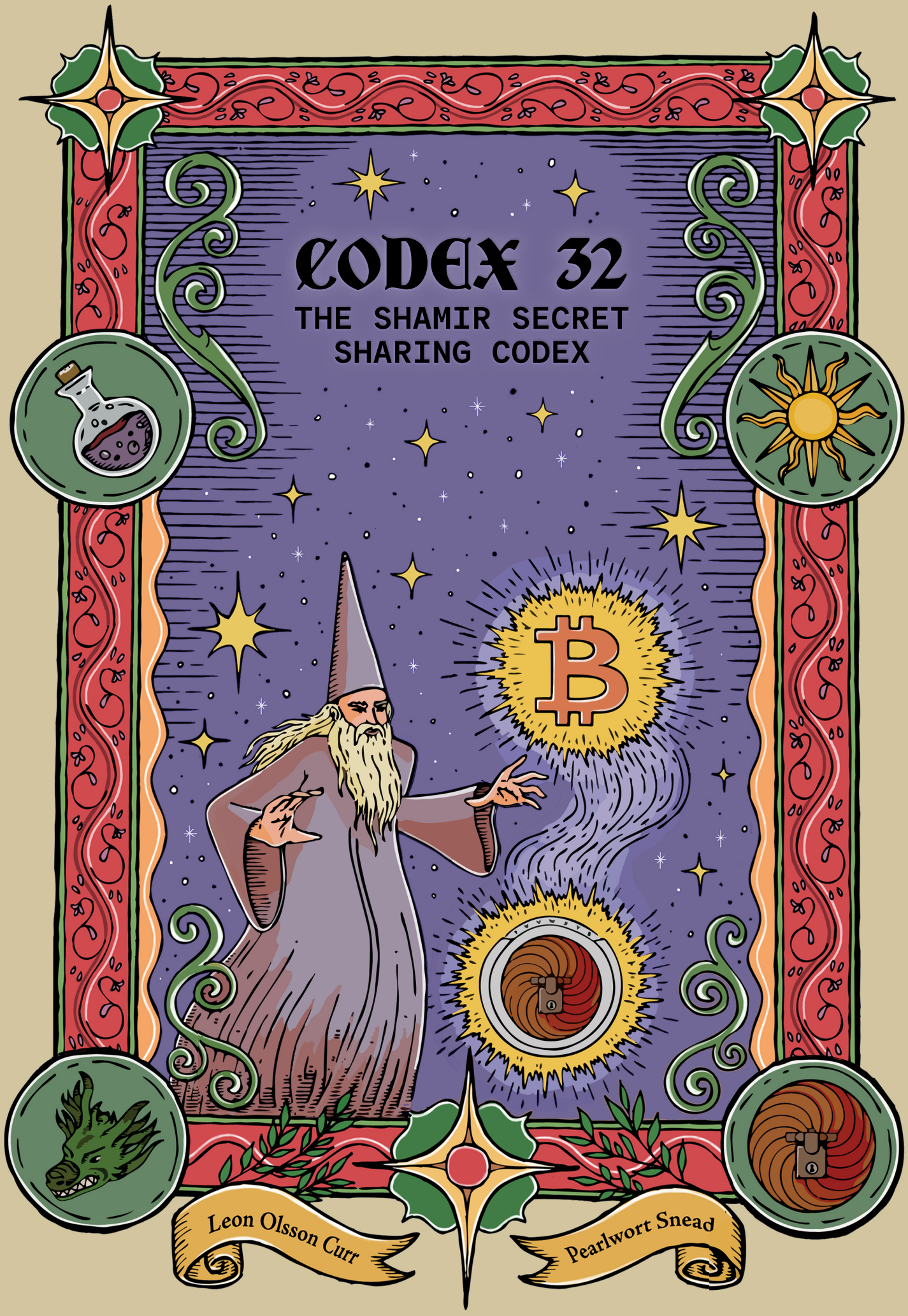
CODEX 32
THE SHAMIR SECRET SHARING CODEX
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Additional materials and copies of this document can be found at:
https://secretcodex32.com/docs/index.html
https://github.com/roconnor-blockstream/SSS32/

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“Keep It Secret, Keep it Safe” — Gandalf

Principal Tables

Addition

	A	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	Z	0	2	3	4	5	6	7	8	9
A	Q	9	S	Y	5	4	2	0	T	Z	X	W	U	A	7	D	K	P	3	N	M	E	L	J	H	V	G	F	8	R	6	C
C	9	Q	4	P	3	S	0	2	W	8	R	T	E	C	M	G	N	Y	5	K	7	U	6	H	J	F	D	V	Z	X	L	A
D	S	4	Q	5	Y	9	6	L	M	J	K	7	V	D	W	A	X	3	P	R	T	F	0	Z	8	U	C	E	H	N	2	G
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F	5	3	Y	S	Q	P	7	M	L	K	J	6	G	F	2	E	Z	4	9	8	0	D	T	X	R	C	U	A	N	H	W	V
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M	X	R	K	Z	J	N	V	F	D	Y	Q	G	6	M	C	T	S	8	H	4	A	L	E	5	3	2	W	0	P	9	U	7
N	W	T	7	2	6	M	Y	P	9	V	G	Q	J	N	S	R	C	0	L	A	4	H	3	U	E	Z	X	8	F	D	5	K
P	U	E	V	C	G	F	K	N	H	7	6	J	Q	P	Z	3	2	A	D	0	8	9	R	W	T	S	5	4	M	L	X	Y
Q	A	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	Z	0	2	3	4	5	6	7	8	9
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S	D	G	A	F	E	C	8	Z	X	0	T	R	3	S	N	Q	M	V	U	7	K	5	J	L	6	P	9	Y	2	W	H	4
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0	J	H	Z	K	X	8	C	A	E	S	5	U	W	0	V	L	Y	N	R	P	F	T	D	Q	9	7	6	M	4	3	G	2
2	H	J	8	N	R	Z	A	C	U	4	3	E	T	2	F	6	P	K	X	Y	V	W	G	9	Q	M	L	7	S	5	D	0
3	V	F	U	G	C	E	X	R	8	W	2	Z	S	3	J	P	6	D	A	L	H	4	N	7	M	Q	Y	9	T	0	K	5
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5	F	V	E	D	A	U	R	X	Z	T	0	8	4	5	H	Y	L	G	C	6	J	S	K	M	7	9	P	Q	W	2	N	3
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Translation

	𝒌	α	β	Γ	Δ	ε	η	Θ	Λ	μ	Ξ	Π	ρ	Σ	Φ	Ψ	Ω	@	#	%	¢	¥	€	¤	⊕	†	‡	§	¶	♦	♥
A	A	N	W	0	J	U	P	7	R	D	S	3	V	Z	L	4	G	X	M	6	8	F	5	T	K	C	9	Y	E	H	2
C	C	E	P	M	R	Z	6	L	8	X	7	Y	U	A	9	H	0	W	K	V	5	4	D	G	S	3	F	N	T	2	J
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G	G	S	C	F	P	E	3	J	6	Z	2	M	N	T	R	D	9	A	4	Y	V	5	U	L	H	0	8	K	7	X	W
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J	J	D	L	6	G	H	9	A	0	S	Z	8	4	2	C	N	P	7	V	F	M	Y	K	W	U	R	3	5	X	E	T
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8	8	W	F	U	M	J	4	3	K	L	C	D	2	R	Y	T	V	9	Z	H	S	E	7	6	A	5	N	X	P	G	0
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Recovery

	A	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	T	U	V	W	X	Y	Z	0	2	3	4	5	6	7	8	9
A	×	#	Θ	Λ	†	Ω	¶	¥	♦	@	Σ	ε	β	μ	Ξ	Φ	ρ	¢	Δ	‡	♥	⊕	α	¤	η	Ψ	Γ	Π	§	%	€
C	@	×	€	Θ	¶	%	Σ	Λ	Φ	♦	♥	†	Π	¤	ε	§	α	Ψ	ρ	η	#	Ξ	¢	Δ	μ	¥	⊕	Γ	‡	β	Ω
D	Λ	¥	×	#	ρ	♦	α	♥	€	Θ	¢	Δ	§	Γ	¤	Ω	ε	¶	Ξ	β	Ψ	μ	†	⊕	Π	Σ	η	‡	%	Φ	@
E	Θ	Λ	@	×	α	Φ	¢	#	Ω	€	Ψ	ρ	‡	⊕	Δ	%	†	Σ	ε	Π	¥	¤	¶	Ξ	Γ	♥	μ	η	β	§	♦
F	‡	§	Π	β	×	⊕	@	%	μ	η	♦	#	ε	¢	♥	¤	Λ	€	¥	ρ	Φ	Σ	Θ	Ψ	α	Ω	¶	†	Δ	Ξ	Γ
G	Ψ	¢	♥	Σ	¤	×	Δ	¶	Λ	¥	ρ	μ	♦	β	η	Θ	⊕	ε	Γ	Ω	α	‡	Ξ	Π	%	†	§	Φ	€	@	#
H	§	Φ	β	%	#	Γ	×	Ω	η	‡	@	♥	Ξ	α	Σ	μ	¥	Θ	Ψ	Δ	♦	¶	Λ	¢	ρ	€	†	ε	¤	⊕	Π
J	€	Θ	♦	@	¢	§	Ψ	×	%	Ω	¥	α	η	Ξ	ρ	β	¶	♥	†	Γ	Λ	Δ	Σ	ε	⊕	‡	¤	μ	Π	‡	Φ
K	♥	Σ	¥	Ψ	Ξ	Θ	ε	¢	×	#	†	⊕	Ω	‡	Γ	@	¤	ρ	μ	Φ	¶	Π	Δ	η	§	α	β	%	♦	€	Λ
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V	%	Ω	§	Φ	¥	η	Λ	♦	Π	β	Θ	Ψ	¤	†	¢	Γ	♥	×	Σ	Ξ	€	α	#	¶	ε	@	ρ	Δ	⊕	μ	‡
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X	†	ε	α	ρ	Π	Ψ	Γ	Δ	Σ	¶	⊕	β	Λ	♦	%	♥	‡	μ	§	×	Ξ	Ω	η	Φ	@	¤	€	Θ	#	¥	¢
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3	ε	Ξ	ρ	Δ	β	¢	Π	¤	¶	†	Γ	%	¥	@	Ω	Σ	§	η	Φ	#	⊕	€	‡	♦	×	μ	Θ	Λ	♥	Ψ	α
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6	ρ	Δ	†	ε	‡	Σ	η	Ξ	¢	α	μ	§	#	€	Φ	Ψ	β	Γ	%	Λ	¤	♦	Π	Ω	Θ	⊕	@	×	¥	♥	¶
7	¶	†	¢	α	Γ	¥	⊕	ρ	♥	Σ	Ξ	Π	Θ	Φ	β	#	η	¤	‡	@	ε	%	μ	§	♦	Δ	Ω	€	×	Λ	Ψ
8	¢	α	Σ	¶	μ	#	¤	†	¥	Ψ	Δ	η	@	%	‡	Λ	Γ	Ξ	Π	€	ρ	§	⊕	β	Ω	ε	Φ	♦	Θ	×	♥
9	¥	Ψ	#	♥	Δ	@	ρ	Σ	Θ	Λ	α	¤	Φ	Π	μ	€	Ξ	†	⊕	%	¢	η	ε	Γ	β	¶	‡	§	Ω	♦	×

Fusion

	𝒌	α	β	Γ	Δ	ε	η	Θ	Λ	μ	Ξ	Π	ρ	Σ	Φ	Ψ	Ω	@	#	%	¢	¥	€	¤	⊕	†	‡	§	¶	♦	♥
𝒌	𝒌	α	β	Γ	Δ	ε	η	Θ	Λ	μ	Ξ	Π	ρ	Σ	Φ	Ψ	Ω	@	#	%	¢	¥	€	¤	⊕	†	‡	§	¶	♦	♥
α	α	Γ	ε	Θ	μ	Π	Σ	Ψ	@	%	¥	¤	†	§	♦	Λ	Ξ	ρ	Φ	𝒌	β	Δ	η	⊕	‡	¶	♥	Ω	#	¢	€
β	β	ε	Δ	Π	Φ	μ	Λ	¤	‡	♦	¶	%	€	@	Ω	⊕	†	♥	§	¢	¥	#	Ψ	𝒌	α	η	Γ	ρ	Σ	Ξ	Θ
Γ	Γ	Θ	Π	Ψ	%	¤	§	Λ	ρ	𝒌	Δ	⊕	¶	Ω	¢	@	¥	†	♦	α	ε	μ	Σ	‡	♥	#	€	Ξ	Φ	β	η
Δ	Δ	μ	Φ	%	Ω	♦	‡	𝒌	Γ	Ξ	Σ	¢	Ψ	♥	†	α	η	Θ	ρ	¥	#	§	⊕	β	ε	Λ	Π	€	@	¶	¤
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η	η	Σ	Λ	§	‡	@	¢	Ω	¥	♥	¤	ρ	μ	β	Γ	Ξ	Π	Δ	α	€	Ψ	⊕	♦	†	¶	%	#	ε	𝒌	Θ	Φ
Θ	Θ	Ψ	¤	Λ	𝒌	⊕	Ω	@	†	α	μ	‡	#	Ξ	β	ρ	Δ	¶	¢	Γ	Π	%	§	♥	€	Φ	η	¥	♦	ε	Σ
Λ	Λ	@	‡	ρ	Γ	♥	¥	†	#	Θ	𝒌	€	♦	Δ	Π	¶	%	Φ	ε	Ψ	⊕	α	Ξ	η	Σ	¢	§	μ	β	¤	Ω
μ	μ	%	♦	𝒌	Ξ	¢	♥	α	Θ	¥	§	β	Λ	€	¶	Γ	Σ	Ψ	†	Δ	Φ	Ω	‡	ε	Π	@	¤	η	ρ	#	⊕
Ξ	Ξ	¥	¶	Δ	Σ	#	¤	μ	𝒌	§	€	Φ	Γ	⊕	@	%	♥	α	Λ	Ω	†	η	Π	♦	¢	Θ	β	‡	Ψ	ρ	ε
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ρ	ρ	†	€	¶	Ψ	η	μ	#	♦	Λ	Γ	Σ	β	%	⊕	Φ	α	¢	¤	@	♥	Θ	Δ	§	Ω	ε	Ξ	𝒌	Π	‡	¥
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€	€	η	Ψ	Σ	⊕	Λ	♦	§	Ξ	‡	Π	@	Δ	¢	α	Ω	ε	¥	𝒌	♥	Θ	¤	Φ	ρ	†	μ	¶	β	%	Γ	#
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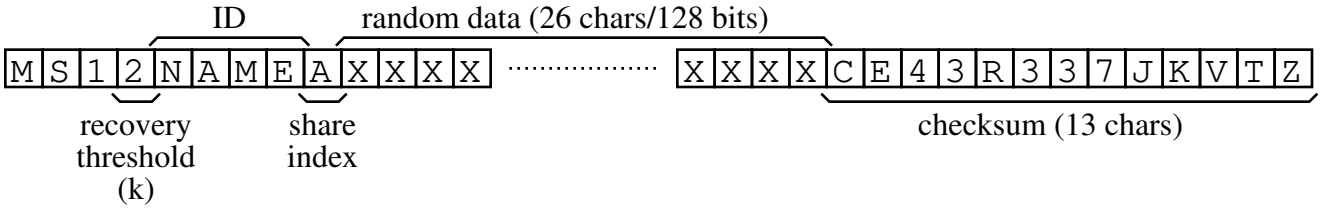
†	†	¶	η	#	Λ	Σ	%	Φ	¢	@	Θ	§	ε	𝒌	‡	♦	Γ	β	⊕	ρ	€	Ψ	μ	Ω	Ξ	Π	¥	α	¤	♥	Δ
‡	‡	♥	Γ	€	Π	Θ	#	η	§	¤	β	Ψ	Ξ	Φ	%	Σ	¢	Ω	μ	⊕	α	ε	¶	Λ	@	¥	ρ	♦	Δ	𝒌	†
§	§	Ω	ρ	Ξ	€	†	ε	¥	μ	η	‡	¶	𝒌	Π	Ψ	Δ	⊕	%	Θ	Σ	@	♥	β	#	Φ	α	♦	¤	Γ	Λ	¢
¶	¶	#	Σ	Φ	@	§	𝒌	♦	β	ρ	Ψ	Ω	Π	α	♥	¢	Θ	ε	‡	†	η	Λ	%	Ξ	¥	¤	Δ	Γ	⊕	€	μ
♦	♦	¢	Ξ	β	¶	¥	Θ	ε	¤	#	ρ	Δ	‡	Ψ	Σ	Π	@	⊕	η	Φ	Ω	†	Γ	μ	%	♥	𝒌	Λ	€	§	α
♥	♥	€	Θ	η	¤	Ψ	Φ	Σ	Ω	⊕	ε	Λ	¥	♦	𝒌	§	β	Ξ	%	‡	Γ	Π	#	@	ρ	Δ	†	¢	μ	α	¶

Share Data Format



Bech32 to Binary Conversion

A: 11101	K: 10110	T: 01011	2: 01010
C: 11000	L: 11111	U: 11100	3: 10001
D: 01101	M: 11011	V: 01100	4: 10101
E: 11001	N: 10011	W: 01110	5: 10100
F: 01001	P: 00001	X: 00110	6: 11010
G: 01000	Q: 00000	Y: 00100	7: 11110
H: 10111	R: 00011	Z: 00010	8: 00111
J: 10010	S: 10000	0: 01111	9: 00101

Binary to Bech32 Conversion

00000: Q	01000: G	10000: S	11000: C
00001: P	01001: F	10001: 3	11001: E
00010: Z	01010: 2	10010: J	11010: 6
00011: R	01011: T	10011: N	11011: M
00100: Y	01100: V	10100: 5	11100: U
00101: 9	01101: D	10101: 4	11101: A
00110: X	01110: W	10110: K	11110: 7
00111: 8	01111: 0	10111: H	11111: L

Symbols

ℵ Aleph	α Alpha	β Beta	Γ Gamma
Δ Delta	ε Epsilon	η Eta	Θ Theta
Λ Lambda	μ Mu	Ξ Xi	Π Pi
ρ Rho	Σ Sigma	Φ Phi	Ψ Psi
Ω Omega	@ At	# Hash	% Percent
¢ Cent	¥ Yen	€ Euro	¤ Scarab
⊕ Earth	† Dagger	‡ Double-dagger	§ Section
¶ Paragraph	♦ Diamond	♥ Heart	

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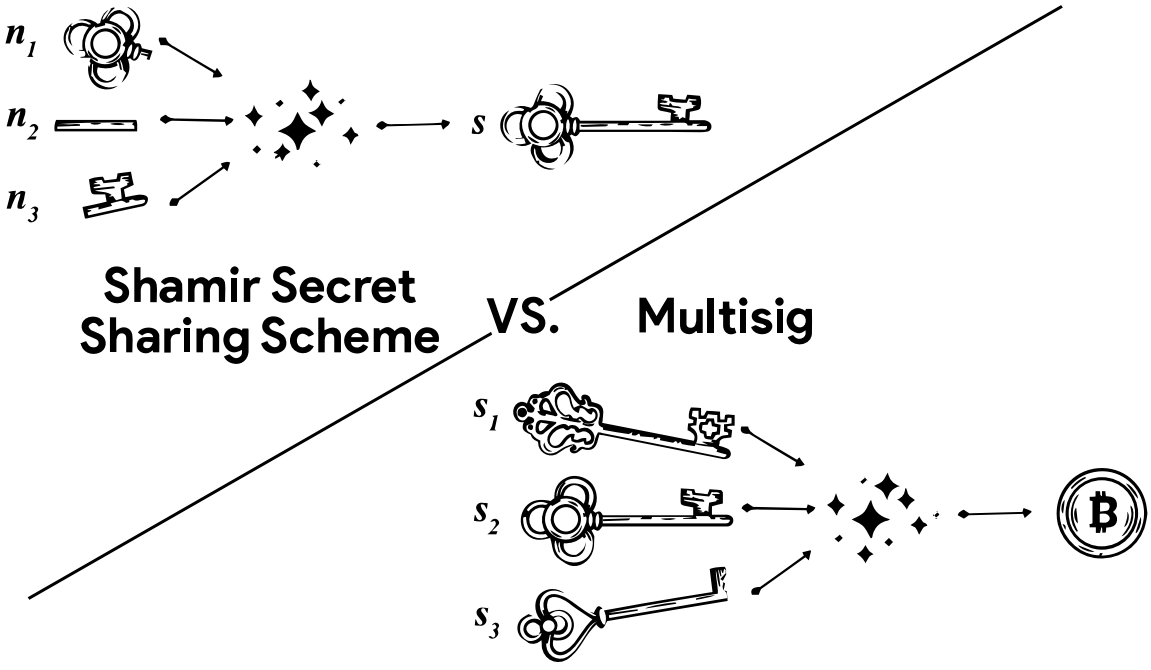
Part I: High-Level Introduction

Cryptography is the art of hiding information. In particular, **Shamir Secret Sharing Scheme (SSSS)** is used to hide secrets in a distributed way. **codex32** describes a way for users, assisted by paper computers in the form of slide charts and circular slide rules (i.e., volvelles), to perform checksums and SSSS on Bitcoin secrets. If you are ready to begin using this process, jump to page 7 to follow the cheatsheet. For a more in-depth primer, continue reading the high-level introduction below.

I.1. Shamir Secret Sharing Scheme

The **Shamir Secret Sharing Scheme (SSSS)** splits a **secret** *s* into *n* **shares**, any *k* of which can be used to reconstruct the original secret. Shares can be kept in separate places. The shares can later be used to reconstruct the original secret. It is important to emphasize that SSSS is a mechanism for storing backups, not a mechanism for enforcing a signing policy, as is done with multisig. In fact, even when using a multisignature scheme, there are still keys to be backed up, which could use SSSS.



With SSSS, *n* is typically five or more, depending on your desire for redundancy, while *k* is two or three, reflecting your fear of individual shares being compromised. There is an inherent trade-off between the availability of a secret and its risk of theft. If you make many copies of your seed words, one of them may fall into the wrong hands. However, if you make too few, they could become lost, destroyed, or misplaced. The consequence in either case is a complete and total loss of funds. By using shares rather than complete copies of our seed, we can make this tradeoff in a more flexible way.

Shamir Secret Sharing Scheme was first proposed in the 1970s, and has historically required the use of computers to generate secrets and shares. Instead, this codex outlines a novel method of secret sharing that can be done entirely on paper.

I.2. codex32



sing volvelles this codex illustrates a method for Shamir Secret Sharing Bitcoin secrets. This document also defines an error-correcting code and complete scheme for generating, checksumming, splitting, and reconstructing secret data.

The function of this codex is to provide a paper-based means to:

- Securely generate random data from potentially biased dice rolls or coin flips to create shares.
- Split a secret into up to 31 shares, of which some number of them are needed to reconstruct the secret.
- Recombine your shares into your original secret.
- Compute and verify powerful checksums as part of each share.

This scheme does not support passphrases or key hardening, so security rests solely on the strength of your randomness. Because of this, it is extremely important to generate truly random numbers. This document provides a dice de-biasing worksheet to generate random values from dice rolls by hand. If you prefer the added security of passphrase-based key hardening, you should instead use SLIP39. SLIP39 is a non-paper-based Shamir Secret Sharing Scheme for Bitcoin secrets. Which does, however, require the use of electronic computers.

I.3. Computers and Trust



t is impossible to sign a Bitcoin transaction without giving an electronic computer access to secret key data, which puts the user in an unfortunate position. If misused or badly generated, private key data can be used to steal all of your coins. To make matters worse, there is no way to know how exactly an electronic computer is interacting with your keys.

General-purpose computers are so complex and exposed to an adversarial environment (i.e., in the form of Internet connections, arbitrary programs, and human beings). The standard advice is to never expose your key material to such machines. Instead, you should provide your keys only to hardware wallets, which interact with general-purpose computers narrowly, through an interface that does not expose your secret key data. But this introduces additional questions: how can the hardware wallet be sure that it's communicating with the correct user, and under correct circumstances? *Ultimately, there is no hardware wallet that a wizard can fully trust.*

Even hardware wallets are opaque and imperfect:

- If tasked with generating random data, it may do so insecurely.
- It may have bugs that cause key leakage, either now or as a consequence of some future software update.
- Key material stored in physical form can be extracted by an attacker with physical access, even if the wallet has "deleted" it.
- It may expose secret data through side channels, such as the electromagnetic waves emitted by processor activity, or by the varying power draw from a USB hub.

These risks have varying degrees of plausibility, but for a Bitcoin secret, which may exceed any one person's lifetime, even "trivial" risks add up to become very serious.

The good news is that unlike electronic computers, paper cannot remember or leak secrets! When handled correctly and disposed of securely, and this can be done without special skills, equipment, or magic.

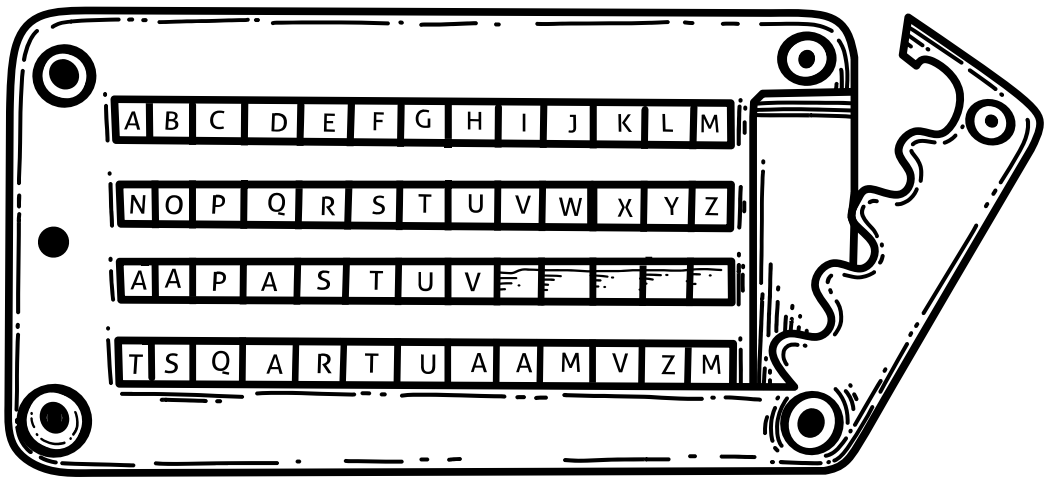
Some limitations of SSSS include:

- SSSS requires that the complete secret be reconstructed in a single place before it can be used. If the shares created were initially distributed among different individuals in a group, the party that brings together the shares to recreate the secret has the opportunity to spend funds, even if their single-party authority was not intended.
- SSSS requires the generation of additional random data beyond the original secret, which must be generated securely.
- If any share is corrupted, the reconstructed secret will be wrong, and it's impossible to determine which share was responsible, or how many.

We have addressed the latter issue through the clever use of error-correcting codes, inspired by SLIP39. However, not much can be done about the fact that SSSS involves a single point of failure at the time that the secret key material is used. This is why this scheme is only to be used for backups, and not for enforcing a signing policy.

I.4. Checksumming and Error Correction

When you copy or transfer keys, and especially when you are conducting hand computations, it is possible that errors may arise. A **checksum** is a technique used to determine the authenticity of received data, to detect whether there was an error in transmission, storage, or copying. Errors might also crop up during long-term storage (e.g., if a paper backup suffers water damage, or a cryptosteels' tiles are damaged making some of the letters illegible).



This scheme does not support BIP39 mnemonic codes, which is currently the most popular way of storing private key backups. Users should note that the BIP39 checksum is less than one word long, and may fail to detect even a single incorrect word. Its primary effects are to cause your key data to be an awkward length, and to prevent you from verifying your data's integrity by hand.

In contrast, the SLIP39 Shamir Secret Sharing Scheme can detect up to three word errors and correct up to one word 100% of the time. Additionally, it will detect other random errors with extremely high probability. However, the SLIP39 checksum is also quite difficult to compute or verify by hand.

In the Codex32 book, we introduce the **codex32** checksum, which can detect up to eight character errors and correct up to four. codex32 has an even higher probability than SLIP39 of successfully detecting random errors. And most importantly, codex32 checksums can be computed and verified entirely by hand.

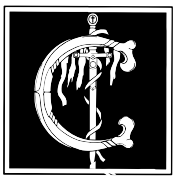
I.5. Seeds and Seed Words



IP32 is a protocol for deriving an effectively unlimited number of addresses from a single **master seed**, which may be between 128 and 512 bits long. Many users interact with BIP32 master seeds indirectly, (e.g., by storing a set of 12 or 24 BIP39 seed words). Unfortunately, these seed words correspond to a 512-bit secret, while codex32 works best with 128-bit secrets. It is recommended that users of codex32 generate a fresh 128-bit seed, using the instructions in this book, and sweep their coins to addresses derived from the new seed.

We note that Bitcoin's EC signatures have only 128 bits of security, so as long as your secret is randomly generated and securely stored, additional bit-length serves no purpose except to complicate things.

I.6. Bech32 and Alternative Alphabets



odex32 inherits its name from the Bech32 alphabet. In order to store 128-bit secrets, we re-use the Bech32 alphabet, which consists of 9 of the 10 Arabic numerals and 23 of the 26 letters of the Latin alphabet. The excluded letters are B, which may be confused with 8; O, which may be confused with 0; and I and 1, which may be confused with many things, such as each other.

Parts of the codex32 process use an alternate alphabet, consisting mostly of Greek letters. This alphabet is used for intermediate computations, but never for data storage, and nothing represented in it is ever secret data. A table of pronunciation is provided on the Reference page at the beginning of this document.

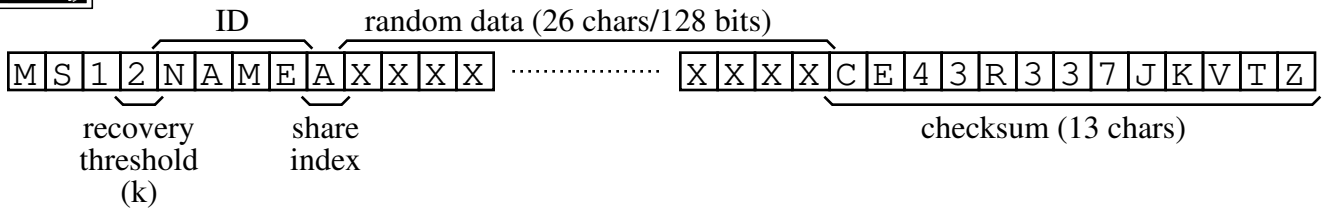
The remainder of this document provides detailed mechanical instructions. If you are interested in learning the mathematical theory behind this all, users are encouraged to check out the mathematical companion or contact Pearlwort at `pearlwort@secretcodex32.com`.

Part II: codex32 Components

II.1. Share Data



or a 128-bit secret seed, each share is 48 characters long. Shares begin with the three-character prefix MS1. This is followed by a six-character **header**. The next 26 characters are the data portion. The final 13 characters are the checksum.



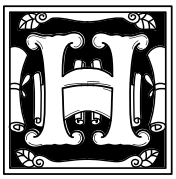
The header consists of:

- The **threshold**, which is the value *k*, a digit between two and nine inclusive, although the main document only supports *k* values two and three. When secret splitting is not used, a zero digit is placed here instead.
- The **identifier**, which is four bech32 characters.
- The **share index**, which is any bech32 character except for *S*. The *S* index is the **secret index**. The data portion of the secret index contains the secret seed.

Shares of one secret all have the same threshold and identifiers. If you have multiple secrets, you should use distinct identifiers for each to avoid mixing up shares of different secrets with each other. The identifiers are not considered secret themselves.

If the user merely wants to checksum their secret and not use secret splitting, they should use the same format, but with the digit 0 for the threshold value and S for the share index.

II.2. Paper Computers & Volvelles



and computation for the procedures in this document can be performed either by using the volvelle wheels or principal tables (at the front of this document) to look up values. Although the volvelle wheels take time to cut out and assemble, they are generally easier to use than the tables, when available.

There are three volvelles in this codex. Each serves a different fuction, and has slightly different usage instructions.

1. Addition. To add two characters, turn the addition wheel to one of them and look through the window corresponding to the other. It does not matter which character is which; addition is symmetric.

2. Recovery. When recovering a secret, you will need to look up "recovery symbols" that will be used. To do this with the recovery wheel, turn the wheel to the share you want to translate. Mark down the symbols pointed to by the *other shares* indices and fuse these together.

Important: Unlike the other wheels, the recovery wheel can easily be used in the wrong order. Be careful!

3. Translation & Fusion. A common task in the scheme is to "translate" share data by a given recovery symbol. To do so, turn the translation/fusion wheel so that the window on the fusion side is showing the correct symbol. Then, turn the wheel over; the translation side will act like a decoder ring, mapping characters to characters.

Sometimes you will need to translate a share by multiple symbols at once. To accomplish this, turn the fusion wheel to the first symbol. Find the next symbol on the inner wheel; whatever symbol that it's pointing to, turn the fusion wheel to that symbol. Repeat for all of the symbols that you need to combine. The fusion wheel will wind up at the final product. You can now turn the wheel over to translate by this symbol. As with addition, the order in which you take your original symbols does not matter.

Part III: Process Instructions / Cheatsheet

1. Volvelle Assembly
You will need: a craft knife, scissors, card stock, brass fasteners, and the volvelle printouts from Module 0.

1. Cut out each disc with scissors. Then, cut out the windows on the top discs with the craft knife.
2. Cut out the small center circle in each bottom disc. Cut a slit along one of the small lines of the cross in each top disc.
3. Attach the discs with a brass fastener through the center holes.

2. Create New Seed (Initial *k* Shares)
You will need: the addition volvelle, dice de-biasing worksheet, checksum worksheet, pencil, eraser, and your secret seed. For each of your initial *k* shares, you should:

1. Generate random data by rolling dice, following the instructions on the dice de-biasing worksheet.
2. Follow the instructions on the checksum worksheet to affix a checksum.

3. Create New Seed (Additional/Derived Shares)
You will need: the addition volvelle, fusion/translation wheel, translation worksheet, and pencil.

1. Translate the initial shares using the symbols in the derived shares section.
2. Add the translated initial shares to get the new derived share.

4. Recover Secret
You will need: the recovery wheel, and everything used for derived share creation (see above). To recover your secret, you must have *k* shares available.

1. Look up their recovery symbols with the recovery wheel.
2. Fuse all of the symbols for each share with the fusion wheel to get a symbol for each share.
3. Translate the share by that symbol.
4. Add all of the translated shares to get your secret.

5. Verify Shares
You will need: the addition volvelle, checksum worksheet, pencil, eraser, and the share to validate.

1. Copy the share data into the bold boxes of the checksum worksheet.
2. Follow the instructions to complete the worksheet, checking that the final result is `SECRETSHARE32`.

6. Correct Shares
You will need: the addition volvelle, checksum worksheet, pencil, eraser, and the share to validate.

1. Follow the instructions above to verify your share.
2. If the result is not `SECRETSHARE32`, enter the result into the online tool. This data does not contain any information about your share data, only about the errors.
3. Add the given values to the given characters in your share, according to the online instructions.

X. Deriving Addresses and Spending Coins
It is an open question as to how to derive addresses or spend coins using paper computers. Please contact Pearlwort at `pearlwort@secretcodex32.com` if you believe you have insight into this.

III.1 Generate a New Secret

We generate new secrets indirectly by generating our *n* shares, which will imply the final secret. The process for generating a new secret seed is as follows:

1. Choose a threshold *k* and total number of shares *n* that suits your needs. The threshold *k* should be two or three, and *n* must be 31 or less. For *k* > *3* see Module 2, but this is not recommended.
2. Choose a four-character identifier for your new secret seed. The identifier can be anything (e.g., a name or nym), as long as it only uses the Bech32 character set. The identifier itself is not secret. However, the identifier should be unique for each secret seed.
3. Follow Section III.1.A to generate the first *k* shares.
4. Follow Section III.1.B to generate the remaining (*n* - *k*).
5. Copy and distribute your *n* shares into safe and secure locations. Additionally, remember that you will need to recover at least *k* of these shares to recover your secret seed. Also remember that anyone else who recovers *k* of these shares can also recover your secret seed and control your coins.
6. Securely dispose of all worksheets that you used in the generation procedure. If these worksheets are not securely disposed of, they could be used to recover your secret seed.
7. (Optional) Load your shares into your codex32-compliant wallet or use the Recover Secret procedure in Section III.2 to compute addresses or access your coins.

III.1.A Create First Share

You will need: 2*k* copies of the checksum worksheet and the dice de-biasing worksheet.

1. Fill out the header portion of the *k* checksum worksheets with your chosen threshold *k* and chosen identifier.
2. Place a unique share index on each worksheet starting with share `A` on the first worksheet, `C` on the second worksheet, and so on through *k* characters from the Bech32 characters. Recall that the `B` and `I` are not valid characters.
3. Using the dice de-biasing worksheet, generate 26 random characters and write them in the **bold squares** of the checksum worksheet.
4. Once all of the random data is generated, use the rest of the checksum worksheet to generate a checksum for each share.
5. **Critical Step**: Verify your checksum by copying each of the 48 characters of the share into a fresh checksum worksheet. Follow the checksum verification instructions to verify each checksum. If any checksum fails to verify, make more copies of the checksum worksheet and redo the checksum generation and checksum verification steps. Failure to verify each checksum may lead to irrecoverable loss of the secret seed and funds.

Special rules for k = 1. If you are not splitting your secret, use a 0 digit in the threshold place, and use the `S` character in the share index place. Follow the same instructions for generating the data portion and the checksum.

Special rules for pre-existing secrets. If you have a pre-existing seed, include this as an initial share, using `S` for its share index. When deriving additional shares, use the alternate table in Module 2 rather than the table in the following section. This process is not recommended, but may be useful in some scenarios such as re-sharing an existing secret.

III.1.B Create Derived Shares

You will need: (*n* - *k*) checksum worksheets, and the translation worksheet for your value of *k*.

The remaining (*n* - *k*) shares are derived from the first *k* shares, using the translation worksheet. For each derived share, use the following process to derive it:

1. Make a copy of the translation worksheet for the value of *k* that you are using and label the shares with the share indices from the shares that you have already generated (e.g., A, C, and D, if *k* = *3*).
2. Label the final share index with the new share index that you want to derive. This can be any bech32 character, but most likely you will just want to use the next available character.
3. In the derivation table (below) for your value of *k*, find the column corresponding to the new share index. Copy the symbols from that that column into the translation worksheet, next to the share index for each row. There is an illustration on Page 18 if this is unclear.

k = 2	D	E	F	G	H	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	Z	0	2	3	4	5	6	7	8	9
A	Π	Θ	Δ	ρ	β	α	Ξ	Ω	¤	μ	€	♥	η	@	¢	Λ	Γ	%	ε	¥	Φ	$	¶	†	#	ǂ	Ψ	⊕	Σ	♦
C	ρ	Λ	Γ	Π	α	β	μ	Ψ	⊕	Ξ	¥	♦	ε	#	%	Θ	Δ	¢	η	€	Σ	¶	$	ǂ	@	†	Ω	¤	Φ	♥

k = 3	E	F	G	H	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	Z	0	2	3	4	5	6	7	8	9
A	μ	Ξ	₿	⊕	¤	#	¥	¶	@	Γ	Σ	#	Φ	$	Ξ	μ	¶	@	Δ	⊕	€	¥	Δ	Σ	Γ	€	$	¤	Φ
C	η	η	₿	¥	€	Ψ	Δ	α	Ω	%	@	Ω	@	α	ε	ε	β	Ψ	¢	€	Δ	Γ	%	#	¢	Γ	β	¥	#
D	Π	ρ	₿	Σ	Σ	α	@	♦	α	Ω	¶	β	$	♥	Π	ρ	♥	β	Ω	Φ	#	#	Ψ	$	Ψ	@	♦	Φ	¶

4. Follow the translation worksheet instructions to derive the new share.

Derivation tables for *k* from four up to eight can be found in Module 2. However, we discourage the use of large *k* values, which are difficult to use and increase the chance of key loss.

III.2 Recover a Secret

You will need: *k* checksum worksheets, and the translation worksheet for your value of *k*.

Normally, you would not recover a secret seed yourself. Instead, you would load shares into a codex32-compliant wallet. However, you can recover the secret seed by hand if no compatible wallets are available or you feel a need to demonstrate your conjuring ability. The recovery procedure uses exactly *k* shares. If you have more than *k* shares, you can select any *k* of them and set the other shares aside.

Use the following procedure to recover the share:

1. For each share, fill in a checksum worksheet and verify the checksum. If a checksum fails to verify, you may have made an error on your worksheet, or there may be an error in your shared data. If there is an error in your share data, you can try substituting the share with a different one. Otherwise, you will need to perform the error correction procedure on your share, which will involve the assistance of an electronic computer.
2. Label the translation worksheet as though you were deriving a new share. Use your existing shares' indices as the "initial shares" and `S` as the "new share" index.
3. Rather than using a derivation table, fill in the symbols for each share on the translation worksheet using one of the following procedures:

III.2.A Recovery by Table Lookup

If your volvelles are missing or otherwise inconvenient to access, you can do the entire process using the Principal Tables located at the front of this booklet.

k = 2. For each share, find that share's **column** in the recovery table and find the symbol on the **row** of the other share. Copy this symbol into the translation worksheet.

k > 2. For each share, find that share's **column** in the recovery table and find all of the symbols in the **rows** of the other shares. Fuse these symbols together pairwise using the fusion table until you have only one left. Copy this into the translation worksheet.

Notice that the fusion table is symmetric, so it does not matter if you swap rows and columns. The recovery table is **not** symmetric, so you must use this table in the correct order.

Once you have copied everything into the translation worksheet, follow the Translation Worksheet Instructions page as though you were deriving a new share. Rather than using the addition wheel, you can use the addition table. The result should be a share with index `S`, which is your recovered secret.

III.2.B Recovery by Volvelle

Using the volvelles is easier and less error-prone than using the tables. If you have your volvelles, the recovery process is as follows.

k = 2. For each share, turn the recovery wheel to **that share's index**. Look up the symbol pointed to by the **other share's index** and copy that into the translation worksheet.

k > 2. For each share, turn the recovery wheel to **that share's index**. Look up the symbols pointed to by the other shares' indices. Fuse these symbols together using the fusion wheel:

1. Turn the wheel so that it is pointing to the first symbol.
2. Find the next symbol on the inner part of the wheel. This symbol will point to a new symbol. Turn the wheel so that it points to the new symbol.
3. Repeat the above step for all the remaining symbols to fuse. (If *k = 3*, then no repetition is needed.) The resulting symbol is your result. Copy this into the translation worksheet.

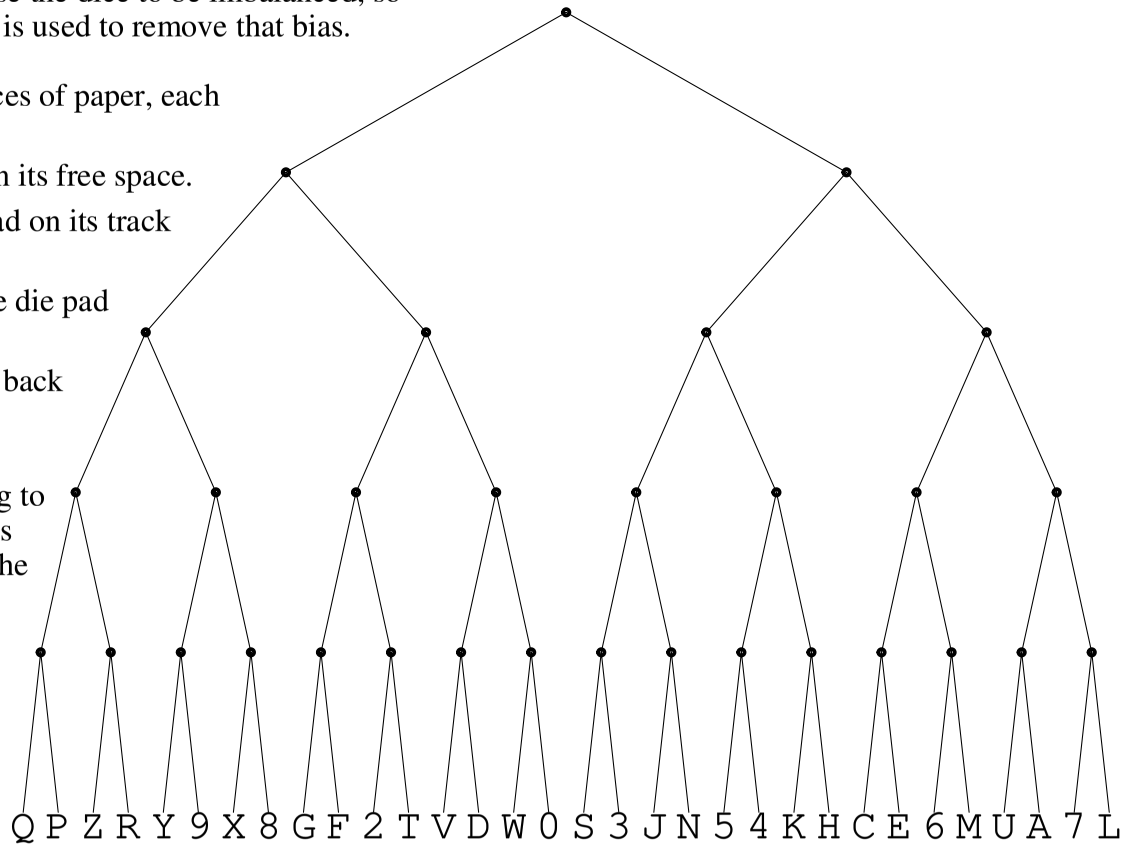
Once you have copied everything into the translation worksheet, follow the Translation Worksheet Instructions page as though you were deriving a new share. The result should be a share with index `S`, which is your recovered secret.

Dice De-biasing Worksheet

Most dice have small manufacturing imperfections that cause the dice to be imbalanced, so some values appear more often than others. This worksheet is used to remove that bias.

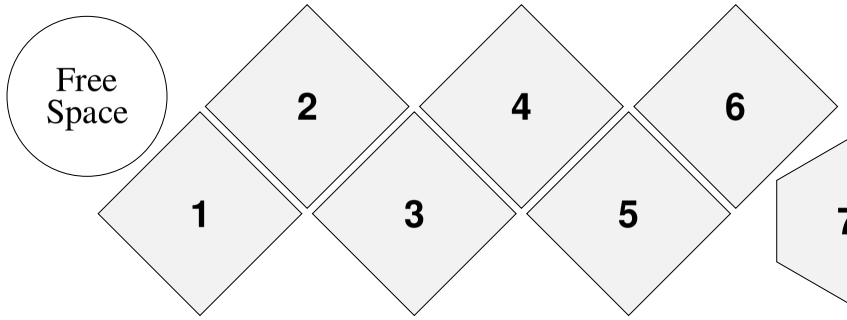
You will need: five distinct dice, five die markers (e.g., pieces of paper, each labeled by which die it corresponds to), and this worksheet.

1. Choose a die track for each die. Put the die's marker on its free space.
2. Roll all five dice. Move each die's marker to the die pad on its track indicating its value.
3. Re-roll the same five dice again and set each **die** on the die pad indicating their second values.
4. If a die showed the same value twice, move its marker back to the free space and repeat steps two and three.
   You must redo both rolls!
5. Using your finger, follow the tree to the right according to the die tracks. Take the first left branch if the first die is to the left of its marker, and the right branch if it is to the right. Similarly, take the second branch based on the results on the second die track, and so on, until the bottom of the tree, which has the resulting character.
6. Repeat steps one through five for each character.

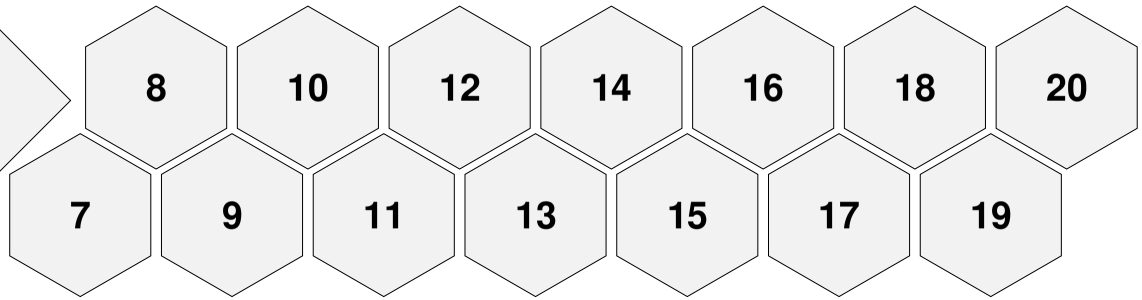


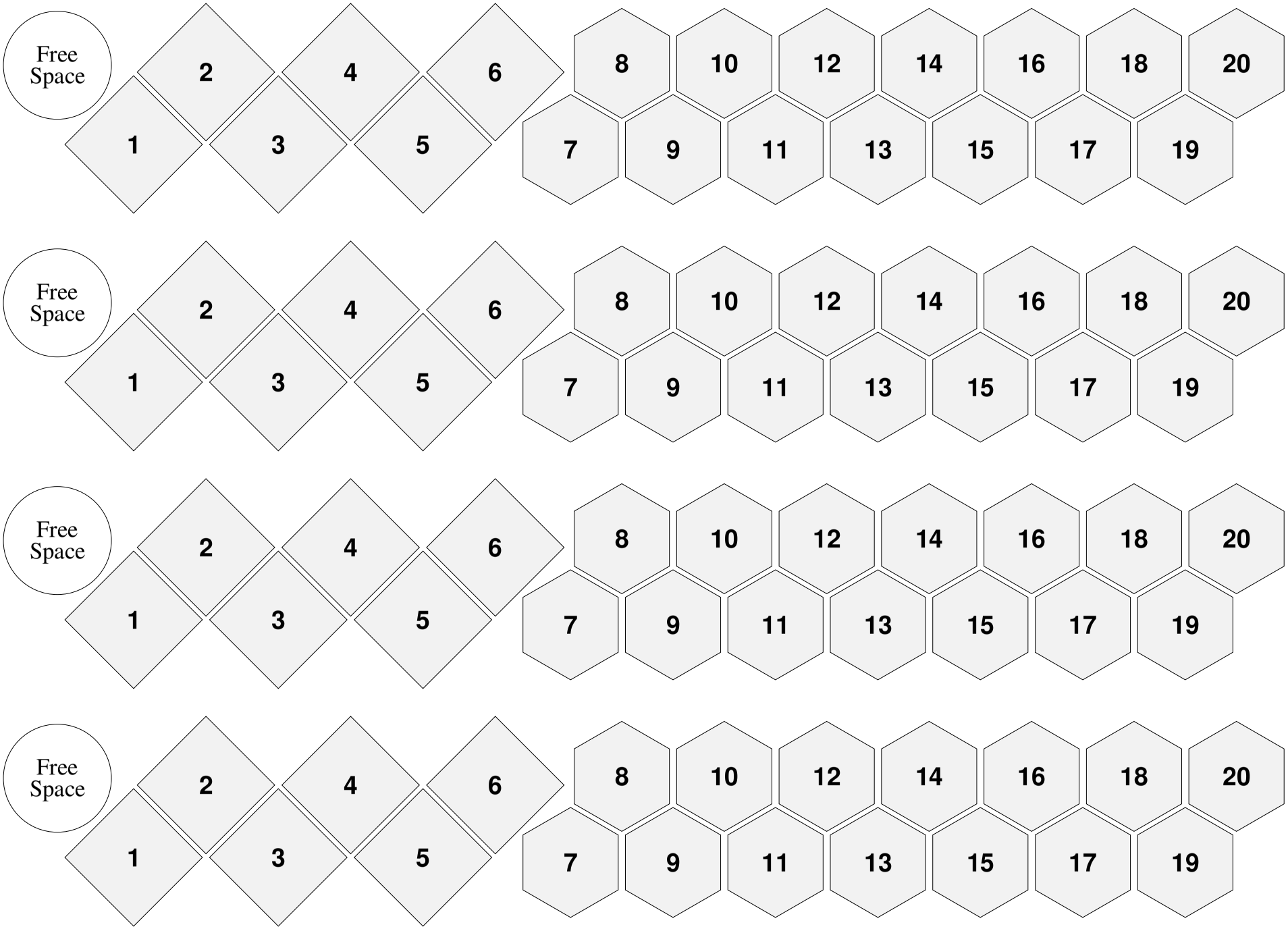
Die Tracks

Die Pads



Die Pads (d7+)




Free Space
2
4
6
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7
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11
13
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17
19
Free Space
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Checksum Worksheet (Generation Instructions)

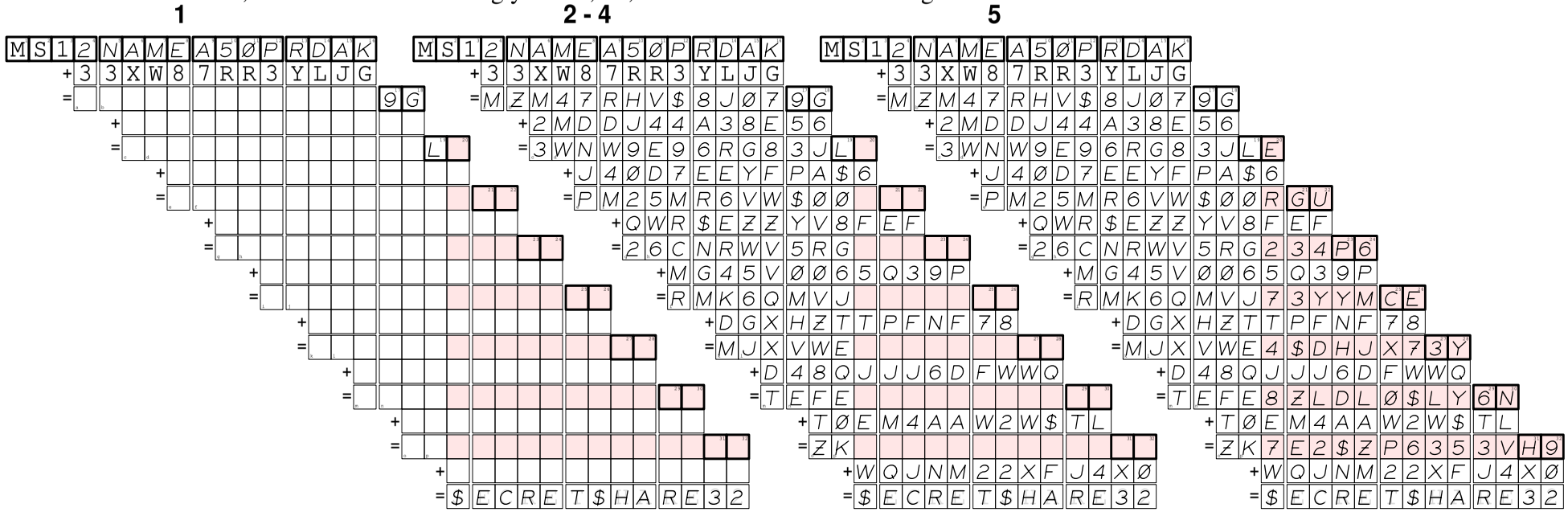
The checksum worksheets are used to generate and verify checksums. These are the most frequently used and important worksheets of codex32.

You will need: a checksum worksheet, checksum table, and addition wheel.

Generating a checksum:

1. Fill in the bottom row with the word `SECRETSHARE32`
2. Fill in the top diagonal squares (i.e., the bold ones) with your random data. You should have enough data to fill the non-pink bolded squares.
3. Add the first row to the second to fill in the third row, using the addition wheel.
4. Look up the two leftmost under hanging symbols from the third row in the checksum table (pages 11-12) to fill in the fourth row.
5. Repeat the above two steps, adding the third and fourth rows, looking up the fifth to fill in the sixth, and so on. With this approach, you will be able to complete the entire sheet except for the pink squares.
6. To complete the pink squares, work from the bottom up, adding each row to the one above it until all of the squares are filled. The completed share can now be read from the top diagonal, including the checksum (i.e., the pink bolded squares).

Note. To avoid confusion, we recommend slashing your `0`s, `7`s, `Z`s and `S`s when handwriting.



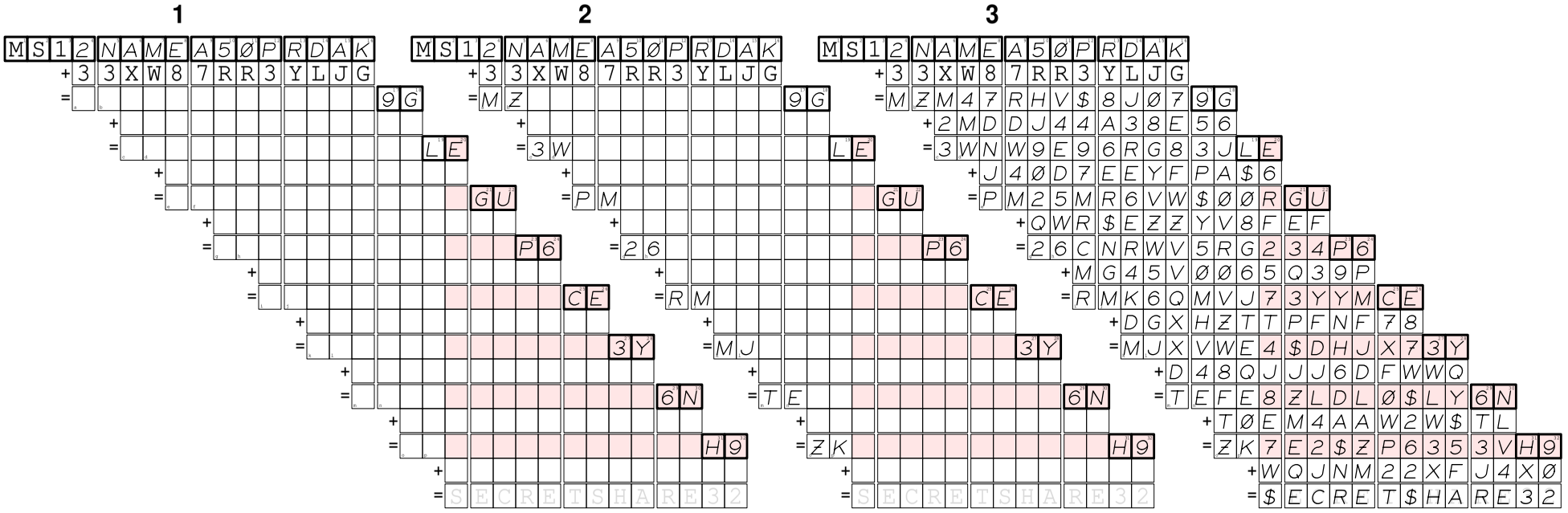
Checksum Worksheet (Verification Instructions)

Verifying a checksum:

1. Fill in the top diagonal with your share data; you should have enough to fill all of the bolded squares.
2. (Optional) Fill the bottom diagonal, if you have access to this data. It will help you catch mistakes.
3. Fill in the rest of the worksheet as you did when generating a checksum. If your final row does not match `SECRETSHARE32`, or if any of your computed bottom diagonal values don't match the expected values, there is a mistake in the worksheet or your data has been corrupted.

In case of error, first recompute every value in the bad column and check that you copied all of the share data correctly. Then, try redoing the worksheet entirely. If the checksum is consistently bad, your data is corrupt and you need to attempt the online recovery process.

Note. To avoid confusion, we recommend slashing your `0`s, `7`s, `Z`s and `S`s when handwriting.



codex32 Checksum Table

AA	STP2KRRLRGTP5	CA	CYANSPPRLRTC0	DA	RJQM3EE7ZVTSL	EA	28TYF334FFT0G	FA	E724WTT5GDT7R	GA	TAUZHMMZ78TFY	HA	Q4S3688WJ7T6T	JA	G6VGU99JW4TRS
AC	K8XTK99EMYGRK	CC	7G6JS88980G6D	DC	97863LLC6QGJA	EC	VTV9FHHN39GD2	FC	LJD5WDDJSPGUP	GC	D3MRHAAYXTGTX	HC	XEHS6PPG2JGCF	JC	WKTFURR5KEGPJ
AD	H9T8KYYCLXUMW	CD	L2H7SXXYRDUZ4	DD	YU2K377E7ZU29	ED	DFPFFKKJ48U4J	FD	7SQCWVVN5RUYE	GD	VNK0HUU9ZFUN7	HD	8M6U6QQFWSUQ3	JD	05X9UZZ4JMUE2
AE	0UHRKUUQYLSNX	CE	8NT6S77UC5S2A	DE	U9KJ3XXP9MSZD	EE	4SADFWW2W7SA6	FE	XFUUW55T06SV3	GE	522THYYAESSMK	HE	LZXC6CC34FSGE	JE	HD6PU66DFZS3Z
AF	GJAWKMM8C38FU	CF	QAPHSEEMY68S8	DF	MTUL3PPXE48CH	EF	J7HQFFFDJS88Q	FF	P8K3WNNVN58KT	GF	NYQXHRR6978PV	HF	CVV46LLKF88JR	JF	SRSVUAA24V8TC
AG	3FVXKZZ782LEV	CG	EXSLSQQZMPLQH	DG	ZSDH3CCLXWLG8	EG	T9XGFSS5DTLHS	FG	CU8EW224V0LXM	GG	2L3WH66R69L3U	HG	PHAA6XX0KULZN	JG	FCPYUYYN2HLMG
AH	UN0GK00N6SD9S	CH	5UN3SDD0XMDUT	DH	02WE344JM5D5M	EH	XL9XFAAES3DTV	FH	4XYHW88C34D68	GH	89JQHHHW8LDDQ	HH	VD7N6TTZTXD70	JH	YZZ2UFF7HDD85
AJ	6LGFKFF4ZUW8J	CJ	JS5SSTTF7HW7F	DJ	FXFC3NN5RCWKE	EJ	QNZ8FMMLGAWFW	FJ	N2RKWPP7FEWC9	GJ	PF4PH33GLNW0Z	HJ	2PEJ6DDYN2WUD	JJ	ZW9TU00C0PW9K
AK	9G7QKKK29T44Q	CK	D8ZES55KEQ4VM	DK	K3L33VVTY04YT	EK	LY5WFYYQ024MU	FK	VA4LW77PWW42H	GK	77RGHWWHCY4AS	HK	4K0M6JJM5A4WL	JK	AENZUSS8GK4HY
AL	T526KCCY5HJGA	CL	RMKRS66CGUJ3X	DL	CDTT3ZZ94NJEK	EL	3CQ5F22W7KJXP	FL	ZPP9WSS0LJJH2	GL	SZHJHQQEFCJQD	HL	M2MP6UU49PJNZ	JL	N98CU77FE2J2E
AM	5RUNK88MNQF60	CM	UVQ2S9980TFR5	DM	86AZ3AA6JYFTY	EM	W0KAF443EPF5N	FM	AKHVW00SC9F9C	GM	04PMHLLXW0FJL	HM	YADG6RR2ZKFPS	JM	VJ33UPPK7AFCT
AN	RYEPKSSVA8KHZ	CN	TT9CSJJSPVKWE	DN	SACS322DURKXF	EN	EGN0FZZXHXKE7	FN	23J7WCC8KZKG4	GN	CJYFHGG3QGKLJ	HN	N6G6655AV3KVA	JN	M45RUKKPS6K4X
AP	L4CUKVVSKKCY3	CP	H6Y9SWWV2ACA2	DP	VVED3KK3HJC46	EP	9EJJF776UHC2D	FP	KQNRWYYMANCMX	GP	YR95H55DTECVP	HP	0TF86GGP8QCLW	JP	8Y47U22AMTCX4
AQ	XWF5K44FFDQ5P	CQ	WP4DSHH44XQD6	DQ	4HG9300GGFQ92	EQ	UZR6F88RRVQ6A	FQ	0MZTWAAZZGQTK	GQ	AC5UHDD55ZQU3	HQ	KSC0633CCMQ07	JQ	7LYKUNNYYSQK9
AR	Y2NVKHHTPFPDC	CR	V904S44HAZP5R	DR	HNJA3DD2QDPUN	ER	7XEZF99PTGPRY	FR	DLCNWLLQ2VPJ0	GR	LUWYH00KUXP9G	HR	55ZH6NN6SLPK8	JR	UM7WU33XV5P0U
AS	PQREKJJW4RHWM	CS	F0LQSSSJFGHHQ	DS	JEZG3GG058HLS	ES	MVFHFQQYLZHQ8	FS	G4GXW6697XH3V	GS	6K73H22NGVHXT	HS	37JZ6KKLY4H4Y	JS	E3WMU55RC7HVL
AT	NDK7KQQU0W7Q4	CT	MZ28SZZQN97EW	DT	Q5H0366AW2737	ET	FPUSFJJK907WF	FT	6CAPWGGHYT7LZ	GT	GMTKHCCPJP7G9	HT	RN896YYD7C7M2	JT	TUMUUXX3ZN7Z3
AU	FSSZK66XUNN3Y	CU	PLVMSCC6QCNGL	DU	6F3N3QQ8AHNQ0	EU	NU6VFGGVKJNLC	FU	Q9MAWJJDHKNWN	GU	JXD2HZZMPUNE5	HU	EWPE677HD9N2M	JU	3PAQUUUT3WNNQ
AV	W760KAAPQAYT7	CV	X3XKSLLAUKYJ9	DV	A8M7388QPEY64	EV	5JSPF00T2UY9Z	FV	8T3SW442TCY5F	GV	4G88H99UAJYRW	HV	7QT56EES3TYSP	JV	K0HDUMMVDQYF6
AW	4P3LKXX6HZAZH	CW	AWDXSYYXTFAMV	DW	XCSW3UUMKXANU	EW	0DM3F55SARAVT	FW	U56QWWW3U8AAQ	GW	WHVHH7782DA28	HW	9LQY6ZZTX5AEG	JW	DSUAUQQH6LAQN
AX	ZX5DK33DE9Z06	CX	2FG5SNN39WZKP	DX	3L4U3TTVCPZ73	EX	C27RFRR8NYZPX	FX	TNLJWEEXJQZSD	GX	ESF9HFFSY2Z82	HX	JC9K644UGNZ59	JX	6HE0UHHQ5CZD7
AY	EELAK22KW6MXN	CY	3KRYSGG2J3MLG	DY	2Q7V3SSH07MHC	EY	R44NFCCUYMMG0	FY	SV5ZWZZA9LMEY	GY	Z0Z4HJJTN4MWR	HY	F8WX6WW8LVMAV	JY	PGJLUVVMR8MYH
AZ	A3ZYKWWJ7JEAG	CZ	477ASVVWZEEYN	DZ	WGR4355NLKEVR	EZ	8AG2FUUC5NEN5	FZ	5YFMWXXE4HEZL	GZ	X8LVHKK0RAE4C	HZ	D0NL622R0YEXH	JZ	9Q0XUGGLN0ELV
A0	V6QHKLLRGE9J8	C0	Y4UWSAAL5J9TU	D0	LRPX399ZFA9RV	E0	KK2EFDDFZC9UM	F0	90TGWHHGRU9DS	G0	HVALH8874K96H	H0	UY3V6MMJE09FC	J0	5TD4UEEW9Y9SR
A2	2K8KKEE9S4XS9	C2	ZEM0SMMEV7XF7	D2	E0X83RRY33XPW	E2	S6DCFTT065X7E	F2	RRVFW33WMSX0J	G2	3Q67HPPCD6XC4	H2	6GKD6AA5PRXT6	J2	J825ULLGAGXJP
A3	CMJ3KTTH2C07T	C3	S5WGSFFTKN08S	D3	TZNQ333KTU00Q	E3	ZHCLFEEAQE0SH	F3	3WEWWRRUPA0PU	G3	RD0EHNN2HH0KM	H3	G9R2600XMW095	J3	Q2LNUDD6890U0
A4	8VYCK55GD05VE	C4	0RCPSKK53Y54Z	D4	549F3WWFVT5AJ	E4	AQWKFXXZ8W5Z9	F4	WE08WUURX25NW	G4	U6ESHVV4SQ5YF	H4	HJ4R6SSEUE5HX	J4	LAF6UJJ9QJ5WA
A5	7H4SKDD3J5VUF	C5	KCFFS00DWLV9J	D5	DW5P3HHSNSVDZ	E5	YML7FLLMC4VJ4	F5	HZ70W996E3VR7	G5	9PGCH44V0MV5E	H5	WFYT6FFQRZV8K	J5	XXCJUTTULFV7D
A6	DCDMK77ZVM32L	C6	9H3ZSUU7SS3NY	D6	7PV23YYRDL3M5	E6	H584FVVGX63YR	F6	YDXYWKKF8734G	G6	KWSNHXXL353Z0	H6	AXUQ666NAD33Q	J6	4FQEUCC0PX3GM
A7	J0MJKPPATV2CD	C7	6Q8TSRRPH82PK	D7	PK6R3MMU2G2FX	E7	GR3UFNNHPD2K3	F7	M6SDWFFKQF286	G7	FEX6HEEQKR2SA	H7	Z32F699V662RJ	J7	27KSU88SX326F
A8	MA99KGG5X76L2	C8	NJEUS22G646X3	D8	GYY53JJ4866WP	E8	P30TF667VL63K	F8	JGW6WQQLDM6QA	G8	QTCDHSSFM36H6	H8	TR576VV9HG6Y4	J8	RVG8UWWETR6AW
A9	QZW4KNN03PRKR	C9	GDJVS33ND2R0C	D9	NM0Y3FFWS9R8G	E9	6WYMFPP9MQRCL	F9	FH92WMMY6YRF5	G9	M5NAHTTJVWR7N	H9	SULW6HH7QHRDU	J9	CNRHU44ZUUR58

KA	JKXXRHHCY5TDV	LA	ADYDD226XUTX6	MA	8PWRJCCSVATGX	NA	6E6L944YCLT5H	PA	YX7FEXXQU0TZJ	QA	K9G7QKKK29T44	RA	FQMWZ009EMT9U	SA	9UF08VVHTPTY7
KC	56P8R337UCG0W	LC	MPRVDVVU7SGYC	MC	PDFZJ77K53G2Y	NC	U4A79NNZQNGK4	PC	Z2EGEQQXYRGQS	QC	SF0LQSSSJFGHH	RC	0VU0ZFFRPHG87	SC	RSWW8223NDGXU
KD	4CVTRSSLC6UHK	LD	6RWQDDDA6JUUQ	MD	Q0YWJLLHSNUJU	ND	AHSJ9JJRY3UWD	PD	RG5YEPP8QPUCG	QD	3TZNQ333KTU00	RD	WW3RZGGZ94ULX	SD	ZJRZ8TTSH0U7Y
KE	DPS0RGG8RRSL7	LE	Z6JYD449PTS5G	ME	CKC2J880T2S65	NE	9WVK922MLGSX9	PE	M3GQEEELMCSSQ	QE	FJ7HQFFFDJS88	RE	KHD8ZSS67VSHW	SE	6TLX8NNGVKSKV
KF	206ZR00QLD89Y	LF	95CFDJJZA98WJ	MF	LCJ8JQQGHY8QW	NF	ZQXM9DDURX8UL	PF	ULZDE77C8K826	QF	WU56QWWW3U8AA	RF	3E82ZHHAZZ8D5	SF	A94T8550SC8VK
KG	N5T2RKKEQKL45	LG	U0FPDTTMZ7L7Z	MG	XRR0JEE3GLLS7	NG	MMHN9559UALV0	PG	9YN9E88PCDL62	QG	H89JQHHHW8LDD	RG	GZKZZWWYAELAY	SG	Y7YR8DDK0RLUX
KH	7WGYRMM5AVDFG	LH	3420DXXKLYDZ7	MH	TEQPJ55U49DVZ	NH	KP5A9EEGP8DSN	PH	G7STE22V9HDXK	QH	6AXUQ666NAD33	RH	9C4VZRRFQRDPC	SH	FY8D8QQMJEDQ6
KJ	CZ09RAAJ9QWT2	LJ	HEDWDQQS8GWQU	MJ	D48QJJJ6DFWWQ	NJ	SDNU9LLWETWJ3	PJ	WJH2EVV2AMWY5	QJ	U3PAQUUUT3WNN	RJ	R5JDZ990C0WR6	SJ	0GQV8XXA24WZC
KK	84EVRZZDZH4EC	LK	GWM8DLL0QL4JW	MK	JZ3FJDD9274UJ	NK	06949QQ37U4QR	PK	39PRENN46V4KX	QK	RXH5QRRRVX4PP	RK	URYYZ66SLC43G	SK	SLK98EEZDZ4S2
KL	FFDKRVVRNTJY9	LL	XJ0AD33P3RJ0N	ML	U79NJRRTMZJP0	NL	PX309WWL0QJA7	PL	LE4EEAAMTSJTM	QL	D6RWQDDDA6JUU	RL	JLS7Z557WYJV4	SL	7RZL8HHVU7JDH
KM	K7MLRNNU5UFKH	LM	E9E5DWW7K5FAP	MM	RFN6JUU5U4FNA	NM	738X933QGHF0V	PM	QWRSEZZYV8FEF	QM	JD48QJJJ6DFWW	RM	DGXHZTTPFNF78	SM	P55K8GGNMFFL9
KN	PE7DRYYT6MKM6	LN	WZUXDEEFCNKSV	MN	5WKGJTTRJJK7S	NN	FKZ59XXHXSKZP	PN	HFXZE44NZQK5Y	QN	92S4Q99952KRR	RN	60R9ZUUK85KN2	SN	KN3Y8LLY4WKJG
KP	AGLSRCCH32CGF	LP	JNAMD994NZCRL	MP	GLH4JHHLERCDR	NP	48RF966TDPC3J	PP	TC8LEFF0F3C8H	QP	EM3GQEEELMCSS	RP	X7ZCZQQ2V9CQE	SP	2ZSE8RRC7LCPM
KQ	YNWCRPPWW3QCE	LQ	TGVNDUUVVEQN0	MQ	3YXAJWWXXCQAN	NQ	VUJP9RRJJ6QPZ	PQ	JRKHESSKK2QH8	QQ	QQQQQQQQQQQQQ	RQ	L9NSZEENN7QSF	SQ	NEP3866PPYQ3T
KR	XH5QRRRVX4PPQ	LR	FVKTD77WYAP2K	MR	NQU9JVVYWUPY2	NR	WCGE9PPS67PCM	PR	S8V0EJJ57WPW7	QR	ZY6CQZZZGYPEE	RR	APFGZMM3M6PFS	SR	3AMF8CCRFQPGJ
KS	RAY4RXXFJLHZR	LS	VXX7DMMTSHHF4	MS	K2VSJFFP6KH8F	NS	TJCV9YY4W5HMC	PS	4DU6EHH32YHDA	QS	8W2DQ888UWH66	RS	CTEAZ7750SH2N	SS	5HTU8AAXA2HT3
KT	3S3JR55MGJ7VD	LT	7TNEDFFE2678M	MT	Y8EHJMMNQM7F8	NT	ELDT9KK85E74K	PT	8QFAE99RSF7RN	QT	4RL2Q444XR755	RT	2XV6ZVVX4A7YA	ST	X67M80058879L
KU	TDHWRWWPM0NAU	LU	YK49DNNRE8NK2	MU	76LTJPPFNXNCK	NU	RZTH9VVA8YNY8	PU	AA0PELLER5NJZ	QU	07EKQ00047N99	RU	SM2XZKKUXQN4V	SU	U8C8844W56N5W
KV	VRARRFFX8PY8X	LV	RCLGD55Y9FYVS	MV	E54XJXXW0GYZV	NV	YVP69TT6M2Y7A	PV	6N9VECC7L6YGC	QV	GSNMQGGGFSYLL	RV	H4QTZ33M6WY0K	SV	MFJ28JJFG5YW5
KW	HUKNRJJAS7AW0	LW	C85CD00LJKA9E	MW	ZT7KJAA4CHAT9	NW	LN229SSPV4AH5	PW	PVWUERR9G9AP3	QW	N0CTQNNN70AKK	RW	V2TMZ22QD3AXL	SW	QKE68FFJLTA8A
KX	QMNPR9927EZRZ	LX	0Q32DCCGU3ZG5	MX	4VMYJ22ZKSZXG	NX	G50C988KZJZ6E	PX	KTTWE55JXZZVU	QX	YGAEQYYYSGZMM	RX	MDWFZAAHRKZTJ	SX	H3UG87793VZ2S
KY	MYC3R773FXM2T	LY	5L66DRRNTWMPA	MY	WNS5J33EP0M0P	NY	NTYG9UUD4DMNS	PY	D5Q7E00F3AM94	QY	LHKFQLLL8HMJJ	RY	QJ9EZXXV5FMZM	SY	VWHC8997XNMRE
KZ	LV9GR664EWE3S	LZ	SH8RD88HMXE6X	MZ	2MDDJ44A38E56	NZ	HRE39CCF99EGT	PZ	FUA8ETTDP4E7W	QZ	MLTSQMMMHLEFF	RZ	Y6CQZZZGYPEEQ	SZ	GX2P8PP6KMECZ
K0	W88MRTTY0997L	L0	PU9SDKKXDD94F	M0	MS07JYYV8V9M4	N0	XGMZ9FFCNW98Y	P0	CHL5E66UH793P	Q0	25FRQ222P59XX	R0	436NZNNEJ29K0	S0	EDGJ8SSTQS9HD
K2	GTQ6RDDZHFXUA	L2	8SZ3DSSQ4PXHT	M2	AUGLJZZ2LQXEH	N2	QYUR9007TZX9X	P2	7MC4EUU60JXNR	Q2	VCWZQVVVECXYY	R2	NAAJZ44L2XX5D	S2	LP0N8KKDCUX40
K3	6X4ARLLSDY0JN	L3	4AHKDZZJ0V0E9	M3	03ACJSSC9D0HE	N3	JFFY9AAV300TG	P3	VKDJEWWG4L0AD	Q3	74M9Q777R4022	R3	PSG4Z88DST06R	S3	DV658YYLZ30MP
K4	93R5RQQ02N5QP	L4	22PLDAADGM5TH	M4	SXT3J008Z659T	N4	D7LD9ZZNKC5E6	P4	NPMME33HJG50L	Q4	PZDVQPPPYZ5CC	R4	787UZCCJHU5G3	S4	JMVA8MMQ9X5FN
K5	U2JUREEK4GVS3	L5	N3SHDYY5HQVM8	M5	FA6EJKK7APV4M	N5	59W99MM2FRVF2	P5	262NEGGWDNVL0	Q5	CEUYQCCCMEVGG	R5	8U05ZPPTG8VCP	S5	TQA48ZZE6AVER
K6	092HR229T83X8	L6	Q7GUDHH8F03D3	M6	6JZJJ99DRW3RD	N6	82KW9GGEHV3LU	P6	E4JCEMMANU3FE	Q6	TKY0QTTT9K377	R6	5NHLZJJCKG3WH	S6	C0978332YJ304
K7	SJU7R446VS254	L7	LF74DGGCWC2LR	M7	995MJ66JYE23L	N7	CAQ89HHXSM2DW	P7	XZY3EYYZ5T2MT	Q7	5PJXQ555ZP2VV	R7	TYPKZDD83L2U9	S7	8CNH8WW4R92A8
K8	EQZFRUUNPZ6NJ	L8	KMQZDPP3R26CY	M8	VH2VJNNMFT6KC	N8	307S9770AF62F	P8	0S6XEDDTEE6UV	Q8	ANV3QAAA0N6TT	R8	ZKLPZYYWUD6MZ	S8	W2DQ888UWH66Q
K9	ZLFER88GKAR6M	L9	DYTJD66254R3D	M9	HGPUJGGQ75RL3	N9	2S4Q99952KRRQ	P9	503KEKKSWXR49	Q9	XV8PQXXXCVRZZ	R9	EF53ZLL4TJRJT	S9	44XS8UU8EGRNF

codex32 Checksum Table

TA	5C0J4ZZ3DETED	UA	ZGHA0NNF4ZTKN	VA	33KVGFFG5XT8C	WA	UHNTNQQD3JTQK	XA	P08HYDDE9STU8	YA	VFZSLYYUQYTMF	ZA	MRDEMLLN03TJM	0A	W59U2SSM8CTH3
TC	J5GN4YYH44GM0	UC	YYSU0440DWG53	VC	HA3DG00WV2G96	WC	6M52NXXTF7GZ5	XC	8RQKYTTLAUG79	YC	2993LZZ6CGGET	ZC	A02CMEE4HAGSE	0C	GCZA2KKAL5G4N
TD	NK9L499K3HURH	UD	9XAS055WFVUVF	VD	KLUPGWW0GGUAZ	WD	MEEXN882DUU6V	XD	XPD6Y227E7UXA	YD	T8GALRRMU2UPN	ZD	UD85MCC5NLUGP	0D	F6032HHUMKUDT
TE	T0EM4AAW2WSTL	UE	ALP50VVKJ4SYP	VE	WXQ9GKKHN3S42	WE	RQ9ZNLLJK9SJY	XE	7C37YJJXZ8SW4	YE	N75ELMMR8NSFM	ZE	Y5MSMQQVGXSQF	0E	3RN4200YQ0S9R
TF	VPNK466FKQ839	UF	63TE0TT3WM87M	VF	FG2GG33S0L80S	WF	YW00NCC42T8G7	XF	EKMNY44P7F850	YF	5S75LUUYMA8NP	ZF	R63AM88T5G86N	0F	KDEC2GGRUP8LE
TG	46Z74RRSFMLP4	UG	R2630JJG3QLWT	VG	SNMQGGGFSYLLQ	WG	A478NPPV4SLCW	XG	QD2MYVVCPJLYL	YG	DT0UL99AYXLR3	ZG	6PQ4M77JTNL2R	0G	0KGS2336R6L0F
TH	CQPS4WWA5PDAF	UH	WSEL0LL9V6DJH	VH	AFCWG99YD7DRU	WH	S0AFNVVPG2DYJ	XH	DHF4YPP4UGDCR	YH	Q3VJLGGSEUDLD	ZH	HMRMMNNLKFDKL	0H	ZVT72UUH7QDN4
TJ	7VX34GGMVDWLT	UJ	GU770EER5KWS4	VJ	M9L0GRRZ4JWP7	WJ	KR6GN228SXWXS	XJ	TMW5Y88NYYW6P	YJ	XATNLWWKPSWA0	ZJ	3HY6M44EW9W5A	0J	YQVL2663XVW3H
TK	PMSC4HHYT64DE	UK	HTGH0XXUNP4Z8	VK	YJFXGUUAJ94NV	WK	F5VPN44CH345Z	XK	5VCAYCCVRN4GN	YK	E2A6L33FX840A	ZK	WQJNM22XFJ4X0	0K	MH6K299WPM4R9
TL	08YZ4EE26XJSY	UL	EHUD0GGJZAJL6	VL	2WAUGJJNREJW3	WL	8GCMNMMKXDJFL	XL	6SV8YKKZJ0J4W	YL	HKFQLLL8HMJJQ	ZL	QUXFMYYGCWJMJ	0L	4TWV2TTQS8J7C
TM	SSJT4XX4A3FZK	UM	XQ2Y0HHD92FDG	VM	4ET4GDDVYWFUR	WM	CLWJNYYFP6FMD	XM	986WYFFA4CF8U	YM	GPLFLQQCSVFQJ	ZM	LTSQMMMHLEFFQ	0M	2UC9255LHSFV2
TN	8HHE433ZNKK0M	UN	380K0QQ6TDKQ9	VN	Z7W8G66M2FK3W	WN	0CTQNNN70AKKQ	XN	JQLUY772MLK23	YN	LX6MLHH07TKDL	ZN	GV4JMVVQ37KYD	0N	AMAH2RRGEHKP8
TP	MXKY4DD7C8CUG	UP	DKWT0UUXQUCNK	VP	7006GXX8PCCZA	WP	NF2AN00ZYVC9N	XP	W37PYZZKSWCEZ	YP	RHMXLTTN46C7V	ZP	5A50MSSU60CH7	0P	P2U22LL5JXCJ5
TQ	ZA8V45588UQVC	UQ	5DLR099LL8QRX	VQ	857JGLL77RQJD	WQ	2JM4NKKMMHQ4R	XQ	H20FYMM004QFJ	YQ	6V2WLJJ22PQWU	ZQ	DX98MFF995Q8W	0Q	C3DZ2XXDDAQZY
TR	QEA54KK90CP4P	UR	KF9M088AHRP6L	VR	9SY2GAAUK8PT5	WR	GKPDN55ENNPV6	XR	4W43YEED83PST	YR	CGSKLSSGZ9PH9	ZR	0ZLLMTT8DSP7H	0R	64H62YY09EPMA
TS	9NDP4NNQMJHKZ	US	NR4W0ZZCRFHEU	VS	Q65LGCCEZDHGH	WS	DU3CN33U8EH0E	XS	SY9YYUUGNMHNG	YS	AZQRL44DK0H5X	ZS	2G02MWWZE6HA5	0S	LL802PP23NHC7
TT	H7CX4PPJPL7CV	UT	PWQF0SS2EY7HJ	VT	JHPCG22TCQ7XE	WT	L3YLNRRWA57PH	XT	ZFSRYWW6FK7AX	YT	004YL88LVZ76G	ZT	C96DMUUSRH7N6	0T	DJJG2NNCT77KS
TU	DR764MMGJZNFA	UU	MNX4022S2ENXR	VU	G28YGSS3TANHG	WU	9VZRNEE5WFNSX	XU	C5KLY55Q6TNVH	YU	4JNCLAA9LLNTE	ZU	ZCU3MXX2S2NZT	0U	H0552FFZCRN8P
TV	2D5H4UU0WVYN8	UV	UAVC0DDHKHYUE	VV	0YDFGHHKHNYDJ	WV	ZZGWN77NJ8Y2U	XV	L6UJYNN8X9YKD	YV	JUE4L66ZR3Y3R	ZV	9KKUMPPDVYYC3	0V	SP7E2WW9YDYAM
TW	3JL84885ENA6W	UW	8Z8G0KKVPGA4S	VW	5MXEGVVDQVAYM	WW	EAR7N99G9CAR4	XW	Y9HZYGGU36ALY	YW	FRJ9LPPE5WAC2	ZW	7FAVM66KMMA3C	0W	T74F2447NJA5J
TX	X4644SSRH5ZHR	UX	S9Z60PPM00ZCA	VX	RURTGMM6WTZFK	WX	W6XVNJJLTLZWC	XX	NZJSYLLTLAZJF	YX	7YHHLKKW6FZ48	ZX	FWC7MDDP4UZU4	0X	UESM2ZZFA4ZEL
TY	A2394TTCQTM72	UY	T6F2066QCSM35	VY	CRGMGQQPE5MQL	WY	49DUNFFYUQM83	XY	GAEQYYYSGZMMQ	YY	9MU8LDD4DKMUW	ZY	J3NWMKK6ZRM4U	0Y	8XMT2EEJ22MSK
TZ	EZVU400USRE93	UZ	0J5N077YGCE20	VZ	UT4ZGYY9FUEMY	WZ	3DS9NDDQVGEU2	XZ	V4YEYQQ5C2EQM	YZ	PNP7LFF3A7E84	ZZ	KEWHMJJ7JTEW8	0Z	RWXJ2AAK6ZETD
T0	GFW0477DXG927	U0	7EKQ00047N99Q	V0	DQH3G445LH95T	W0	QXJKNUU36R9N9	X0	A7X2Y339WP905	Y0	SCRDLCCQT49G6	Z0	8JVYMRR0YQ9PG	00	J9YP2VV8VF9YZ
T2	W9FW4CCT7YXGU	U2	C43P0FFNXLX8Z	V2	TVSSGNNJ8MXKF	W2	X24HN66HZ0X38	X2	MJPTYHHRKDXDK	Y2	K5YVL77XNEX2C	Z2	P7T9M99FUVXR2	02	5FRQ222P59XXQ
T3	UGUF422EYF0XJ	U3	2CYX0MMPUJ0FV	V3	EP9HGPPQAK0C8	W3	58QSNGG9CZ0LF	X3	FL5VY99VQ0RC	Y3	YE3TLVV5F50YK	Z3	NN7ZMHHMXP0DY	03	XYK82CCNWG0GW
T4	RL2Q444XR755Q	U4	40J00YY7M95M7	V4	XKN7G77L6P524	W4	TSKENHH6L45DM	X4	KGZ9Y66WTH532	Y4	MW8ZLNNTWR5KY	Z4	VYGTMGGYPK5LK	04	ENQW288VFL56U
T5	6YMG4VVLU9VYS	U5	V5R80AA8Y7VTW	V5	LDZKG88X96V69	W5	JT83NWWRQWVAT	X5	0NNDYRRH5VVP6	Y5	Z4K2L22J3CVX5	Z5	4LERM33A7DV0X	05	QG3X2774KYV2V
T6	FTRR4LLVZ23JX	U6	LMMV0WW5633AC	V6	VZ6AG554M43VN	W6	PYL6NAAS7P3TA	X6	UUTXYSSY2R3HV	Y6	36WPLEEP0H3SZ	Z6	XSPGMZZWQZ3ES	06	N8FD2DDXGT3U6
T7	KU424QQN9A2Q5	U7	QVD9033TAX202	V7	N4V5GTT2UZ27P	W7	7NFNNZZ0EK2E0	X7	RTA0Y00MD5297	Y7	WDCGLXX7GQ2ZS	Z7	E8HPMAA3842TZ	07	VSLY2JJE0U2WG
T8	LWTA4FF6G068N	U8	F7NJ0CCZS56GD	V8	68JRGZZR3S6EX	W8	HPHYNTTX5Y67G	X8	2ERCYXXJQX6ZE	Y8	8LXLL00H9J69H	Z8	S4FKM55C286V9	08	9ZPN2MMSZW6F0
T9	Y3QD4JJPLSRW6	U9	JPCZ0RRE8TRPY	V9	PCENGEECX0RS0	W9	V7U5NSSARMRHP	X9	3XGGYAAFHERTS	Y9	UQD0L55VJDRV7	Z9	T2ZXM00RACR9V	09	7A2R2QQT43RQX

2A	XME9VJJ8MNTW2	3A	HLLC7UUPATTNE	4A	DN4KPWWTH2TA9	5A	LSRPC77APQT2Z	6A	4ZC5TGGX6HTLP	7A	0WJ6566VSKT3A	8A	NV3QAAA0N6TTQ	9A	7258X552KWTVW
2C	QH7YV55PRLGVG	3C	3NCE766898G3M	4C	TLJHPGGD0XGL8	5C	EUYQCCCMEVGGQ	6C	NWL4TWWQZMGAR	7C	FZ4M5UU2G6GNL	8C	4QKPAMMFTKGFZ	9C	CXNXXJJVWZGWV
2D	P4NGV44Q8AU5S	3D	S3447MMXP9UFR	4D	2ALMPFFVTYU8L	5D	C7FVCEE6AWUSC	6D	JVJET00PXEU9M	7D	GQCH5AATVCUT8	8D	5ZMDA66G05U36	9D	EY72XNND2QUK5
2E	EV0VVDDCUYSUC	3E	GGF37RR76USPT	4E	JYRLP335SAS0H	5E	Q84GCPPZXHSCS	6E	24WATHHEAQSDN	7E	SEYN599NHPSR0	8E	VM8FAZZS5DSEJ	9E	PAZWXTT43ES7U
2F	7Z9PV22LQ28XZ	3F	0XRU7YYEXJ8M3	4F	42FJPKKNVN84D	5F	8FL9CXX96E8Z2	6F	DMYSTSS7PW8HF	7F	HHW75Z5T08E4	8F	T4DYA99HGR8RG	9F	XNGRXVVJDH8YX
2G	8E5FVNNXL3LKJ	3G	KAJ57AAQEFLTP	4G	V3C6P002NGL9A	5G	7JWDCLLU9ZLJ6	6G	5Q4CTFF874L8E	7G	WVLK5MMD55LF9	8G	JWUVAUUWHCLNC	9G	LGETX44TJVL5K
2H	2RH8V77TZTD2W	3H	M8367SSDYNDHA	4H	PTM5PZZ8WJDEP	5H	NGDRCJJ3CCDWX	6H	E6KKTYY2R0DM9	7H	RKUC5KKQFWD4E	8H	L5LZA33R2ZD0Y	9H	JJ69XCCX0KDG2
2J	V0SXVCCD68WGV	3J	ATKM7KKTULW4L	4J	88U4PYYPK7WMR	5J	4Y2ZC55HQ5WVY	6J	LK3HTZZVMRWE8	7J	96ME5SSX3ZWHM	8J	ECCRAHH9JWWDX	9J	57AYX77QH6W2G
2K	NCX0V88JAS467	3K	ZUQJ7FF5MG48D	4K	CS2UPMM73F4F3	5K	2NUTCTTG8R47K	6K	QP87TAANU54T4	7K	6DDS500EK449F	8K	X0W2AGG64E4L5	9K	TFTDXPPLSD4C6
2L	AYJ4VFFUVVJ8R	3L	VQ5G788625J6S	4L	KV7XP44SQ4J5V	5L	Y0G3C99XKLJRT	6L	WANYTNNADGJKG	7L	53E25PPH8FJC5	8L	GN6SAXX5Y9JZF	9L	94LHX003P3J98
2M	ZNYUVKKRTMF43	3M	NHZP7CC9DRFGZ	4M	FMG0P2208ZFX7	5M	MC7CC66E3GF3E	6M	329DTVVZ2LFY6	7M	TX0R577GQ7F2X	8M	HYVEAEETRJFSM	9M	6ZF7XSSWXXFH4
2N	45PWVPP59UKCU	3N	YS8N700JRYK90	4N	7UDAPAACF9KTN	5N	VLM2CDDWL0KU5	6N	XDQLTMM4YCKFH	7N	UP235FFLWEK8T	8N	QRFTAWWUD4KAK	9N	D9VVX88EGPK6C
2P	F9QNVAAGWDCT0	3P	CPXW7NNWG4CKU	4P	ZDVQPPPYZ5CCQ	5P	SW6HC33J57C08	6P	6UPZT88F0FC6Y	7P	QSTV544R9GC5C	8P	UJGKAJJQXYCW9	9P	35D3XMM9RSCFT
2Q	S73MVYY33KQML	3Q	P6HX722HHWQXV	4Q	MKAGPCCAA0QGS	5Q	F4TLCGGTT9QLH	6Q	R8S2T77SSJQ25	7Q	ET6Y5VV66NQYG	8Q	9FE7ATTEELQ74	9Q	G0UEXZZUUTQEM
2R	J6TRVXXNEJPZX	3R	R7D77GG4L2PL4	4R	EJ8SP66L4TP3F	5R	T338C22FRPPXW	6R	PR2JTUUJCKPND	7R	M0QU5WWCJHPA3	8R	8DRXAFFM3MP8V	9R	2TXPXQQ750PQZ
2S	HSMKVRRKDCHP9	3S	X5AT7DDSTQHUK	4S	UCH9PLL6PPHJ2	5S	WMPJC00VHTH9D	6S	YF68TEEHVUHSW	7S	79SF5TTAXAH7J	8S	Z8NNAVV793HY0	9S	0PK5X99MQ9HRP
2T	9AW3V33YH470T	3T	5EGV7LLZ3D7JC	4T	W4ZZPDDGMV7UY	5T	UK54CAA7DX7TR	6T	KY0QTTT9K377Q	7T	VG9W5EE0US7SU	8T	S2X5A77VLU72P	9T	AVRNXHHF6G7D0
2U	LQGDVTT7YGN76	3U	WYWS799CZSNRF	4U	5GY7PHHJG3ND4	5U	XTJFC88Y7MN6J	6U	VEFUT33L9VN03	7U	K4RJ5RR40DNPD	8U	2HQGAYYKVPNMS	9U	8390XDDNF4NU7
2V	CWZQVVVECXYYQ	3V	F2YA7ZZL77YEN	4V	NXWNPSS45LYH0	5V	P9CYCQQRZ4YQG	6V	THR3TKKCEZY4T	7V	3MFL5YYJNRYMH	8V	DE29ARR3S0YP2	9V	QL0ZX2254MYXY
2W	R3FSVHHZ0EADF	3W	J40D7EEYFPAS6	4W	GE9RPTTWRQA7X	5W	66N5CMMC42AFP	6W	SGGPTDDRWAAUZ	7W	2YZ05LLFYUAJ7	8W	KXP4ACC28SAGR	9W	MQYJX330ZYA0D
2X	5KVZVQQ4P7ZQY	3X	9J2L7WWN8XZAH	4X	L7Q3PUUED8ZNT	5X	DAKXCVV0MDZYV	6X	80DNT665Q6Z30	7X	AR8A5GG72MZLN	8X	PPY8A00AFHZ9W	9X	V8PQXXXCVRZZQ
2Y	0F8JVMMWKPMFD	3Y	7DP0744GSEM57	4Y	YPTPP88Z6CM6Z	5Y	KZAKCHH5VJMD9	6Y	USXRTPP0H9MCX	7Y	XUVD5NN9AYMK6	8Y	670HA55X7GMV8	9Y	HC2SXAARMUMTF
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20	62CCVWWMSZ9AE	30	TW797QQAK69Q2	40	3Z5TPJJHUM9WK	50	RPZUCZZP239E3	60	FNEFT5563X9VJ	70	NLN85XXSM89ZW	80	0ASAAPPNCT9CN	90	ZM46XGGKAL9LA
22	UXLEVGGAGWXLM	32	DZEY7XXMWKXZG	42	HWN2P553YHXV5	52	9D9ACYY8JAXMN	62	0L7GTJJUF2XWS	72	4N5X5QQKRTXQV	82	F3HUA884Q8X63	92	YHJMXWWS9NXAL
23	WT27V660JR034	33	L0VR755F5M0VX	43	9RXDPXXR760Z6	53	HQS6CKK4GS04A	63	AJT0TQQWN80Q7	73	87PP5JJYEX0WZ	83	MUZMA4486205L	93	K68UXUUZL70N3
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25	G8DLVUUF20VNH	35	ERTZ7JJ0VHVWY	45	R0PVPQQ9XKVQC	55	3VHMCSSNSUVHL	65	M7VWTXXGTTVZU	75	PJXQ555ZP2VVQ	85	AS96ANNPZXVKA	95	SKQAX66Y8JV3N
26	MG45V0065Q39P	36	2VNF7PPUJC3CJ	46	SQE8PNNKCE3KW	56	ZR0SCRRQWN3PF	66	G359T44M4Y352	76	JA7T5883L936K	86	WLA3AQQJUF3QT	96	RECKXFFHEA389
27	YLRAVSS9NH2HN	37	4M9Q777R4022Q	47	0H0WPVVFLW2YU	57	A5EECUULFY2NM	67	HXZVT22YJN2XC	77	D2GZ5CCWCJ2GY	87	3GTCALLDM72JE	97	UWWLXKKG7224H
28	DDA2VEEV796S5	38	UFMH7HH2CA6D8	48	X93EP99QJU6RM	58	5X8WC44KYK65U	68	75UMTRRDLP6PL	78	YCK453384Q60R	88	C640AKKYKV647	98	4USGXLLPNC6JS
29	KJK6VZZHF6REA	39	8KS87VV30ZRYW	49	A66FP77M9RR2J	59	0EV7CWWDNFRA4	69	9THTTCCKG7RGK	79	L8A9522UZLRX2	89	R97LADDLPNRUH	99	WRMCXYY6Y8RME

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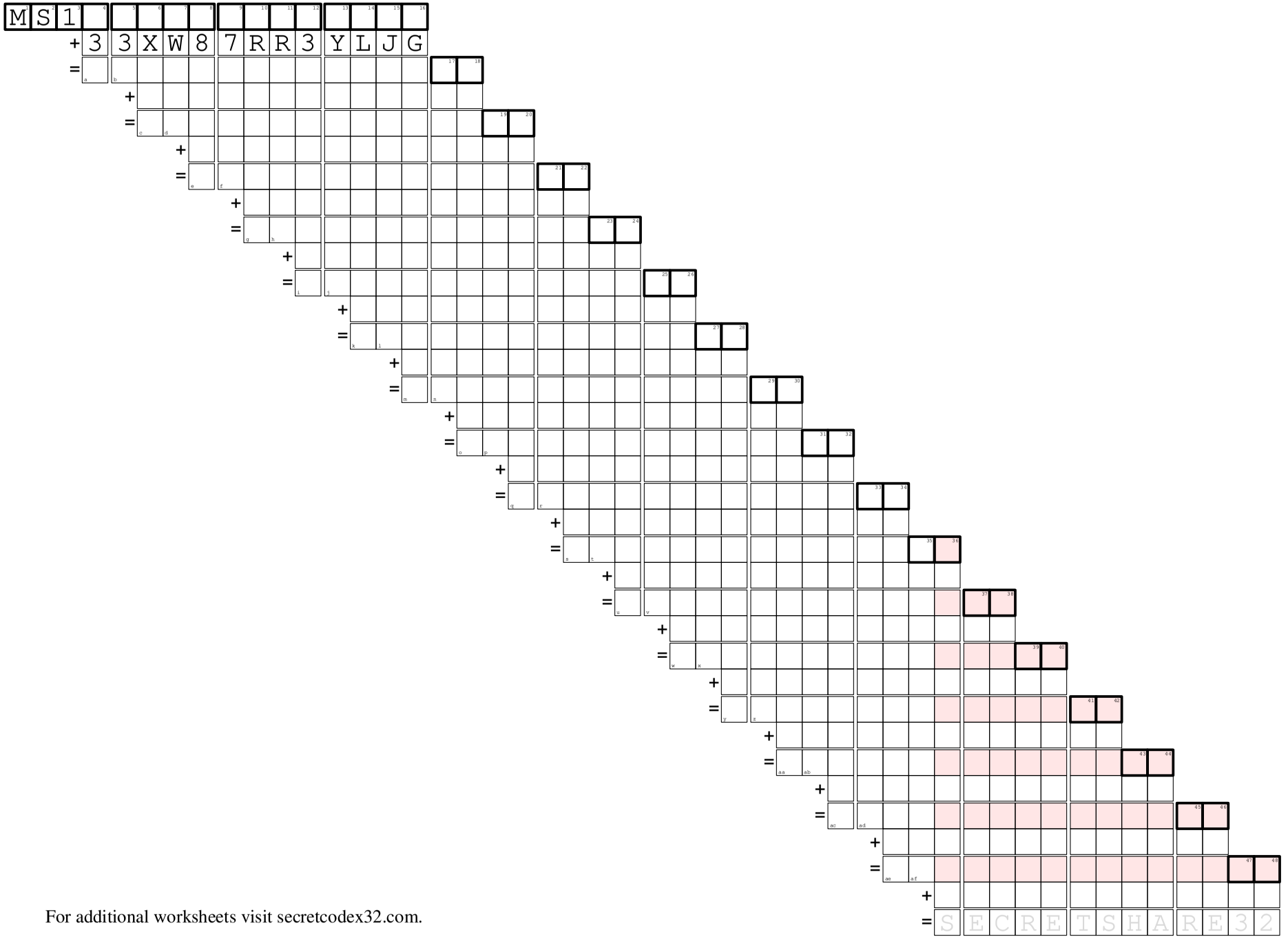

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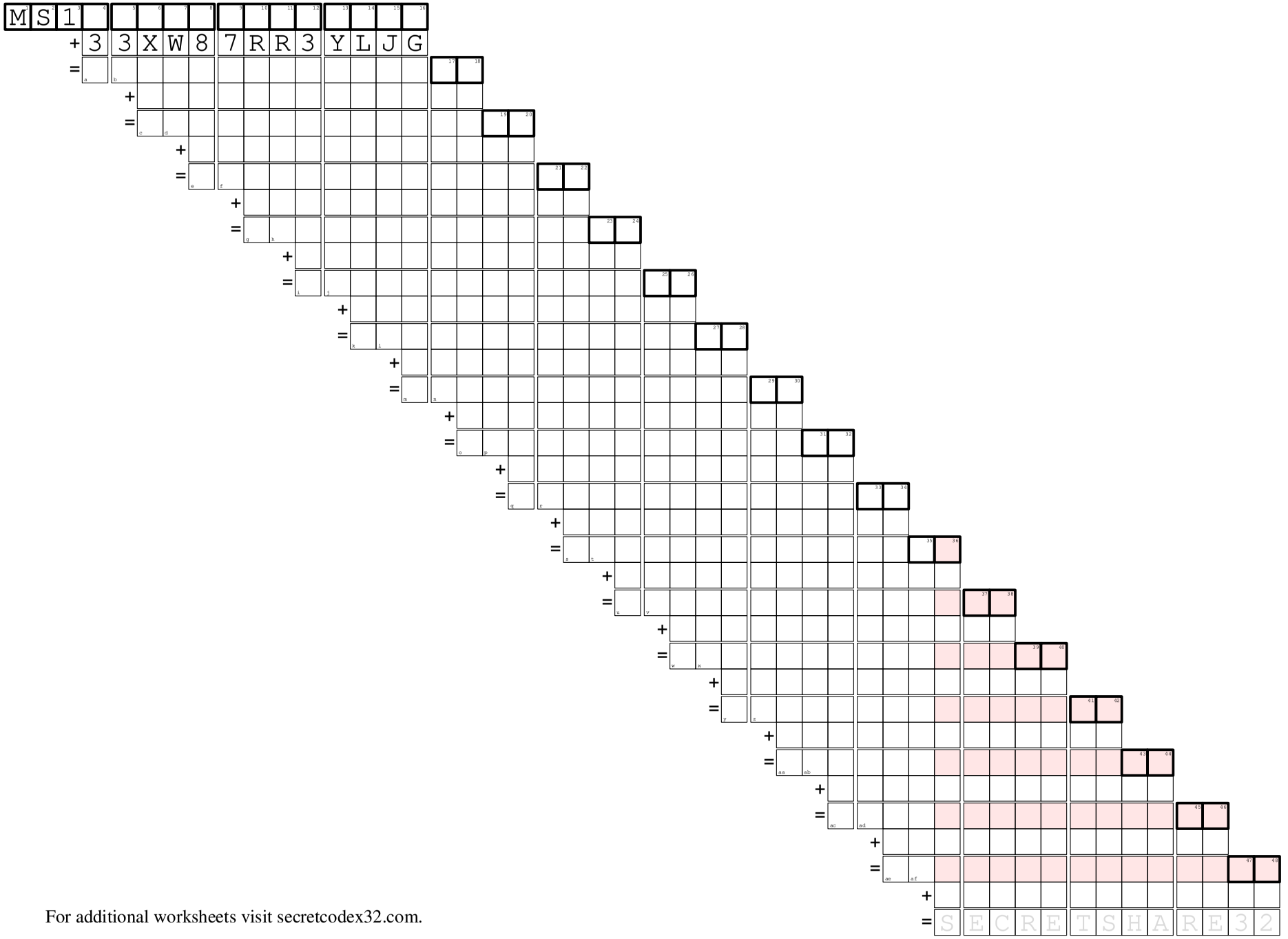

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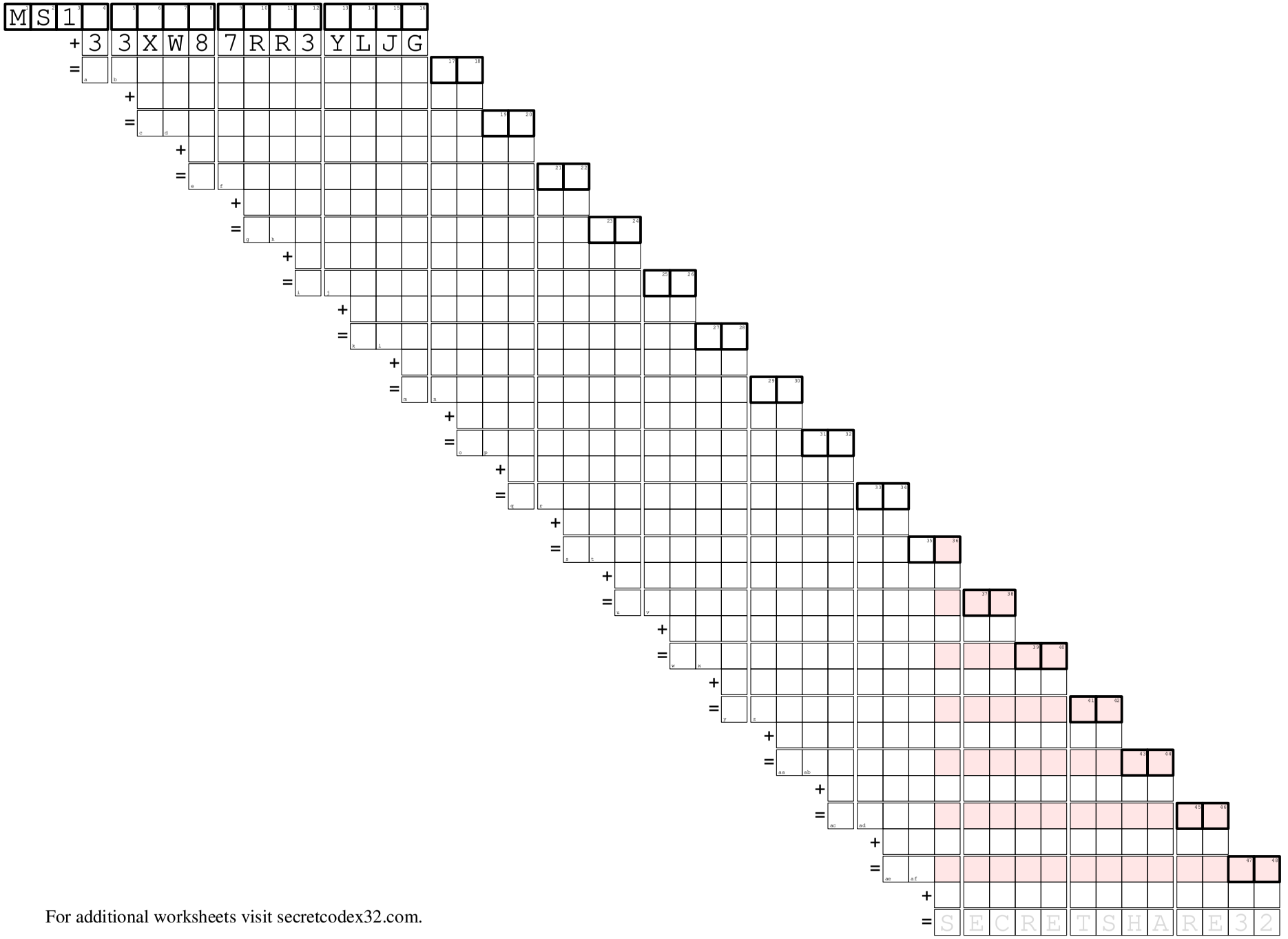

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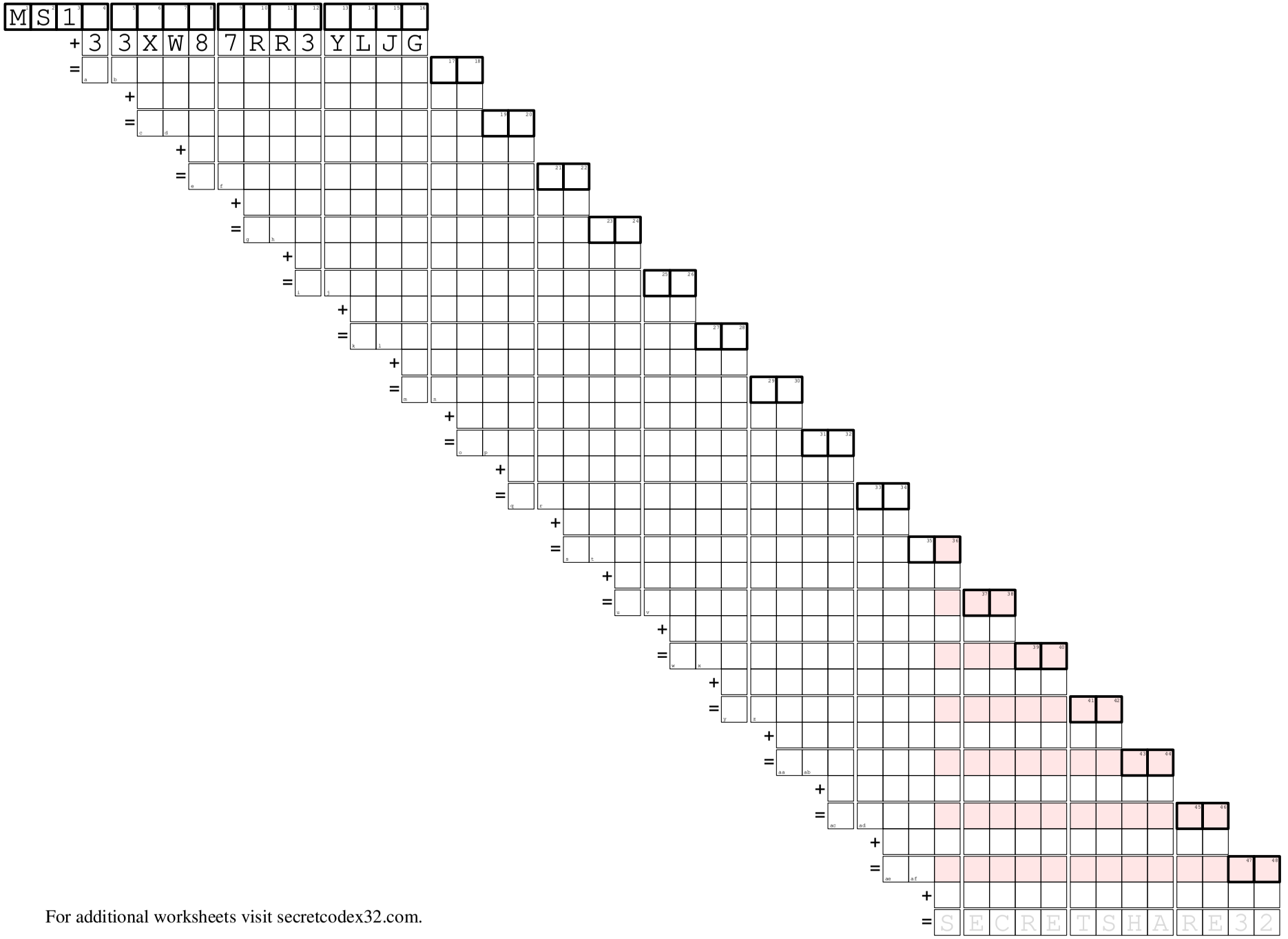

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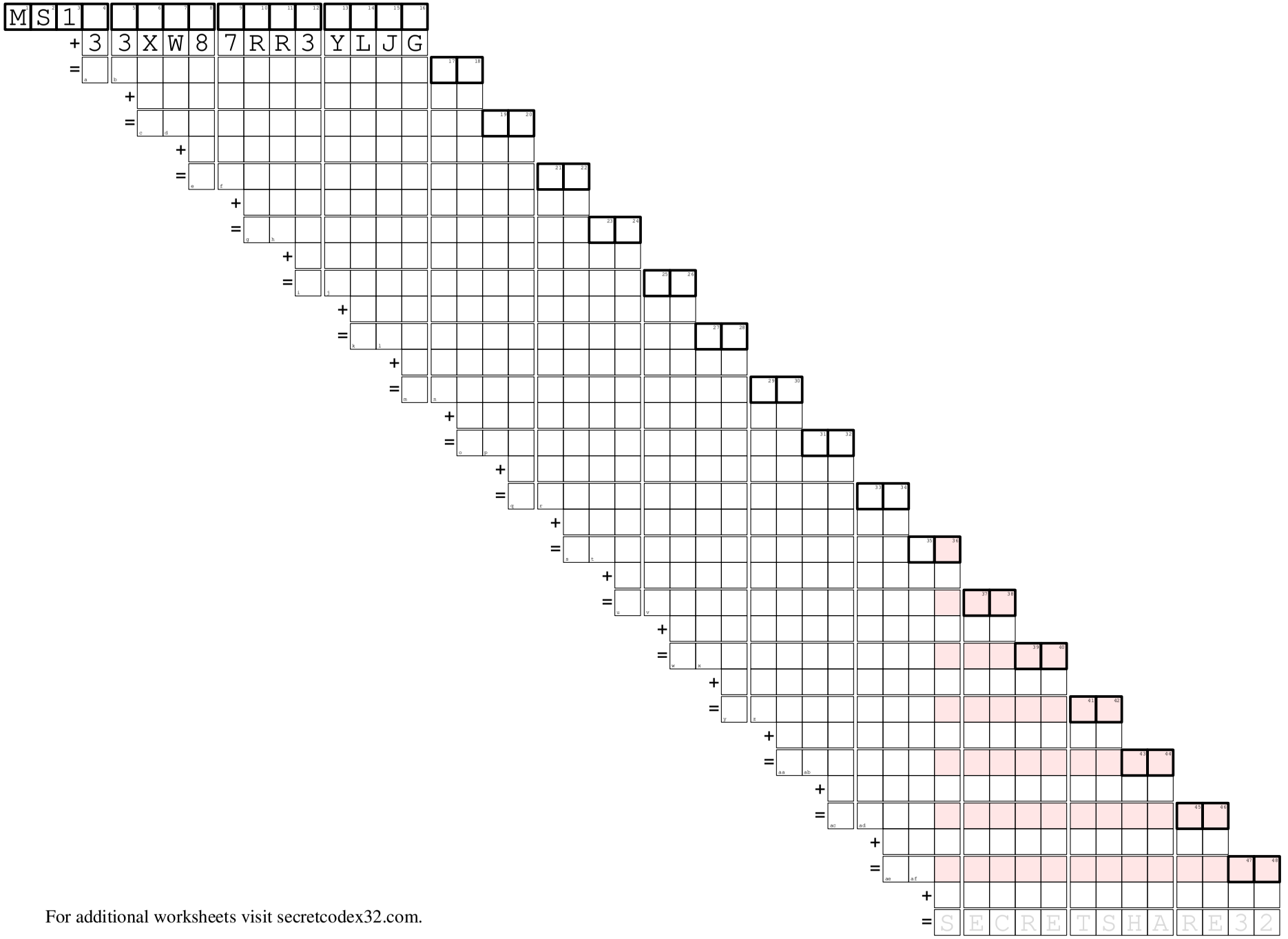

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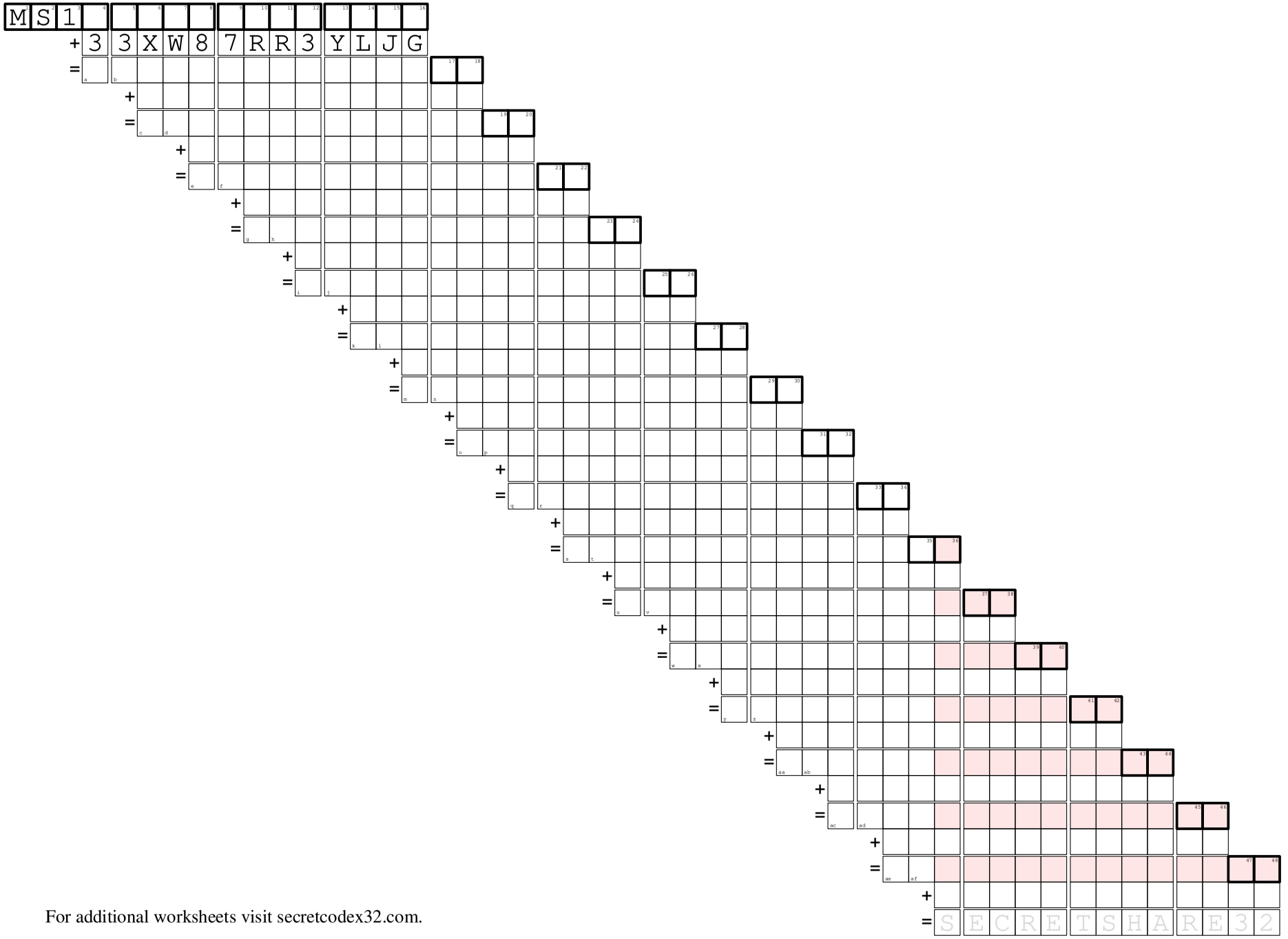

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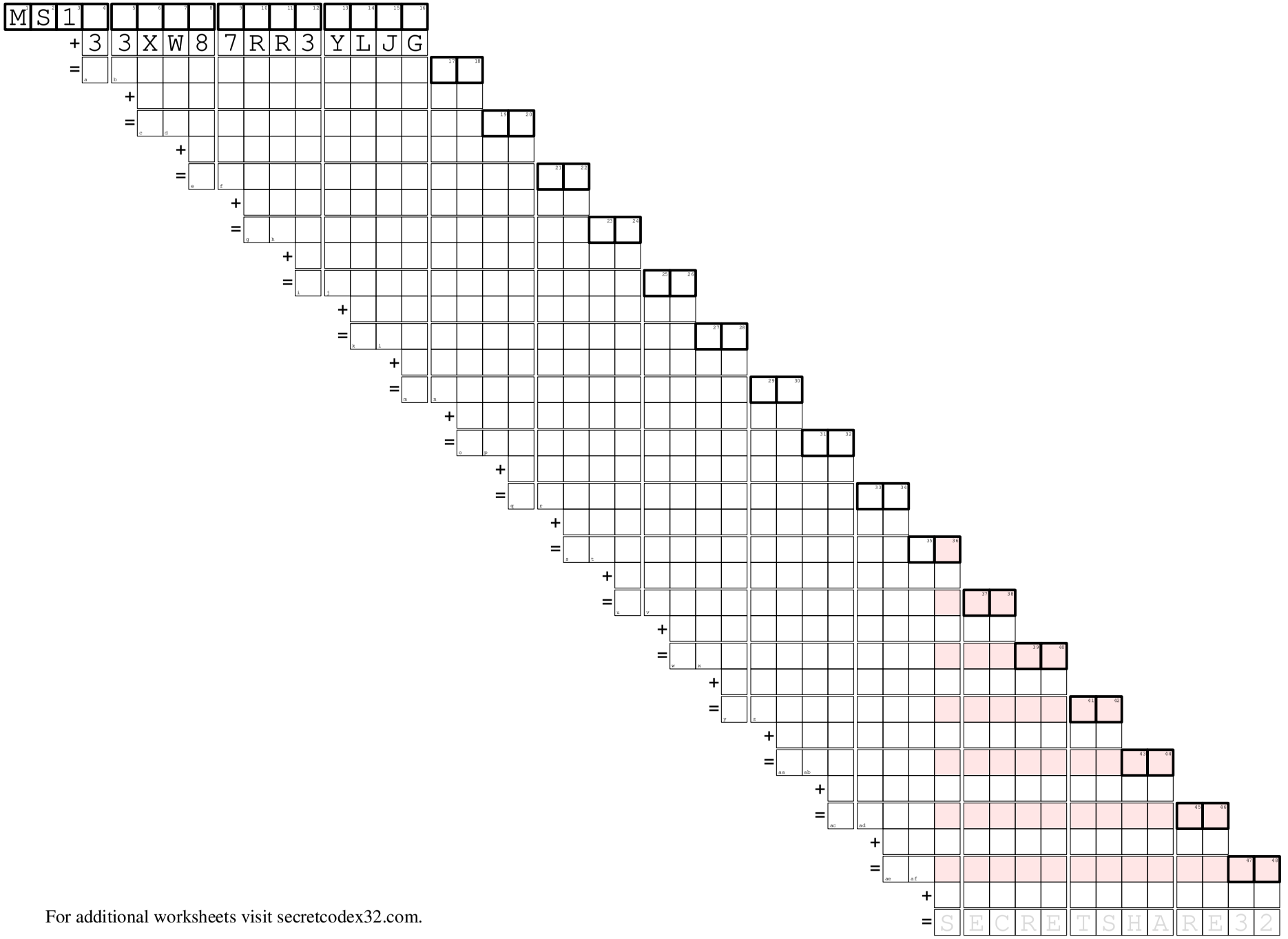

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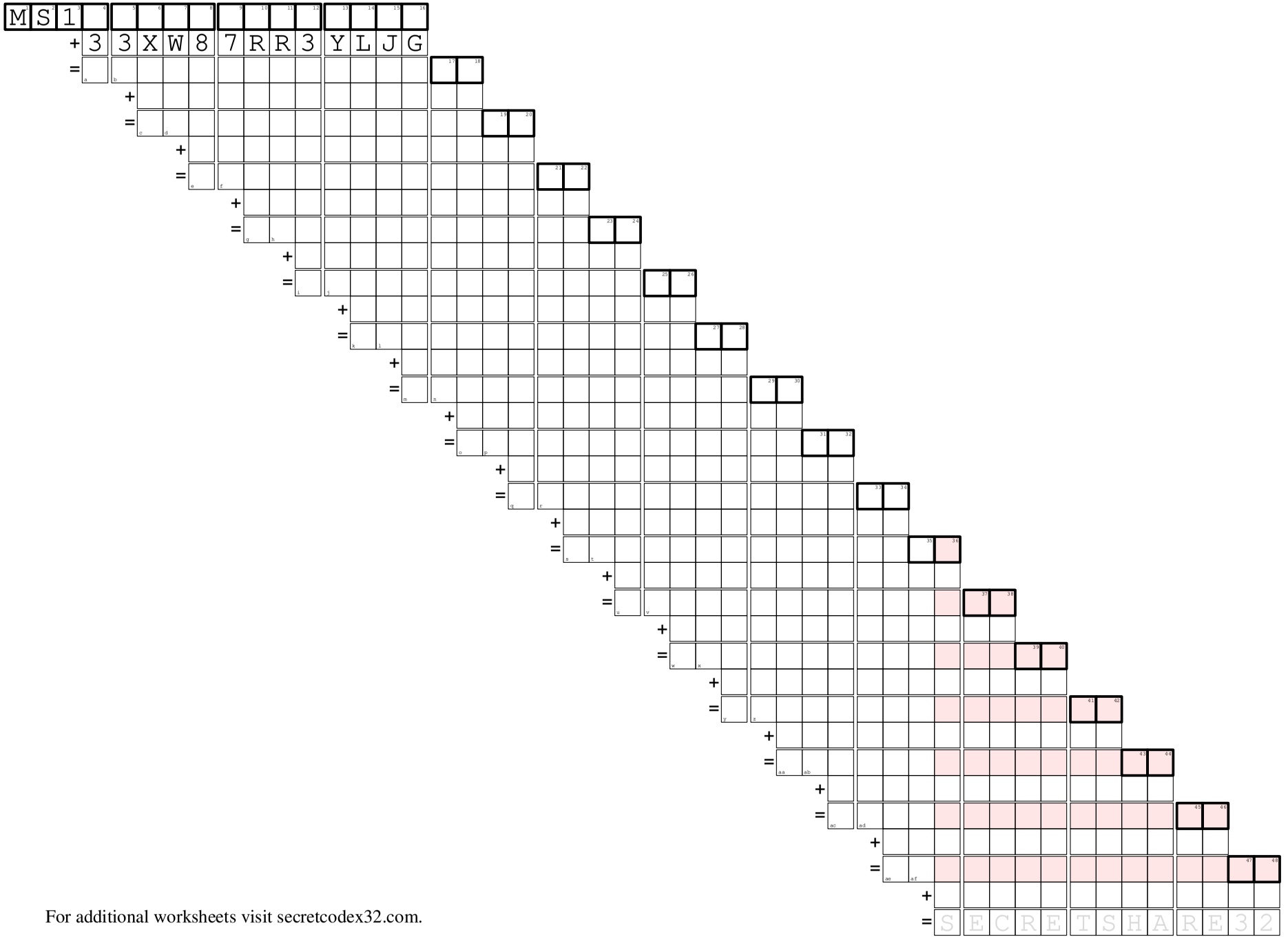

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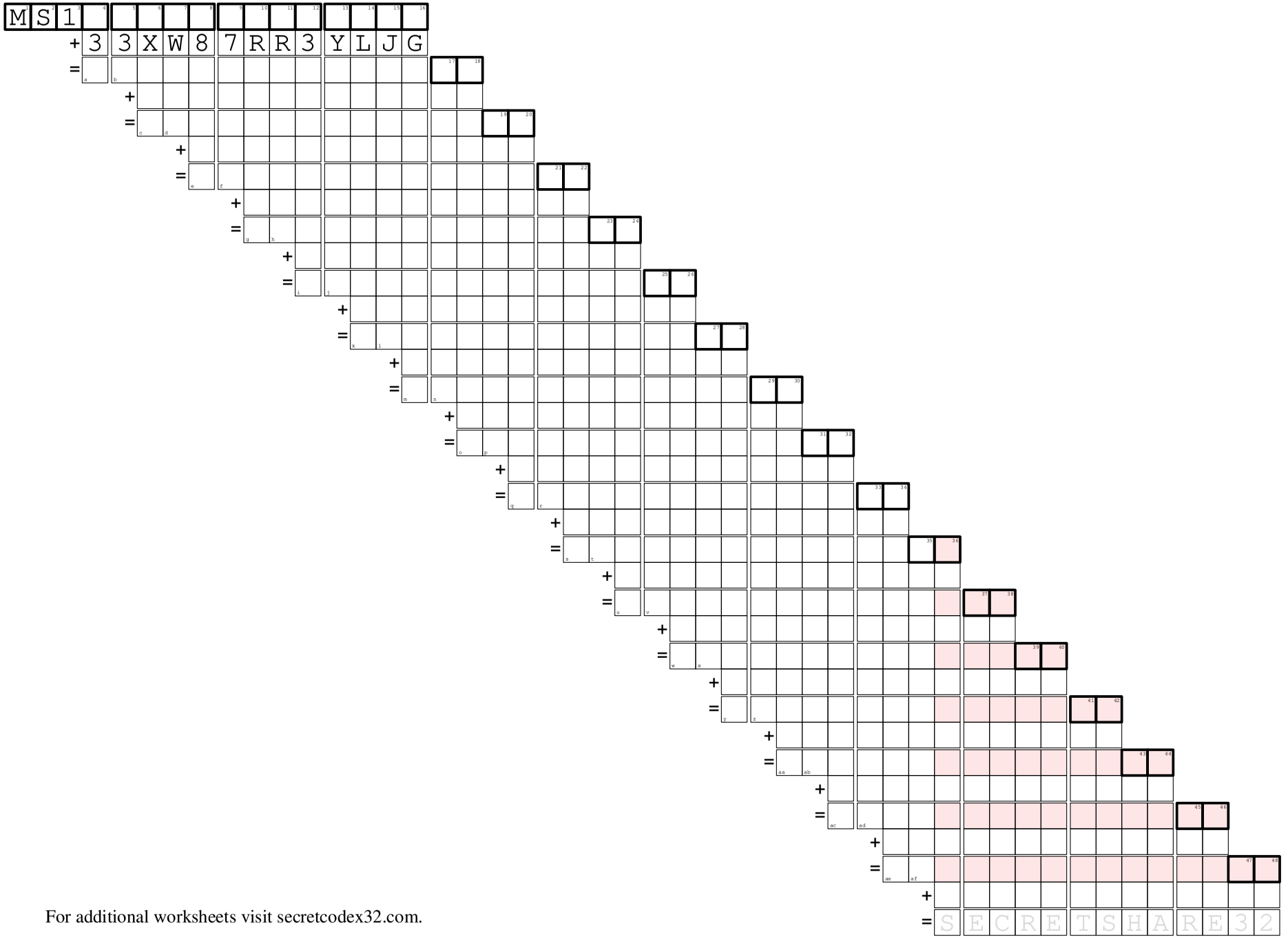

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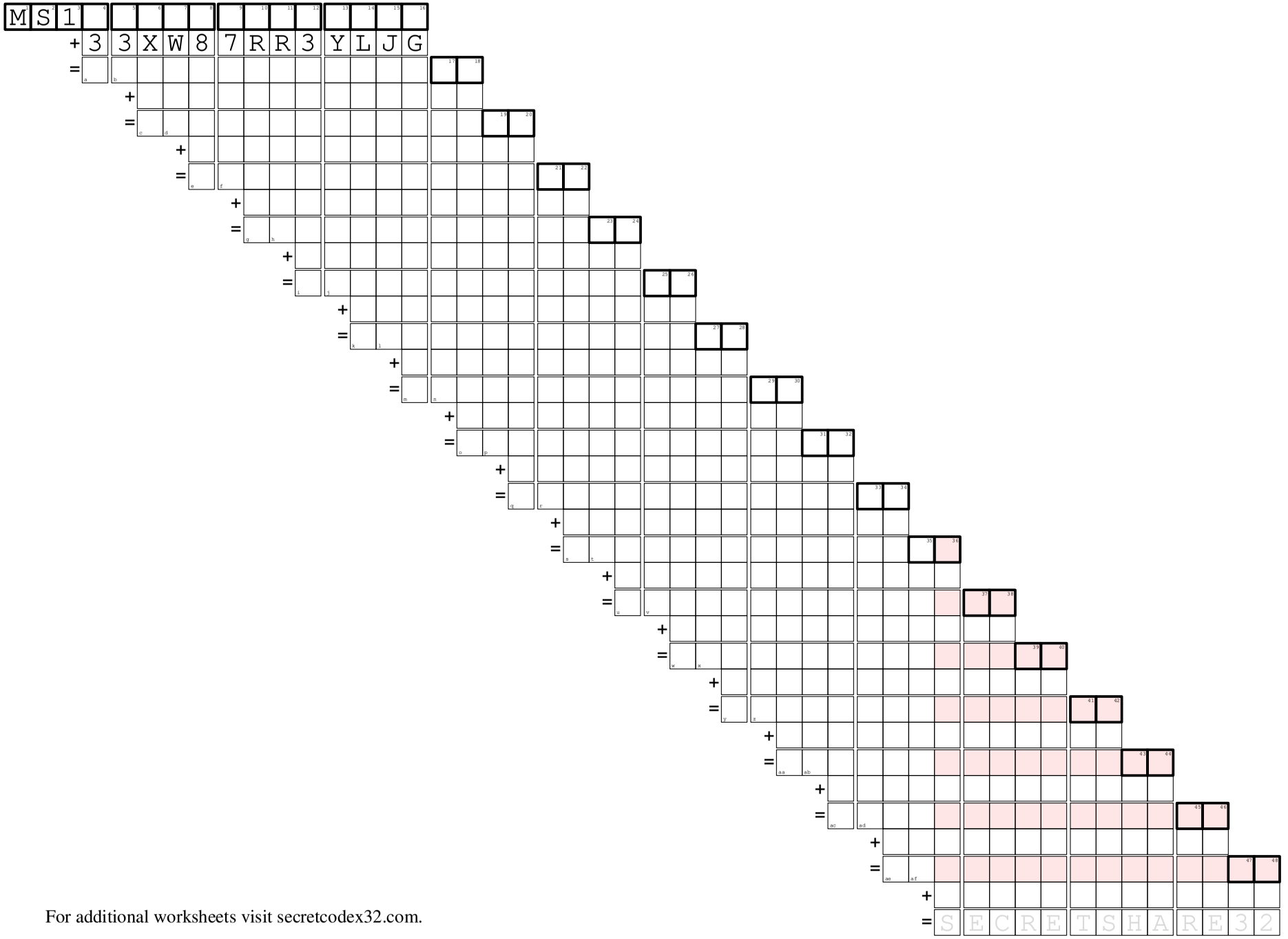

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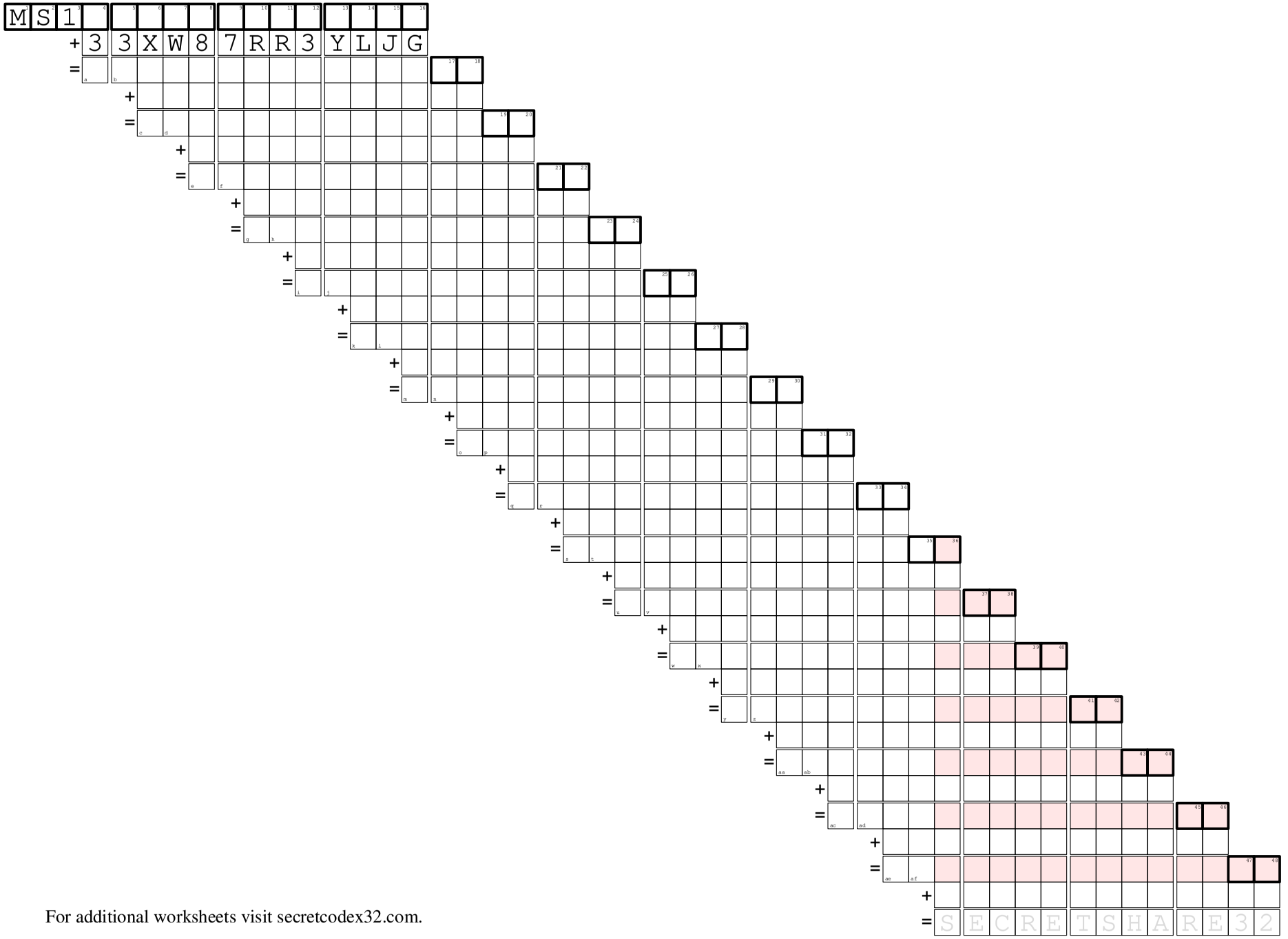

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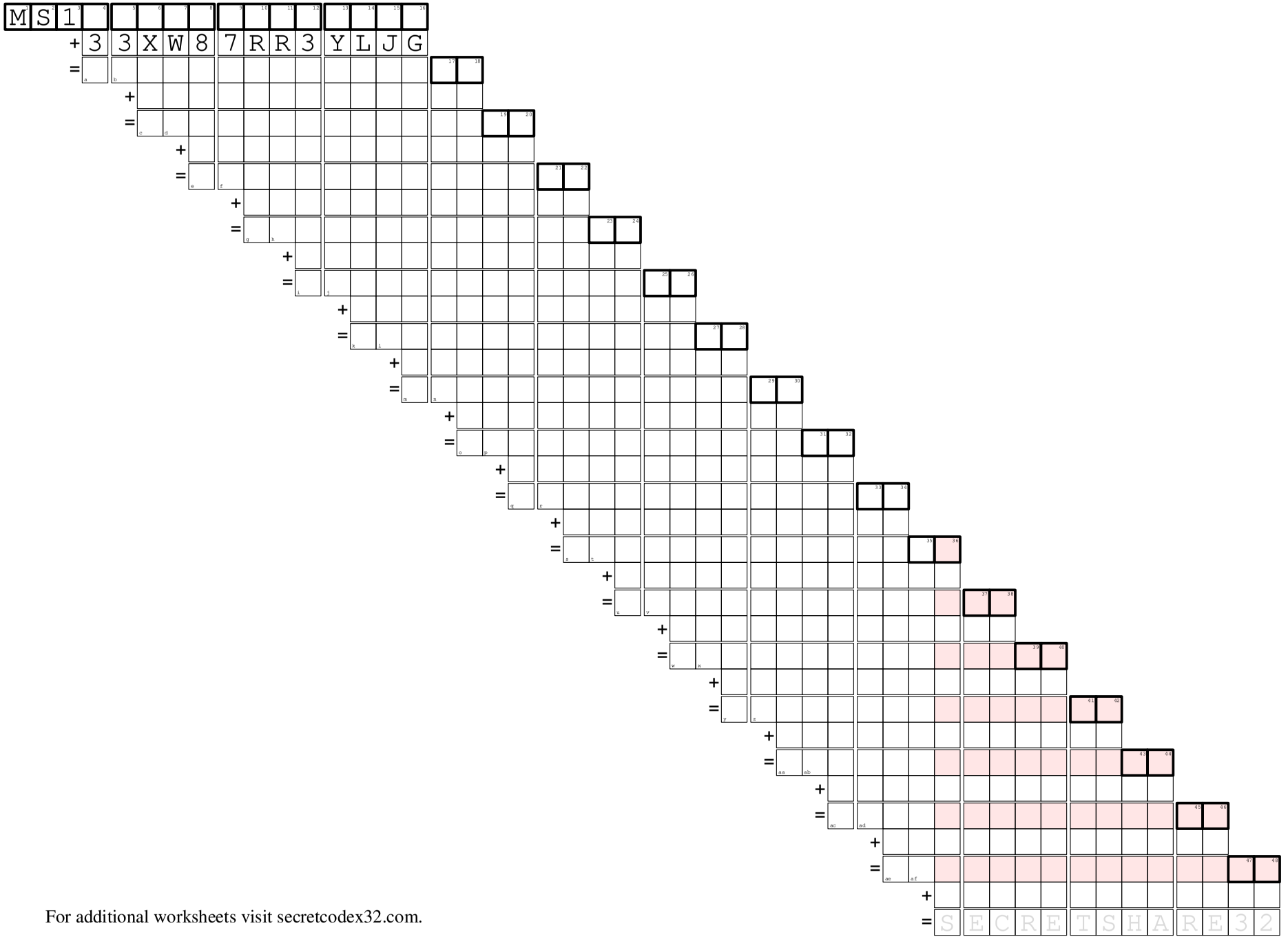

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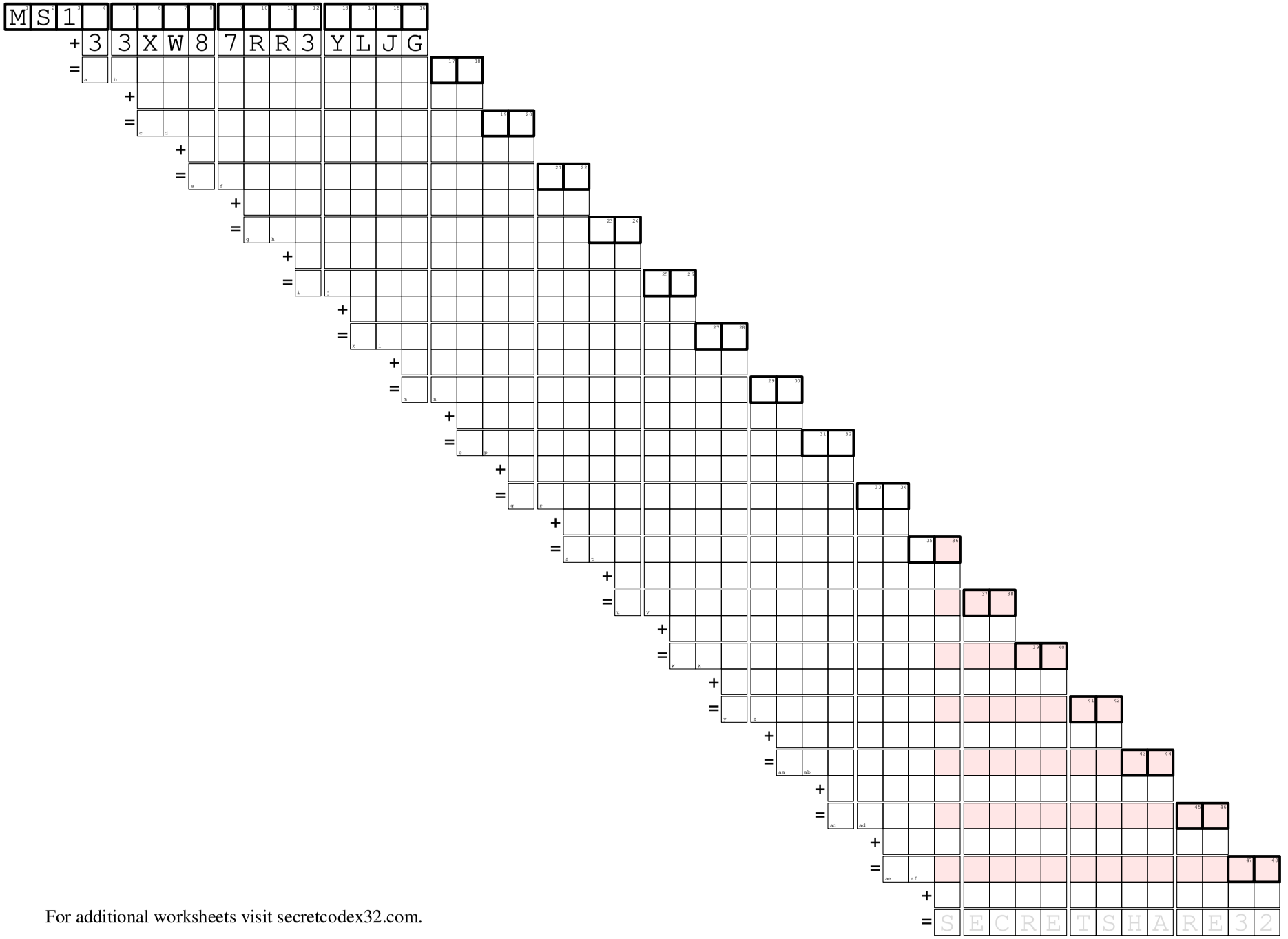

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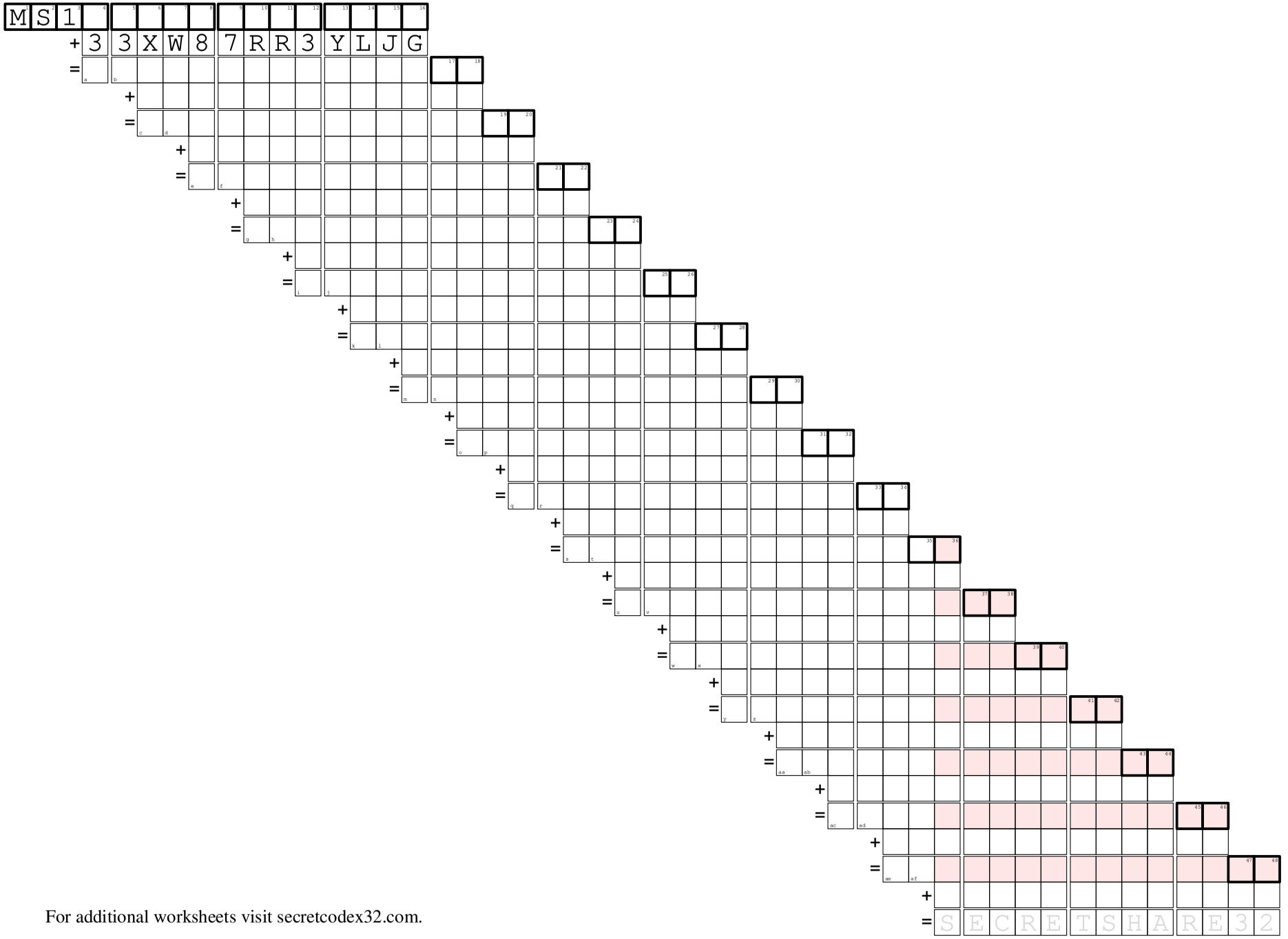

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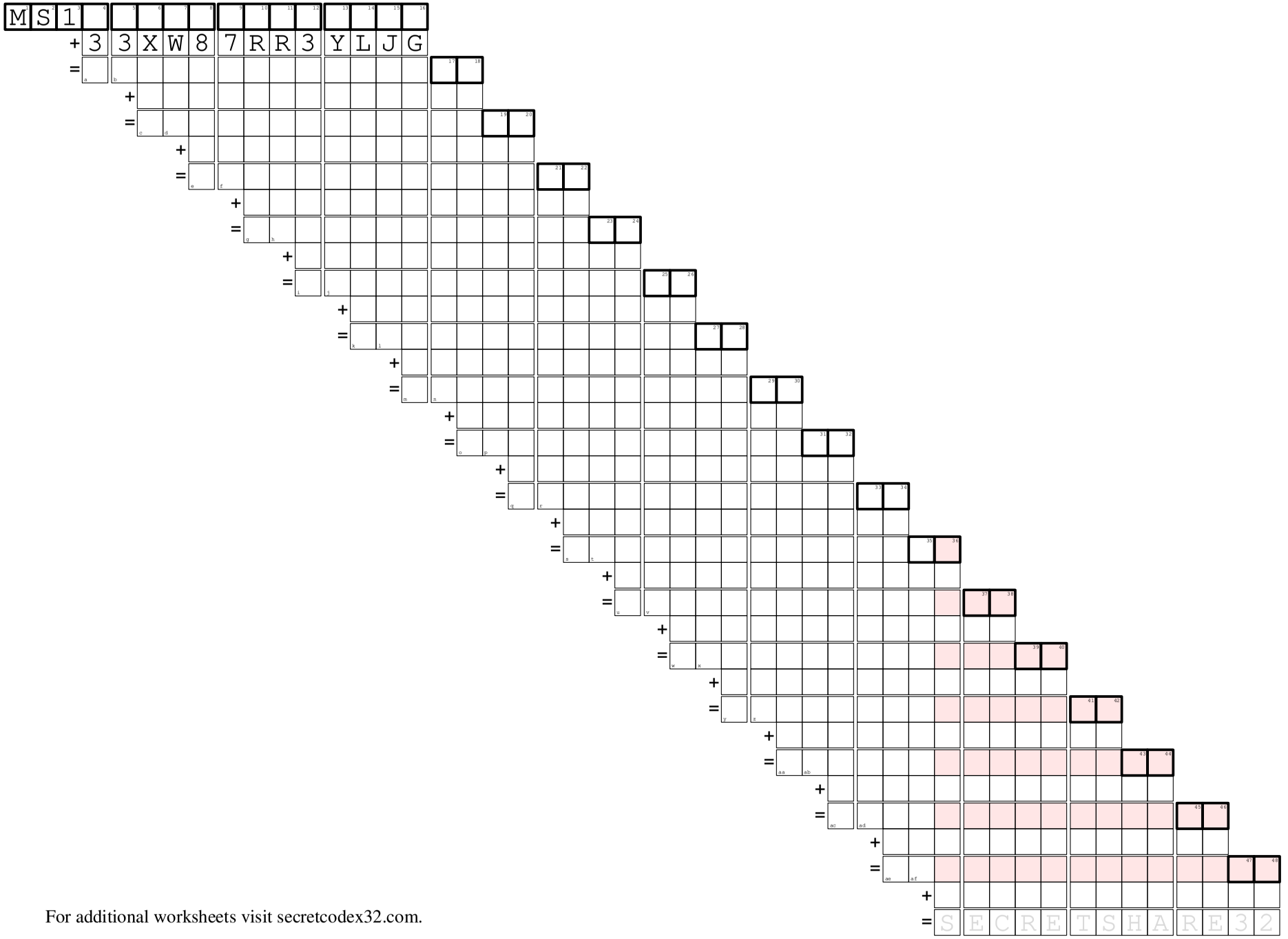

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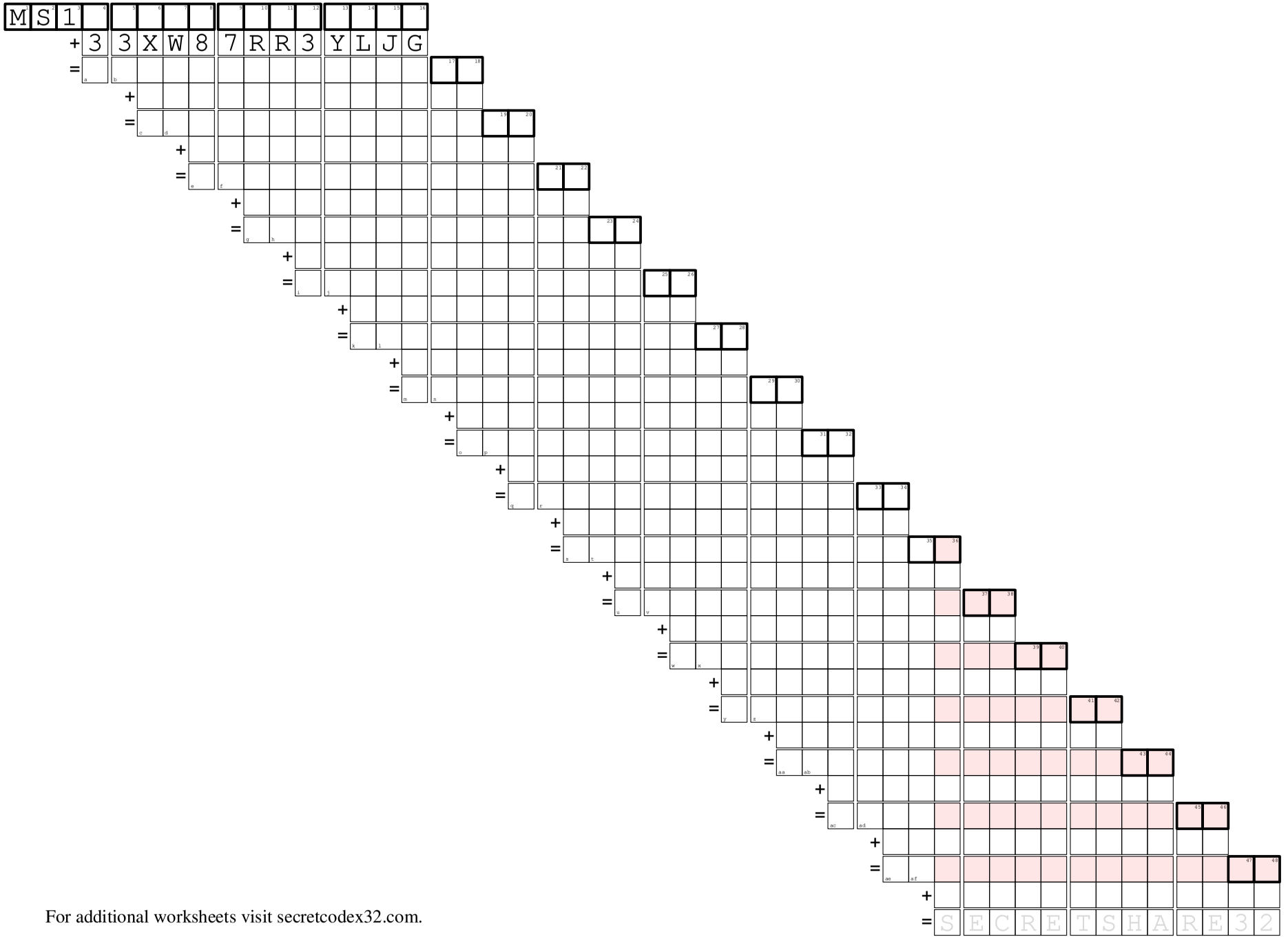

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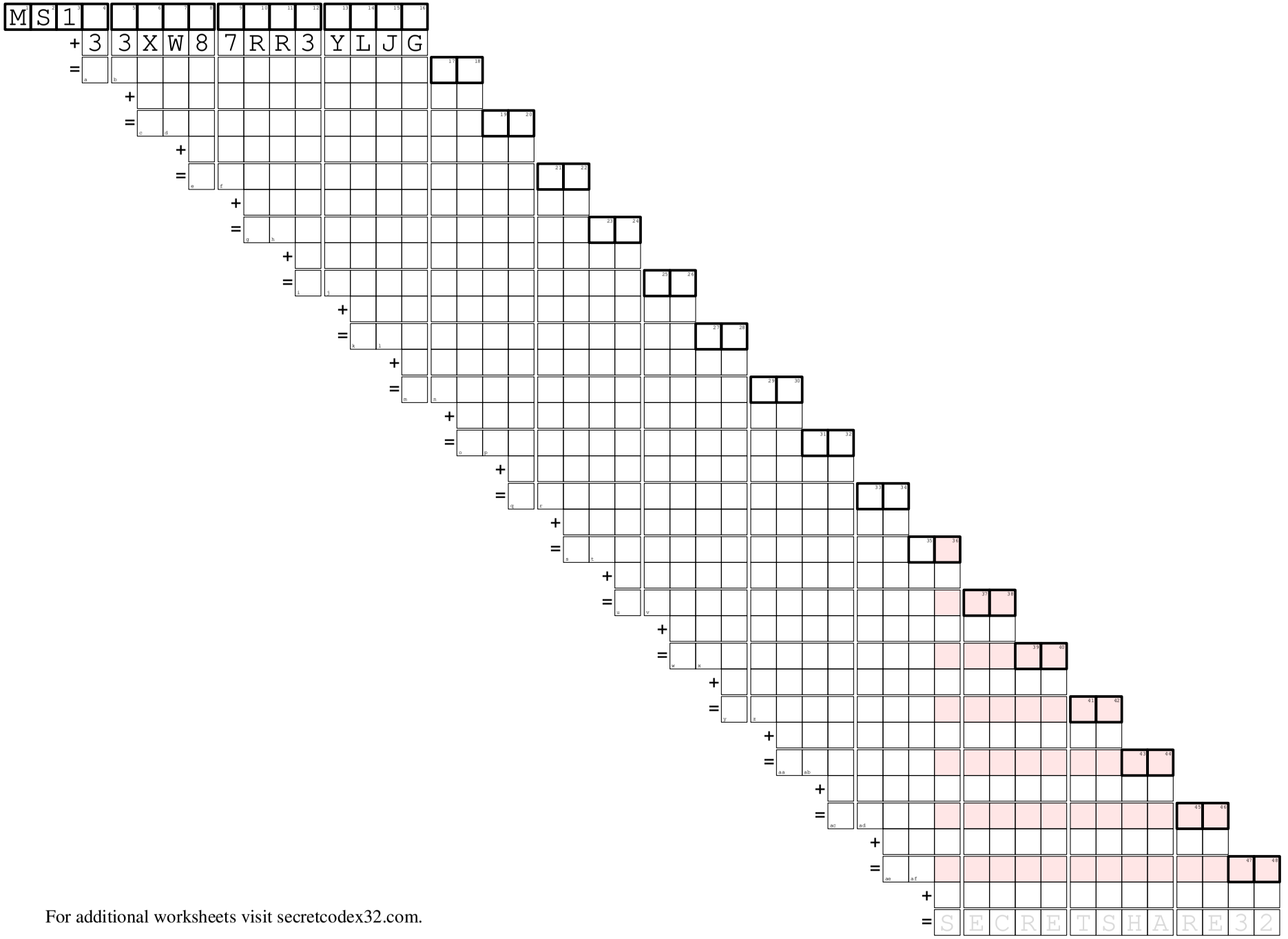

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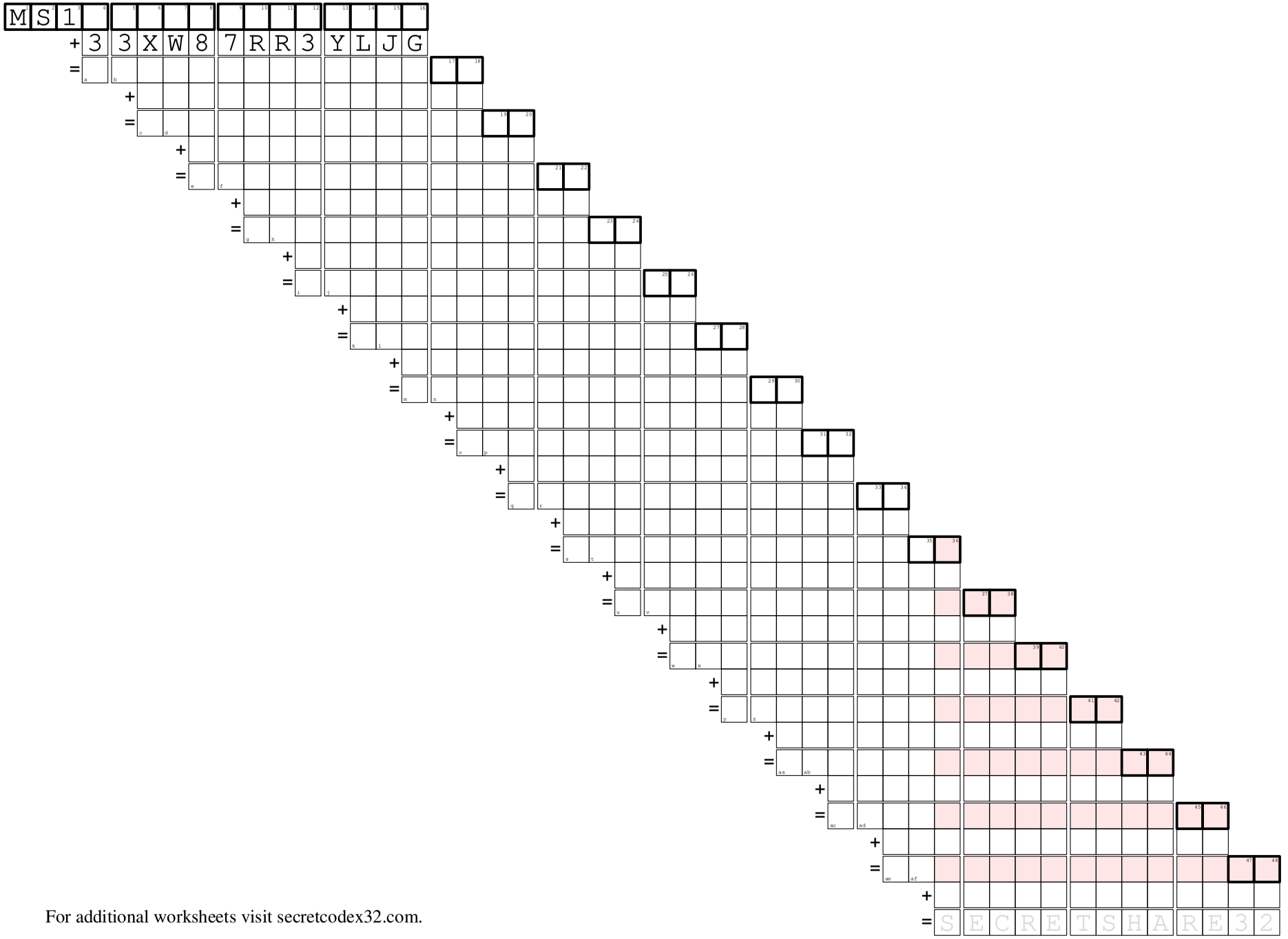

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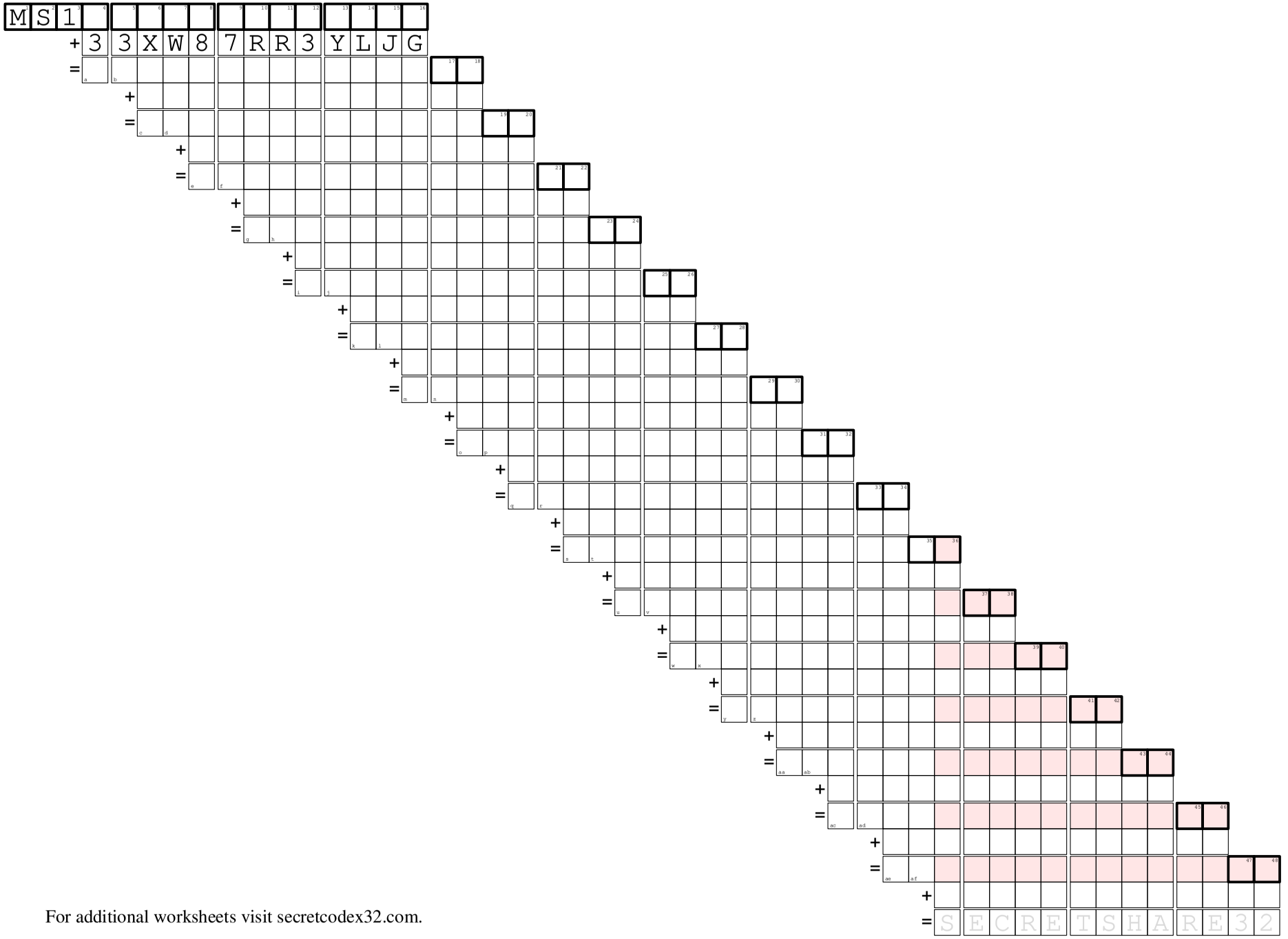

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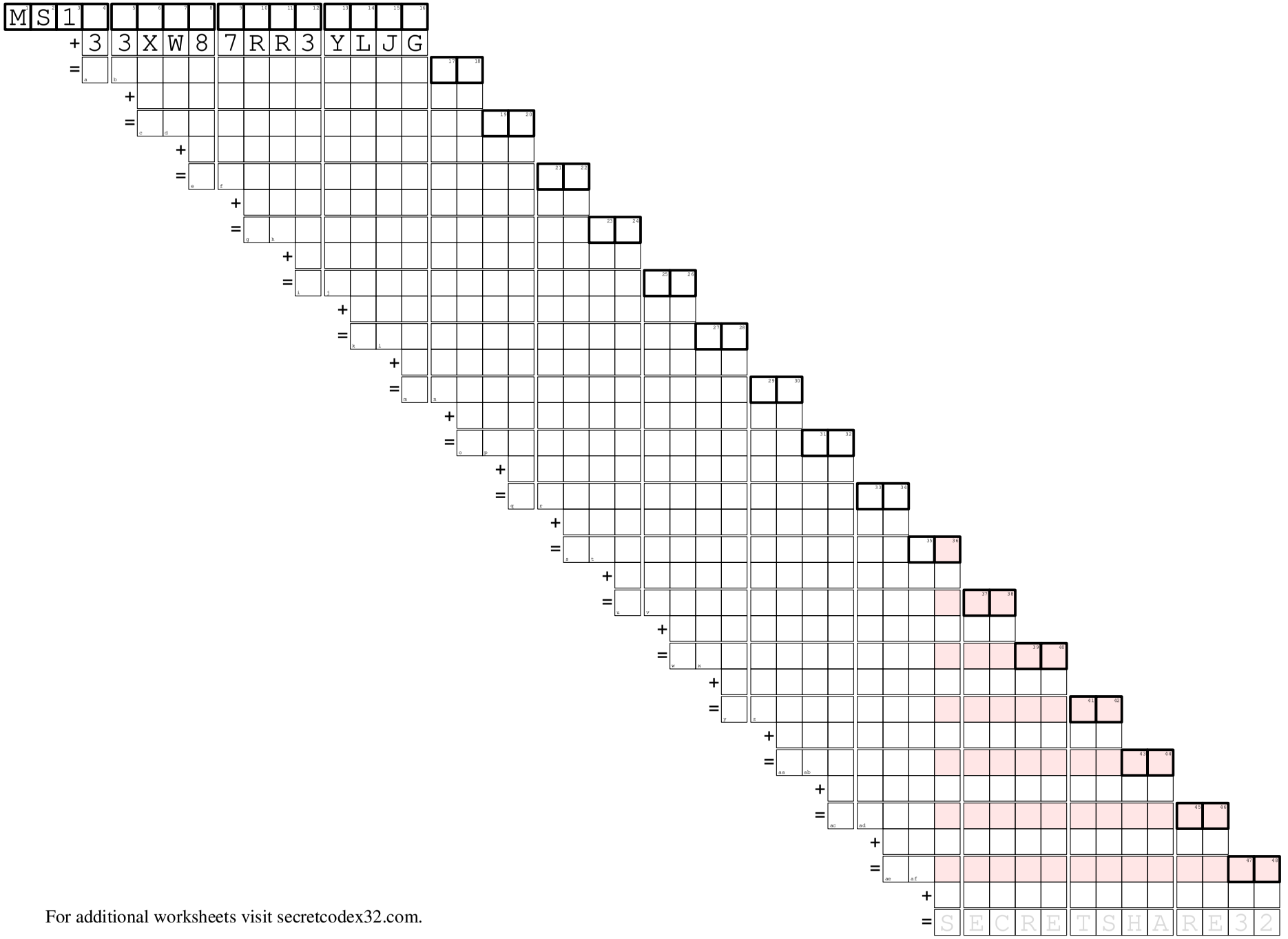

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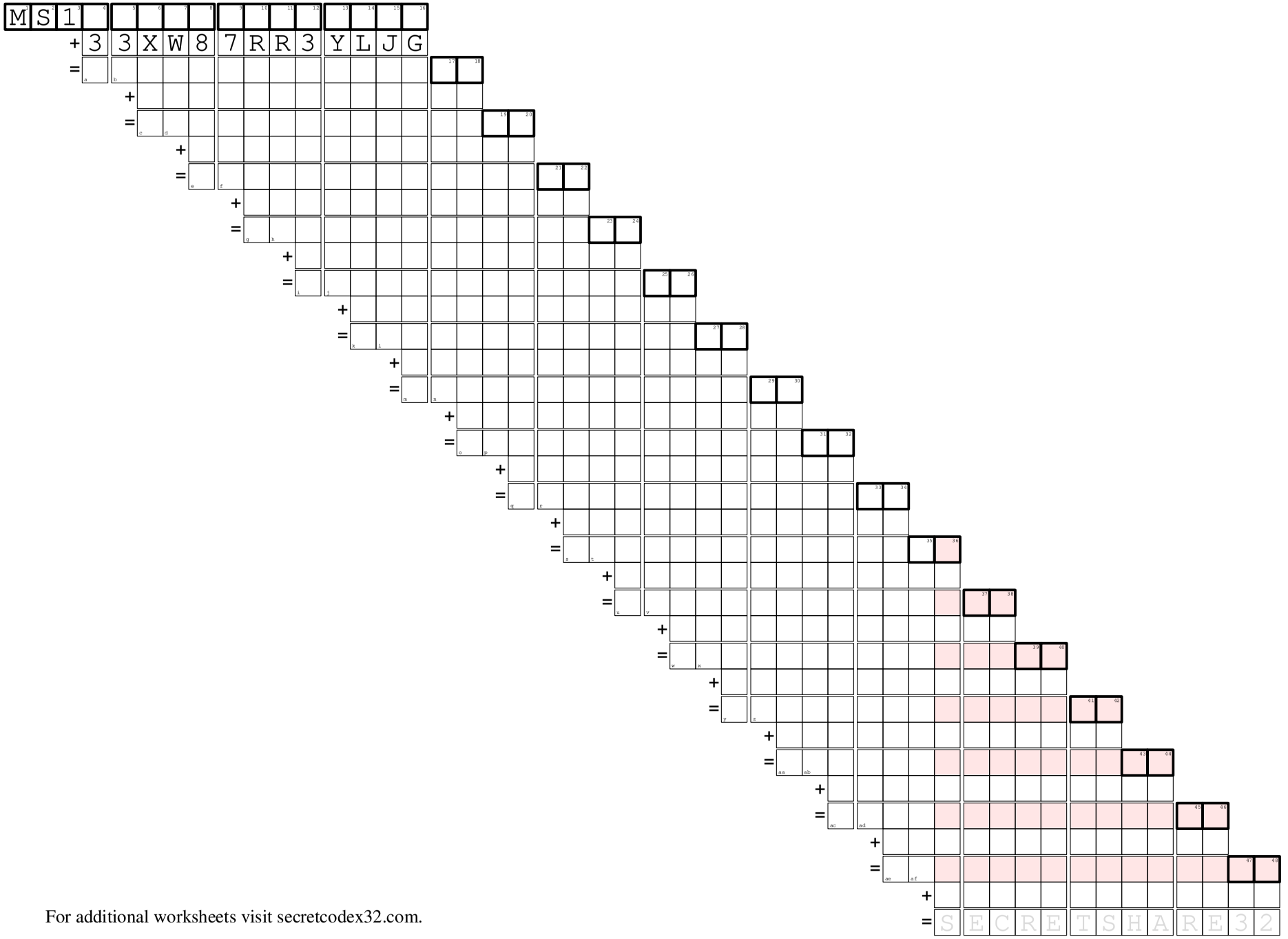

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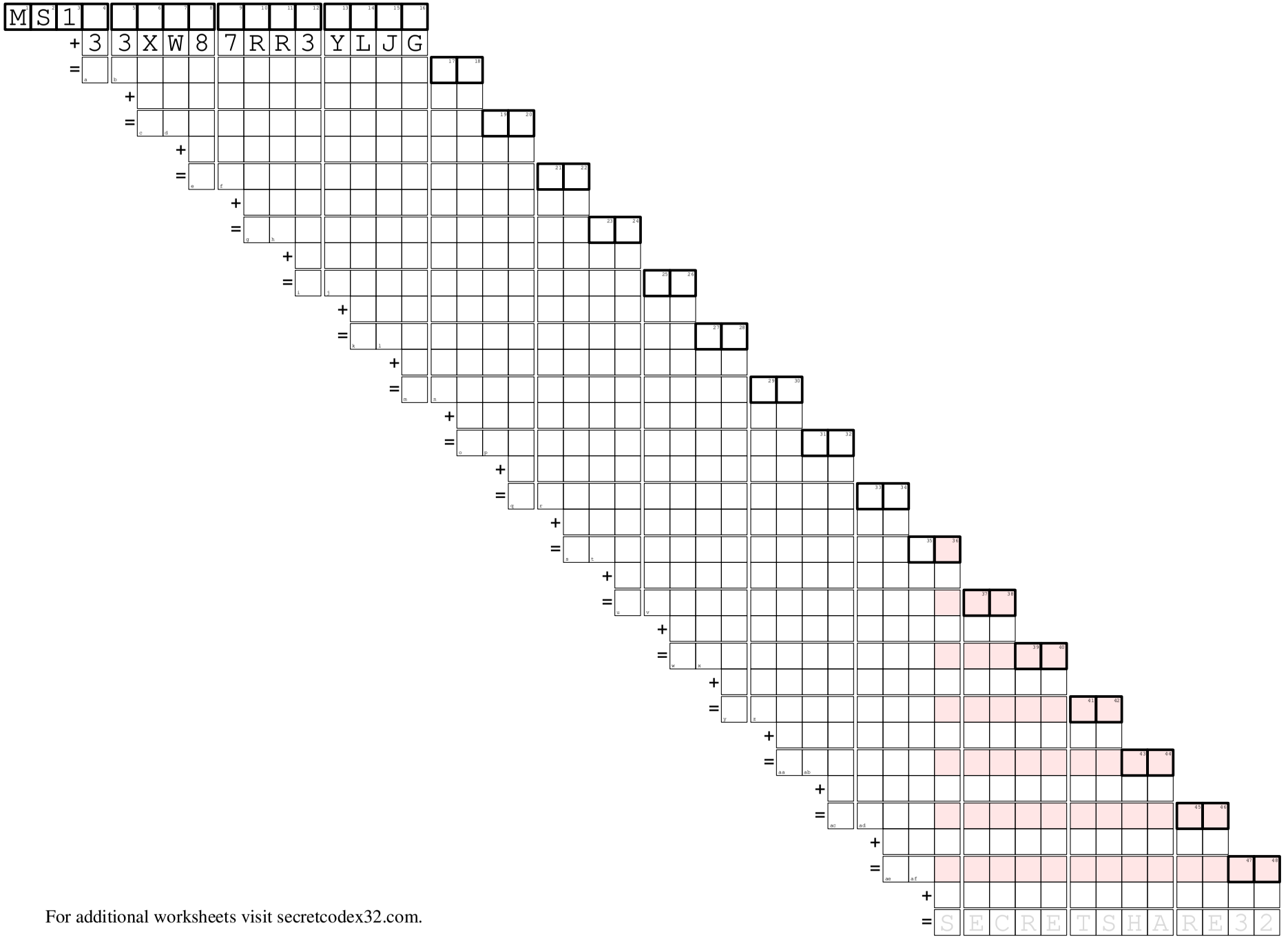

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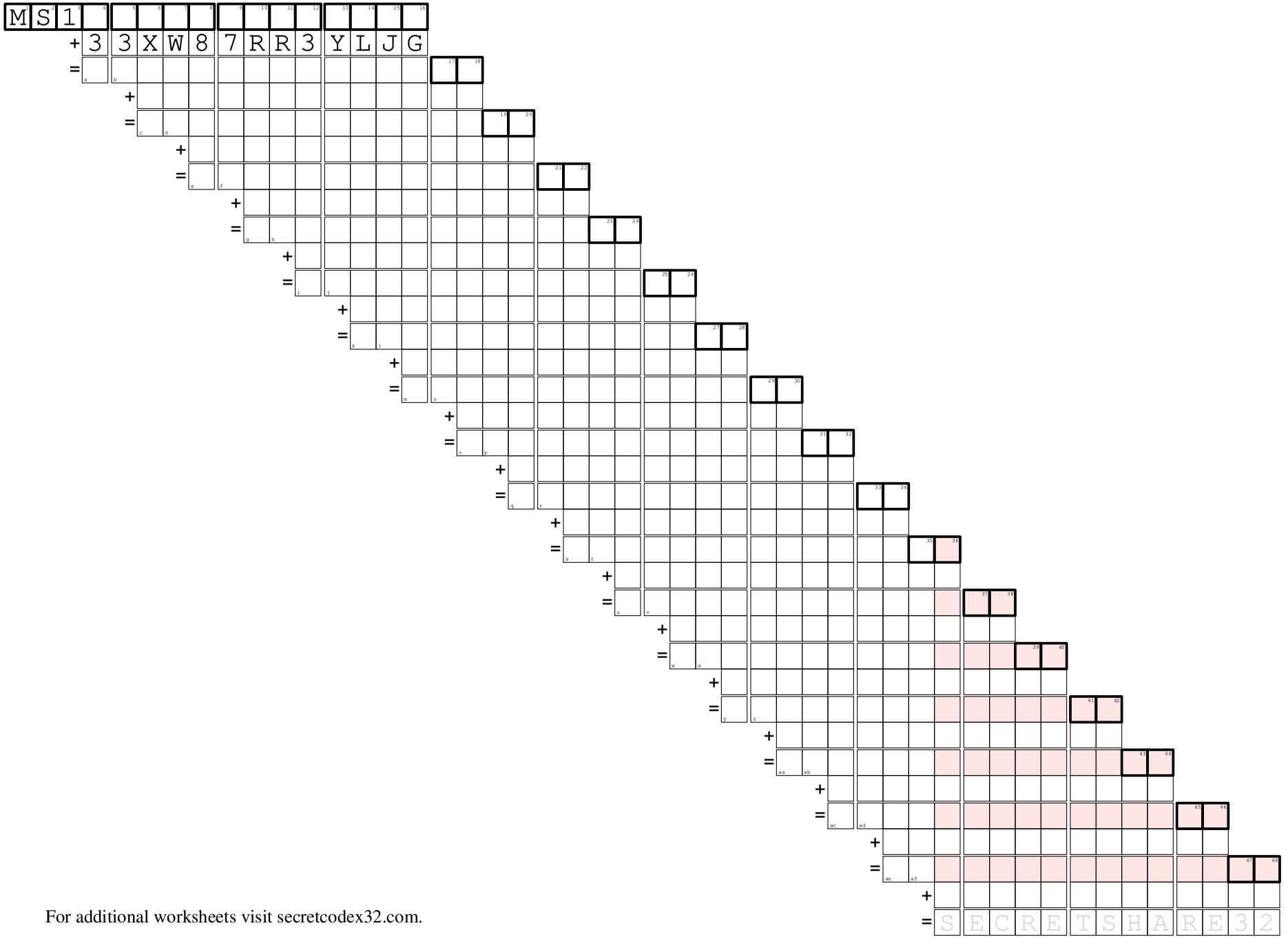

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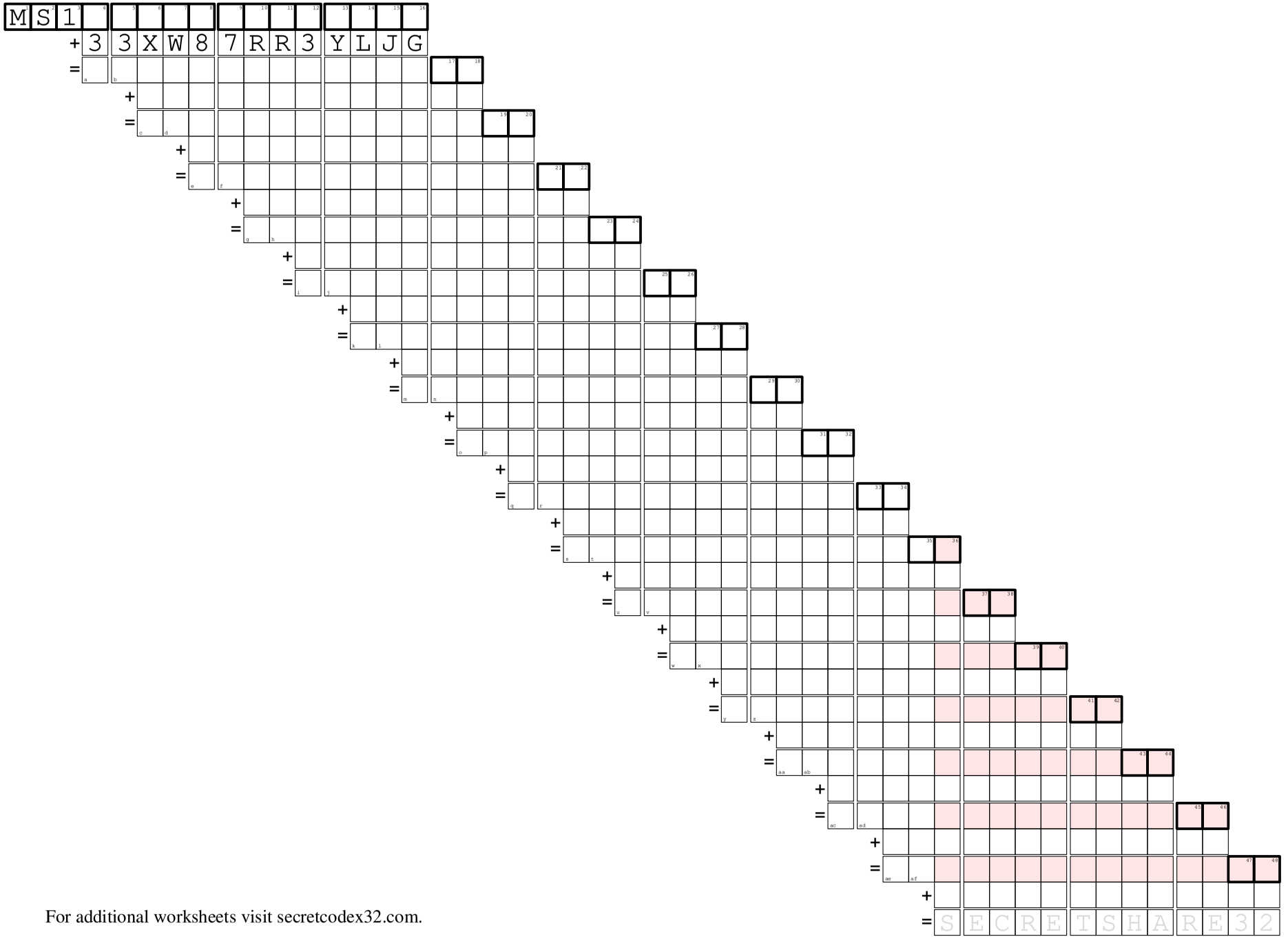

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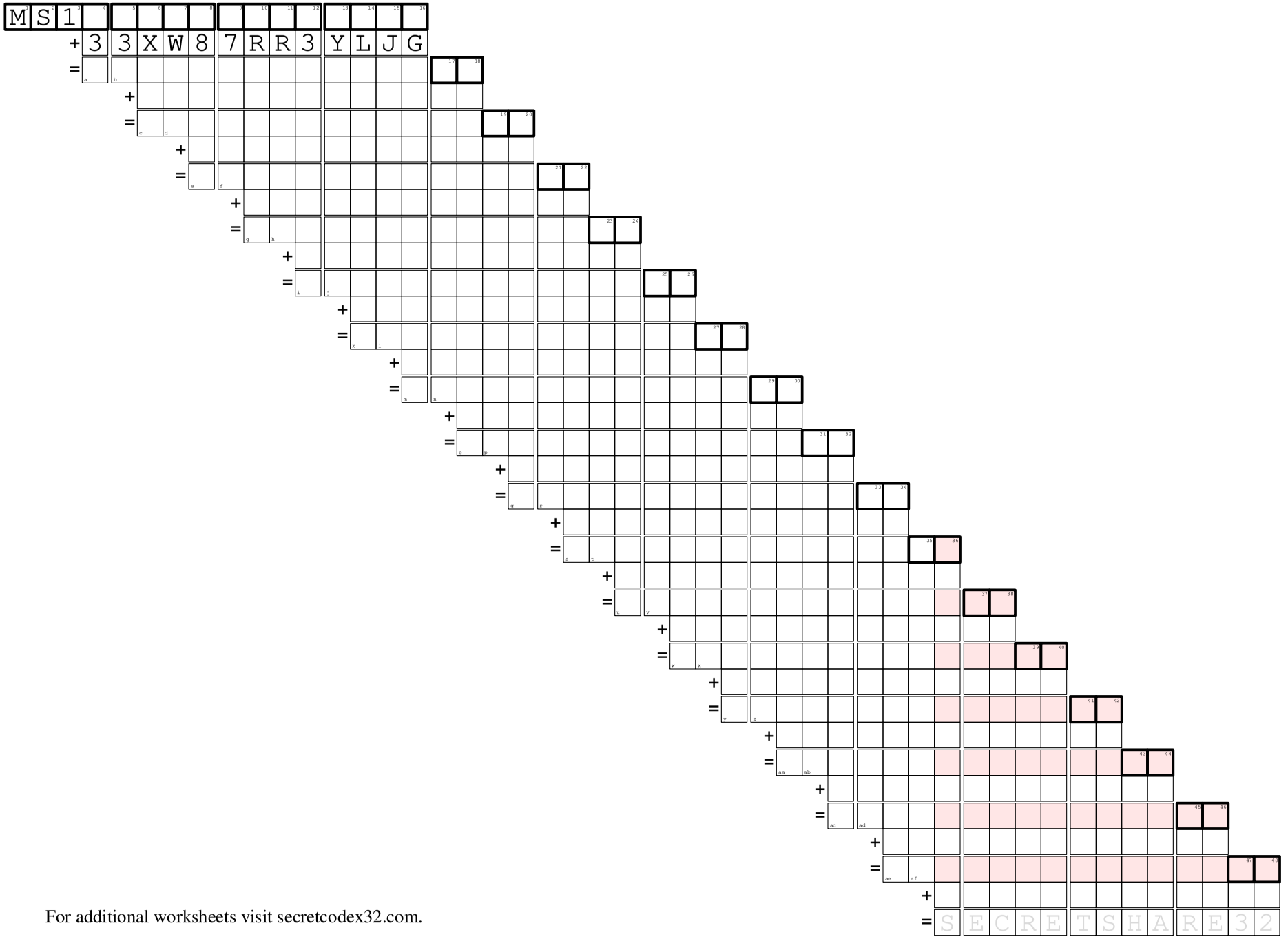

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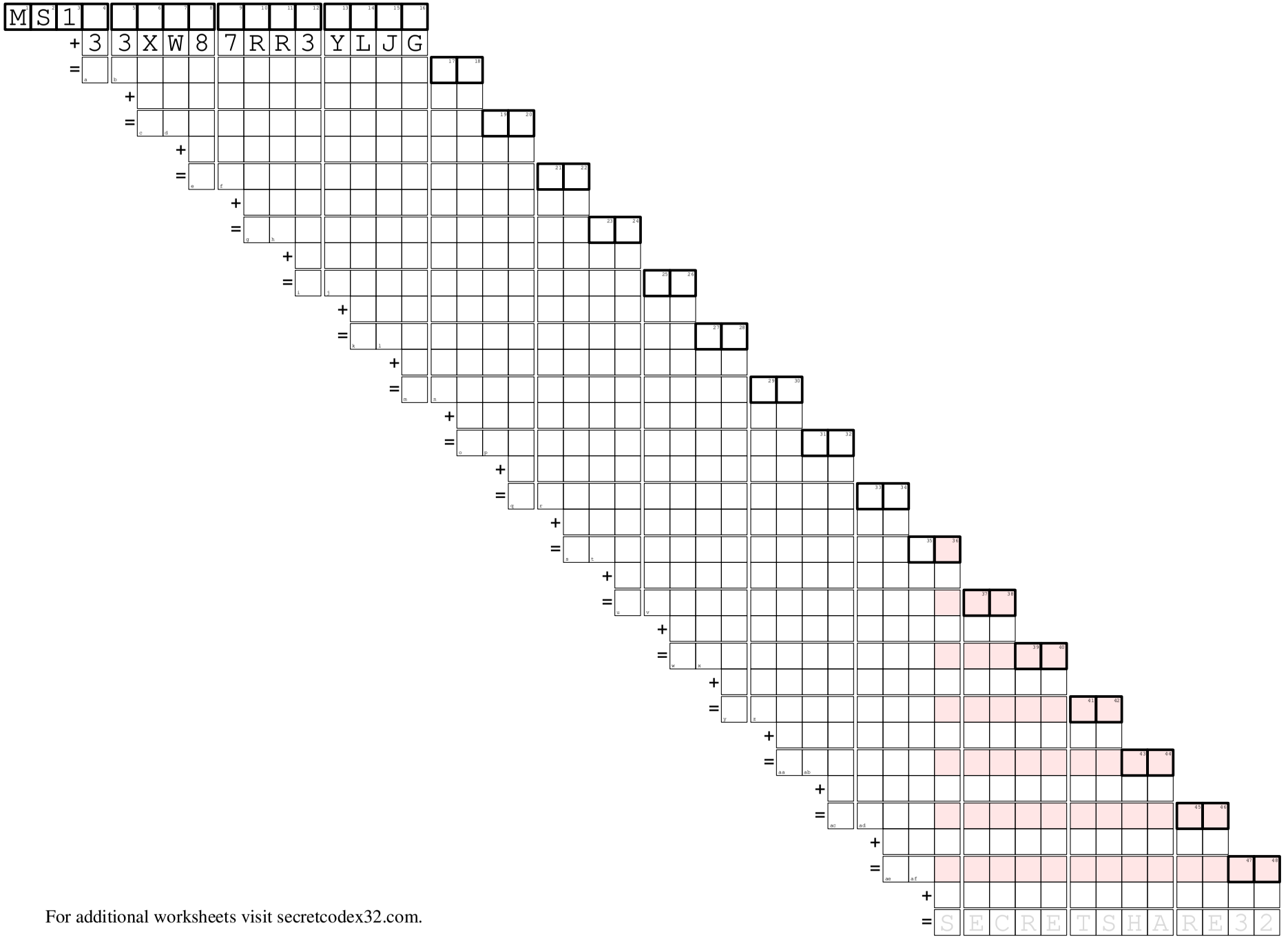

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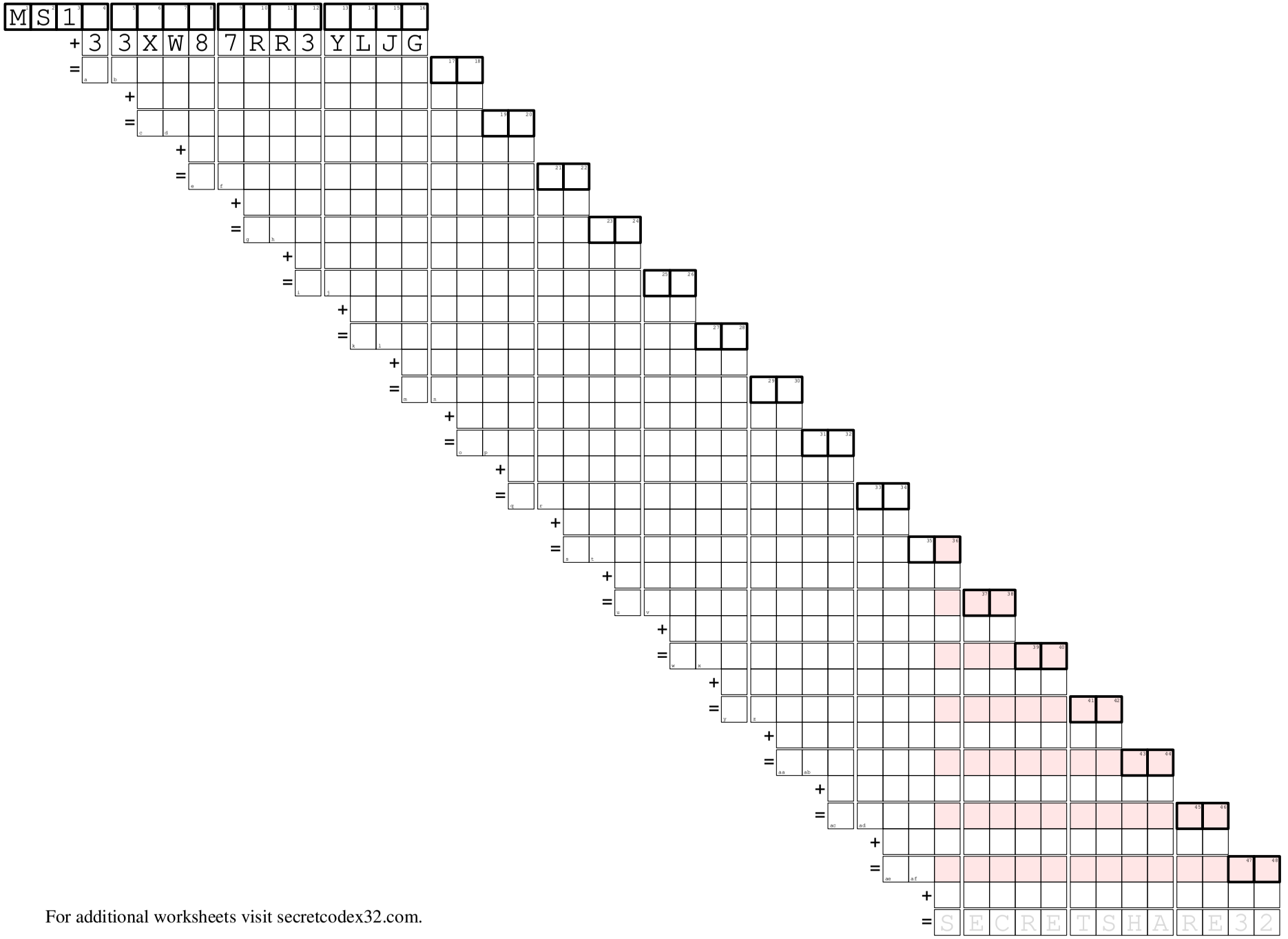

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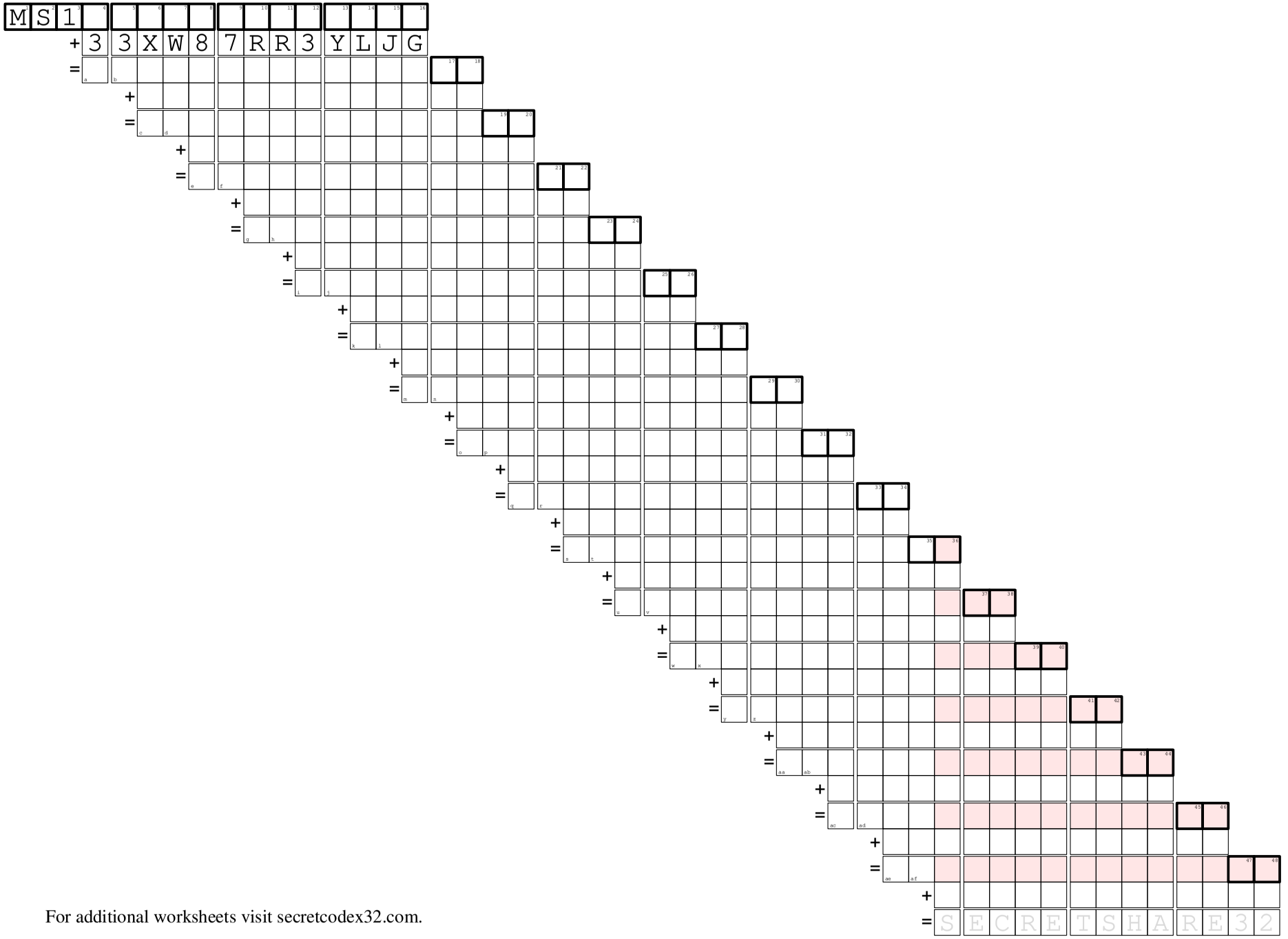

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Translation Worksheet

The translation worksheet is used to derive shares when splitting keys, and during key recovery. In all cases, the process is to translate a set of shares using the translation wheel, and then to add the translated results using the addition wheel.

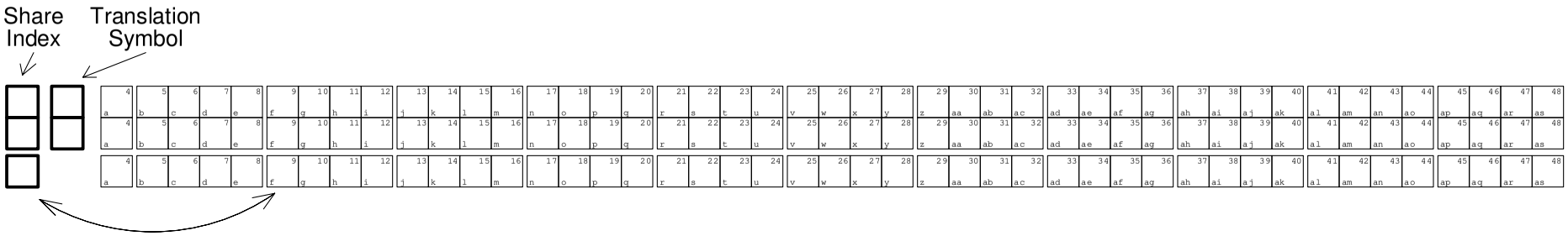
You will need: translation worksheet, translation/fusion wheel, addition wheel, recovery wheel (i.e., for key recovery), and the derivation table (page 7, for share derivation).

In all cases, the number of shares to combine is your *k* value, the number of required shares to reconstruct the secret. The process is:

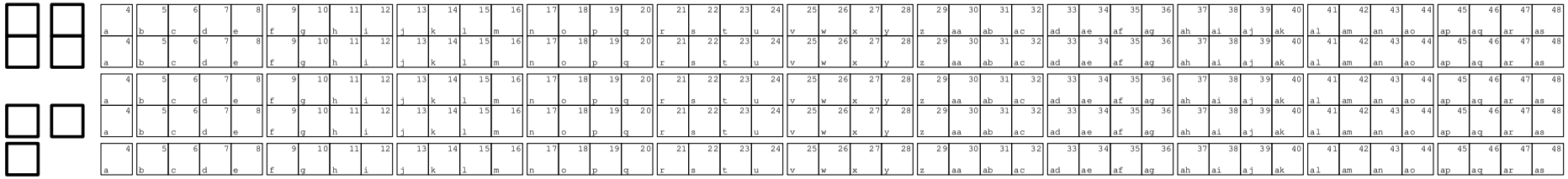
1. Make sure that you have completed checksum worksheets for all input shares.
2. Look up the translation symbols for each share, either in the derivation table or using the recovery wheel and fusion wheel.
3. Mark down each share's index (the sixth character of its header) and translation symbol in the appropriate squares.
4. Character by character, translate each share from its checksum worksheet to its row, using the translation wheel.
5. Using the addition wheel, add all rows together.

Notice that the resulting share will automatically have the correct share index in its header. **If not, you have likely misread the instructions.**

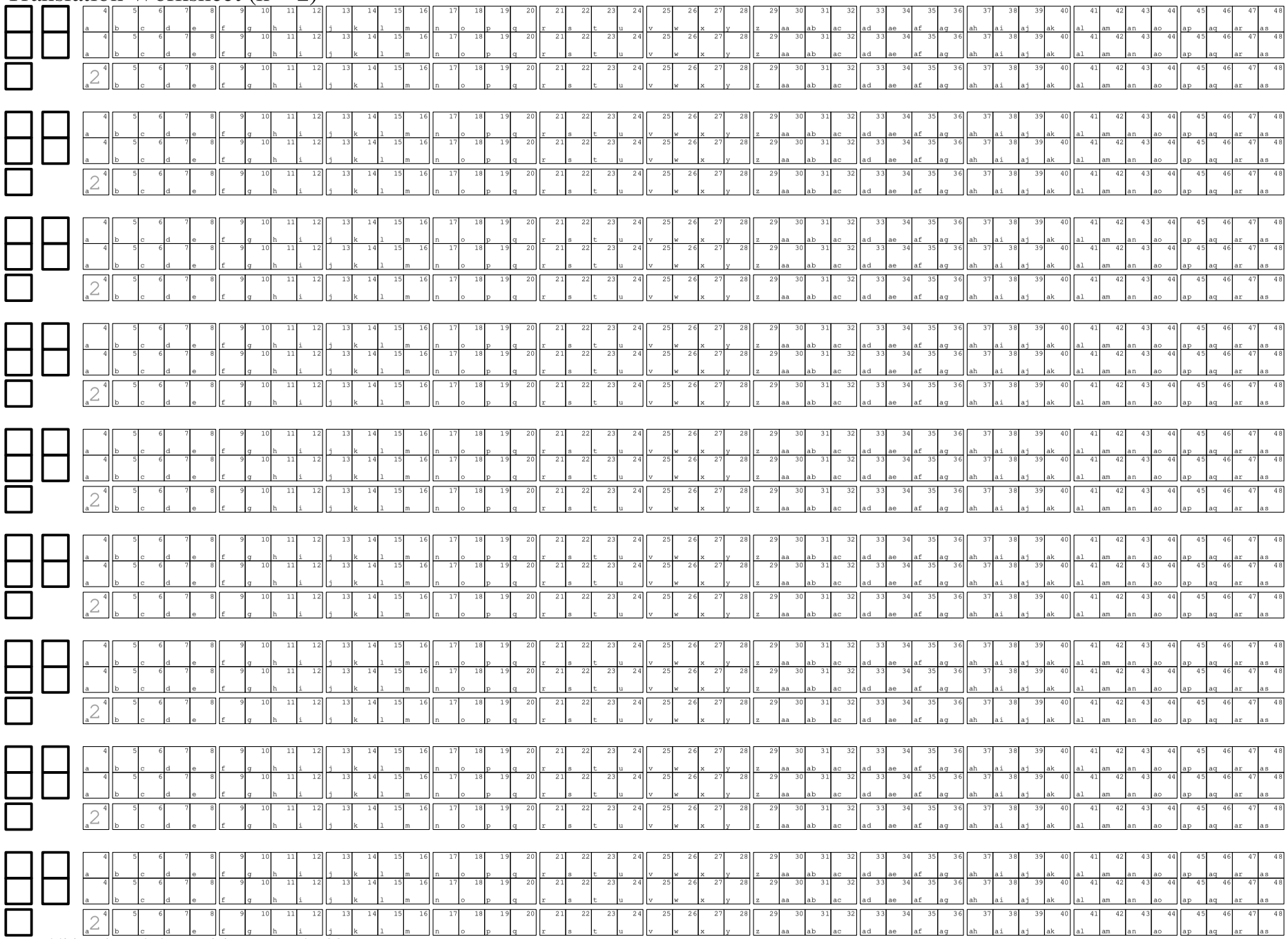
k=2 Example



k=3 Example



Translation Worksheet (k = 2)



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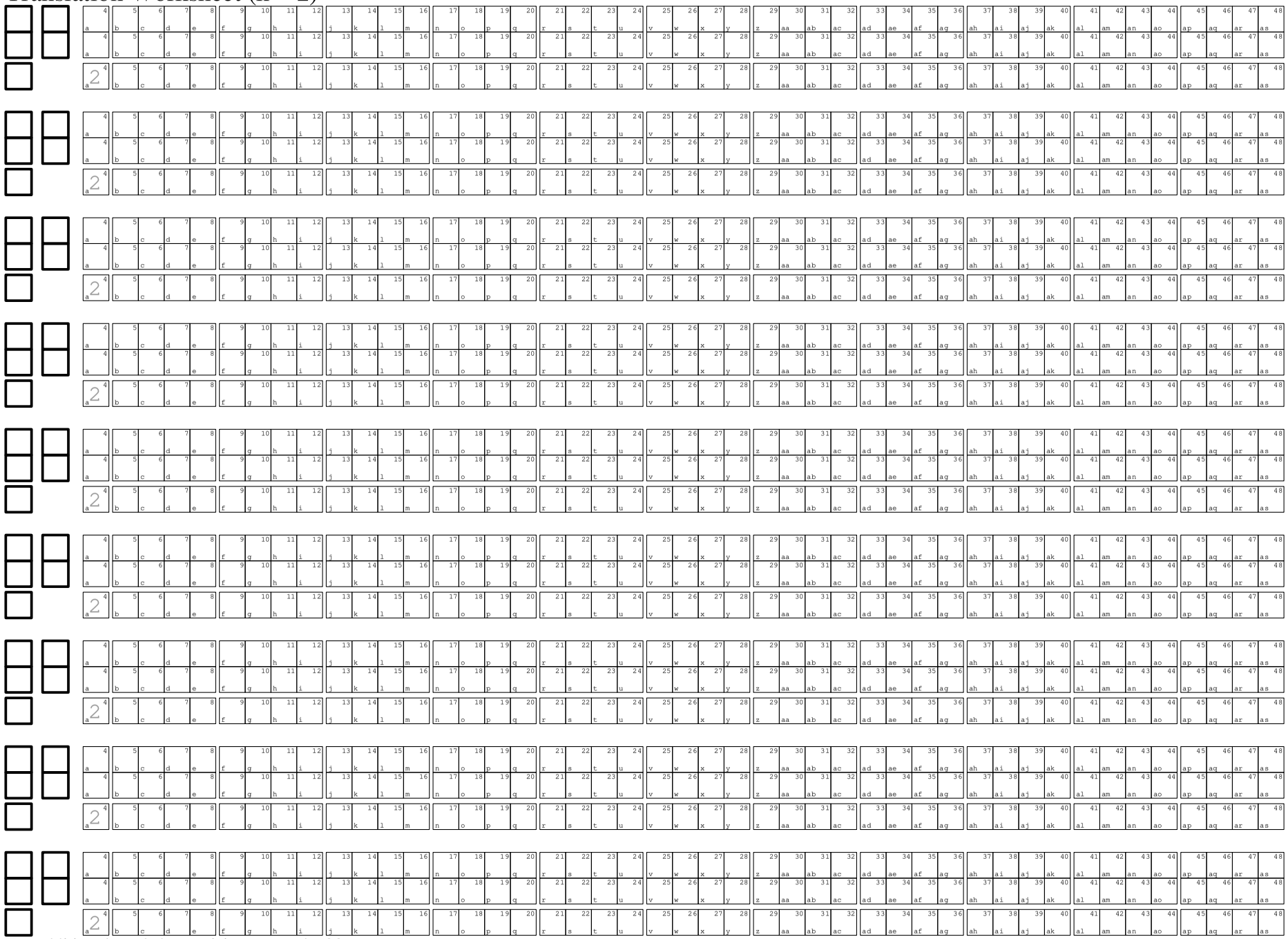

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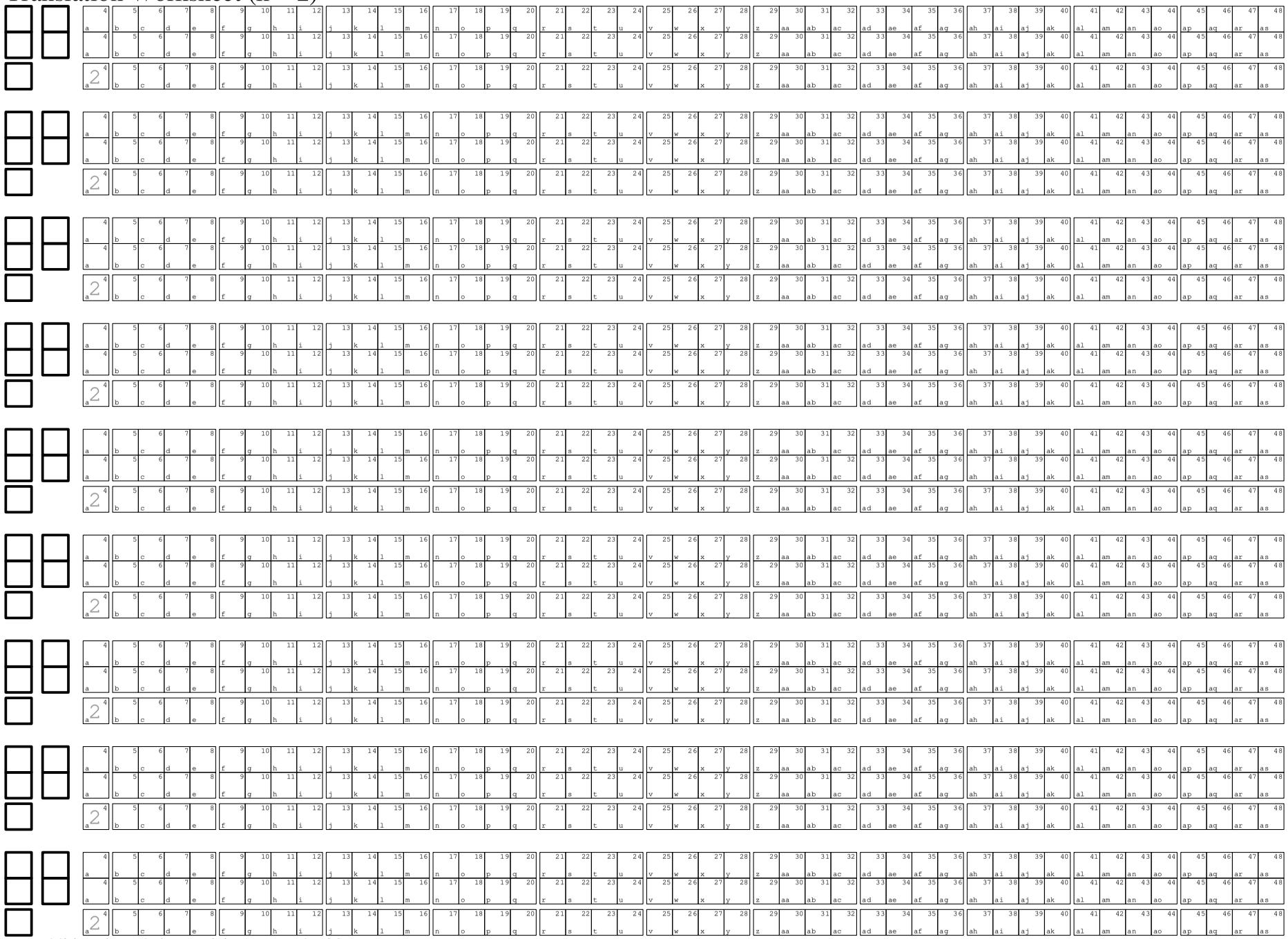

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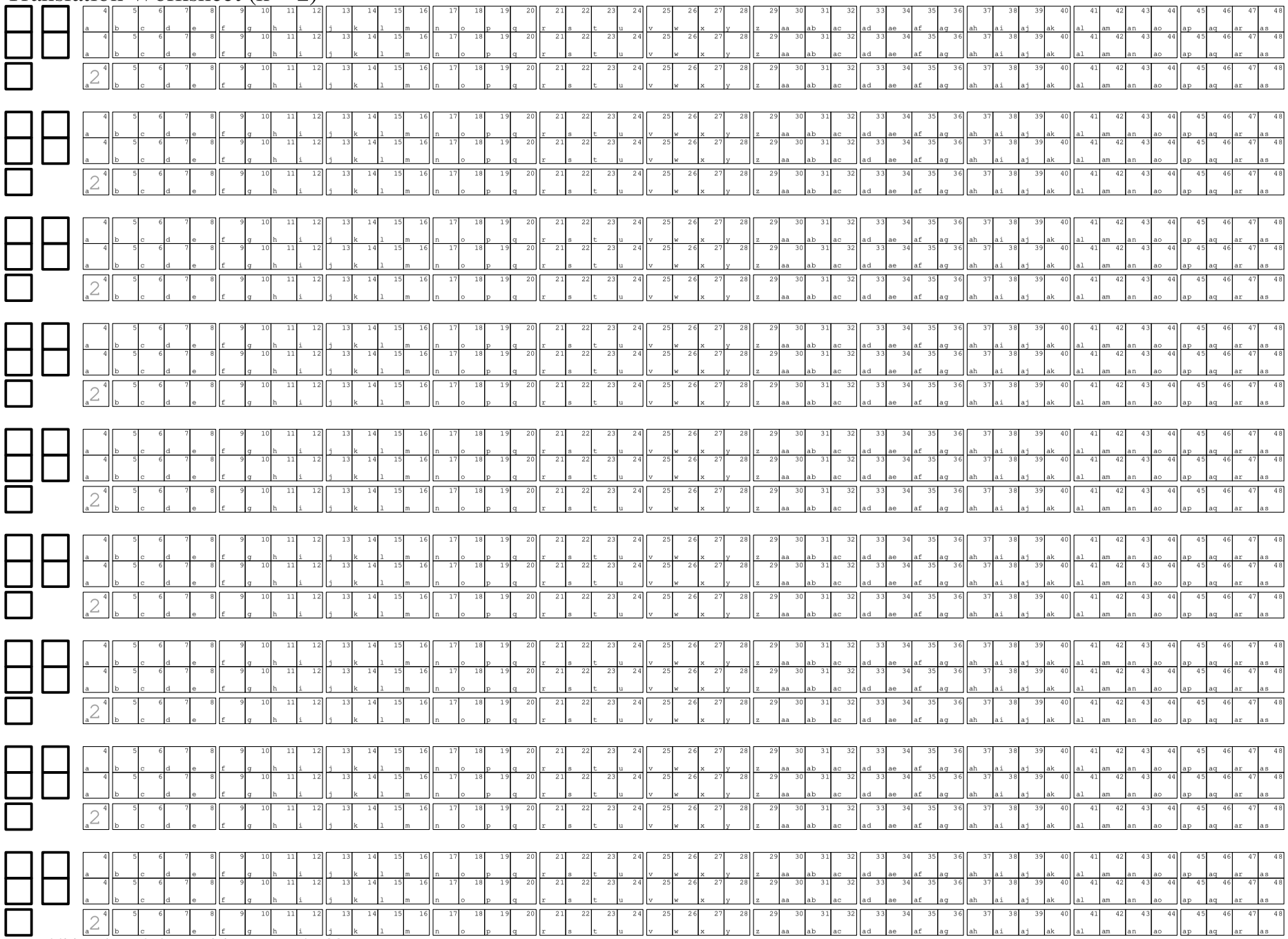

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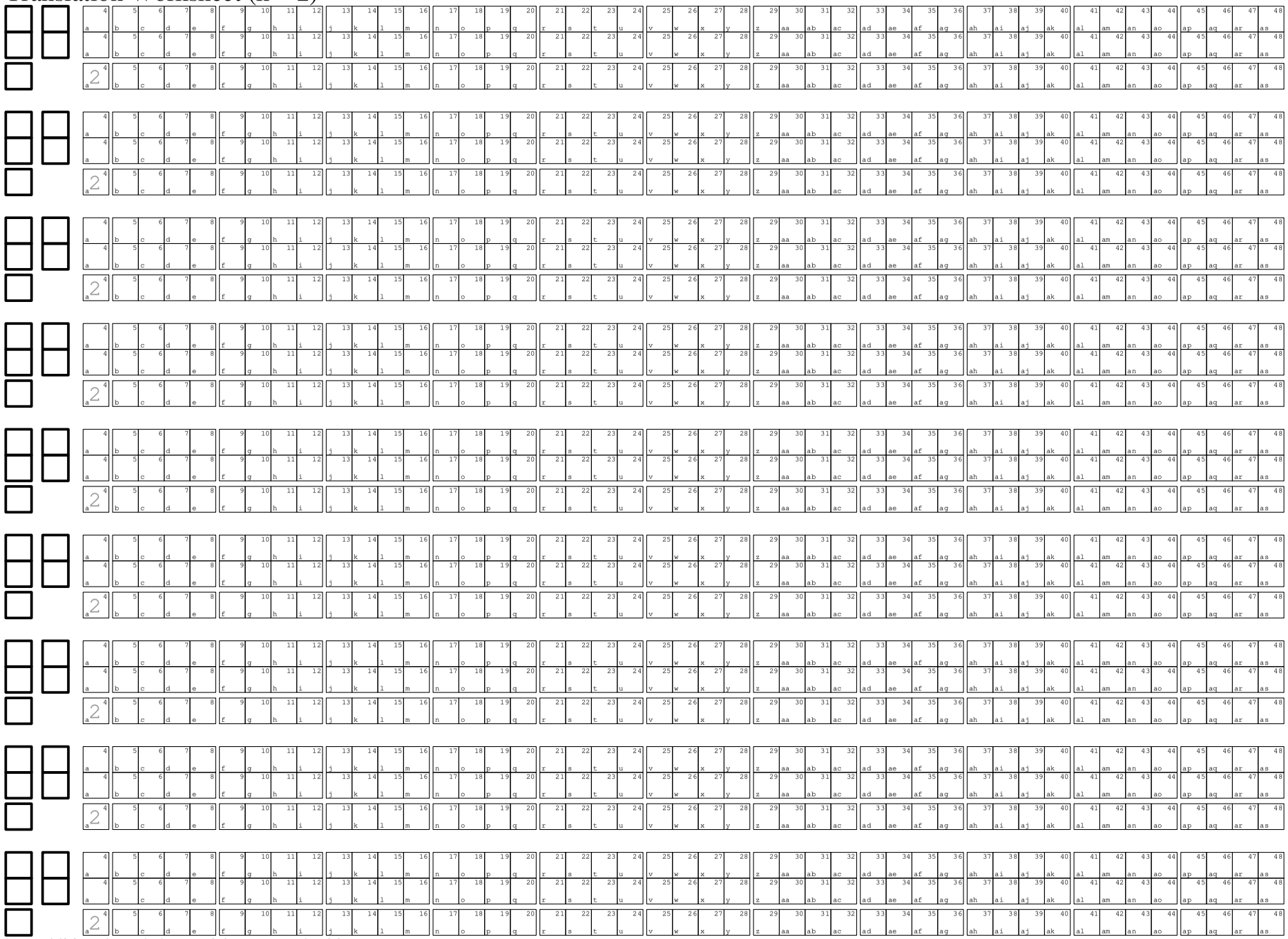

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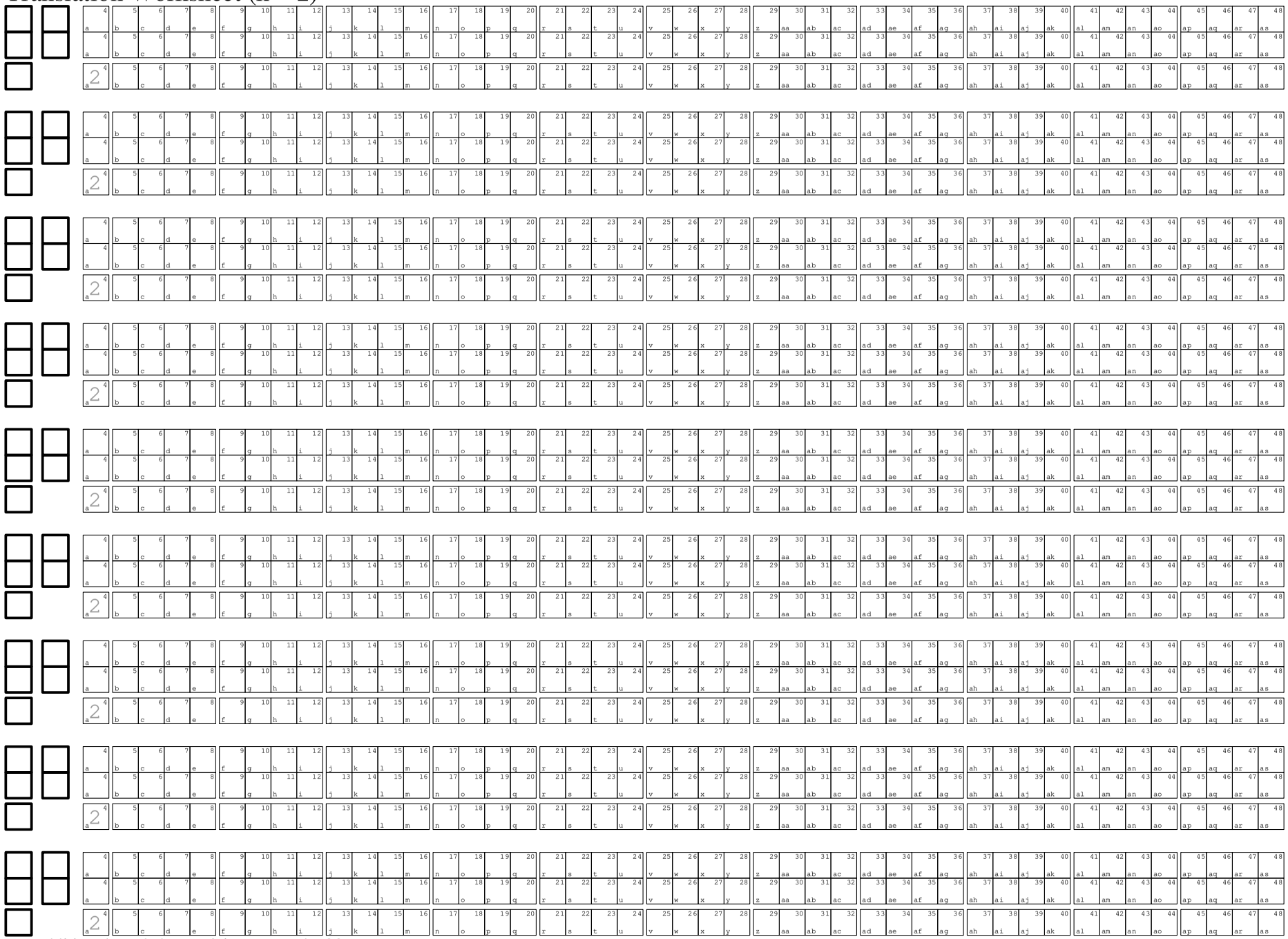

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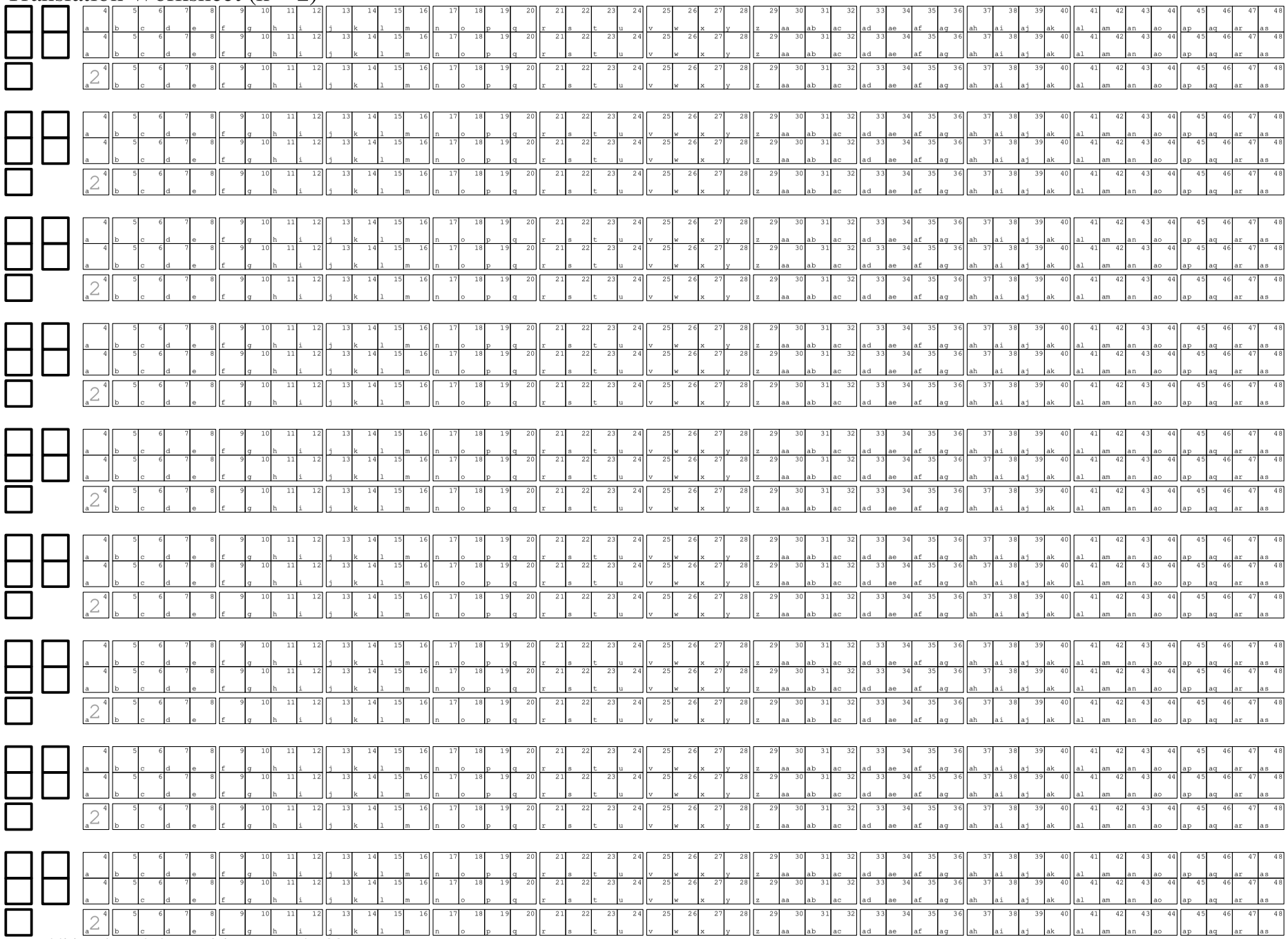

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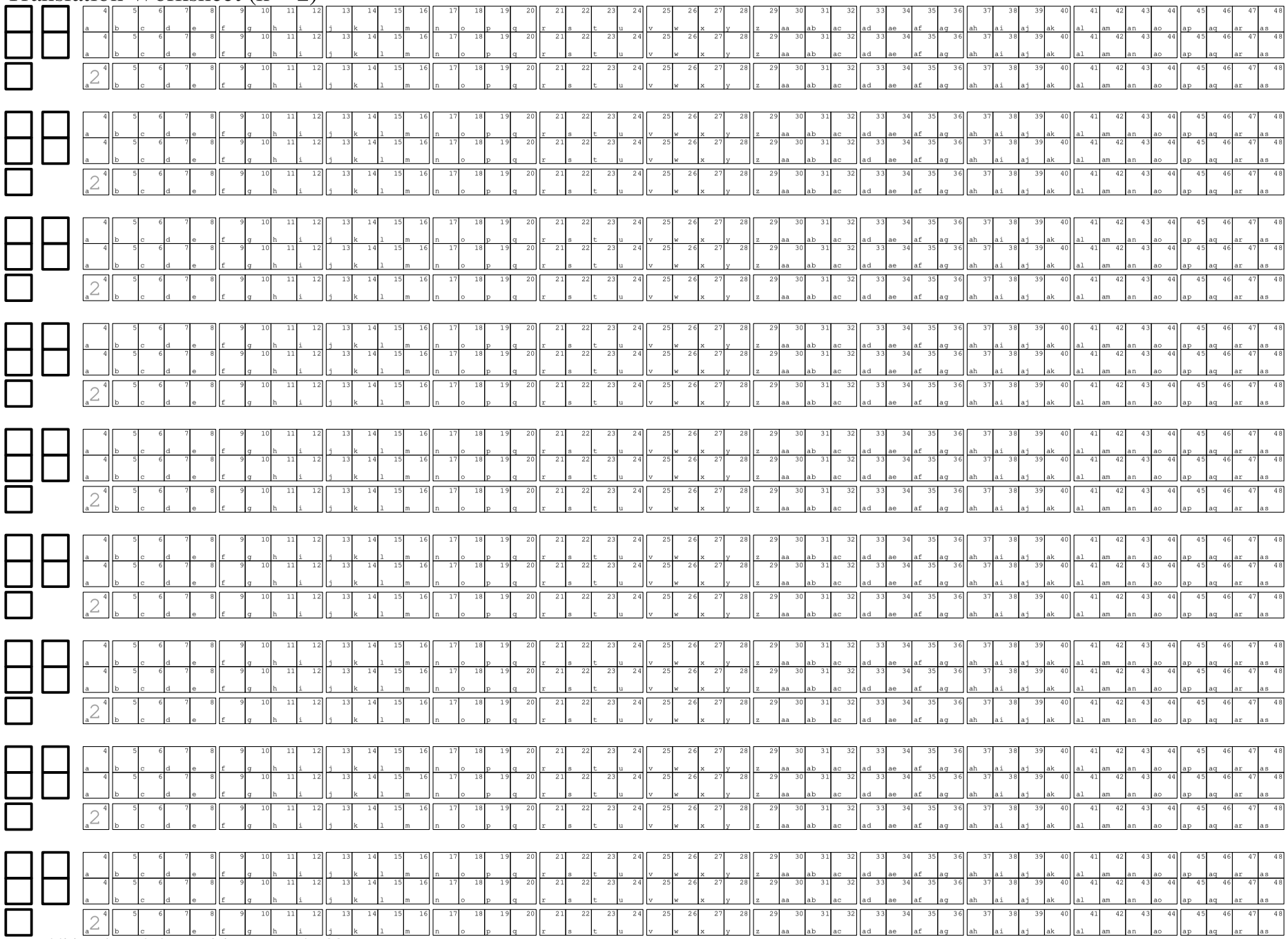

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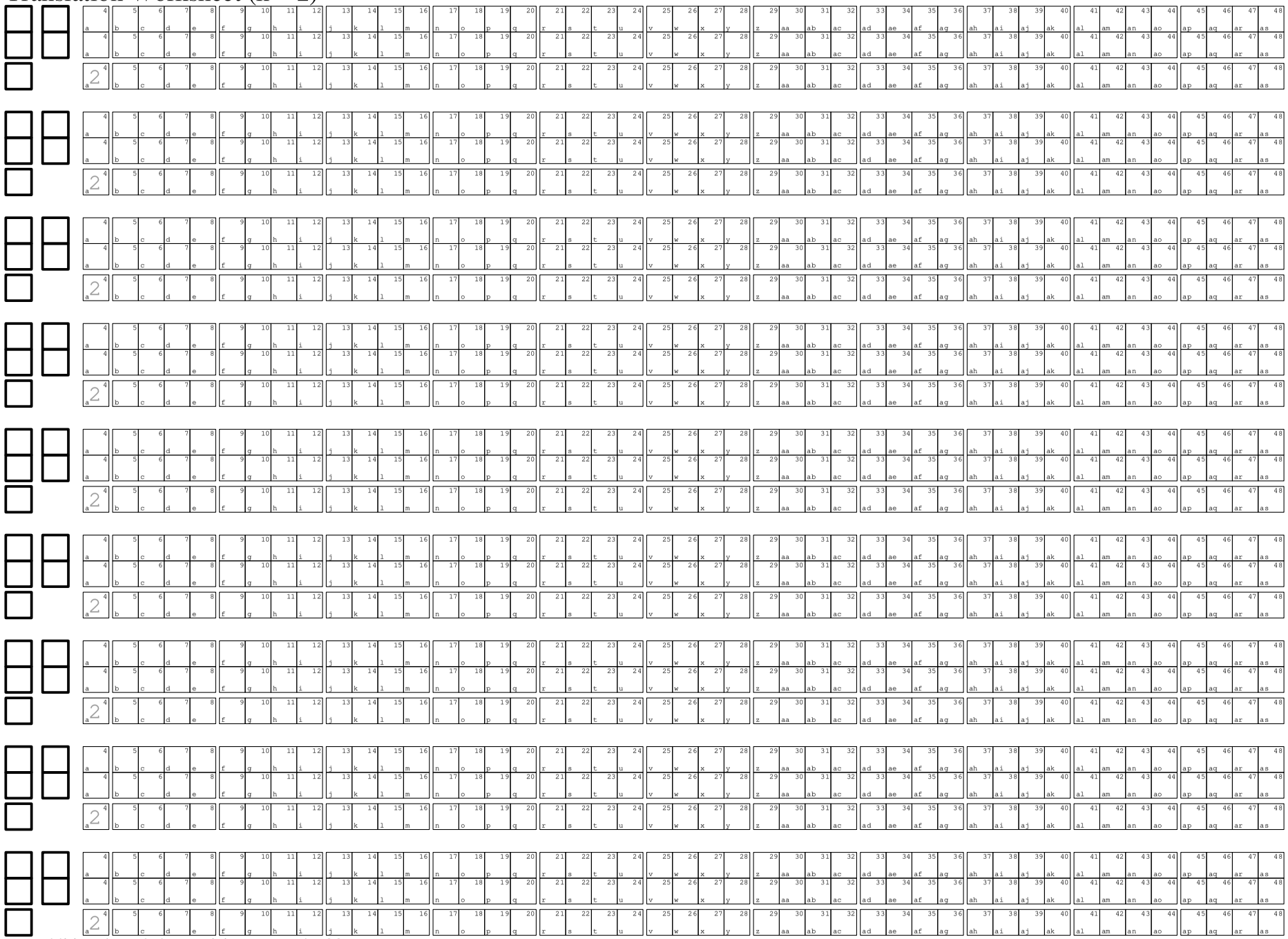

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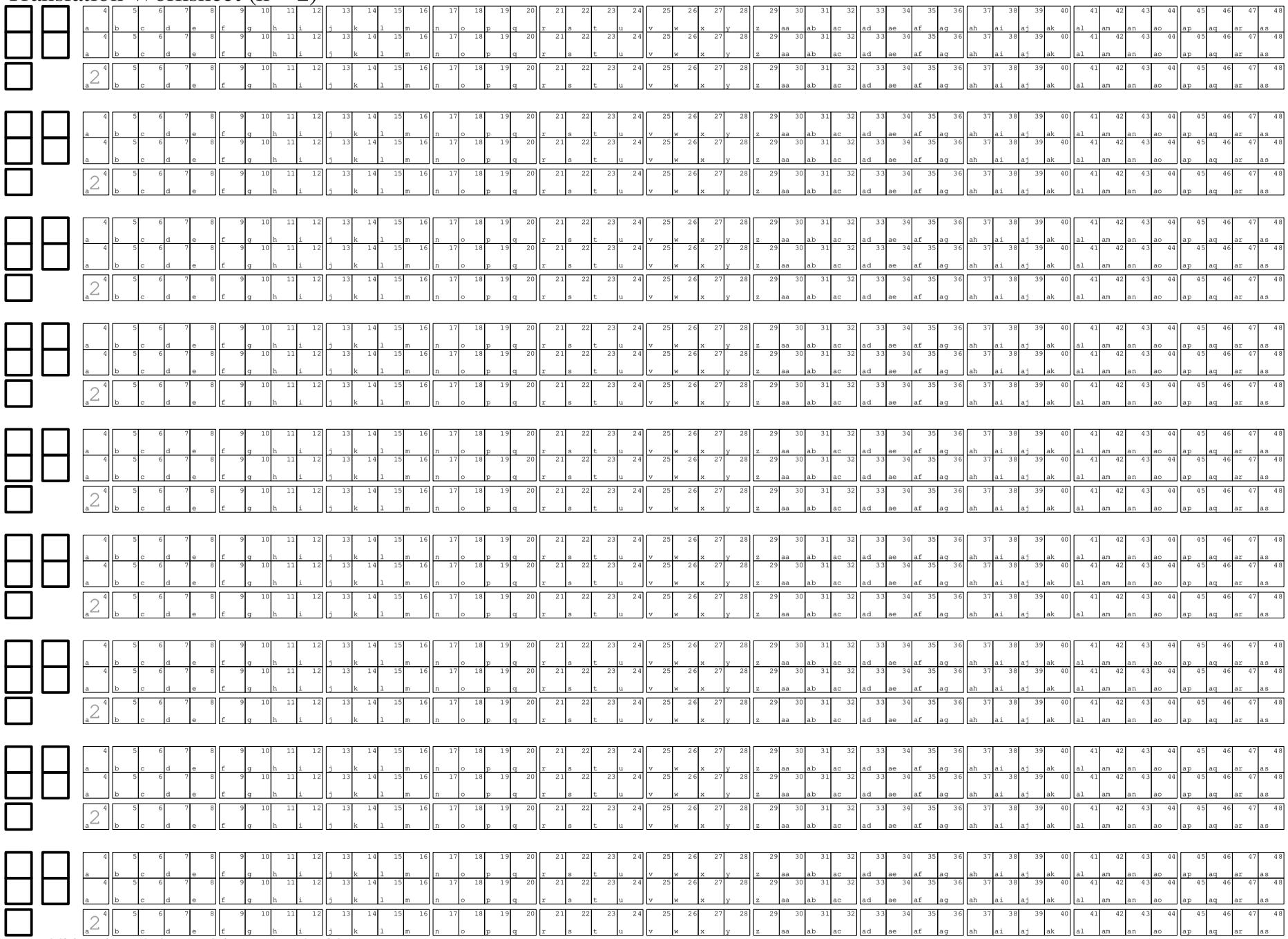

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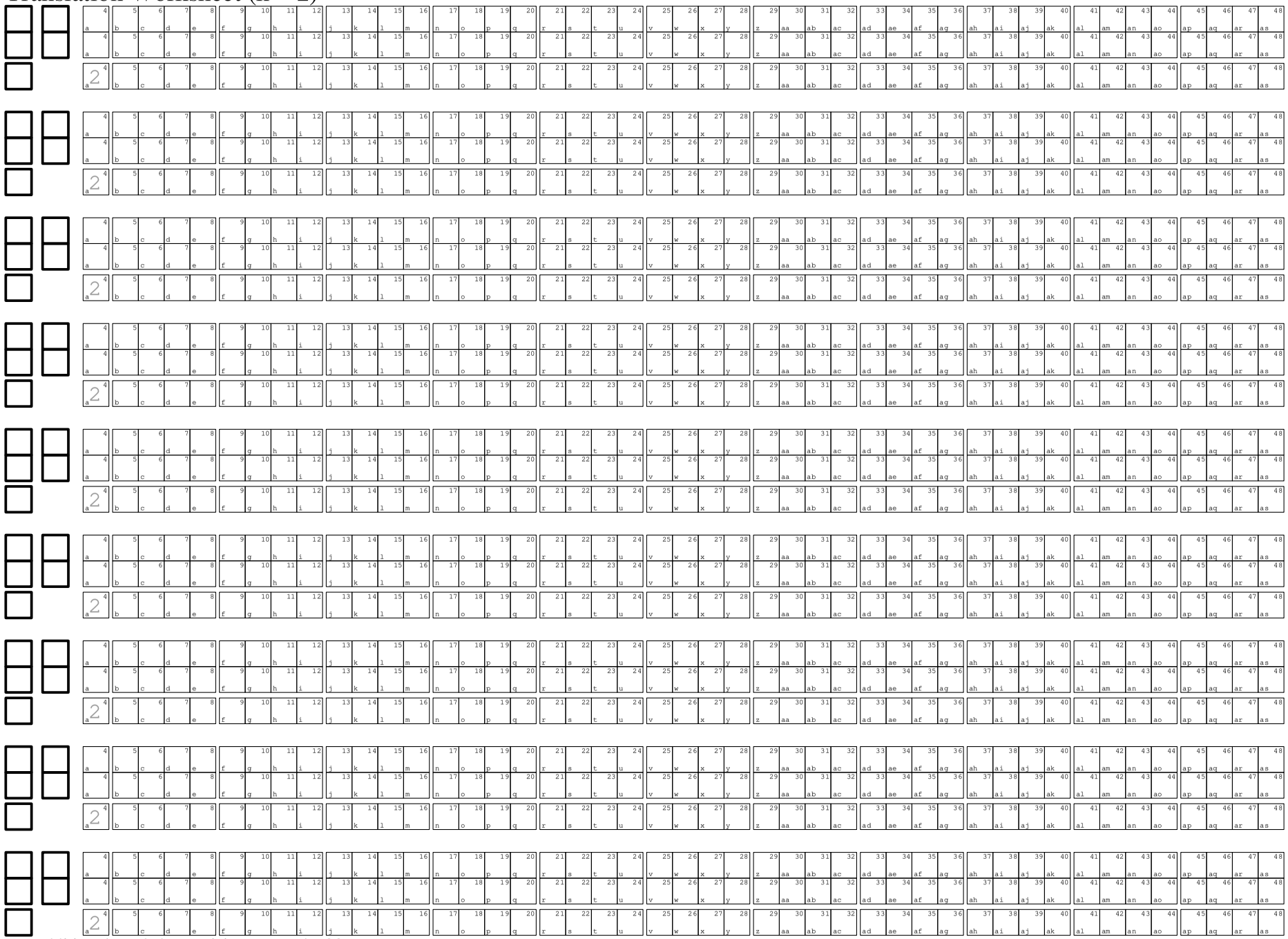

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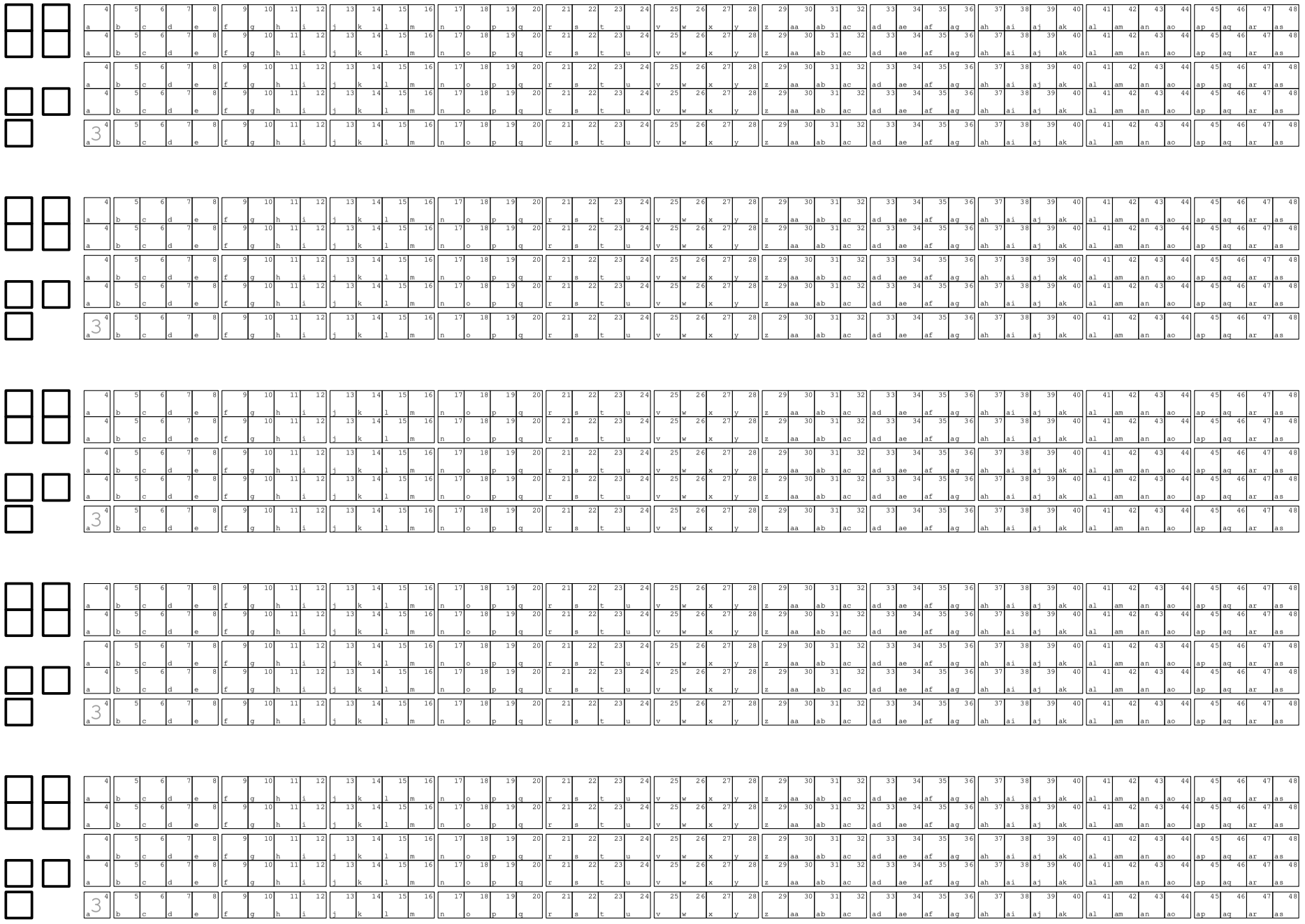

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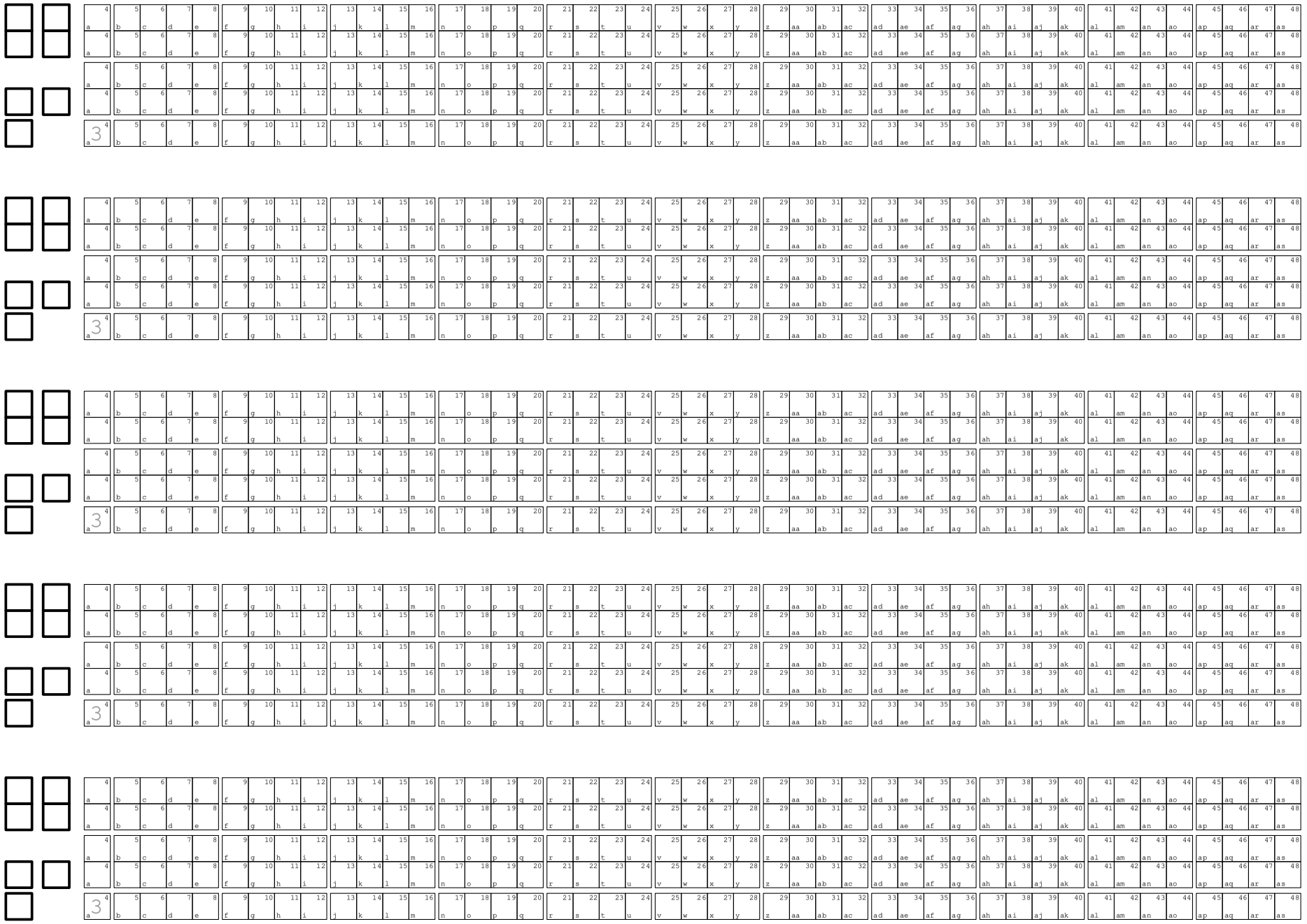

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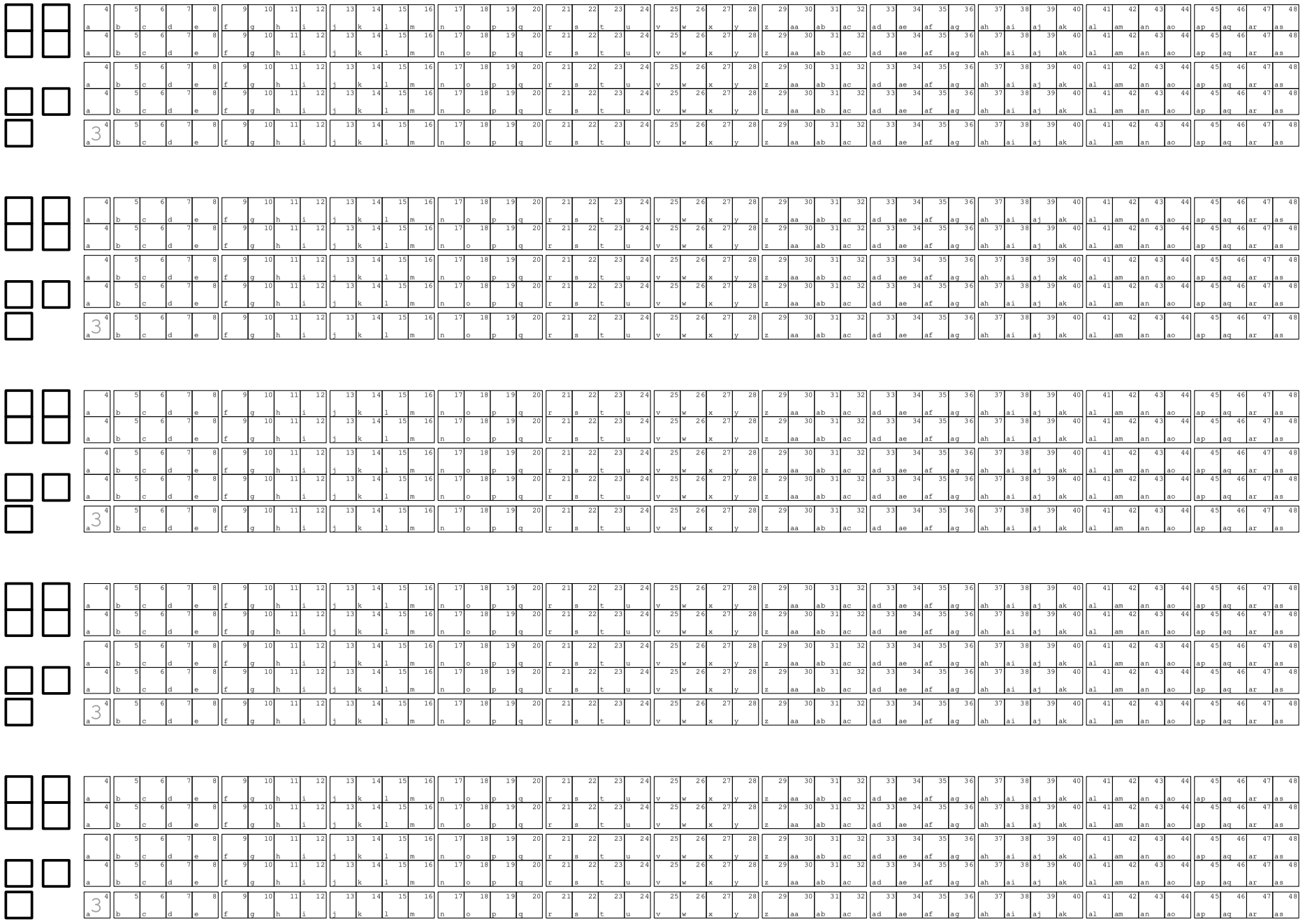
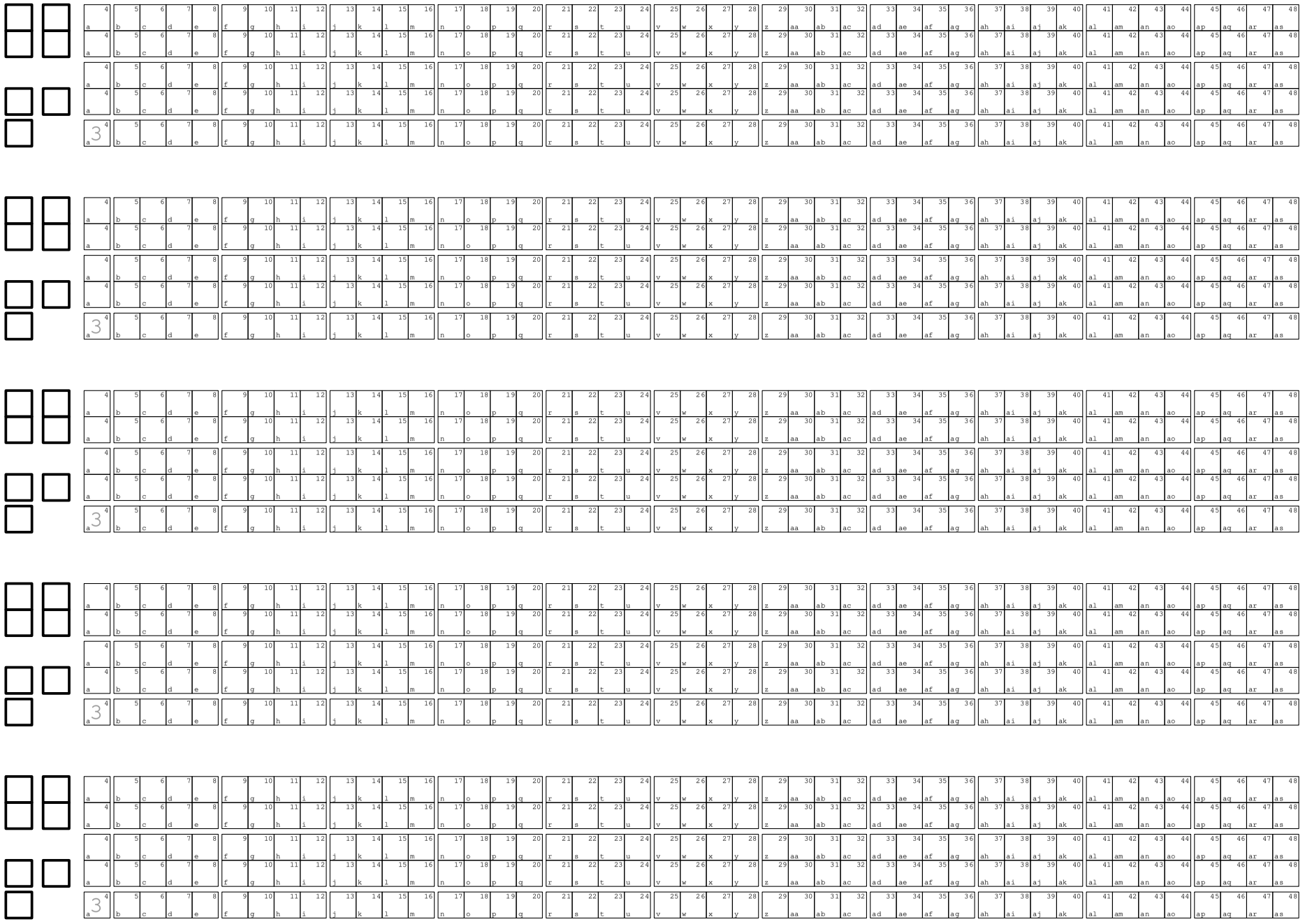


For additional worksheets visit secretcodex32.com.

Translation Worksheet (k = 3)



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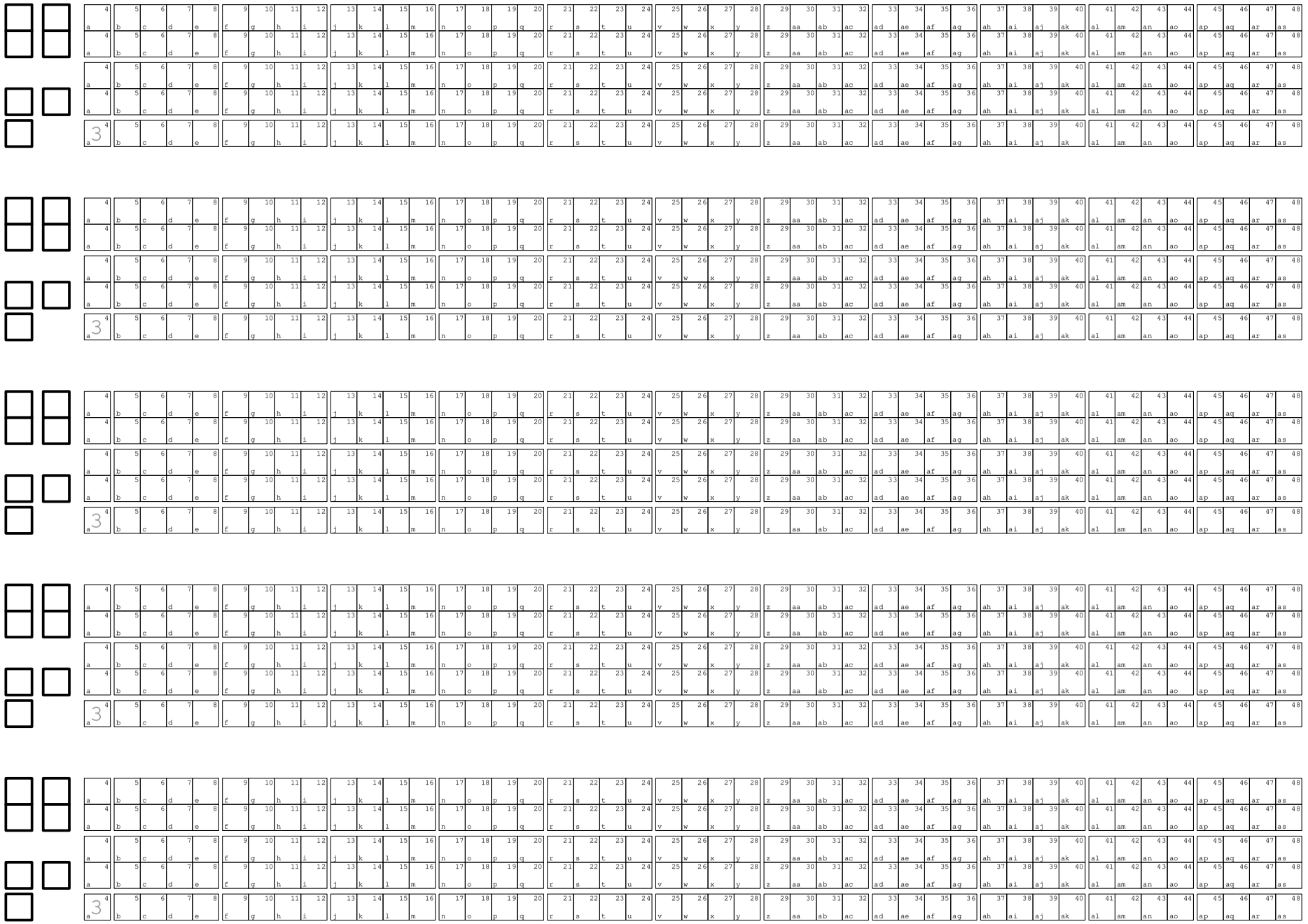

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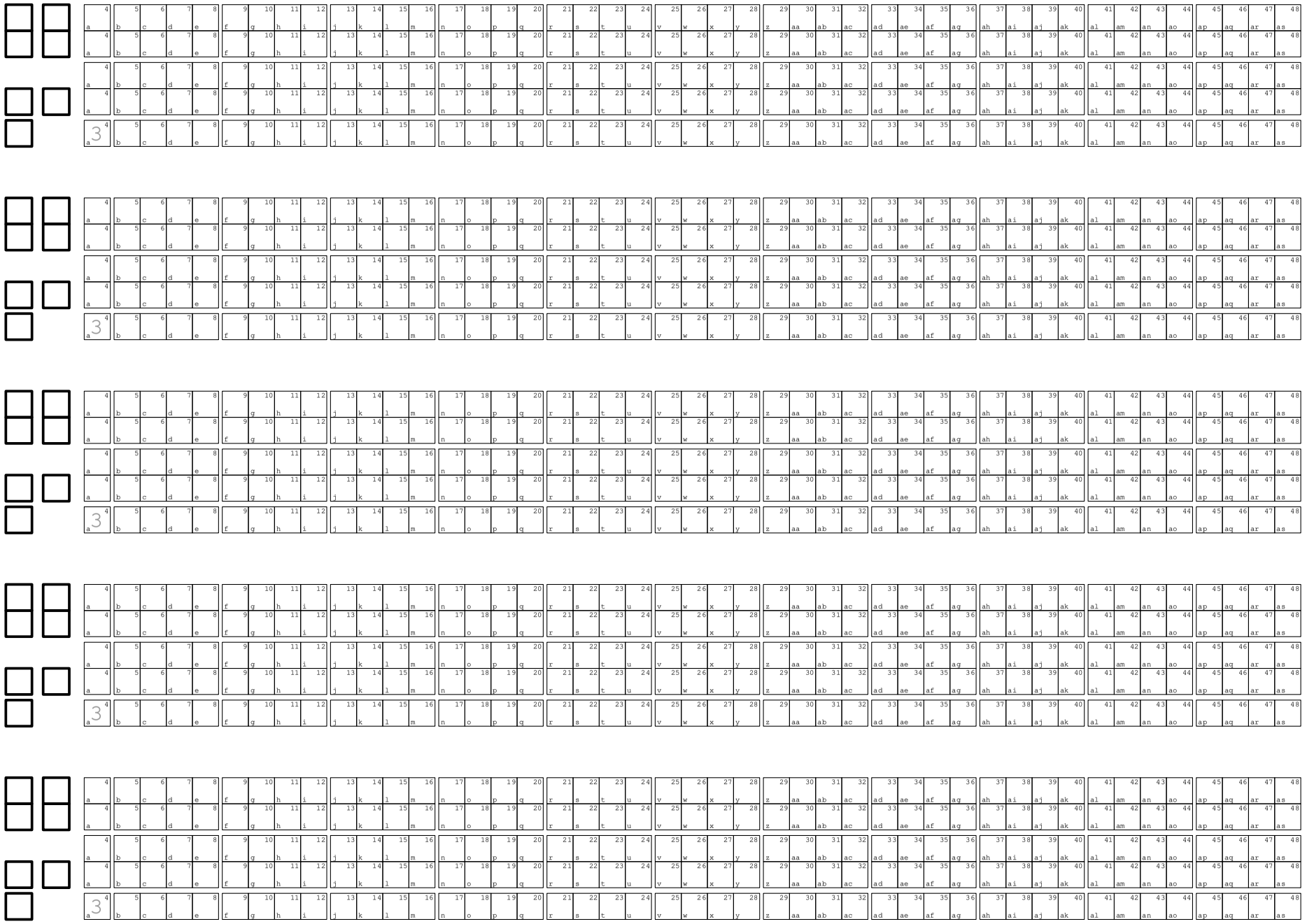
Translation Worksheet (k = 3)



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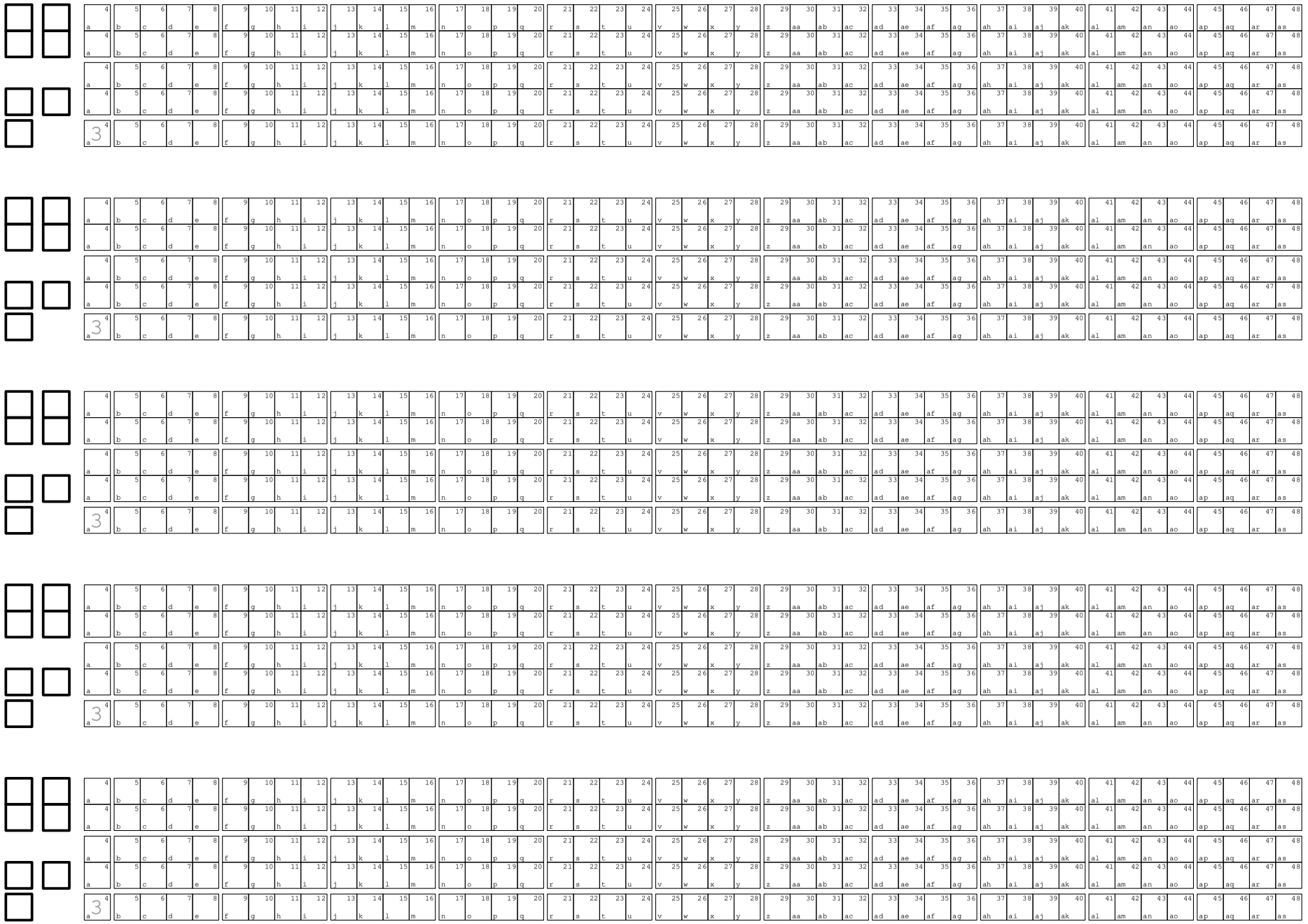

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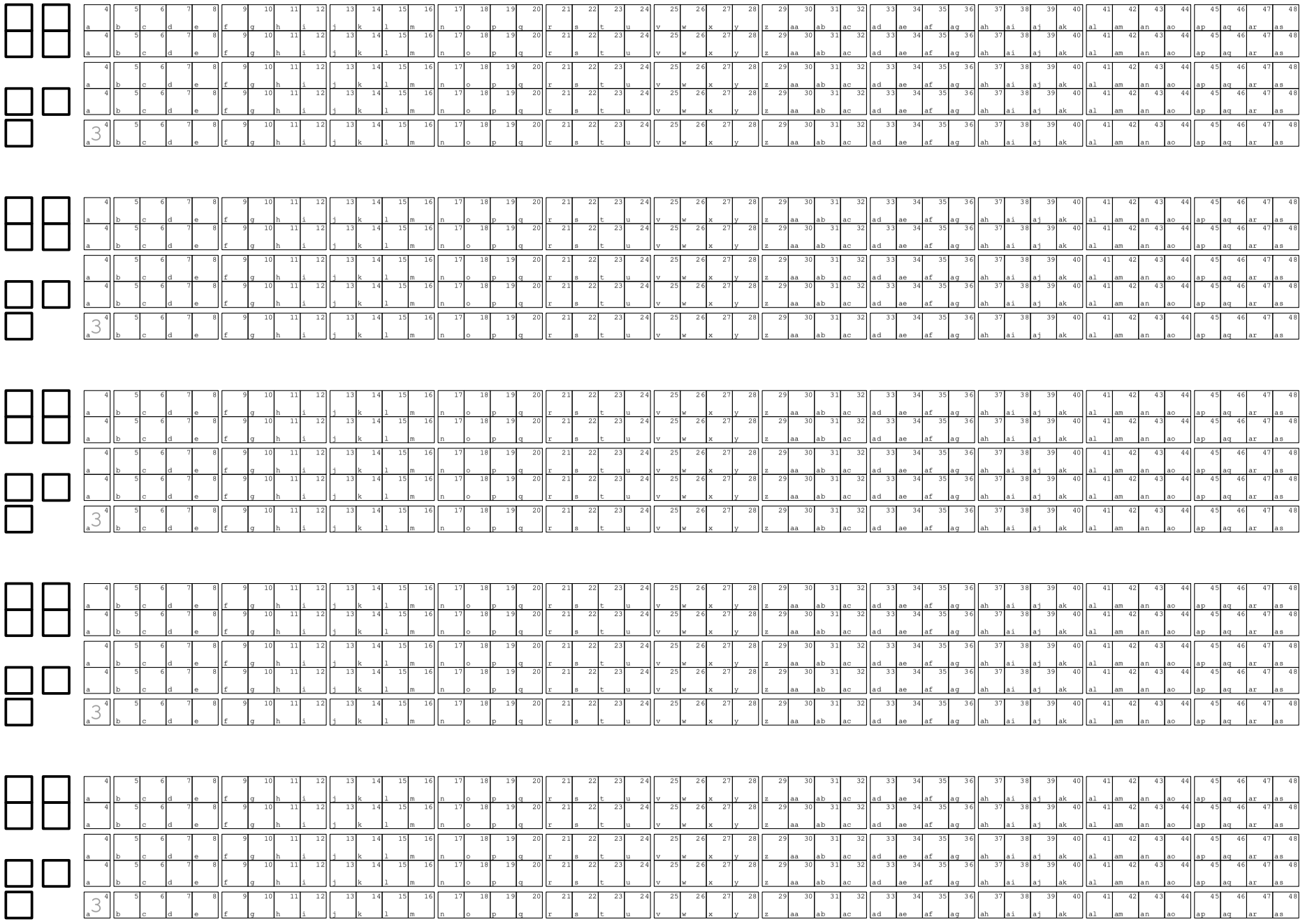

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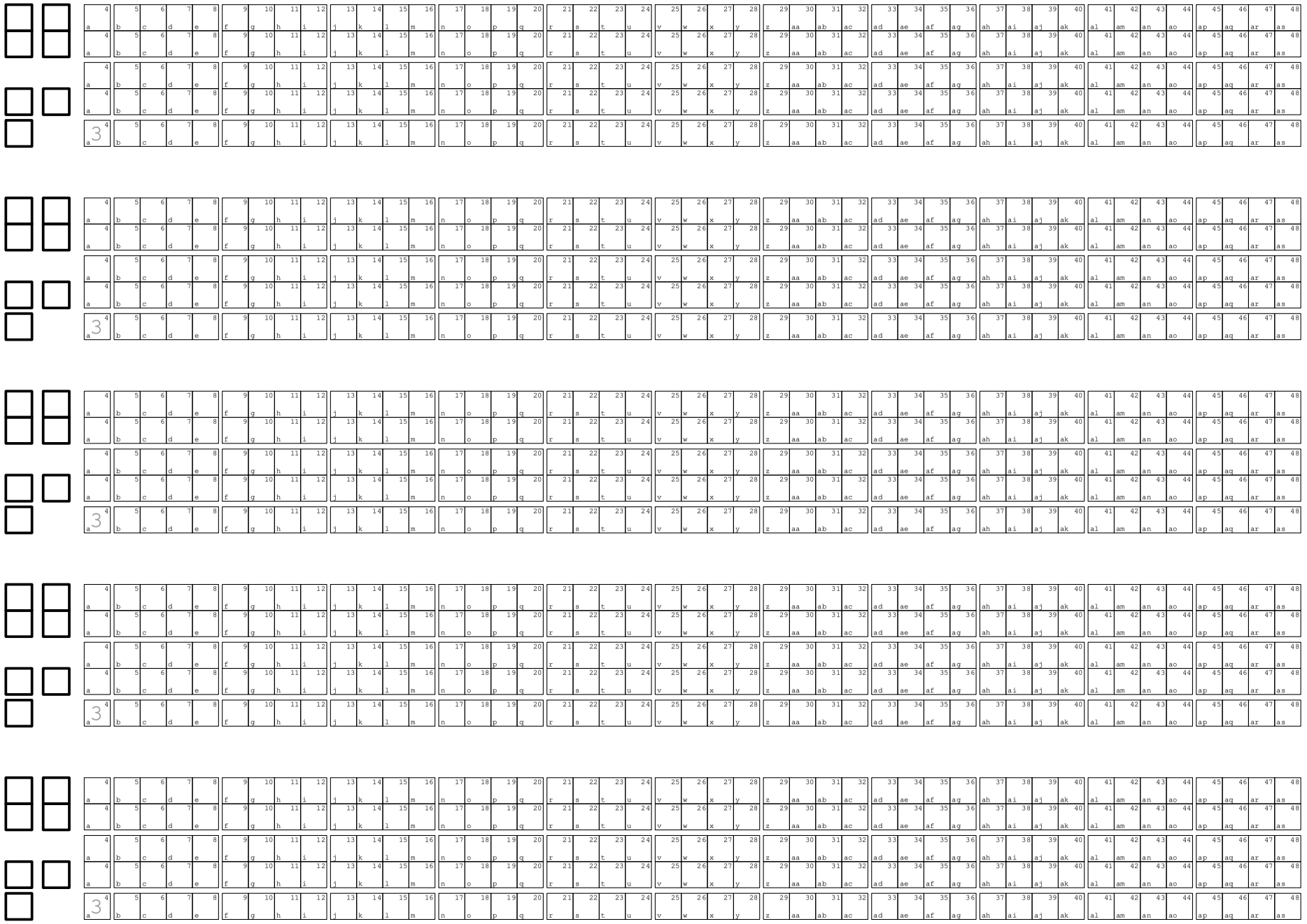
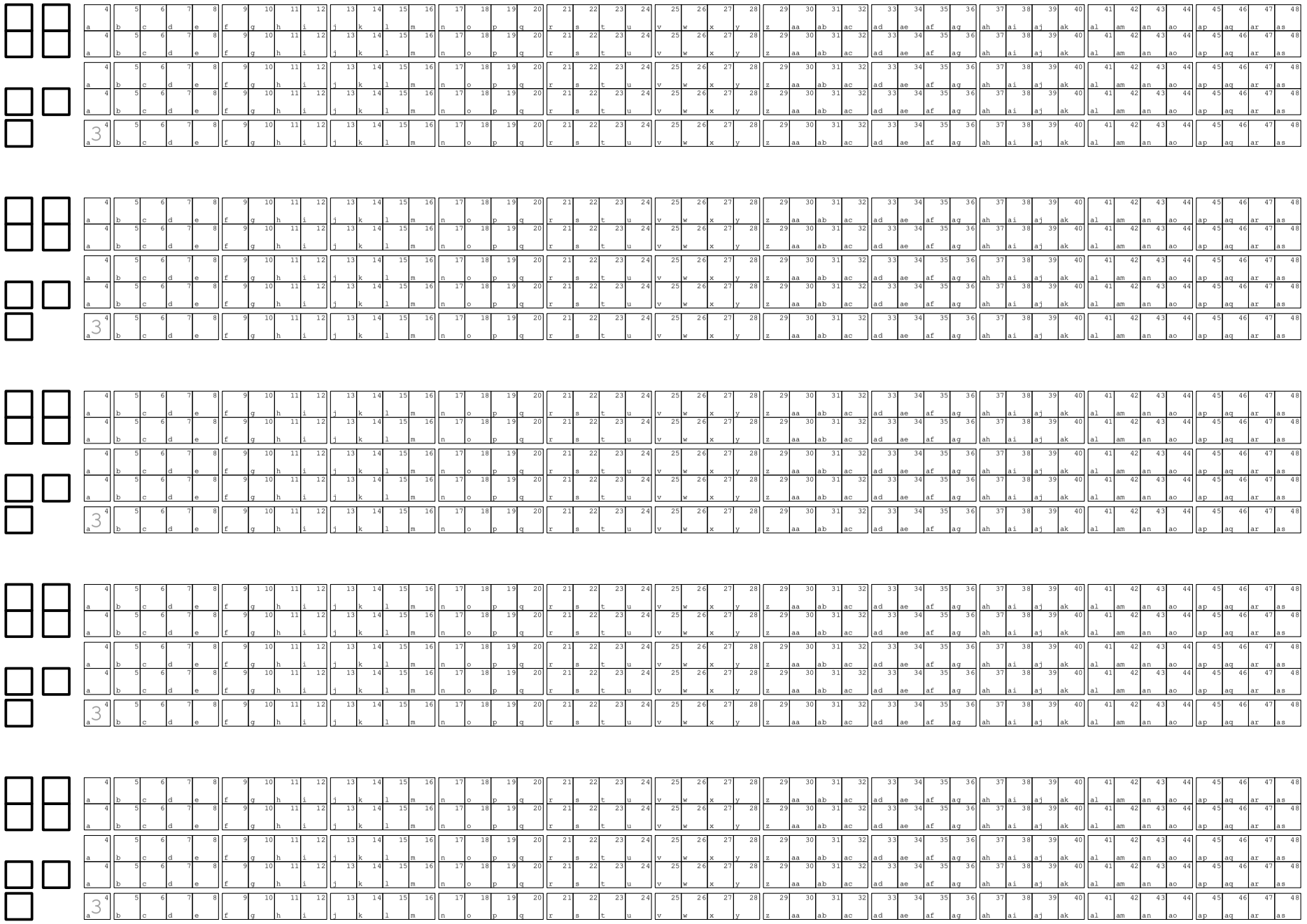
Translation Worksheet (k = 3)



For additional worksheets visit secretcodex32.com.

Translation Worksheet (k = 3)



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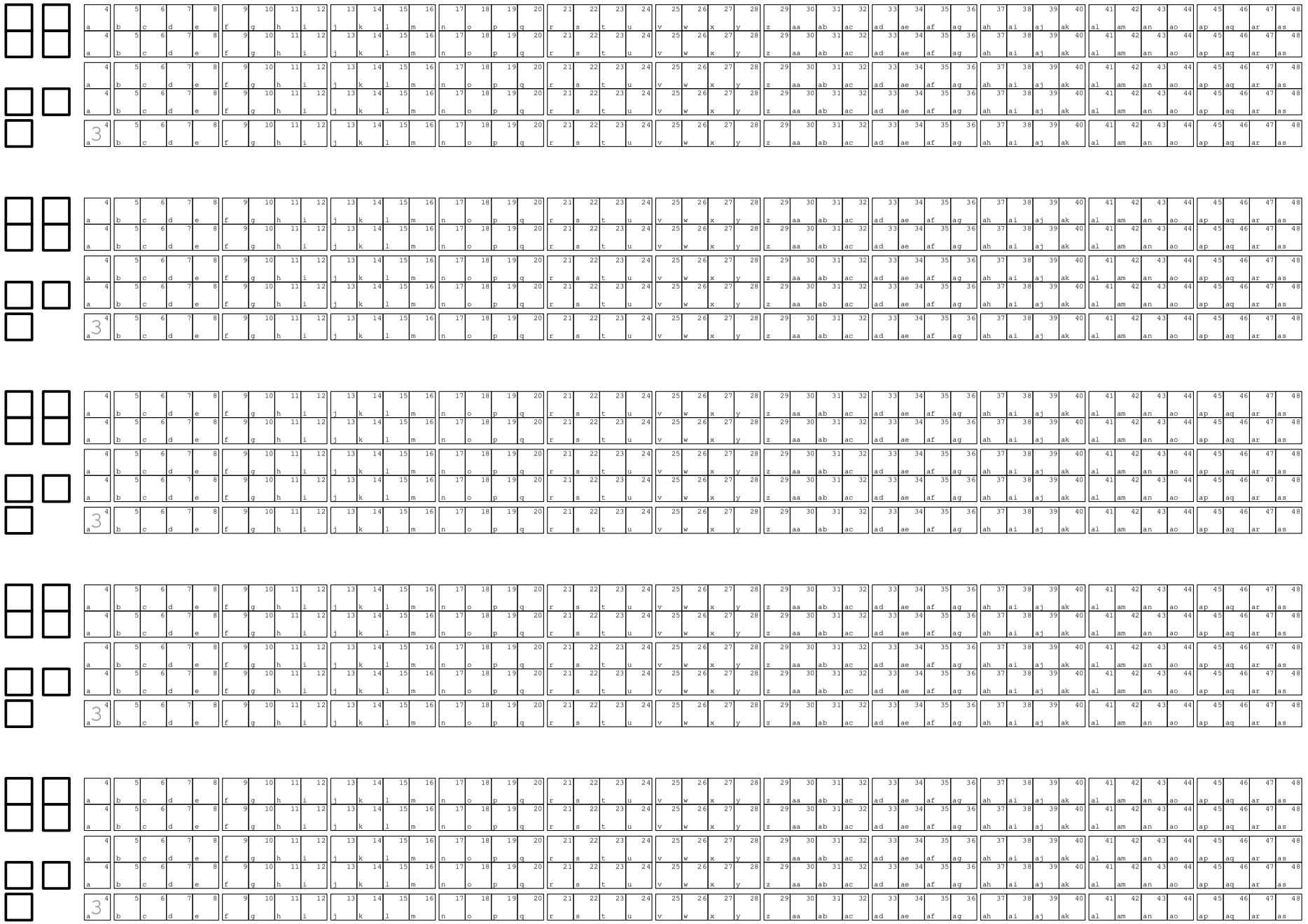
Translation Worksheet (k = 3)



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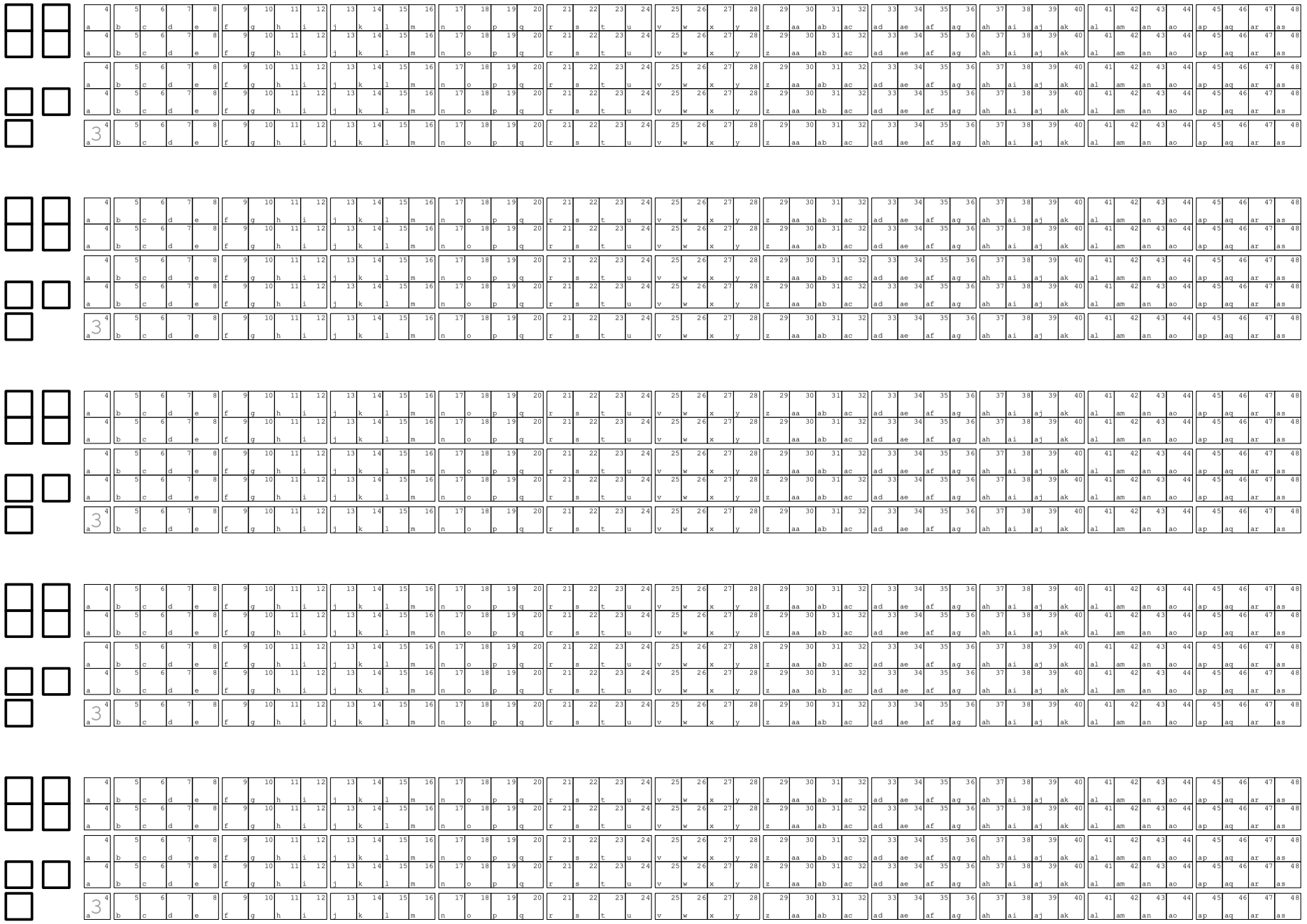

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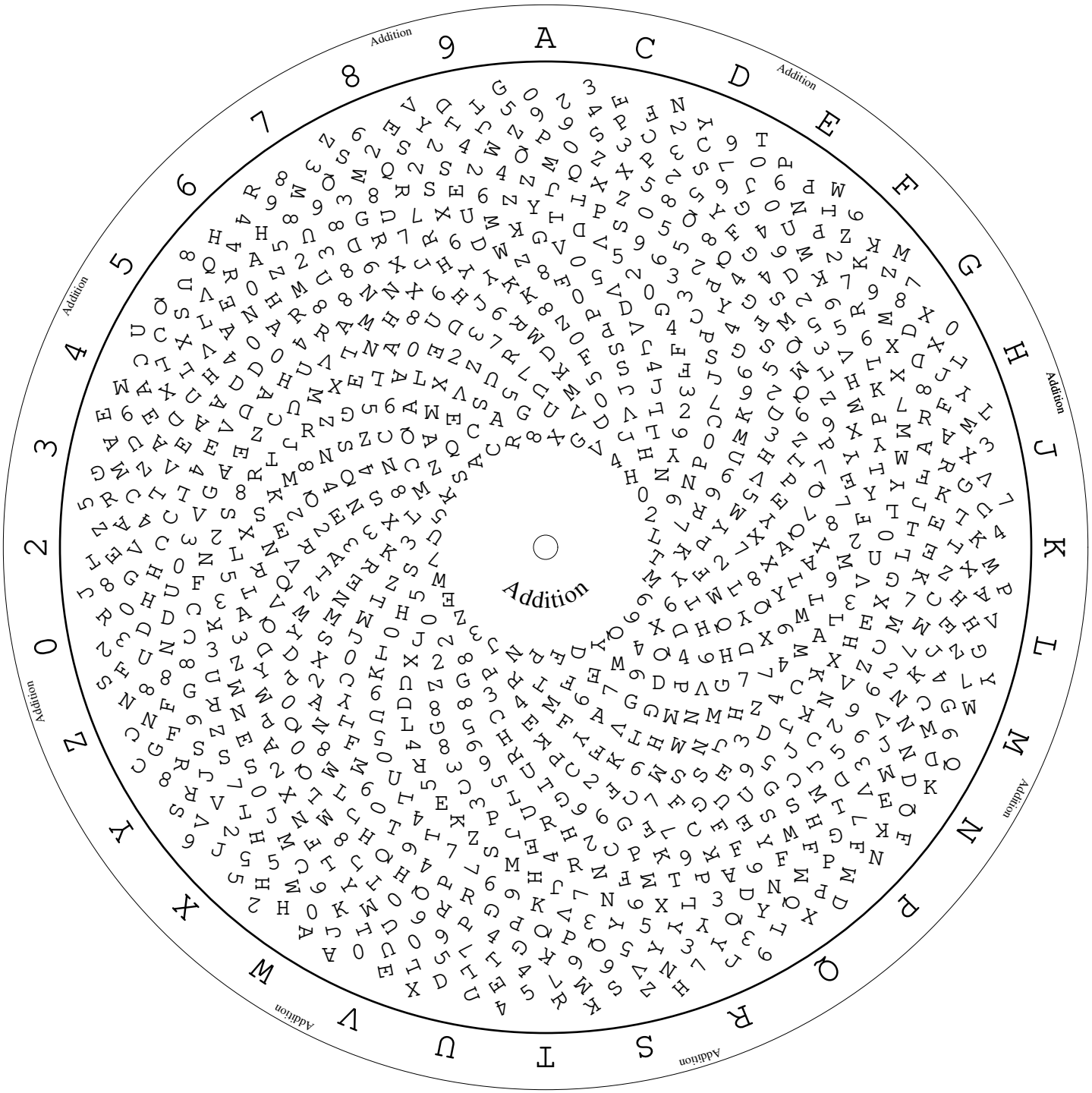
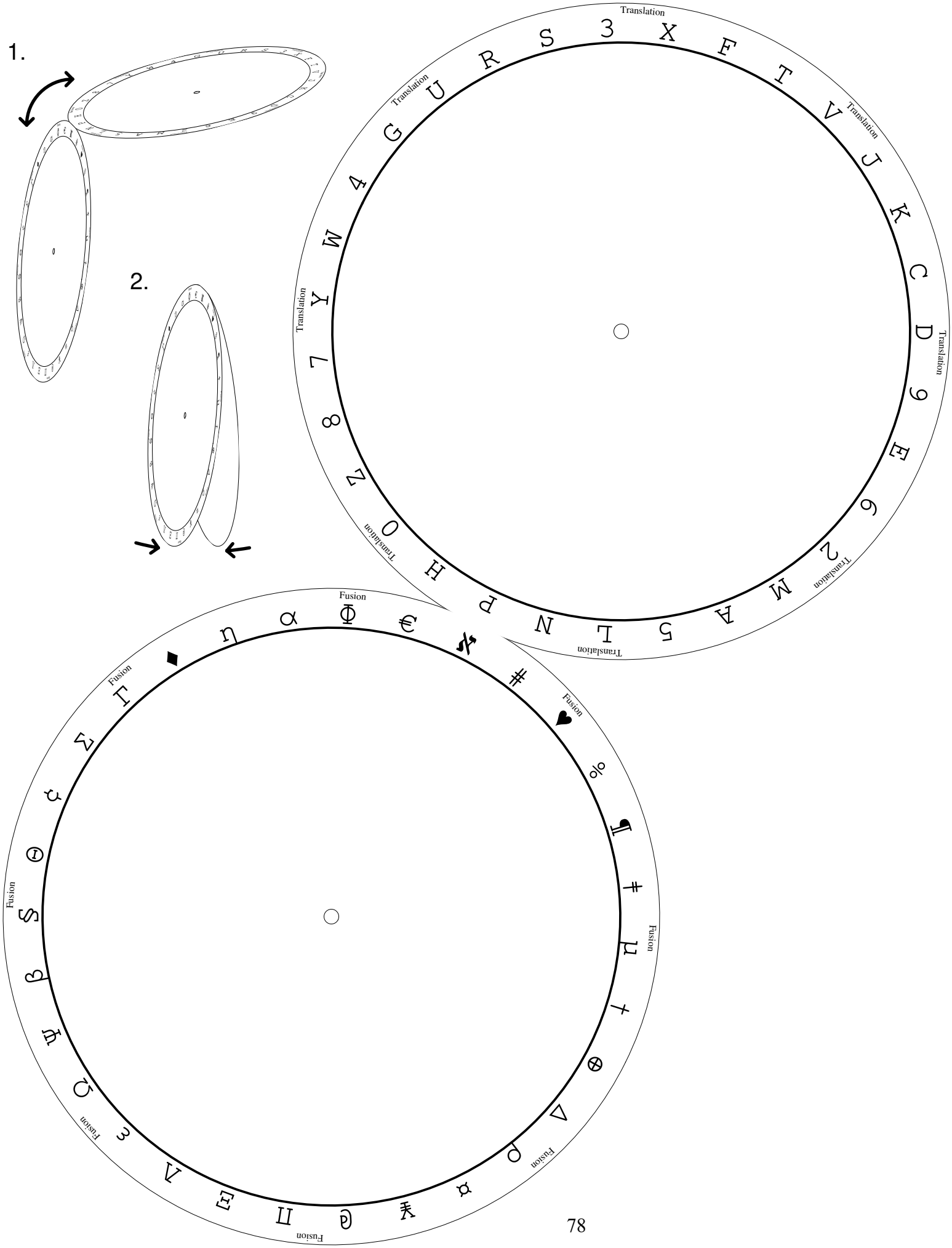
Module 0: Volvelles



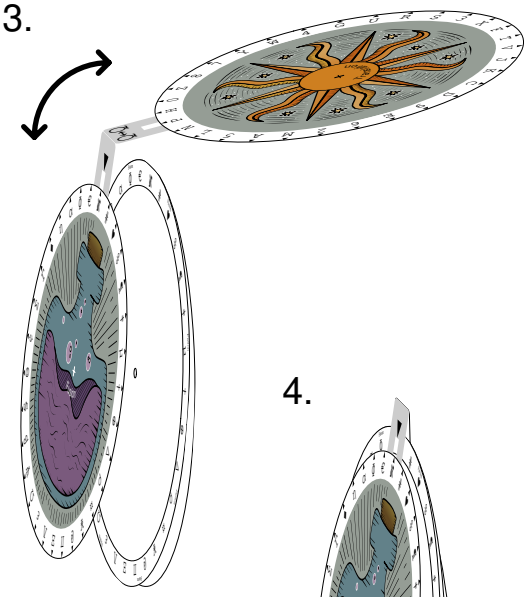

Addition

share to
translate
Recovery

Recovery


1.
2.
Translation
Fusion

3.



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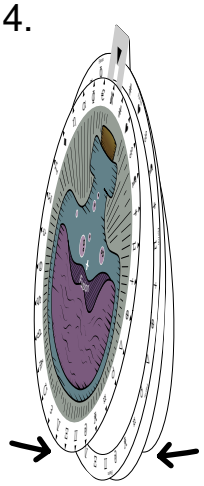

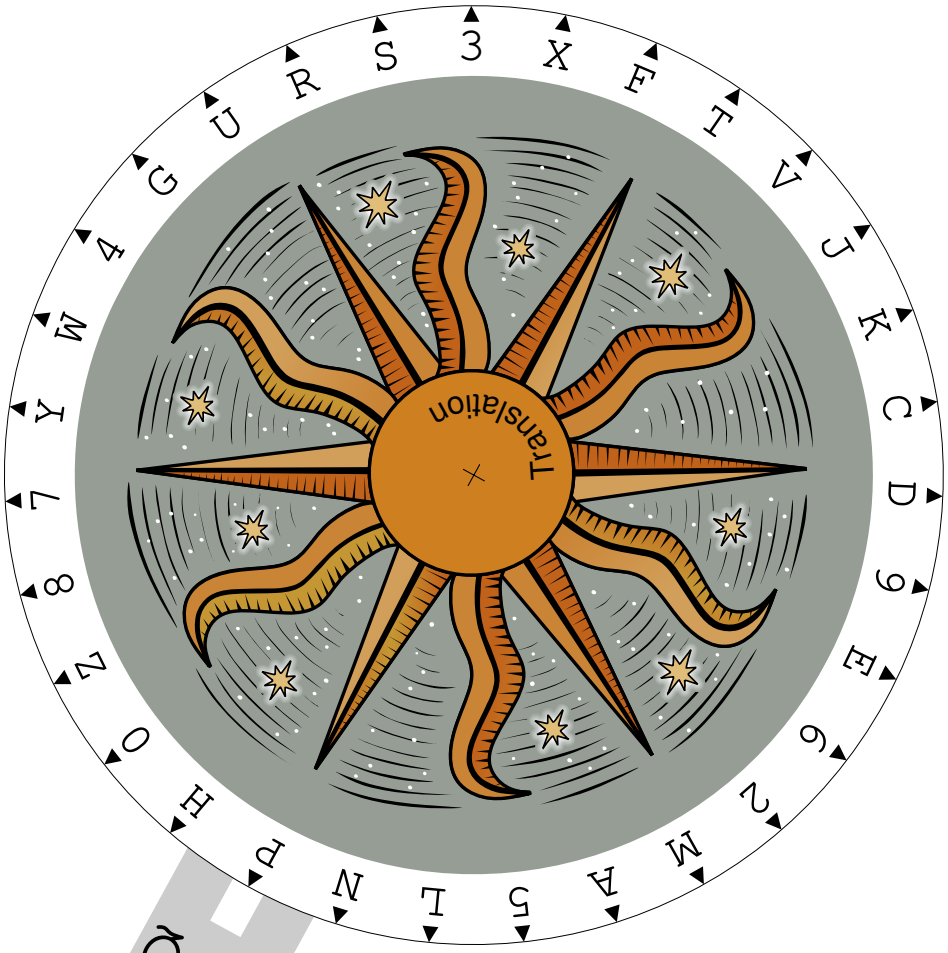

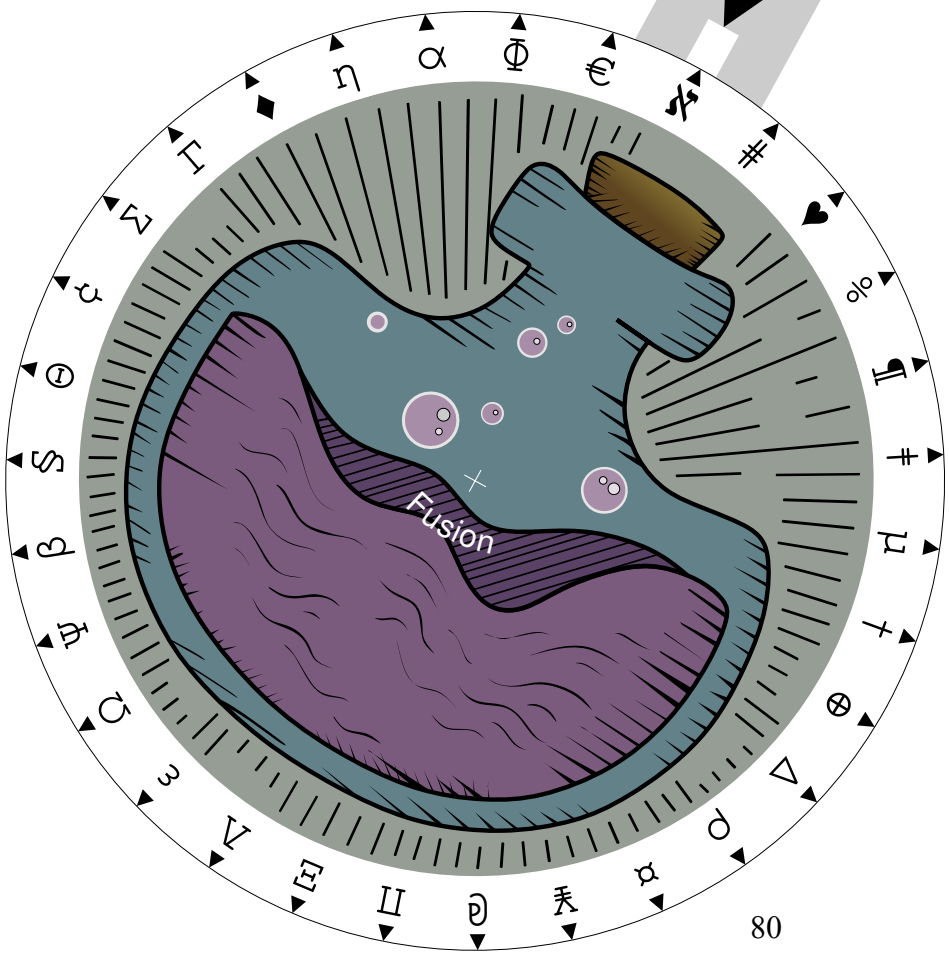

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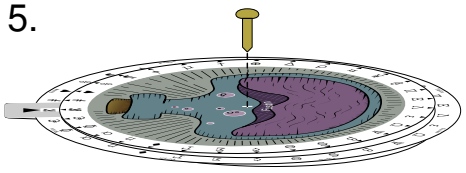

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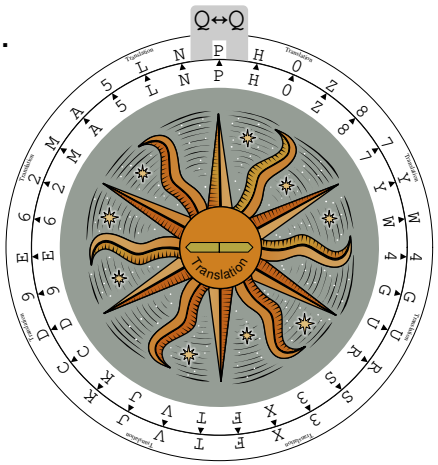

Module 1: Share Booklet

In the common case that your threshold value `k` is 2, there is a much faster way to generate shares rather than using the translation worksheet and the volvelles.

In this case, your two initially generated shares will be `A` and `C`. To generate further shares, go through the characters of your `A` share one by one. For each character, find the table labeled by the character, and then find the row labeled by the corresponding character of your `C` share.

All of the corresponding characters for the `D`, `E`, `F`, and additional, shares can be read off of this row in the correspondingly labeled column.

We have removed the `S` share from these tables since this share contains your secret data. If you want to generate the `S` share, you must use the recovery process.

Page: **A**

	C	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**	**P**	**Q**	**R**	**T**	**U**	**V**	**W**	**X**	**Y**	**Z**	**0**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A	A
C	P	F	K	8	S	R	6	5	L	3	D	M	V	U	Q	0	7	E	9	Z	T	W	H	2	Y	N	X	G	J	4
D	U	0	E	M	7	X	H	R	8	N	J	6	L	S	3	G	2	Q	P	T	4	9	5	C	V	F	K	Z	Y	W
E	H	D	U	G	R	9	T	W	0	2	Q	Z	F	5	7	J	X	S	6	V	L	M	4	K	N	C	P	Y	3	8
F	K	L	C	W	Q	7	P	S	4	Y	0	9	T	E	J	8	3	D	X	6	H	R	U	N	Z	V	2	M	G	5
G	Q	M	J	P	N	C	S	2	9	L	Z	U	W	3	V	6	F	Y	E	5	R	K	7	0	4	8	D	H	T	X
H	V	U	T	Q	8	G	N	0	E	9	5	3	K	L	W	S	M	4	Y	2	C	J	F	6	X	P	Z	7	R	D
J	S	G	Q	6	2	K	5	X	M	F	Y	H	8	7	N	Z	C	3	U	4	W	P	R	D	L	0	E	T	V	9
K	6	C	P	0	5	W	Z	4	F	7	E	G	N	H	S	D	R	U	M	Y	V	8	T	X	3	2	9	J	Q	L
L	C	4	F	R	J	3	K	Q	5	Z	8	X	H	D	G	W	Y	0	2	P	U	7	E	V	6	T	N	9	M	S
M	J	9	G	K	V	F	Q	N	X	4	6	E	R	Y	T	P	L	Z	D	S	7	C	3	8	5	W	0	U	H	2
N	X	V	2	4	E	S	9	U	T	J	F	W	Z	K	D	L	Q	C	R	M	6	5	P	3	G	Y	7	8	0	H
P	Z	K	6	D	4	8	Y	L	C	R	U	J	2	T	5	E	W	H	G	3	N	0	V	9	7	X	M	Q	S	F
Q	5	J	S	Z	X	P	4	9	G	C	3	T	0	R	2	Y	K	7	H	L	8	6	W	E	F	D	U	V	N	M
R	8	7	W	N	6	T	0	Z	3	U	X	F	Q	M	P	2	H	9	L	D	J	V	G	5	E	S	4	C	K	Y
S	4	Q	5	Y	9	6	L	M	J	K	7	V	D	W	X	3	P	R	T	F	0	Z	8	U	C	E	H	N	2	G
T	N	H	V	S	0	J	2	D	U	M	4	7	P	F	8	5	G	L	3	X	K	Q	C	Z	9	6	Y	R	W	E
U	T	E	H	J	W	M	V	8	D	X	S	Y	C	4	R	Q	9	5	Z	N	F	G	L	P	2	K	6	3	7	0
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W	0	R	8	2	Z	V	D	Y	7	H	9	C	S	G	6	X	T	M	F	E	Q	N	J	4	U	5	L	K	P	3
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5	L	S	4	3	M	Z	F	G	Q	P	R	N	E	8	9	7	6	W	V	C	D	Y	0	H	K	U	T	2	X	J
6	Y	P	Z	E	L	0	3	F	K	W	H	Q	X	V	4	U	8	T	J	7	2	D	N	M	R	9	G	S	5	C
7	W	3	R	V	P	H	8	6	Y	E	2	L	J	9	K	N	U	X	4	0	G	T	M	S	D	Q	5	F	C	Z
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9	G	X	M	C	T	L	J	V	2	5	P	D	7	Z	H	K	4	6	0	Q	3	F	Y	W	S	R	8	E	U	N

Page: **C**

	C	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**	**P**	**Q**	**R**	**T**	**U**	**V**	**W**	**X**	**Y**	**Z**	**0**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
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Page: **D**

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H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H	H
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C	R	N	Y	0	G	8	U	Q	K	2	M	7	E	S	P	L	5	6	T	9	H	A	X	4	F	W	D	3	V	Z
D	7	4	T	N	X	Z	3	H	W	G	Y	L	2	U	S	C	Q	R	0	V	F	K	9	8	P	5	A	M	6	E
E	4	H	W	Q	M	P	D	6	X	3	K	8	U	C	L	Z	V	N	5	T	R	G	Y	F	7	9	2	A	0	S
F	5	9	2	X	C	6	8	Y	U	L	E	Q	7	4	N	H	M	W	G	A	T	S	D	V	0	3	P	Z	K	R
G	Z	P	Q	F	T	U	K	7	V	Y	5	E	M	A	D	2	R	8	H	N	L	9	0	S	C	6	X	W	4	3
H	W	X	E	G	L	V	4	M	S	7	Z	5	R	N	0	Q	3	K	2	D	Y	P	C	9	T	U	F	8	A	6
J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J	J
K	C	Z	N	8	V	2	Y	P	Q	9	0	D	X	M	3	A	F	L	4	R	S	5	6	E	U	H	W	T	7	G
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N	Y	K	C	A	P	5	R	G	Z	F	L	T	H	6	V	0	2	M	D	U	X	8	S	W	9	E	4	7	3	Q
P	Q	V	G	9	D	R	Z	T	3	C	2	H	L	8	4	F	Y	5	X	K	0	U	A	6	N	M	S	E	W	7
Q	K	G	Z	2	7	9	N	3	P	R	8	W	6	0	T	5	U	A	E	C	M	F	L	X	Y	S	H	4	D	V
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Page: **K**

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S	J	2	Z	C	G	5	K	Y	E	T	X	4	9	U	3	Q	6	N	7	H	V	R	P	0	A	D	M	F	W	8
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V	D	P	9	G	Q	W	0	X	U	4	8	6	J	2	C	Y	F	E	T	M	Z	3	S	H	7	K	A	5	R	N
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D	W	6	K	P	E	T	G	N	5	0	S	7	X	8	C	4	Z	M	Y	A	L	R	Q	F	J	2	H	V	U	9
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X	9	3	A	2	J	Q	R	C	L	Y	M	4	D	V	N	7	F	S	0	K	5	G	T	Z	E	P	U	8	H	W
Y	Q	E	F	5	A	V	G	9	K	M	P	W	8	U	X	D	S	Z	C	2	4	T	0	N	7	H	J	L	3	R
Z	0	P	U	L	V	C	4	T	D	N	X	2	E	9	S	3	J	A	G	8	K	W	R	F	H	Y	Q	7	M	5
0	8	U	4	X	5	L	H	D	Z	C	9	M	F	K	T	A	W	R	7	N	Y	3	E	G	J	Q	2	S	V	P
2	M	G	7	U	E	P	S	Y	Q	5	4	A	C	H	K	0	D	8	X	V	J	Z	N	L	T	W	3	9	R	F
3	A	L	X	G	N	F	9	J	W	E	7	0	5	S	H	2	Y	M	U	R	T	Q	V	P	K	D	Z	4	8	C
4	H	0	8	A	D	3	N	P	U	W	R	S	Q	E	5	9	L	K	M	J	F	X	Y	2	C	G	7	V	T	Z
5	P	T	D	J	7	H	Z	M	V	4	W	F	9	3	2	C	8	L	Y	U	A	N	X	K	0	R	E	Q	G	S
6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6	6
7	S	2	M	0	Y	Z	V	F	G	D	8	9	W	N	E	4	P	H	A	T	C	U	J	3	5	L	X	R	K	Q
8	N	4	H	9	P	X	J	Z	0	L	K	V	G	Y	D	R	3	E	S	C	Q	A	F	7	W	2	M	T	5	U
9	K	A	R	M	W	2	E	L	X	Q	V	H	Z	5	C	S	G	T	8	Y	P	7	D	0	F	U	4	N	J	3

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	C	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**	**P**	**Q**	**R**	**T**	**U**	**V**	**W**	**X**	**Y**	**Z**	**0**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
A	D	J	Q	0	Z	5	Y	E	8	6	F	U	3	X	4	S	L	9	K	V	T	G	C	N	W	R	H	2	M	P
C	3	X	T	4	0	2	R	S	9	K	E	6	Q	8	G	Z	U	P	W	N	A	M	J	Y	H	D	V	L	5	F
D	V	Q	Y	F	P	0	W	8	A	5	X	M	N	T	E	9	G	C	2	6	R	S	3	K	L	H	U	4	Z	J
E	8	Z	P	6	U	V	J	2	4	D	5	R	9	0	K	L	Y	G	3	A	F	W	S	C	Q	X	T	N	H	M
F	X	S	9	U	L	H	C	5	0	R	M	Y	8	Z	6	2	N	4	D	T	P	K	E	A	3	J	Q	V	W	G
G	S	5	0	N	V	3	F	W	L	C	K	A	Z	2	Y	H	T	U	J	9	4	R	M	P	X	E	8	Q	D	6
H	U	N	K	J	C	P	2	T	R	Z	Q	S	6	Y	X	A	E	D	0	M	W	8	V	5	4	L	G	F	9	3
J	Q	8	A	G	4	L	D	Z	P	W	S	K	T	9	M	0	6	F	H	Y	C	5	X	R	V	3	N	U	2	E
K	2	H	U	A	T	8	M	3	N	E	D	F	L	V	C	Q	P	Y	S	4	6	J	W	G	Z	5	0	9	X	R
L	G	6	5	3	D	C	0	Y	W	9	N	8	M	K	Q	R	X	H	P	S	2	T	U	Z	F	4	E	J	A	V
M	Z	2	4	Y	N	Q	E	H	U	J	W	C	0	L	R	V	A	6	X	P	G	D	5	F	8	S	9	T	3	K
N	K	R	H	8	X	E	U	C	3	4	A	0	W	D	9	J	Z	Q	G	2	V	P	Y	L	M	6	5	S	F	T
P	J	E	8	L	2	W	A	M	Z	Y	G	N	X	S	U	5	V	0	R	Q	9	6	F	T	D	C	3	H	K	4
Q	Y	A	D	S	E	G	V	P	J	L	9	2	R	C	Z	F	5	X	U	W	3	0	T	H	6	N	K	M	4	8
R	H	3	N	P	9	Z	K	X	T	M	J	G	V	Q	F	8	4	A	5	U	Y	E	D	6	2	W	L	0	S	C
S	9	0	F	K	6	N	X	L	G	3	2	D	P	4	W	U	R	M	Q	C	E	H	Z	J	T	8	A	Y	V	5
T	R	C	3	Z	S	M	N	F	X	U	P	L	D	J	0	E	2	8	6	H	Q	4	A	V	K	Y	W	5	G	9
U	M	K	2	Q	3	J	4	R	H	P	Y	9	5	W	T	D	8	V	F	Z	L	A	6	0	E	G	S	X	C	N
V	6	Y	W	X	J	F	L	A	D	0	T	Z	K	R	8	C	S	3	4	5	H	9	N	2	G	U	M	E	P	Q
W	L	V	6	C	A	9	5	Q	Y	S	3	E	U	N	J	T	F	R	Z	G	K	X	H	M	0	2	4	P	8	D
X	T	9	C	M	G	U	3	0	F	H	Z	W	A	P	5	4	K	E	V	R	J	2	8	D	N	Q	Y	6	L	S
Y	W	D	V	9	8	S	6	J	Q	G	C	4	H	3	P	X	0	T	M	L	N	F	R	U	5	K	2	Z	E	A
Z	P	4	E	W	K	Y	8	U	M	Q	L	3	F	G	H	6	D	5	T	J	S	V	0	X	A	9	C	R	N	2
0	F	G	S	H	W	R	9	6	5	T	U	Q	E	M	V	K	3	2	A	X	Z	N	4	8	C	P	J	D	Y	L
2	4	U	M	D	R	A	Z	N	K	8	V	X	G	6	3	Y	J	W	9	E	5	Q	L	S	P	0	F	C	T	H
3	N	T	R	E	F	4	H	9	C	2	8	5	Y	A	S	P	M	J	L	K	D	Z	Q	W	U	V	6	G	0	X
4	E	M	Z	V	H	D	P	K	2	A	6	T	S	5	N	W	Q	L	C	8	0	Y	G	9	J	F	X	3	R	U
5	0	L	G	R	Y	T	S	V	6	X	H	J	4	U	D	N	C	K	8	F	M	3	2	E	9	Z	P	A	Q	W
6	5	W	L	T	Q	X	G	D	V	F	R	P	2	H	A	3	9	N	E	0	U	C	K	4	S	M	Z	8	J	Y
7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7	7
8	A	P	J	5	M	6	Q	4	E	V	0	H	C	F	2	G	W	S	N	D	X	L	9	3	Y	T	R	K	U	Z
9	C	F	X	2	5	K	T	G	S	N	4	V	J	E	L	M	H	Z	Y	3	8	U	P	Q	R	A	D	W	6	0

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	C	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**	**P**	**Q**	**R**	**T**	**U**	**V**	**W**	**X**	**Y**	**Z**	**0**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
A	H	5	4	U	7	F	R	T	E	3	P	V	W	G	C	L	K	J	Z	X	2	S	6	9	D	0	N	M	Q	Y
C	T	Q	7	X	N	H	Y	Z	M	A	3	2	L	F	9	D	4	K	6	E	U	R	S	J	5	P	G	W	0	V
D	K	X	3	6	A	J	F	4	R	L	W	T	V	9	5	2	P	0	7	S	Z	G	N	Q	U	M	C	Y	E	H
E	A	Y	5	F	Q	3	4	C	T	X	U	N	6	P	M	S	D	L	9	H	G	K	J	W	R	2	0	Z	V	7
F	U	K	S	0	R	2	L	X	3	G	N	5	C	V	H	9	6	Z	E	P	Q	W	M	T	J	7	Y	A	4	D
G	2	J	6	Q	S	V	W	U	P	N	7	D	A	Y	F	C	Z	T	X	0	5	M	E	H	9	4	R	3	K	L
H	X	4	R	P	Y	U	D	E	A	F	G	Q	9	2	T	J	S	6	M	3	0	L	W	Z	K	N	V	C	7	5
J	6	P	G	M	F	Z	2	S	L	9	C	X	5	T	K	Q	N	7	R	W	E	V	Y	4	0	A	H	D	3	U
K	S	3	F	W	H	6	U	R	D	J	9	E	Q	Z	4	0	G	N	Y	L	M	2	V	7	P	C	T	5	A	X
L	J	U	P	Z	3	9	G	K	S	W	M	H	Y	C	D	V	0	Q	4	6	T	N	7	5	2	E	A	R	X	F
M	C	V	Q	H	0	A	7	9	Z	E	X	G	S	3	W	R	5	D	J	T	F	4	K	L	Y	U	P	6	2	N
N	V	9	Z	5	6	Y	M	2	0	7	4	L	3	R	G	A	T	H	U	Q	D	E	X	F	C	K	S	P	J	W
P	G	L	J	V	K	N	6	F	U	0	Q	R	E	7	3	M	9	C	H	2	Y	Z	T	A	W	5	4	X	D	S
Q	7	M	C	R	9	4	T	N	V	5	D	6	U	K	0	X	A	3	G	Y	S	H	F	P	E	L	J	2	W	Z
R	D	H	X	J	E	L	3	5	4	S	6	C	N	W	Y	G	U	2	Q	K	9	P	0	V	F	Z	M	7	T	A
S	L	F	U	9	X	W	P	D	K	6	Z	A	7	M	R	N	2	V	5	J	C	0	Q	Y	G	T	E	4	H	3
T	E	7	Y	3	V	X	5	M	C	H	F	0	J	U	Z	K	R	S	W	A	P	D	L	6	4	G	2	9	N	Q
U	P	S	L	N	D	0	J	3	F	2	V	4	T	Q	X	Z	W	M	A	G	7	9	C	E	6	Y	5	H	R	K
V	Q	Z	M	4	W	5	C	0	N	Y	R	J	F	D	2	H	E	X	P	7	K	A	3	U	T	S	L	G	6	9
W	9	2	0	T	P	C	N	J	6	M	E	F	R	A	L	Y	Q	5	K	Z	H	7	4	D	V	X	3	S	U	G
X	3	R	D	G	5	P	K	A	H	U	2	7	Z	0	E	6	L	W	C	F	N	J	9	M	S	V	Q	T	Y	4
Y	5	T	E	K	M	D	A	Q	7	R	S	9	G	L	V	F	X	U	0	4	J	3	P	2	H	6	W	N	Z	C
Z	M	N	V	A	2	E	Q	W	9	T	H	P	K	X	6	4	Y	R	L	C	3	5	D	S	7	F	U	J	G	0
0	N	W	9	Y	J	7	Z	G	2	Q	5	S	X	4	P	E	C	A	F	V	R	T	H	3	M	D	K	U	L	6
2	0	6	W	7	L	Q	9	P	G	V	Y	K	H	5	U	T	M	E	3	N	4	C	A	X	Z	R	D	F	S	J
3	F	D	K	2	4	G	S	H	X	P	0	Y	M	N	A	W	J	9	T	U	V	6	Z	C	L	Q	7	E	5	R
4	R	A	H	L	T	S	X	Y	5	K	J	M	0	6	7	P	F	G	V	D	W	U	2	N	3	9	Z	Q	C	E
5	4	E	A	S	C	K	H	7	Y	D	L	Z	2	J	Q	U	3	P	N	R	6	F	G	0	X	W	9	V	M	T
6	W	G	2	C	U	M	0	L	J	Z	T	3	4	E	S	7	V	Y	D	9	A	Q	5	R	N	H	X	K	F	P
7	Y	C	T	D	Z	R	E	V	Q	4	K	W	P	S	N	3	H	F	2	5	L	X	U	G	A	J	6	0	9	M
8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8	8
9	Z	0	N	E	G	T	V	6	W	C	A	U	D	H	J	5	7	4	S	M	X	Y	R	K	Q	3	F	L	P	2

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	C	**D**	**E**	**F**	**G**	**H**	**J**	**K**	**L**	**M**	**N**	**P**	**Q**	**R**	**T**	**U**	**V**	**W**	**X**	**Y**	**Z**	**0**	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**
A	S	7	R	Q	N	8	2	5	J	V	E	4	X	6	0	W	D	Z	H	C	F	3	U	K	G	M	L	P	Y	T
C	V	2	G	6	7	E	D	A	S	Q	F	N	H	M	J	U	W	X	0	8	L	Z	K	P	3	4	Y	5	T	R
D	3	V	8	X	S	U	Q	2	G	Z	K	J	Y	H	R	M	6	L	T	W	P	F	4	N	E	0	5	7	A	C
E	6	W	Z	4	D	L	U	8	Q	M	Y	2	J	N	V	P	K	0	S	F	T	H	5	A	X	7	R	C	G	3
F	M	U	X	N	W	Y	K	E	6	4	T	D	S	7	Q	5	P	J	V	L	R	0	A	C	H	2	G	8	3	Z
G	D	C	V	U	A	Z	8	R	2	W	X	5	4	K	7	F	E	M	N	3	H	6	L	Y	Q	P	0	T	J	S
H	P	L	4	A	F	J	Y	X	K	5	S	E	D	C	U	R	T	2	W	0	V	7	G	3	N	8	Q	Z	6	M
J	A	T	7	8	Y	V	R	0	5	C	Q	L	U	E	P	3	G	W	K	S	6	D	Z	X	2	F	M	H	4	N
K	H	M	L	J	6	5	4	U	X	0	A	Q	G	S	Z	7	N	R	3	P	C	T	2	D	Y	V	8	W	E	F
L	4	K	H	7	U	T	P	F	M	N	R	W	V	2	6	A	5	S	Q	Y	G	J	C	8	0	D	3	E	Z	X
M	L	X	K	T	Z	N	H	6	F	Y	7	3	C	R	E	J	0	A	8	4	2	5	S	V	P	G	D	Q	W	U
N	T	0	5	G	H	2	J	4	Y	R	D	X	E	3	L	V	S	8	F	7	W	C	Q	6	A	Z	U	M	K	P
P	0	4	Y	S	M	A	N	K	H	J	C	6	3	V	X	2	7	G	Z	5	8	R	D	W	T	Q	E	U	F	L
Q	E	3	W	L	G	M	Z	V	8	F	4	R	5	Y	C	H	X	P	A	6	N	K	0	J	U	T	7	S	2	D
R	2	A	S	W	5	3	C	T	7	D	Z	P	M	U	N	E	8	6	4	G	X	Q	F	L	V	K	H	Y	0	J
S	C	R	2	E	T	Q	G	J	A	8	6	Y	K	F	5	Z	3	U	P	V	M	W	X	H	D	L	4	0	N	7
T	7	5	J	D	P	G	A	Y	N	2	3	K	6	W	4	8	C	Q	M	R	Z	V	E	F	S	U	X	L	H	0
U	X	6	F	0	Q	P	M	W	Z	H	5	V	R	J	3	N	4	T	G	K	A	Y	7	2	L	S	C	D	8	E
V	8	G	D	F	R	6	3	S	C	E	M	T	P	L	A	X	Z	K	5	Q	4	U	H	0	W	Y	N	J	7	2
W	Z	Q	E	H	V	K	6	D	3	X	P	S	T	0	G	4	M	Y	R	U	5	L	N	7	F	J	A	2	C	8
X	K	F	M	5	E	0	L	Z	U	P	J	8	2	A	W	T	Y	7	D	H	S	N	R	G	4	C	V	3	Q	6
Y	N	P	0	2	K	R	5	L	4	7	G	U	Q	D	M	C	A	V	6	T	3	S	8	E	J	W	Z	F	X	H
Z	U	E	6	P	8	H	F	3	W	K	0	C	7	5	D	Y	L	N	2	X	J	4	T	R	M	A	S	G	V	Q
0	5	Y	N	C	L	S	T	H	P	A	V	F	W	8	K	G	R	D	U	J	Q	2	3	Z	7	E	6	X	M	4
2	G	S	C	Z	J	W	V	7	R	3	U	0	L	X	T	6	Q	F	Y	D	K	E	M	4	8	H	P	N	5	A
3	W	8	Q	K	C	X	E	G	D	U	H	A	N	P	2	L	F	4	7	Z	0	M	Y	T	6	5	J	R	S	V
4	Y	H	P	R	X	7	0	M	L	T	2	Z	8	G	F	S	J	C	E	N	D	A	V	Q	5	3	W	6	U	K
5	J	N	T	V	4	C	7	P	0	S	8	M	Z	Q	H	D	2	3	X	A	E	G	W	U	R	6	F	K	L	Y
6	F	Z	U	Y	3	4	X	Q	E	L	N	G	A	T	8	0	H	5	C	M	7	P	J	S	K	R	2	V	D	W
7	R	J	A	3	0	D	S	N	T	G	W	H	F	Z	Y	Q	V	E	L	2	U	8	6	M	C	X	K	4	P	5
8	Q	D	3	M	2	F	W	C	V	6	L	7	0	4	S	K	U	H	J	E	Y	X	P	5	Z	N	T	A	R	G
9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9

Module 2: Extra Share Generation Tables

The main instructional section contains share derivation tables for *k* values of two or three, assuming that initially generated shares are `A`, `C`, and (sometimes) `D`. This page provides tables for higher *k* values; the next provides tables for the case where your `S` share is an initial one.

Even higher values of *k* can be obtained by editing the PostScript source of this document. Search for the text `EDITME` to find the right section.

We caution users that higher *k* values, in our view, are a bad trade-off between usability and robustness (which are damaged) and security (which is improved).

k = 4	F	G	H	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	Z	0	2	3	4	5	6	7	8	9
A	Δ	Σ	†	#	ǂ	¶	†	Γ	¤	†	Π	β	Δ	€	¶	Δ	Ş	Ψ	Ψ	ε	Ψ	μ	@	ρ	Γ	¢	¥	Γ
C	Ξ	Ω	ǂ	Π	ε	♦	Γ	Σ	Π	Ş	Γ	Φ	ρ	♦	Δ	Ψ	Ş	η	¶	Ş	♦	Γ	Ξ	♥	Π	Λ	†	Θ
D	♦	Ξ	Π	ǂ	¢	η	β	⚷	♦	Δ	Σ	%	¥	β	€	Φ	Ψ	Ψ	⚷	ρ	€	†	#	♦	€	Ψ	Ş	Θ
E	Ω	¢	Π	Δ	Λ	Δ	Ş	μ	Ξ	α	η	⊕	♥	Ξ	Σ	ǂ	Ω	ε	ρ	¥	¤	¢	Ξ	ρ	♦	ρ	Ω	Δ

k = 5	G	H	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	Z	0	2	3	4	5	6	7	8	9
A	Ş	€	%	¶	@	ε	Φ	€	β	ε	Γ	%	Ψ	ρ	♥	Λ	♦	⚷	⚷	ǂ	Π	⚷	¤	¢	Ψ	♥	ǂ
C	⚷	@	#	#	β	β	@	Ω	Ψ	@	Ψ	β	⚷	⚷	α	#	Ψ	#	β	α	Ω	Ω	Ψ	α	α	@	Ω
D	Ş	Ξ	Λ	⚷	Π	⊕	@	¢	⚷	ǂ	ε	Ξ	Ω	Π	⚷	¢	¶	Ş	♥	Γ	Σ	α	ǂ	μ	Σ	β	¤
E	¶	Ş	♦	€	♥	Ξ	Γ	Ω	Γ	Π	α	¤	Ψ	Π	@	α	⊕	μ	ρ	¥	Ξ	ε	♦	⊕	Ş	¢	¶
F	¶	#	Ω	⊕	β	¥	μ	β	€	α	Ω	Δ	Ω	ρ	Φ	Π	Ξ	Δ	Ω	μ	⊕	¢	Π	Δ	⚷	†	Σ

k = 6	H	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	Z	0	2	3	4	5	6	7	8	9
A	Δ	Ω	†	β	♦	¤	¢	Ψ	Δ	@	⚷	€	¥	η	ε	ε	Π	¶	ρ	€	¥	Δ	@	⊕	⊕	¢
C	η	β	⊕	⚷	♥	€	Ξ	Θ	Δ	¤	Ş	Ξ	μ	♦	μ	Π	Ψ	α	μ	†	%	Ş	Θ	Ş	¢	Δ
D	⊕	Π	ε	¶	⚷	Δ	€	@	¤	Ψ	♦	¥	€	⊕	†	Δ	Ω	β	@	¢	¢	ε	ρ	η	Δ	¥
E	ǂ	Ξ	†	Π	Φ	¥	Λ	Φ	¤	Ş	@	¶	Ş	¥	%	¶	Γ	Ψ	Θ	ǂ	%	Φ	%	Ξ	%	η
F	%	Γ	%	Ψ	@	¤	ǂ	Ş	¥	Φ	Φ	Ş	¶	Ξ	†	Φ	Ξ	Π	%	Λ	η	¶	Θ	¥	ǂ	%
G	¢	Ψ	μ	α	Ş	Δ	†	¤	€	Θ	♥	μ	Ξ	Ş	⊕	Ş	β	⚷	Θ	Ξ	Δ	Π	μ	♦	η	%

k = 7	J	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	Z	0	2	3	4	5	6	7	8	9
A	Ş	#	ǂ	%	€	Φ	¥	μ	%	Ξ	⊕	¤	Φ	Φ	¥	⚷	Δ	⊕	ρ	%	¢	ε	Ω	Ş	€
C	⚷	ρ	Σ	Ω	♦	Φ	¢	Π	Δ	@	#	@	ǂ	♦	ε	@	ρ	¥	♦	♥	¥	%	⊕	@	Σ
D	Λ	ρ	Ψ	†	η	¶	ǂ	†	⊕	Δ	β	α	Δ	Ω	%	%	Σ	ρ	♥	@	€	@	ǂ	Ş	Ω
E	⚷	Π	¥	Ψ	@	¶	¶	Ş	Σ	ρ	♦	♥	η	α	¥	Σ	μ	♥	Φ	†	Γ	β	†	Φ	Λ
F	⊕	⊕	Ξ	#	ρ	Θ	Γ	β	€	Σ	ρ	Π	α	€	¶	¥	€	¥	†	Φ	Φ	μ	♥	Φ	Ş
G	♦	¶	ε	♥	#	ε	⊕	⚷	Λ	Ş	Ψ	Ω	η	Σ	β	ρ	Δ	Σ	€	¶	#	Π	Δ	@	Π
H	#	†	♥	α	β	Φ	⊕	β	⊕	α	Ξ	Ξ	@	†	ρ	#	♥	Γ	Φ	Ψ	ρ	Γ	@	⚷	Ψ

k = 8	K	L	M	N	P	Q	R	S	T	U	V	W	X	Y	Z	0	2	3	4	5	6	7	8	9
A	α	ε	Ş	#	#	η	♦	♥	Γ	%	⊕	Ş	%	♦	Ş	Ξ	Ş	#	#	¤	ρ	%	Ξ	⚷
C	Φ	α	α	β	Σ	€	♦	⚷	Ξ	Ψ	♥	β	¢	¢	♦	⊕	ε	Δ	¢	¢	Ψ	Λ	€	ε
D	♥	η	Ş	Γ	%	Λ	¢	%	Ξ	¤	Ş	α	Ψ	@	β	♦	Ψ	β	†	Π	♥	ε	¤	Ξ
E	Σ	†	β	Φ	Ş	♥	Σ	μ	%	¶	@	♥	Λ	Δ	α	♦	Φ	%	Ψ	η	η	μ	μ	⚷
F	α	β	¥	ǂ	Ω	♥	♥	Θ	η	Φ	¶	@	α	¤	♦	Φ	Ω	Θ	β	ρ	¢	¤	Λ	Ξ
G	Θ	β	¤	Γ	¤	Π	¤	μ	Θ	ǂ	μ	ρ	β	Γ	Θ	μ	α	¥	Σ	¤	Φ	Λ	Φ	μ
H	¢	%	¶	¤	Ş	¥	Φ	η	η	€	#	Γ	#	@	¤	α	η	Δ	μ	Ω	†	Ω	Π	Δ
J	α	Π	#	¶	⚷	α	@	Γ	⊕	β	ρ	¤	Ξ	#	Π	%	Ψ	ǂ	μ	β	Γ	Ψ	Δ	Θ

These tables allow you to generate shares in the case that your S share is an initial share.

k = 2	C	D	E	F	G	H	J	K	L	M	N	P	Q	R	T	U	V	W	X	Y	Z	0	2	3	4	5	6	7	8	9
S	€	Δ	Ξ	Σ	@	η	Ψ	ǂ	Ω	†	Π	¤	Γ	Λ	♥	§	⊕	Θ	♦	Φ	¢	%	β	¶	¥	μ	ε	ρ	α	#
A	¥	Γ	μ	Φ	#	ε	Ω	†	Ψ	ǂ	ρ	⊕	Δ	Θ	♦	¶	¤	Λ	♥	Σ	%	¢	α	§	€	Ξ	η	Π	β	@

k = 3	D	E	F	G	H	J	K	L	M	N	P	Q	R	T	U	V	W	X	Y	Z	0	2	3	4	5	6	7	8	9
S	ρ	Σ	β	ρ	%	%	†	¢	ǂ	†	α	Π	€	¥	Σ	β	¥	€	α	⊕	¤	¤	Φ	🗙	Φ	¢	ǂ	⊕	Π
A	⊕	α	†	¤	μ	Ξ	Θ	μ	Λ	Λ	†	¤	Ω	Ω	β	ǂ	Ψ	Ψ	ǂ	#	@	#	α	🗙	β	Ξ	Θ	@	⊕
C	¢	ρ	¤	%	♥	♦	#	♦	#	@	⊕	¢	η	ε	Π	⊕	η	ε	¤	Ξ	Ξ	μ	Π	🗙	ρ	♥	@	μ	%

k = 4	E	F	G	H	J	K	L	M	N	P	Q	R	T	U	V	W	X	Y	Z	0	2	3	4	5	6	7	8	9
S	¢	ρ	Ξ	μ	#	⊕	#	@	Φ	†	β	Ψ	Γ	†	Λ	α	ρ	Δ	♥	¶	%	Ξ	†	♥	Ω	♥	ρ	#
A	¥	@	#	Γ	Φ	⊕	🗙	Δ	¢	♥	♥	¢	Λ	Ψ	ε	β	Ξ	♥	¤	Θ	Δ	€	¢	Δ	♦	¶	🗙	¤
C	§	@	β	ε	ǂ	Π	Λ	§	Λ	€	ρ	α	¤	Δ	Λ	Σ	Δ	¶	§	β	ρ	¥	Ψ	♦	Δ	Θ	β	♥
D	♦	Π	†	Λ	ε	ρ	†	μ	@	#	Ψ	ε	%	Σ	η	Σ	α	ε	†	€	¶	Ξ	♦	Δ	Ξ	Ξ	Σ	¢

k = 5	F	G	H	J	K	L	M	N	P	Q	R	T	U	V	W	X	Y	Z	0	2	3	4	5	6	7	8	9
S	@	ε	Π	🗙	§	♥	Γ	Ψ	♥	¥	ρ	Θ	🗙	¢	¤	η	α	Θ	🗙	Ψ	§	ǂ	η	Θ	@	β	μ
A	†	Γ	Σ	Ψ	¥	¢	¥	¶	Ψ	Λ	ǂ	¶	%	Ξ	Γ	¢	¥	Θ	Δ	Λ	η	¥	Γ	§	μ	#	†
C	#	†	ρ	β	¥	♥	Ω	Θ	ρ	Ω	¶	Σ	Ω	⊕	¢	¤	⊕	♦	#	¤	%	♥	ǂ	Φ	Ω	Ξ	¢
D	€	Θ	μ	Φ	ǂ	§	🗙	Λ	Δ	Σ	§	@	€	Λ	β	η	Ω	Δ	⊕	♥	%	μ	Λ	#	⊕	Λ	ρ
E	ρ	Ω	Γ	§	ε	Θ	β	ρ	ε	🗙	¥	Θ	@	Φ	Ξ	Π	¶	†	Φ	♥	†	⊕	Ψ	Λ	Ω	#	Λ

k = 6	G	H	J	K	L	M	N	P	Q	R	T	U	V	W	X	Y	Z	0	2	3	4	5	6	7	8	9
S	Δ	#	α	Ξ	μ	€	Ω	Λ	β	⊕	¤	Ξ	Σ	€	ε	€	Φ	Δ	🗙	Σ	Ω	¢	Ξ	¶	ǂ	¥
A	Θ	Λ	§	¤	#	Θ	⊕	†	Φ	⊕	Φ	¢	§	Ω	Ω	Ψ	%	¢	♥	¶	€	♦	Ψ	♥	Θ	Ω
C	β	Ω	†	η	η	@	¤	Π	Λ	¢	%	¢	€	#	Θ	🗙	¢	🗙	@	η	ǂ	Θ	¥	€	§	Ψ
D	α	†	Δ	@	⊕	Ψ	Φ	μ	Ξ	♥	Λ	α	🗙	Θ	🗙	%	€	🗙	α	β	♥	♦	⊕	@	Ξ	€
E	€	#	†	🗙	Ξ	Π	Φ	β	α	€	🗙	ε	Ψ	¢	Σ	♦	%	η	%	€	ρ	¶	Φ	Φ	μ	¤
F	†	β	†	ε	ρ	Ψ	Ω	€	ρ	§	μ	Σ	¢	Λ	Ω	ρ	Π	¥	ǂ	🗙	Σ	🗙	†	Λ	Φ	⊕

k = 7	H	J	K	L	M	N	P	Q	R	T	U	V	W	X	Y	Z	0	2	3	4	5	6	7	8	9
S	¢	Σ	€	Γ	β	¥	§	🗙	¥	β	†	†	ǂ	€	♥	Σ	Γ	ε	§	¤	♥	ε	ǂ	¢	¤
A	♦	ǂ	Π	⊕	🗙	§	🗙	α	🗙	♦	%	¢	¥	Ψ	ρ	ε	η	†	β	¤	Σ	Δ	Θ	α	ǂ
C	#	♦	%	†	♦	α	¤	Ψ	Ψ	¶	†	ǂ	€	η	♦	ρ	⊕	Θ	Λ	§	Σ	μ	¢	🗙	ρ
D	🗙	†	€	Φ	¤	Γ	@	α	⊕	η	Θ	Λ	€	Ξ	⊕	η	Ω	Λ	Ψ	α	†	¥	Λ	¶	🗙
E	Λ	η	⊕	η	α	Λ	Ω	#	η	♥	♥	♦	Θ	€	Θ	Θ	ǂ	@	β	η	†	Σ	¢	ε	%
F	Θ	Π	¥	Δ	β	¢	Ξ	#	ǂ	♦	η	ε	♥	¤	Σ	β	⊕	♥	⊕	α	§	β	α	η	Ω
G	⊕	ǂ	¥	Ξ	Γ	Ω	Π	Ψ	β	η	Δ	Γ	ǂ	Δ	@	Θ	Θ	Ω	¶	†	α	#	⊕	Ξ	Ξ

k = 8	J	K	L	M	N	P	Q	R	T	U	V	W	X	Y	Z	0	2	3	4	5	6	7	8	9
S	μ	%	β	†	ρ	μ	%	Ψ	Π	♦	Λ	ε	§	†	β	Δ	Γ	¤	¥	♦	🗙	Γ	Ξ	α
A	⊕	⊕	Σ	⊕	Δ	μ	§	α	ρ	¥	Θ	Π	🗙	ǂ	%	#	ǂ	🗙	♥	†	@	#	ρ	¥
C	μ	ǂ	🗙	¤	Σ	Γ	β	Σ	η	Σ	¥	Δ	Λ	Φ	¶	§	α	¶	β	Ξ	Ω	ρ	§	Γ
D	Δ	¢	@	Ω	¥	Ω	β	¶	ρ	€	Π	🗙	♦	♥	¥	Θ	@	Φ	Ω	β	Ξ	Γ	Λ	μ
E	¥	Ξ	Γ	Ω	ε	μ	†	μ	€	Σ	†	μ	Σ	€	§	¢	Σ	@	🗙	%	ρ	Ξ	¥	¢
F	α	ε	ǂ	⊕	Θ	#	ǂ	@	§	Λ	η	Ξ	%	€	ε	Σ	¤	€	€	Ξ	¶	Ω	β	†
G	¥	ρ	¶	μ	ρ	Σ	Λ	§	Ξ	Θ	α	¤	Γ	¥	¥	🗙	β	Ψ	♥	Ξ	Δ	Θ	#	♦
H	♥	α	¶	Λ	@	β	🗙	Γ	μ	♥	Δ	¥	¢	ε	Ω	⊕	ǂ	♥	#	⊕	¶	ρ	%	Ξ