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a<sup>n</sup>g<sup>e</sup>.an<sup>p</sup>-debc-delbe<sup>v</sup> fle)c<sup>a</sup>

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# | Contents

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0.1	Introduction . . . . .	5
1	Phonology and orthography . . . . .	7
1.1	Phoneme inventory . . . . .	7
1.2	Hacmisation . . . . .	8
1.3	Phonotactics . . . . .	8
1.4	Stress . . . . .	9
1.5	Vowel harmony . . . . .	9
1.6	Allophony . . . . .	9
1.7	The script of Lek-Tsaro . . . . .	10
2	Syntax . . . . .	15
2.1	Basic word order . . . . .	15
2.2	Questions . . . . .	15
2.3	Multiple clauses . . . . .	15
3	Nouns . . . . .	17
3.1	Number . . . . .	17
3.2	Case . . . . .	17
3.3	Noun classes . . . . .	17
3.3.1	Countable . . . . .	18
3.3.2	Measurable . . . . .	18
3.3.3	Uncountable . . . . .	18
3.4	Definiteness . . . . .	18
3.5	Declension table . . . . .	18
3.5.1	Countable classes . . . . .	18
3.5.2	Measurable classes . . . . .	19
3.5.3	Uncountable classes . . . . .	19
3.6	Pronouns . . . . .	20
3.6.1	Last-clause pronouns . . . . .	21
3.7	Compounding . . . . .	21
3.8	Possession . . . . .	21
4	Verbs . . . . .	23
4.1	Aspect . . . . .	24
4.2	Obliques . . . . .	25
4.3	Conjunctions . . . . .	26

4.4	Subordinate clauses . . . . .	26
4.4.1	Conditions . . . . .	27
4.5	Comparatives . . . . .	27
4.6	Ditransitive-like constructions . . . . .	27
4.7	Transitivisation . . . . .	28
4.8	Clauses with nullary arguments . . . . .	28
4.9	The copula . . . . .	29
5	Descriptors . . . . .	31
5.1	Conversion . . . . .	31
6	Tree mode . . . . .	33
6.1	Activation . . . . .	33
6.2	Branch-switching . . . . .	33
6.3	Anaphoric pronouns in joiner clauses . . . . .	33
6.4	Errors . . . . .	33
6.5	Example . . . . .	34
7	Numerals . . . . .	35
7.1	Single-digit numerals . . . . .	35
7.2	Numerals up to $19 \cdot 17$ . . . . .	35
7.3	Numerals up to $13 \cdot 19 \cdot 17 = 4199$ . . . . .	36
7.4	Numerals up to and including $4199 \cdot (4199 + 1)/2 = 8817900$ . . . . .	36
7.5	Higher numerals . . . . .	37
7.6	Cardinal and ordinal numerals . . . . .	38
8	Derivational morphology . . . . .	39
8.1	Abstraction . . . . .	39
8.2	Dematuration . . . . .	39
8.3	Verb-to-noun conversions . . . . .	39
9	Names . . . . .	41
9.1	Nominal names . . . . .	41
9.2	Clausal names . . . . .	41
10	Calendar . . . . .	43
10.1	Tides . . . . .	43
10.2	Months . . . . .	44
10.3	Years . . . . .	44
10.4	Eras . . . . .	45
10.5	Subdivisions of the day . . . . .	45
10.5.1	Traditional timekeeping . . . . .	46
10.5.2	Modern timekeeping . . . . .	46
11	Miscellanea . . . . .	47
11.1	Colour . . . . .	47

0.1. INTRODUCTION	5
A Listings of programs	49
A.1 workfiles/7/tides.sage . . . . .	49
A.2 workfiles/7/bins.pl6 . . . . .	50
A.3 workfiles/7/conno.pl6 . . . . .	50
A.4 workfiles/7/count-days.pl6 . . . . .	52
B Arithmetic in base v	55
B.1 Operations on small numbers . . . . .	55
B.1.1 Additions . . . . .	55
B.1.2 Subtraction . . . . .	55
B.1.3 Determining parity . . . . .	55
B.1.4 Dividing by two . . . . .	55
B.1.5 Multiplication . . . . .	56
B.2 Operations on larger numbers . . . . .	56
B.2.1 Addition . . . . .	56
C Dictionary	59

## 0.1 | Introduction



# 1 | Phonology and orthography

## 1.1 | Phoneme inventory

Table 1.1: The consonants of Lek-Tsaro.

	Bilabial	Alveolar	Palatal	Velar	Glottal
Nasal	m	n	ɲ	ŋ	
Plosive	p b	t d	c ɟ	k g	ʔ
Fricative	f	s	ʃ	x	
(coarticulated)	θx	fx		ff	
Affricate		ts	tʃ		
Lateral fricative		ɬ			
Approximant		ɹ	j	w	
Lateral approximant		l			
Trill		r			

Table 1.2: The vowels of Lek-Tsaro.

Spread	Half-rounded	Rounded
i	ɣ	y
u	ɤ	u
ɛ		œ
ʌ		ɔ
ä		

In addition to consonants and vowels, Lek-Tsaro has rod signals, represented by numbers. Rod A is blue and held by one's dominant hand and B is red and held by one's non-dominant hand.

1. Rod A is raised to one's chest, while B is pointed down.
2. Rods A and B are crossed in the front.
3. Rod B is raised upwards in front of the nondominant arm, while rod A is lowered.
4. Rod A is pointed sideways near one's nondominant arm, while rod B is lowered.
5. Rods A and B are extended to the sides.

6. Rods A and B are extended, facing forward.
7. Rod A is raised forward, while B is pointed to the side.
8. Rod B is raised forward, while A is pointed to the side.

Lowering both rods is interpreted as an absence of a rod signal.

If the use of rods are unavailable, the numerals of the positions may be pronounced.

## 1.2 | Hacmisation

Lek-Tsaro uses the hacm script with superscript letters to indicate phonemes not found in Arka. The transcriptions can be found in Tables 1.3 and 1.4.

Table 1.3: The consonants of Lek-Tsaro.

	Bilabial	Alveolar	Palatal	Velar	Glottal
Nasal	ɒ	n	n <sup>ɥ</sup>	n <sup>ɣ</sup>	
Plosive	d b	f ɳ	f <sup>ɥ</sup> ɳ <sup>ɥ</sup>	ɣ ɸ	.
Fricative	a	j	l	h	
(coarticulated)	j <sup>h</sup>	a <sup>h</sup>		a <sup>l</sup>	
Affricate		tʃ	ʃ		
Lateral fricative		s			
Approximant		ɹ	ɥ	o	
Lateral approximant		l			
Trill		r			

Table 1.4: The vowels of Lek-Tsaro.

Spread	Half-rounded	Rounded
ɕ	ɕ <sup>ə</sup>	ɕ <sup>ɔ</sup>
ə <sup>ɕ</sup>	ə	ə <sup>ɔ</sup>
e		e <sup>ɔ</sup>
ɔ <sup>e</sup>		ɔ
ɪ		

Rod signs are represented by the hacm digits <1 2 3 4 5 6 7 8> attached to the end of the verbs they encompass. Proper words are preceded by a backslash <\>.

Vowels that are inferrable from context are sometimes omitted. For example, /æfan/ (to speak) is written <µean>, but /æfin/ (to spread), which is less common, is written <µeacn>, with the second vowel. Most of this grammar will leave all vowels written.

## 1.3 | Phonotactics

An onset consists of one of the following:

- any single consonant other than /l/ (the exceptions are <le> [lek] and related words),



- any obstruent followed by an approximant other than /l/,
- or any plosive followed by /r/,
- or any nasal followed by /j/ or /w/.

A nucleus consists of one vowel.  
A coda consists of one of the following:

- nothing,
- a nasal,
- a voiceless plosive (excluding /ʔ/),
- /ɹ/, /s/ or /l/

1.4 | Stress

Stress falls on the last syllable with a coda, or otherwise the second-to-last syllable.  
See table 1.5 for examples.

Table 1.5: Examples of stress locations.

Orthography	Location of stress (# from last)
ɒʒɪ	2
nɪ.cn	1
.əʔfəlb	2
lɪjnedc <sup>a</sup>	3

1.5 | Vowel harmony

For the purposes of vowel harmony, vowels are divided into front and back vowels.  
/a/ is neutral. A root with neither front nor back vowels acts as if it has front vowels.  
If by some odd chance a word has both front and back vowels, it is treated as either by random chance.

1.6 | Allophony

The following changes are made:

$$s \rightarrow \text{ʃ} \quad (\blacklozenge\{w, j, u, y\}) \quad \text{NB this is a whistled sibilant.}$$
$$C_1\{n, \eta\}C_2\{k, g\} \rightarrow nC_2[+uv] \quad [2 \mid \#\sigma]$$
$$C_1[+av] \rightarrow C_1[+rt] \quad \left[ \sum_{n \in \chi} n^2 \in \mathbb{P} \right]$$

Some examples:


























- $\langle \text{joc}\text{f} \rangle$  turning from turquoise to blue /swit/ [ʃwit]
- $\langle \text{j}^h\text{cnle} \rangle$  does not go /θxinkε/ [θxinqε] because the number of syllables is even
- $\langle \text{n}\text{l.cn}\text{l}\text{f} \rangle$  but was waiting /naʔin{16}/ [ŋaʔin{16}] because  $1^2 + 6^2 = 37$  is prime

## 1.7 | The script of Lek-Tsaro

Lek-Tsaro also uses its own script, inspired by one of Uruwi's old childhood cyphers.

The consonants within a word are divided into pairs (plus one single consonant at the end if applicable). Thus,  $\langle \text{d}\text{ə}\text{n}^{\text{p}}\text{i}\text{d}\text{ɔ}^{\text{e}}-\text{m}\text{i} \rangle$  would have  $\langle \text{d}\text{n}^{\text{p}} \text{d}\text{m} \rangle$ . These pairs then get a glyph that combines the glyphs for their constituent consonants.

Table 1.6: Single consonants in the script.

 d	 f	 l	 j	 a
 n	 ɒ	 h	 j <sup>h</sup>	 ɥ
 r	 l/s	 l	 o	 φ
 n <sup>p</sup>	 ɔ	 b	 a <sup>l</sup>	 a <sup>h</sup>
 ɔ <sup>ɥ</sup>	 ɥ	 μ	 n <sup>ɥ</sup>	 .

The full table of consonant pairs can be found at tables 1.7 and 1.8. There are some general rules:

- Double consonants get their single-consonant glyphs with a ring below.
- d-coloured glyphs bear the characteristic middle bar of  $\langle \text{z} \rangle \langle \text{d} \rangle$ :  $\text{z d} + \text{l l} \rightarrow \text{z l dl}$ .
- l-coloured glyphs rest under the characteristic arrow of  $\langle \text{z} \rangle \langle \text{l} \rangle$ :  $\text{z l} + \text{f f} \rightarrow \text{z f lf}$ .
- f-coloured glyphs rest under the characteristic hilt of  $\langle \text{f} \rangle \langle \text{r} \rangle$ :  $\text{f r} + \text{r r} \rightarrow \text{f r rr}$ .
- j-coloured glyphs bear the characteristic bar-and-circle of  $\langle \text{j} \rangle \langle \text{b} \rangle$ :  $\text{j b} + \text{b b} \rightarrow \text{j b bb}$ .
- a-coloured glyphs bear the characteristic double-swash of  $\langle \text{a} \rangle \langle \text{n}^{\text{p}} \rangle$ :  $\text{a n}^{\text{p}} + \text{n}^{\text{p}} \text{n}^{\text{p}} \rightarrow \text{a n}^{\text{p}} \text{n}^{\text{p}}$ .
- ɒ-coloured glyphs bear the characteristic brook of  $\langle \text{ɒ} \rangle \langle \text{d} \rangle$ :  $\text{ɒ d} + \text{d d} \rightarrow \text{ɒ d dd}$ .
- j<sup>h</sup>-coloured glyphs bear the characteristic arc of  $\langle \text{j}^h \rangle \langle \text{ɒ} \rangle$ :  $\text{j}^h \text{ɒ} + \text{ɒ ɒ} \rightarrow \text{j}^h \text{ɒ j}^h \text{ɒ}$ .
- ɥ-coloured glyphs rest under the characteristic triangle of  $\langle \text{ɥ} \rangle \langle \text{φ} \rangle$ :  $\text{ɥ φ} + \text{φ φ} \rightarrow \text{ɥ φ φ φ}$ .
- r-coloured glyphs rest under the characteristic overring of  $\langle \text{r} \rangle \langle \text{l} \rangle$ :  $\text{r l} + \text{l l} \rightarrow \text{r l ll}$ .

Table 1.7: Consonant pairs in the script.

0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I																	

- l-coloured glyphs rest to the left of the characteristic vertical line of  $\langle \text{I} \rangle \langle \text{I} \rangle$ :  $\text{I} \text{I} + \text{I} \rightarrow \text{I} \text{I} \text{I}$ .
- o-coloured glyphs are superimposed with a copy rotated either  $\pi$  or, in the case of a few glyphs,  $\pi/2$ :  $\text{O} + \text{I} \rightarrow \text{OI}$ ;  $\text{O} + \text{h} \rightarrow \text{oh}$ .
- n-coloured glyphs are superimposed with  $\langle \text{X} \rangle \langle \text{n} \rangle$ :  $\text{X} \text{n} + \text{f} \rightarrow \text{Xfn}$ . In some cases, the cross might be rotated  $\pi/4$ :  $\text{X} \text{n} + \text{n} \rightarrow \text{Xn}$ .
- b-coloured glyphs rest inside the characteristic room of  $\langle \text{E} \rangle \langle \text{b} \rangle$ :  $\text{E} \text{b} + \text{C} \rightarrow \text{E} \text{bC}$ .
- a<sup>l</sup>-coloured glyphs rest under the characteristic flare of  $\langle \text{Z} \rangle \langle \text{a}^l \rangle$ :  $\text{Z} \text{a}^l + \text{.} \rightarrow \text{Za}^l \text{.}$
- n<sup>u</sup>-coloured glyphs rest under the characteristic P-shape of  $\langle \text{P} \rangle \langle \text{n}^u \rangle$ :  $\text{P} \text{n}^u + \text{j} \rightarrow \text{Pn}^u \text{j}$ .
- p-coloured glyphs rest to the left of the characteristic flare of  $\langle \text{C} \rangle \langle \text{p} \rangle$ :  $\text{C} \text{p} + \text{A} \text{n}^u \rightarrow \text{A} \text{Cp} \text{n}^u$ .

0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7	8	9	A	B	C	D	E	F	G	H	I	J	K	L	M	N	O	P	Q	R	S	T	U	V	W	X	Y	Z
0	1	2	3	4	5	6	7																												

- $n^h$ -coloured glyphs bear the characteristic inner circle of  $\langle A \rangle \langle n^h \rangle$ :  $A n^h + \mathbb{C} a^h \rightarrow \mathbb{C} n^h a^h$ .
- If all else has failed, the two consonants are superimposed. The default order is the same as the ordering used in table 1.6.
- In coloured-consonant pairs, the colourant is assumed to occur first unless the order is switched by an order reversal mark.
- A negative-sloping mark below a glyph means that the order of consonants is switched.

Thus, after adding vowels we get  $\langle \hat{F} \hat{E} \rangle$ .

Table 1.9: Vowel pairs in the script.

[illegible]

Table 1.10: Miscellaneous symbols.

- 1 ◡ ◢ ◣ ◤ ◥ ◧ ◨ ◩ ◪ ◫ ◬ ◭ ◮ ◯ ◰ ◱ ◲ ◳ ◴ ◵ ◶ ◷ ◸ ◹ ◺ ◻ ◼ ◽ ◾ ◿
- ◊ period (circumfix)
- ⋮ comma
- name mark (equiv. to <\>)



## 2 | Syntax

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### 2.1 | Basic word order

The basic word order is VSO. Descriptors follow what they modify.

### 2.2 | Questions

Binary questions have the interrogative polarity marker and no change to syntax.

In wh-questions, the wh-word is pulled to the front (i. e. before the verb). This requires case marking for the wh-word:

flen peac<sup>ə</sup>jhi nc<sup>ə</sup>ʒ  
who-ACC speak-FAR.PAST-Q PR.FAR.SG  
Whom did you speak to?

This applies only to questions, not interrogative-mood clauses that act as relative clauses:

peac<sup>ə</sup>jhi nc<sup>ə</sup> flel, qif pɔ.  
speak-FAR.PAST-Q PR.FAR.SG who, see-NEAR.PAST PR.ANAPH\_OBJ.INT  
I saw the person whom you talked to.

### 2.3 | Multiple clauses

A sentence might have multiple clauses. Each clause in a sentence follows the basic VSO order, and clauses are separated with commas.





## 3 | Nouns

Nouns are declined for number, case and definiteness.

### 3.1 | Number

Lek-Tsaro has many grammatical numbers:

Table 3.1: The discrete grammatical numbers of Lek-Tsaro.

Number	Constraint on $x \in \mathbb{Z}$
Integral	none
Nullary	$x = 0$
Singular	$ x  = 1$
Dual	$ x  = 2$

Table 3.2: The continuous grammatical numbers of Lek-Tsaro.

Number	Constraint on $x \in \mathbb{R}$
Nullary	$x = 0$
Subsingular	$ x  < 1$
Supersingular	$1 \leq  x  < 2$
Plural	$ x  \geq 2$ or $x$ is unknown

### 3.2 | Case

In a clause with both the subject and object directly expressed in that order, both the subject and object are declined in the nominative case (and their roles are inferred through word order). In a clause where only one is present, or where both are expressed in the opposite order, the subject will receive the nominative case and the object will receive the accusative case.

### 3.3 | Noun classes

There are three overarching groups of noun classes.

### 3.3.1 | Countable

Nouns in these classes are declined for a discrete number.

1. Sentient – such as humans, AIs, deities.
2. Animate – nonsentient animals.
3. Inanimate – anything else.

### 3.3.2 | Measurable

Nouns in this class are declined for a continuous number.

4. Measure – all measurable nouns, especially units of measurement.

### 3.3.3 | Uncountable

Nouns in these classes are not declined for number, and require compounding with a countable or measurable noun in order to be quantified.

5. Fluid – liquids and gases.
6. Edible – edible (to humans) non-fluids.
7. Inedible – inedible (to humans) non-fluids.
8. Abstract – abstract ideas.

## 3.4 | Definiteness

The definite form of a noun is formed regularly by reduplicating the first syllable (without the coda): <Dɪɪ> “a person” becomes <DɪDɪɪ> “the person”.

## 3.5 | Declension table

### 3.5.1 | Countable classes

Note that noun declensions respect vowel harmony. For nouns with back vowels, replace the front vowels with the back vowels of the same height and rounding, and vice versa.

Table 3.3: Declensions for countable nouns.

	Integral	Nullary	Singular	Dual
Sentient: <Dɪɪ> “person”				
Nominative	Dɪɪ	Dɪɪe	Dɪɪ	Dɪɪ
Accusative	Dɪɪn	Dɪɪn <sup>ɸ</sup> e	Dɪɪncɪ	Dɪɪnɪl
Sentient: <ɟʰi.en> “magician”				
Nominative	ɟʰi.en	ɟʰi.efe	ɟʰi.eɟ	ɟʰi.el
Accusative	ɟʰi.eɟcn	ɟʰi.en <sup>ɸ</sup> e	ɟʰi.eɟcɪ	ɟʰi.eɟcl
(Note that the final consonant is preserved only in the integral nominative form.)				
Animate: <Dən <sup>ɸ</sup> ɔ> “rabbit”				



	Mass
Inedible: <ᵐᵒᵐᵒ> “stone”	
Nominative	ᵐᵒᵐᵒ
Accusative	ᵐᵒᵐᵒᵈᵉ
Abstract: <ᵃᵃᵐᵒᵈᵒ> “empathy”	
Nominative	ᵃᵃᵐᵒᵈᵒ
Accusative	ᵃᵃᵐᵒᵈᵒᵐᵒ
Abstract: <ᵐᵒᵐᵒ> “[the number] five”	
Nominative	ᵐᵒᵐᵒ
Accusative	ᵐᵒᵐᵒᵐᵒ

### 3.6 | Pronouns

Personal pronouns are not divided into first, second and third persons as in most languages. Instead, they fall into four categories which exhibit different behaviour depending on whether they occur as the first or second noun in the clause:

Table 3.6: Pronoun persons and their functions.

Person	Role in first position	Role in second position
Near	The speaker.	The first argument of the sentence.
Far	The listener.	If the first argument is the speaker, then the listener. Otherwise, the speaker.
Other	A third entity.	An entity that is neither the speaker, the listener nor the first argument.
Generic	A generic entity (akin to “one”).	
Anaphoric Subject	The subject of the previous clause.	
Anaphoric Object	The object of the previous clause.	

In wh-questions, the wh-word assumes the second position and the other argument becomes the first.

If a clause has no explicit arguments, the first argument is understood to be the subject.

Table 3.7: Personal pronouns. <-n>, <-en> or <-ᵐᵒᵐᵒ> is suffixed for the accusative case.

(continuous) (discrete)	Pl. / Sub. / Sup. Integral	Nullary Nullary	Singular	Dual
Near	ᵐᵒ	ᵐᵒᵐᵒ	ᵐᵒ	ᵐᵒᵐᵒ
Far	ᵐᵒᵐᵒ	ᵐᵒᵐᵒᵐᵒ	ᵐᵒᵐᵒ	ᵐᵒᵐᵒᵐᵒ
Other	ᵐᵒᵐᵒ	ᵐᵒᵐᵒᵐᵒ	ᵐᵒᵐᵒ	ᵐᵒᵐᵒᵐᵒ
Anaph. Sub.	ᵐᵒᵐᵒ	ᵐᵒᵐᵒᵐᵒ	ᵐᵒᵐᵒ	ᵐᵒᵐᵒᵐᵒ
Anaph. Obj.	ᵐᵒᵐᵒ	ᵐᵒᵐᵒᵐᵒ	ᵐᵒᵐᵒ	ᵐᵒᵐᵒᵐᵒ
Generic		ᵐᵒᵐᵒ		

(For the observant readers: notice the similarity to Kavinan’s system.)

### 3.6.1 | Last-clause pronouns

The anaphoric pronoun <bej> (accusative: <bejen>) is grammatically an other pronoun, and it refers to the previous clause said. Likewise, <bedcj> (accusative: <bedcn>) refers to the clause before the previous one.

## 3.7 | Compounding

Nouns can be compounded together in a head-initial manner. When that happens, only the leftmost noun is the one to be declined.

Del-mɛɔʔ<sup>e</sup>-aʼəpəʔ-ɸɕj  
 volume-cup-water-five  
 five cupfuls of water

Note that integral pronouns can modify other nouns, in which personal possession is indicated:

Del-mɛɔʔ<sup>e</sup>-aʼəpəʔ-ɸɕj-fi  
 volume-cup-water-five-PR.NEAR.INTEGRAL  
 (arg1)’s five cupfuls of water

Descriptors can also compound on nouns. This compounding is productive in Lek-Tsaro.

ɗɟɟi-ləʔfi  
 person-old  
 old people  
 (Compare to ɗɟɟi ləʔfi “person old-SENTIENT”).

## 3.8 | Possession

“X’s Y” is translated as <Y=ɗɪ jcl X>. The possessive construction is also used to create appositives.

Observe that possession marks the head, and <-ɗɪ> is a clitic, not an affix, as in the following example:

dəðənʰɔʔ-aʼəpəʔ-ɗɪ jcl jʰi.ej  
 DEF~rabbit-SING-water=GEN POS magician-SING  
 the magician’s water rabbit

In more casual speech, <jcl> may be dropped.



## 4 | Verbs

Verbs are conjugated for person of the subject, tense, polarity and tellicity, in two paradigms. Conjugation respects vowel harmony.

Table 4.1: Person-tense conjugations for verbs, using <ḏilɪn> “(S) eats (O)”.

	Nonpast	Past
Near	ḏilɪn	ḏilɪf
Far	ḏilɪn	ḏilc <sup>ə</sup> j
Other	ḏilɪ	ḏilc <sup>ə</sup>
Anaph. Sub.	ḏile	ḏilel
Anaph. Obj.	ḏilc.e	ḏilc.el
Generic	ḏilc <sup>ɔ</sup>	ḏilc <sup>ɔ</sup>

Table 4.2: Person-tense conjugations for verbs, using <peacn> “(S) spreads (O)”.

	Nonpast	Past
Near	peacn	peacɪ
Far	peaɪn	peac <sup>ə</sup> j
Other	peaɪ	peac <sup>ə</sup>
Anaph. Sub.	peae	peael
Anaph. Obj.	peac.e	peac.el
Generic	peac <sup>ə</sup>	peac <sup>ə</sup>

to which a suffix is added:

Table 4.3: Polarity-tellicity suffixes for verbs. The interrogative affix can also follow a negative affix.

	Positive	Negative	Interrogative
Telic	-	-le / -lɔ <sup>e</sup>	-hɪ
Atelic	-ɔc / -ɔc <sup>c</sup>	-ɪ	-lc <sup>ə</sup> / -lə

Notes:

- “Negative atelic” means something akin to “unsuccessfully tried to avoid doing X”.

- The interrogative polarity, in addition to marking questions, is used to mark clauses that may or may not be true but are referred to later in the sentence.

Some examples:

ḍilīn sīde flw.   
 eat-NEAR.NONPAST fish flower   
 Fish eat flowers.

ḍilīn sīde flw, ḍilīn nūqī pī.   
 eat-NEAR.NONPAST fish flower, eat-NEAR.NONPAST cat PR.ANAPH\_SUB   
 Fish eat flowers, and cats eat fish.

ḍilīn sīde flw, ḍile pīfibe.   
 eat-NEAR.NONPAST fish flower, eat-ANAPH\_SUB.NONPAST grass-ACC   
 Fish eat flowers, and they eat grass.   
 (Grass is inedible to humans, but edible to fish.)

ḍilīnle flw sīde.   
 eat-NEAR.NONPAST-NEG flower fish   
 Flowers don't eat fish.

ḍycn sc<sup>o</sup> ḥyḥycne, jenīn lī bej.   
 carry-NEAR.NONPAST PR.OTHER.SG DEF~book-SG, worry-NEAR.NONPAST PR.NEAR.INT   
 PR.LAST\_CLAUSE   
 He has the book; that worries me.   
 or: That he has the book worries me.

ḍycnhī sc<sup>o</sup> ḥyḥycne, jenīn lī bej.   
 carry-NEAR.NONPAST-INTERROGATIVE PR.OTHER.SG DEF~book-SG, worry-NEAR.NONPAST   
 PR.NEAR.INT PR.LAST\_CLAUSE   
 He might have the book; that worries me.   
 or: That he might have the book worries me.

## 4.1 | Aspect

Verbs can also be marked for aspect, either using a rod sign directly on the verb, or a particle with a rod sign, placed anywhere between the verb it modifies and the next verb.

Table 4.4: Aspect markers. Those with hyphens are attached to verb. Those without hyphens are placed as separate particles anywhere after the verb.

Aspect name	Marking	Meaning
Imperfect	–1	An action that is currently going on. Also used to distinguish static actions as opposed to dynamic (e. g. <i>wear</i> as opposed to <i>put on</i> ).
Interrupted	flcl1	An action that was interrupted.



Aspect name	Marking	Meaning
Perfect	–ɿ	An action that has already finished. Changes present tense to immediate past. Also used to distinguish dynamic actions as opposed to static (e. g. <i>put on</i> as opposed to <i>wear</i> ).
Gnomic	–ʔ	A general truth or aphorism, or an action done habitually.
Gnomic dubitative	ɿcɿʔ	A general truth or aphorism that the speaker considers to be false.
Deontic necessity	–ɲ	An action that the speaker insists on happening.
Epistemic necessity	ɿəʔɲ	An action that the speaker infers is happening.
Deontic potential	–ɸ	An action that the speaker permits to occur.
Epistemic potential	ɿəʔɸ	An action that the speaker infers that might happen.
Unexpected	–ɿ	An action that is unexpected (akin to using “but”).
Comparative	deɿ	Indicates an action of greater intensity than what was described in the previous clause.
Nonexclusive subject	ɿcɿ	Indicates that the subject comprises not only of what is explicitly mentioned, but also other things.
Nonexclusive object	ɿcʔ	Indicates that the object comprises not only of what is explicitly mentioned, but also other things.
Nonexclusive argument	ɿcɲ	Combination of both nonexclusive subject and nonexclusive object.

An example:

ɿɿɿɿɿɿɿɿ de nc, ɿcnc.ɿɿɿ dənʔɿɿɿɿɿ–ɿɿ.  
 fight-NEAR.PAST-ATELIC-IMPERFECT PR.NEAR.SG PR.OTHER.INT, shoot-ANAPH\_OBJ.PAST-  
 UNEXPECTED knee-SG.ACC-PR.ANAPH\_SUB.INT  
 I tried to fight them, but they shot my knee.

## 4.2 | Obliques

Lek-Tsaro lacks oblique arguments. Instead, equivalent expressions employ serial verb constructions. For instance, “he ate soup with a spoon” would be reduced to “he held a spoon and ate soup”:

dɿcʔ scʔ ɿəʔɿɿɿɿ, dɿɿɿɿ ɿɿɿɿɿ.  
 INST-OTHER.PAST PR.OTHER.SG spoon-SG, eat-ANAPH\_SUB.PAST soup-ACC  
 He held a spoon and ate soup.  
 or: He ate soup with a spoon.

Likewise:

ni.i nc jəjəl-hi.ɪp, ncbe hihidəʔdɔ̃.  
 TEMPORAL-OTHER PR.OTHER.INT DEF~day-SG-spring, dance-ANAPH\_SUB DEF~statue-SG.ACC  
 They will wait until the spring equinox and dance around the statue.  
 or: They will dance around the statue on the spring equinox.

A similar construction can be used for the negation of obliques:

dɪcʰə scʰ ɔʰjɔ̃ʰ, dɪlɛɪ sɪdʒn.  
 INST-OTHER.PAST-NEG PR.OTHER.SG spoon-SG, eat-ANAPH\_SUB.PAST-UNEXPECTED soup-ACC  
 He did not hold a spoon, but ate soup.  
 or: He ate soup without a spoon.

### 4.3 | Conjunctions

Conjunctions such as “and” are treated like obliques. For instance, “and” is represented by the verb <acn>, and precedes the clause in which the two are used:

acʰ ɪcʰəje ɪɪpəl, dɪlɛɪ fɛp.cʰn.  
 and-OTHER.PAST Ryse Tarul, eat-ANAPH\_SUB.PAST beef-ACC  
 Ryse and Tarul ate beef.

Sufficiently complex nesting may be unrepresentable using only anaphoric referents. The easiest way to resolve this issue is to use definite nouns in place of anaphoric referents.

acʰ ɪcʰəje ɪɪpəl, acʰ fɛp.cʰ sɪdʒ, dɪlcʰ ɔʰjɔ̃ ɪɪ.  
 and-OTHER.PAST Ryse Tarul, and-OTHER.PAST beef soup, eat-OTHER.PAST DEF~person-DU PR.ANAPH\_SUB.CONT  
 [They,] Ryse and Tarul ate beef and soup.

### 4.4 | Subordinate clauses

Ideas such as “if” or “because” are also expressed with verbs. For example, <ni.cn> “wait, when” is also used for “if”:

fɛɪlɛhi, ni.cn ɪ bej, æhcn.  
 rain-OTHER-NEG-Q, wait-NEAR PR.NEAR.INT ANAPH\_CLAUSE, play-NEAR  
 If it doesn’t rain, we will play.

Note the clausal argument to <ni.cn>, since our condition is an entire clause instead of a noun.

#### 4.4.1 | Conditions

Conditional ideas whose English translations contain “if” can also be expressed in a more concise way, but this usage can sometimes sound colloquial:

feɸilehi, æhcn.  
rain-OTHER-NEG-Q, play-NEAR  
If it doesn't rain, we will play.

### 4.5 | Comparatives

The comparative is a function  $\text{cmp} : A \times A \times (A \rightarrow \mathbb{R}) \times (A \times A \rightarrow \{0, 1\}) \rightarrow \{0, 1\}$ , where  $\text{cmp}(a, b, f, \sqsupset) = f(a) \sqsupset f(b)$ .

Consider the following sentences:

Fish eat flowers more than cats.  
More fish eat flowers than cats.

Semantically, they can be translated to:

$$\text{cmp}(\text{fish}, \text{cats}, a \mapsto (\# \text{ of flowers eaten by } a), >) \quad (4.1)$$

$$\text{cmp}(\text{fish}, \text{cats}, a \mapsto (\# \text{ of } a \text{ that eat flowers}), >) \quad (4.2)$$

The heart of comparatives in Lek-Tsaro is the quadrivalent verb  $\langle \text{᠋ᠠᠨᠠᠨᠠᠭᠤᠨ} \ a \ b \ f \ \sqsupset \rangle$ . Thus:

᠋ᠳᠢᠴᠢᠰᠢ ᠋ᠪᠯᠠᠭᠠᠳᠤᠵᠢᠴᠢᠨ, ᠋ᠠᠨᠠᠨᠠᠭᠤᠨ ᠋ᠰᠢᠳᠡ ᠋ᠨᠠᠭᠢᠰᠢ ᠋ᠵᠠ ᠋ᠨᠡᠯᠢ.  
eat-GENERIC-Q flower-ACC.INT-how\_many, CMP-NEAR fish cat PR.ANAPH\_OBJ.INT >  
Fish eat more flowers than cats.

᠋ᠳᠢᠴᠢᠰᠢ .᠋ᠭᠢᠨᠠᠨᠠᠭᠤᠨ ᠋ᠪᠯᠠᠭᠠᠳᠤ, ᠋ᠠᠨᠠᠨᠠᠭᠤᠨ ᠋ᠰᠢᠳᠡ ᠋ᠨᠠᠭᠢᠰᠢ ᠋ᠤᠰᠢ ᠋ᠨᠡᠯᠢ.  
eat-GENERIC-Q PR.GENERIC-how\_many flower, CMP-NEAR fish cat PR.ANAPH\_SUB.INT >  
More fish eat flowers than cats.

Note that we place a clause whose argument is the generic pronoun before the comparative clause. From the *doran*-clause, we refer to the function using the anaphoric pronoun referring to the position of the return value.

### 4.6 | Ditransitive-like constructions

In English, some verbs such as *give* take two objects: the item being given and the recipient of the item. Since clauses in Lek-Tsaro can take only one object, translating such verbs requires multiple clauses:

᠋ᠰᠢᠰᠢᠰᠢ ᠋ᠳᠡ ᠋ᠬᠤᠴᠢᠴᠢᠨᠡᠨ, ᠋ᠨᠡᠪᠢᠯ ᠋ᠤᠴᠡᠵᠡᠨ.  
lose-NEAR.PAST PR.NEAR.SG DEF~book, give\_to-ANAPH\_SUB.PAST Ryse-ACC  
I gave the book to Ryse.

Table 4.5: Comparators in Lek-Tsaro.

□	Comparator
>	nef
<	ac <sup>ə</sup> l
=	fe <sup>ə</sup> n <sup>ə</sup>
≥	f <sup>ə</sup> il
≤	dcj
≠	.c <sup>ə</sup> j
≈	pej
≫	a <sup>h</sup> e
≪	din

#### 4.7 | Transitivity

Verbs that are used intransitively (i. e. have no object passed at this time) can be turned into a causative form with the prefix <φC->:

flcrcl<sup>f</sup> aqeapen<sup>u</sup>e.  
 fall-NEAR.PAST DEF~coin  
 The coins fell.

de φcflcrcl<sup>a</sup> aqeapen<sup>u</sup>e.  
 PR.NEAR.SG TRANS-fall-OTHER.PAST DEF~coin  
 I dropped the coins.

Note that the word order changes to SVO. In addition, the verb is conjugated for its object, rather than the subject as expected. If the following clause uses an anaphoric subject, it refers to the object of the current clause.

Moreover, the verb does not need to be one that can never take an object. In the above example, <flcrcln> means “(S) falls on (O)”. However, if the verb in question is taking an object, it cannot be transitivity directly and a more roundabout way is required:

flcrcl<sup>f</sup> aqeapen<sup>u</sup>e pifi.  
 fall-NEAR.PAST DEF~coin grass  
 The coins fell on the grass.

de φcflcrcl<sup>a</sup> aqeapen<sup>u</sup>e, flc<sup>del</sup> pifi<sup>be</sup>.  
 PR.NEAR.SG TRANS-fall-OTHER.PAST DEF~coin, fall-ANAPH\_SUB.PAST grass-ACC  
 I dropped the coins; they fell on grass.  
 or: I dropped the coins on grass.

#### 4.8 | Clauses with nullary arguments

A clause with one or more arguments that are nullary or modified by nullary-number nouns (either through compounding or possession) will have a negative verb as well:

dəfinle dijile.

recall-NEAR-NEG person-NULL  
No one knows.

ʃɔɫʃɪnle de ʃɪʃɪɪɪ ʃɪ ʃʰi.ele.  
want-NEAR-NEG PR.NEAR.SG ring=GEN POS magician-NULL  
I don't want the rings of any magician.

## 4.9 | The copula

The copula <ɟɕn> can take a noun as an object, in which case it can mean identity or membership. (Location is expressed with <ɟɪn> “be at”.) With no object at all, it is used to denote existence.

It can also accept a descriptor, in which case the descriptor is attached before <ɟɕn> in the dictionary form.



## 5 | Descriptors

Descriptors act as adjectives or adverbs. They follow what they modify, and are inflected for the noun class or verbal person of their antecedents.

Table 5.1: Descriptor declensions, using the descriptors <hedfi> “large” and <laʔfi> “old”.

Class or person	Declined form	
Sentient	hedfi	laʔfi
Animate	hedfi	laʔfi
Inanimate	hedfe	laʔfə <sup>e</sup>
Measure	hedfiy	laʔfiy
Fluid	hedfej	laʔfə <sup>j</sup>
Edible	hedfc	laʔfə <sup>c</sup>
Inedible	hedfeʔ	laʔfə
Abstract	hedfcə	laʔfə
Near	hedfiy	laʔfiy
Far	hedfiy	laʔfiy
Other	hedfey	laʔfey
Anaph. Sub.	hedfiy	laʔfiy
Anaph. Obj.	hedfey	laʔfey
Generic	hedfcəy	laʔfəy

### 5.1 | Conversion

A noun can be converted to a descriptor by appending <-ji>.

A descriptor can be converted to an abstract noun meaning “the nature of being ~” by replacing the final <-i> with <-cnel>.





## 6 | Tree mode

---

As mentioned in section 4.3, anaphoric referents in a linked-list sentence are sometimes insufficient for expressing even simple sentence structures. While the easiest method of resolving this issue is using definite nouns, Lek-Tsaro also provides a mode where sentences are not linked lists of clauses, but rather (binary) trees.

### 6.1 | Activation

Tree mode is enabled automatically when the treeing particle  $\langle n^4i^9 \rangle$  is used, and disabled at the end of a sentence.

### 6.2 | Branch-switching

The aforementioned particle  $\langle n^4i^9 \rangle$  marks the beginning of the right branch of the tree. The right branch is ended by the particle  $\langle n^4i^{\Delta} \rangle$ , which causes the next clause to join the left and right branches.

(N. B.  $\langle n^4i^9 \rangle$  and  $\langle n^4i^{\Delta} \rangle$  can occur only between clauses. If the particles are represented by left and right brackets, respectively, then the brackets should match.)

### 6.3 | Anaphoric pronouns in joiner clauses

In clauses that join two branches, anaphoric pronouns require marking whether the antecedent occurs in the left predecessor  $\langle n^4i^9 \rangle$  or the right predecessor  $\langle n^4i^{\Delta} \rangle$ . This is done by marking the pronoun with  $\langle -^9 \rangle$  or  $\langle -^{\Delta} \rangle$ .

Likewise, verbs can be modified with  $\langle -^9 \rangle$  or  $\langle -^{\Delta} \rangle$  to indicate which branch the subject came from.

### 6.4 | Errors

The following are ungrammatical:

- Using the particle  $\langle n^4i^{\Delta} \rangle$  or the branched anaphoric pronouns when tree mode is disabled
- Using the particle  $\langle n^4i^{\Delta} \rangle$  other than to close a corresponding  $\langle n^4i^9 \rangle$
- Using the unbranched anaphoric pronouns in clauses with two predecessors

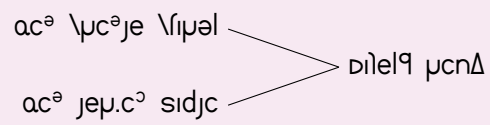
- Using the branched anaphoric pronouns in clauses with one predecessor
- Starting a new branch with  $\langle n^4i^9 \rangle$  when the current branch is empty

### 6.5 | Example

The second example in section 4.3 can be expressed as follows:

$ac^a \setminus \mu c^a je \setminus i^9 \mu \partial$ ,  $n^4i^9 ac^a je \mu.c^3 si d^9 j c$ ,  $n^4i^9 \Delta \partial i^9 \mu c n \Delta$ .

The resulting tree is shown below:



## 7 | Numerals

Lek-Tsaro uses a mixed-base system for its numerals. Numerals are abstract nouns. A Perl 6 program to convert numerals can be found in Section A.3.

### 7.1 | Single-digit numerals

Here are the numerals for  $n < 17$ :

Table 7.1: The cardinal numbers from 0 – 16.

base 10	base v	word
0	0	μəɔ
1	1	ac <sup>ə</sup> l
2	J	ʃij
3	ʔ	ɔ <sup>h</sup> e <sup>ɔ</sup> n
4	ŋ	a <sup>l</sup> ɪμ
5	ʔ	ʔcɟ
6	ʃ	ɔɥe
7	ɣ	ʃɟɟ
8	Δ	də <sup>ɔ</sup> n
9	L	hed
10	F	bən <sup>ʔ</sup>
11	ʔ	nə <sup>c</sup>
12	£	le <sup>ɔ</sup>
13	‡	j <sup>h</sup> cd
14	A	ɥin
15	V	lel
16	Ψ	.ɪμ

Note that digits above 9 use capital hacm letters.

### 7.2 | Numerals up to $19 \cdot 17$

These are represented by two digits. The multiples of 17 are shown below:

Table 7.2: Multiples of 17, up to  $18 \cdot 17$ .

base 10	base v	word
17	10	selc <sup>a</sup>
34	J0	ɔɪlc <sup>a</sup>
51	?0	ɔ <sup>4</sup> e <sup>3</sup> lc <sup>a</sup>
68	00	ʃɔɪlc <sup>a</sup>
85	†0	ʔcɪlc <sup>a</sup>
102	ʃ0	ɔ <sup>4</sup> elc <sup>a</sup>
119	90	ʃcɪlc <sup>a</sup>
136	Δ0	də <sup>3</sup> nə
153	L0	helc <sup>a</sup>
170	F0	bən <sup>4</sup> ə
187	70	nə <sup>c</sup> lə
204	£0	le <sup>3</sup> lc <sup>a</sup>
221	#0	j <sup>h</sup> cdlc <sup>a</sup>
238	A0	yinc <sup>a</sup>
255	V0	lelyc <sup>a</sup>
272	ψ0	.ilyc <sup>a</sup>
289	Ð0	jɪlsc <sup>a</sup>
306	Ψ0	heddc <sup>a</sup>

Thus  $y \cdot 17 + x$  is written  $\langle x-y \rangle$ .

### 7.3 | Numerals up to $13 \cdot 19 \cdot 17 = 4199$

These are represented by three digits. The multiples of  $19 \cdot 17$  are listed below:

Table 7.3: Multiples of  $19 \cdot 17$ , up to  $12 \cdot 19 \cdot 17$ .

base 10	base v	word
323	100	hɪjɪfɪn
646	J00	ʃɪjɪfɪn
969	?00	ɔ <sup>4</sup> e <sup>3</sup> jefɪn
1292	000	ɔ <sup>4</sup> ɪpɪfɪn
1615	†00	ʔcɪfɪn
1938	ʃ00	ɔ <sup>4</sup> ejɪfɪn
2261	900	ʃcɪfɪn
2584	Δ00	də <sup>3</sup> nɪfɪn
2907	L00	heɪfɪn
3230	F00	bən <sup>4</sup> ɪfɪn
3553	700	nə <sup>c</sup> ɪfɪn
3876	£00	le <sup>3</sup> ɪfɪn

Thus  $(z \cdot 19 \cdot 17) + (y \cdot 17) + x$  is written  $\langle z-x-y \rangle$ .

### 7.4 | Numerals up to and including $4199 \cdot (4199 + 1)/2 = 8817900$

The numeral for 4199 is  $\langle \text{ə.ɔ} \text{ə}^c \rangle$ , written as  $\langle 1:000 \rangle$ .



$$y(n, b_i) = \sum_{i=1}^n (b_i + 1 - n) \quad (7.4)$$

$$= \frac{1}{2} \cdot (n \cdot (2 \cdot b_i + 1 - n)) \quad (7.5)$$

$$N(y, b_i) = \left\lfloor \frac{1}{2} \cdot \left( 2 \cdot b_i - \sqrt{4 \cdot b_i^2 + 4 \cdot b_i + 1 - 8 \cdot y} \right) \right\rfloor \quad (7.6)$$

It follows that  $y(n_1, b_i) + n_2$  is represented as  $\langle n_1 :^i n_2 \rangle$  ( $i$  colons), and such a numeral must satisfy  $n_1 + n_2 < b_i$ .

Here are the names of the bases themselves:

Table 7.5: Names of higher bases.

Base	base v	word
$b_1$	1:000	ḡə.ɔlə <sup>c</sup>
$b_2$	1::000:000	ɒɐɱc <sup>ɔ</sup> fi
$b_3$	1:::000:000::000:000	fiɪɱə <sup>ɔ</sup>
$b_4$		əɛncɔɪ

## 7.6 | Cardinal and ordinal numerals

Cardinal numerals compound to their antecedents; ordinal numerals use the possessive  $\langle -\text{Dɪ} \text{ jcl} \rangle$  construction:

ɒcɔɪ-ə<sup>c</sup>e<sup>ɔ</sup>n  
 child-three  
 three children

ɒcɔɪɔɪ jcl ə<sup>c</sup>e<sup>ɔ</sup>n  
 child-SG=GEN POS three  
 the third child

## 8 | Derivational morphology

---

The following methods are used to derive related terms from existing ones.

### 8.1 | Abstraction

Abstraction is a derivation that takes a non-abstract noun and returns the abstract noun representing the concept of the argument. This formation appends <-ne> or <-nɔ̃<sup>e</sup>> to the noun.

Examples:

- <hɥɔ̃nɛn> *book* → <hɥɔ̃nɛne> *literature*
- <hɔ̃lɔ̃> *cart* → <hɔ̃lɔ̃nɔ̃<sup>e</sup>> *transportation*

Note that any double letters collapse into a single.

### 8.2 | Dematuration

Dematuration is a derivation that takes a noun and returns a noun of the same class that represents an immature form of the argument (not necessarily a diminutive). <fɔ̃- > or <fə̃- > are prepended to nouns that begin in <j> or <l>, or <jɔ̃- > or <jə̃- > otherwise.

Examples:

- <ɔ̃ɲɔ̃> *person* → <jɔ̃ɔ̃ɲɔ̃> *child*
- <fɔ̃ɔ̃pɔ̃> *fruit* → <jə̃<sup>c</sup>fɔ̃pɔ̃> *unripe fruit*
- <jɛɲɔ̃lɔ̃n> *essay* → <fɔ̃jɛɲɔ̃lɔ̃n> *draft*

### 8.3 | Verb-to-noun conversions

Verb-to-noun conversions involve an operation called *inversion*; this operation swaps certain phonemes of a word:

- front vowels ↔ back vowels
- voiceless plosives ↔ voiced plosives (in any position other than in a coda)
- f ↔ ɲ, d ↔ ɖ (in coda position)

- $a \leftrightarrow j^h$
- $j \leftrightarrow a^h$  (in any position other than in a coda)
- $h \leftrightarrow a^l$
- $p \leftrightarrow d$  (in any position other than after a fricative in an onset or in a coda)
- $s \leftrightarrow l$  (in any position other than in a coda)
- $p \leftrightarrow l$  (in coda position)
- $u \leftrightarrow o$

For instance,  $\langle \mu i.cfin \rangle$  would be inverted to  $\langle di.ə^\circ nɔn \rangle$ .

All other phonemes are unchanged.

Since all of the conversions below are straightforward, only their names will be mentioned.

Table 8.1: Verb-to-noun conversions, from the inversion of the verb stem.

Name	Affix
Agent	$-e^\circ n^\circ$ / $-ɔn^\circ$
Patient	$-e^\circ d$ / $-ɔd$
Location	$-e^\circ \mu$ / $-ɔ\mu$
Instrument	$-ɪfɪ$

Table 8.2: An example with  $\langle nə^\circ bɪn \rangle$  to *steal*.

Name	Derivation	Meaning
Agent	$nc^\circ de^\circ n^\circ$	thief
Patient	$nc^\circ de^\circ d$	stolen goods
Location	$nc^\circ de^\circ \mu$	site of theft
Instrument	$nc^\circ dɪfɪ$	tool used for theft



## 9 | Names

Names fall into two grammatical categories:

- *Nominal names* act as nouns. They are usually single words.
- *Clausal names* are entire clauses. These names usually refer to places, although a few people have clausal names. In extreme cases, such a name can span multiple clauses.

### 9.1 | Nominal names

These names act as nouns, and they are preceded by a backslash <\>. If the name spans multiple words (as common in foreign names), spaces are escaped by backslashes. No distinction is made between native and foreign names.

Only personal names can stand on their own, and even then, only given or full names. Other names must modify a common noun describing the nature of what is named, in the integral number without definiteness.

Table 9.1: Some examples of nominal names.

Name	Type
\ɰc <sup>ə</sup> je	Personal (native)
\ɪpəl	Personal (native)
\ɰeɔcn	Personal (foreign)
dɰe <sup>ə</sup> ɔe-\ɔɪɪɪ.c	Place (foreign)

Native names will usually respect vowel harmony. Children of parents who work in professions demanding physical labour (e. g. bricklaying) will usually have names with back vowels. In contrast, those born to parents of professions that do not demand physical strength (e. g. computer programming) will usually bear names with front vowels.

### 9.2 | Clausal names

These names comprise of one or more clauses. Due to the nature of clausal names, they are all considered native. Most of these names refer to places; personal clausal names are almost always nicknames or such. Orthographically, they are put into square brackets <[]>.

Clausal names are used by saying them as their own clauses, then using an anaphoric pronoun to backreference the entity described by the name in question. The type of anaphoric pronoun used varies from name to name. It might be the anaphoric subject pronoun, the object pronoun or the last-clause pronoun.

We call the *referent* the subject, the object or the verb of the last clause, respectively depending on the type of anaphoric pronoun used to refer to the name. If the referent is a noun, it must be declined in the integral number without definiteness.

Here, as common in maps and such, the referent will be capitalised. However, other contexts that make the type of anaphoric pronoun to use clear do not use this type of capitalisation.

Table 9.2: Some examples of clausal names.

Name	Type	Literal meaning
[AEXΨΕ³ dɾiʃjɪ ʃɔɔɔ]	Place	The trees <i>covered</i> the ground
[ɔəʃi ɸXΕ³ΘΕ μcəʃ-\\leɲμc³]	Place	The <i>city</i> remembers the Šedrý star
[ac³ ʎpɪfə-ɔɪ jcl jəp jʰɪ.en-ɔɪ jcl ʎɔɔc³, ɸœjɔ.el ɸXΕ³ΘΕΘ]	Place	The <i>city</i> was founded by the warrior of the sun and the wizard of the moon
[ɔejɪ \\ΨΞTFΞ jc³ -selc³]	Personal	<i>Gulto</i> takes care of 17 foxes

An example of usage:

ni.ɪ bɪnɛn-bəj, [ɔəʃi dɸe³ɔe μc³-\\leɲμc³], jʰɪn ɔɪɔɪjɪ .cɔ.  
 wait-OTHER year-future, (name), go-NEAR DEF~person-SG PR.ANAPH\_SUB.SG  
 He will go to Muta Pröme Ryk-Šedrý next year.

## 10 | Calendar

Domain II, which contains *Rymako*, has a day that is 26.99410 hours long. Other figures are given in terms of local days:

Table 10.1: Astronomical measures for Domain II.

Period	Length in local days
Local (synodic) day	1.00000
Sidereal day	0.99699
Tropical year ( $l_y$ )	301.94714
Sidereal year	302.03719
Synodic month ( $l_m$ )	30.80152
Sidereal month	27.95032

### 10.1 | Tides

In Domain II, the offset of the sea level due to the tide can be modeled by the following equations:

$$y = y_s + y_m \quad (10.1)$$

$$y_s = A_s \cdot (1 + A_{sa} \cdot \cos(\tau \cdot t)) \cdot \cos(2 \cdot \tau \cdot t) \quad (10.2)$$

$$y_m = A_m \cdot \left(1 + A_{ma} \cdot \cos\left(\frac{\tau \cdot t}{l_m}\right)\right) \cdot \cos\left(\frac{2 \cdot \tau \cdot (1 - l_m) \cdot t}{l_m}\right) \quad (10.3)$$

where:

$$\tau = 2 \cdot \pi$$

$$A_s \approx 0.675$$

$$A_{sa} \approx 0.0532$$

$$A_m \approx 1.267$$

$$A_{ma} \approx 0.176$$

$y$  = offset of sea level in metres

$t$  = time since HAT in local synodic days

An exact solution to  $dy/dt = 0$  is not known to exist. However, the solutions to this equation can be found numerically. Consult Section A.1 for a Sage program to do so.

As the calendar used by Lek-Tsaro uses the high and low tides to count time, it is not synchronised even with days. The basic unit of time in the calendar is the *tidal day*  $\langle \mu\partial\partial\partial^c \rangle$  ( $l_t$ ) – the amount of time between a high tide and the second high tide thereafter, which is, on average, 1.03356 local synodic days, but can vary considerably. Thus:

$$l_m/l_t \approx 29.80148 \quad (10.4)$$

$$\approx 4053/136 \quad (10.5)$$

$$l_y/l_m \approx 9.80299 \quad (10.6)$$

$$\approx 7215/736 \quad (10.7)$$

This suggests that:

1. most months will have 30 days, but every 136 months, 27 months will have only 29.
2. most years will have 10 months, but every 736 years, 145 years will have only 9.

## 10.2 | Months

Months follow a 136-month cycle wherein the  $5n+2$ -numbered months (zero-indexed,  $n \in \mathbb{N}$ ) have 29 days and the other months have 30.

The names of months, on the other hand, are determined from their positions relative to the first month of the year:

Table 10.2: The months of the year.

#	Name
0	$\alpha\partial^3b\partial^3$
1	$\mu c^a.e\partial$
2	$f_j\partial\partial$
3	$\partial\partial\mu\partial_j$
4	$j\partial\partial\mu\partial$
5	$f\partial^e\partial\partial f$
6	$n^{\partial}\partial\mu\partial^c f$
7	$lcbcl_i$
8	$b\partial\partial\partial^3_l$
9*	$.cj\partial^3\mu_i$

Days within a month are indexed from one.

## 10.3 | Years

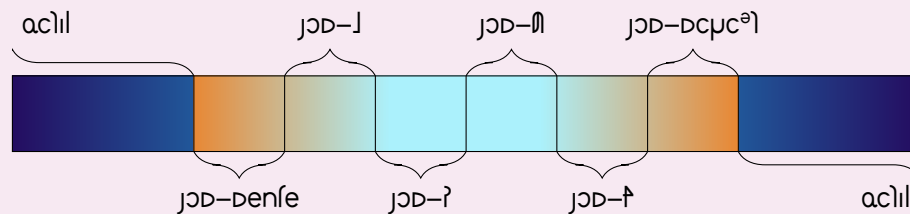
The lengths of the year follow a 736-year cycle as specified in Figure 10.1. The code used to generate this table can be found in Section A.2.



### 10.5.1 | Traditional timekeeping

The traditional system of timekeeping relies on subdivisions of the solar day. As shown in Figure 10.2, the period between sunrise and sunset are divided into six equally-sized parts  $\langle \text{ጋድ} \rangle$ , and the night is considered a separate category. This implies that the length of the “hours” depends on the seasons.

Figure 10.2: Hours in traditional timekeeping.



The traditional timekeeping system is vague – typically, the most precise interval used is a quarter or eighth of an “hour”.

### 10.5.2 | Modern timekeeping

The need for precise schedules necessitated another standard for subdividing the day. The modern system is based on the tidal day, rather than the solar day. In theory, each tidal day is divided into 23 equal parts  $\langle \text{ገረ} \rangle$ , each of which is divided into 80 equal parts  $\langle \text{ጋረ} \rangle$ , which are each divided into 40 equal parts  $\langle \text{ብረ} \rangle$ .

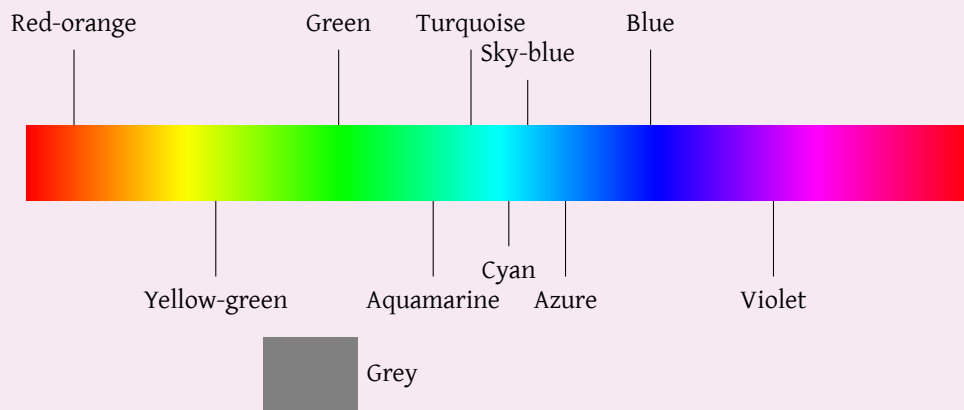
Of course, having 23  $\langle \text{ገረ} \rangle$  per tidal day requires predicting the next two high tides. For that reason, each day’s  $\langle \text{ገረ} \rangle$  are based on the length of the *previous* tidal day, such that each day might have more or less than 23  $\langle \text{ገረ} \rangle$ .

## 11 | Miscellanea

---

### 11.1 | Colour

Lek-Tsaro has eleven non-derived colour terms:



Note that “grey” refers generically to a loss of chroma. There is no distinction between a decrease in saturation and a decrease in value.

Lek-Tsaro works with colour *transitions*, not static colours, and uses abstract nouns to represent them. See table 11.1.

Table 11.1: Colour transitions in Lek-Tsaro. Each row represents a different starting colour; each column represents a different ending colour.

	RO	YG	Gn	Aq	Tu	Cy	SB	Az	Bl	Vi	Gy
RO	hij	deɪ	ɔ <sup>u</sup> en	ail	j <sup>h</sup> cɥ	dəl	be <sup>ɔ</sup> f	ɔil	ɔ <sup>l</sup> ɔ <sup>e</sup> d	fɛn <sup>ɸ</sup>	ɔc
YG	ɔɔ <sup>e</sup> f	μə <sup>ɔ</sup> ɔ	hɔ <sup>e</sup> d	ɔc <sup>ə</sup> l	n <sup>ɸ</sup> c <sup>ɔ</sup> j	fəl	n <sup>ɸ</sup> ɸ	ɔ <sup>h</sup> ef	fje <sup>ɔ</sup> n <sup>ɸ</sup>	yed	də <sup>ɔ</sup>
Gn	f <sup>ɸ</sup> ɔ <sup>e</sup> n	ɔ <sup>l</sup> ef <sup>ɸ</sup>	seɪ	ɔɔ	ɸə <sup>e</sup> f	nə <sup>c</sup> l	bɔn <sup>ɸ</sup>	le <sup>ɔ</sup> f <sup>ɸ</sup>	jɔ <sup>c</sup> l	j <sup>h</sup> ə <sup>ɔ</sup> j	ɔ
Aq	j <sup>h</sup> ɸ	fəɥ	μc <sup>ə</sup> ɔ	ocɪ	f <sup>ɸ</sup> əl	.ə <sup>c</sup> l	fɔɥ	ɸɔɔ	noed	fɔɔ	be <sup>ɔ</sup>
Tu	ɔə <sup>c</sup> l	n <sup>ɸ</sup> ə <sup>ɔ</sup> j	ɪel	ɔ <sup>ɸ</sup> c <sup>ə</sup> μ	ɔyɛn	μɔj	hɔɔ	f <sup>ɸ</sup> el	jocɪ	ɔə <sup>ɔ</sup> μ	ɔə
Cy	bc <sup>ə</sup> μ	ɔɔ <sup>e</sup> f	nc <sup>ɔ</sup> μ	.cɪ	ɔə <sup>c</sup> j	bɔel	fɔcɪ	n <sup>ɸ</sup> il	əμcn	bə <sup>c</sup> f	nɔ
SB	dɔɪ	n <sup>ɸ</sup> il	de <sup>ɔ</sup> n <sup>ɸ</sup>	fɔ <sup>c</sup> l	ɔ <sup>l</sup> e <sup>ɔ</sup> ɔ	fɔə <sup>ɔ</sup> μ	oid	j <sup>h</sup> μɔd	den	ɔcd	fɔc <sup>ə</sup>
Az	ɔɸ	jɔ <sup>e</sup> l	ɔɔ	ɸɔe <sup>ɔ</sup> j	ɔɔə <sup>e</sup> μ	n <sup>ɸ</sup> il	əμe <sup>ɔ</sup> f <sup>ɸ</sup>	acj	fɔμ	μəɔ	oi
Bl	hef <sup>ɸ</sup>	fɔcn <sup>ɸ</sup>	ɔ <sup>h</sup> əμ	nɸɔ <sup>e</sup> f <sup>ɸ</sup>	ɔ <sup>h</sup> ɸə <sup>c</sup> l	j <sup>h</sup> μə <sup>c</sup> n	bɔə <sup>e</sup> n	ɔə <sup>c</sup> l	hɪl	ɔc <sup>ə</sup> n <sup>ɸ</sup>	ɸə <sup>ɔ</sup>
Vi	ɔə <sup>e</sup> n <sup>ɸ</sup>	ɔɔ <sup>e</sup> f <sup>ɸ</sup>	ac <sup>ɔ</sup> j	əμil <sup>ɸ</sup>	fɔcɪ	dcɔɪ	μə <sup>c</sup> f <sup>ɸ</sup>	ɔc <sup>ə</sup> f <sup>ɸ</sup>	ɸən <sup>ɸ</sup>	hɔn	ai
Gy	ɔɔ	bc <sup>ə</sup>	ɪe	də	μe	jɔ	fɔɪ	ɸi	ɔ <sup>h</sup> e	j <sup>h</sup> c	.cɪ



## A | Listings of programs

### A.1 | workfiles/7/tides.sage

```
1 # How many values to output
2
3 limit = int(sys.argv[1]) if len(sys.argv) > 1 else 1000
4
5 # :P
6
7 tau = 2 * pi
8
9 t = var("t")
10
11 # Constants
12
13 A_s = 0.675; A_sa = 0.0532; A_m = 1.267; A_ma = 0.176; l_m = 30.80152
14
15 # Solar component
16 y_s2 = A_s * (1 + A_sa * cos(tau * t)) * cos(2 * tau * t)
17 # Lunar component
18 y_m2 = A_m * (1 + A_ma * cos(tau * t / l_m)) * cos(2 * tau * t / l_m -
19             2 * tau * t)
20 y = y_s2 + y_m2
21 yp = diff(y, t)
22
23 # High and low tides occur at values of t where dy/dt = 0.
24
25 i = 0
26 time = 0
27 print(0)
28 while i < limit:
29     try:
30         time2 = find_root(yp == 0, time + 0.000000001, time + 0.35)
31         print(time2)
32         time = time2
33         i += 1
34     except:
35         time += 0.01
```

workfiles/7/tides.sage

## A.2 | workfiles/7/bins.pl6

```

1  # CONSTANTS
2
3  constant \MONTHS_PER_YEAR_CYCLE = 7215;
4  constant \YEARS_PER_YEAR_CYCLE = 736;
5  constant \AVG_MONTHS_PER_YEAR = MONTHS_PER_YEAR_CYCLE /
6      YEARS_PER_YEAR_CYCLE;
7
8  # COMPUTATION
9  # For each year, take as many months as are needed
10 # in order to cycle to the next.
11
12 my $c = 0;
13 my @k;
14
15 for 0 .. ^ YEARS_PER_YEAR_CYCLE -> $i {
16     my $need = 1 - ($c - floor($c));
17     my $objs = ceiling($need * AVG_MONTHS_PER_YEAR);
18     @k[$i] = $objs;
19     $c += $objs / AVG_MONTHS_PER_YEAR;
20 }
21
22 # DISPLAY
23
24 my \cols = 4;
25 my $len = @k.elems;
26
27 say ("    0123456789" xx cols).join(" | ");
28
29 my \total-rows = ceiling($len / 10);
30 my \rows = ceiling(total-rows / cols);
31
32 for 0 .. ^ rows -> $j {
33     for 0 .. ^ cols -> $p {
34         print(" | ") if $p != 0;
35         my $q = $j + rows * $p;
36         next if $q >= total-rows;
37         printf("%3d ", $q);
38         for 0 .. ^ 10 {
39             my $i = 10 * $q + $_;
40             if $i >= $len { print " "; }
41             else {
42                 print "0123456789XE".substr(@k[$i], 1);
43             }
44         }
45     }
46     say " ";
47 }

```

workfiles/7/bins.pl6

## A.3 | workfiles/7/conno.pl6

```

1 my $digits-str = "0123456789TKXSNVFM";
2 my @digits = $digits-str.comb;
3

```

```

4 sub convert-small-fwd($n, $pad = False) {
5   die "$n must be < 4199" if $n >= 4199;
6   my $a = $n div (19 * 17);
7   my $b = ($n div 17) % 19;
8   my $c = $n % 17;
9   return
10    (!$pad && $a == 0 ?? " " !! @digits[$a]) ~
11    (!$pad && $b == 0 && $a == 0 ?? " " !! @digits[$b]) ~
12    @digits[$c];
13 }
14
15 sub convert-small-back($s) {
16   die "$s must be 3 chars or fewer" if $s.chars > 3;
17   my $c = $digits-str.index($s.substr(* - 1, 1) // "0");
18   my $b = $digits-str.index($s.substr(* - 2, 1) // "0");
19   my $a = $digits-str.index($s.substr(* - 3, 1) // "0");
20   return $c + 17 * ($b + 19 * $a);
21 }
22
23 sub triangle($n, $p) {
24   return ($n * (2 * $p + 1 - $n)) div 2;
25 }
26
27 sub sqrt-floor($y) {
28   die "$y is negative" if $y < 0;
29   return $y if $y < 2;
30   my $small = sqrt-floor($y +> 2) +< 1;
31   my $large = $small + 1;
32   return $small if $large * $large > $y;
33   return $large;
34 }
35
36 sub sqrt-ceil($y) {
37   my $n = sqrt-floor($y);
38   return $n if $n * $n == $y;
39   return $n + 1;
40 }
41
42 sub untriangle($y, $p) {
43   return (2 * $p + 1 - sqrt-ceil(4 * $p * $p + 4 * $p - 8 * $y + 1))
44     div 2;
45 }
46
47 my @powers = (4199);
48
49 for 0 .. 10 {
50   my $p = @powers[* - 1];
51   @powers.push: $p * ($p + 1) div 2;
52 }
53
54 sub convert-large-fwd-h($n, $i, $pad = False) {
55   # base case
56   if $i == 0 {
57     return convert-small-fwd($n, $pad);
58   }
59   # recursive
60   my $super = untriangle($n, @powers[$i - 1]);
61   my $infra = $n - triangle($super, @powers[$i - 1]);
62   if $super == 0 && !$pad {
63     return convert-large-fwd-h($infra, $i - 1, False);
64   }
65   return
66     convert-large-fwd-h($super, $i - 1, $pad) ~

```

```

65     (":" x $i) ~
66     convert-large-fwd-h($infra, $i - 1, True);
67 }
68
69 sub convert-large-fwd($n, $pad = False) {
70     my $i = 0;
71     ++$i while @powers[$i] <= $n;
72     convert-large-fwd-h($n, $i, $pad);
73 }
74
75 sub convert-large-back($s) {
76     # Find the longest run of colons
77     my @matches = ($s ~~ m:g/" ":"+/); #/"
78     if (!@matches) {
79         return convert-small-back($s);
80     }
81     my $longest-match = @matches.max(*.chars);
82     my $i = (~$longest-match).chars;
83     my $left = $s.substr(0, $longest-match.from);
84     my $right = $s.substr($longest-match.to);
85     my $sup = convert-large-back($left);
86     my $inf = convert-large-back($right);
87     return triangle($sup, @powers[$i - 1]) + $inf;
88 }
89
90 multi MAIN(Int :$fwd) {
91     say convert-large-fwd($fwd);
92 }
93 multi MAIN(Str :$back) {
94     say convert-large-back($back);
95 }

```

workfiles/7/conno.pl6

## A.4 | workfiles/7/count-days.pl6

```

1  # Count the number of days between 1/0/0 and D/M/Y, inclusive.
2
3  # CONSTANTS
4
5  constant \MONTHS_PER_YEAR_CYCLE = 7215;
6  constant \YEARS_PER_YEAR_CYCLE = 736;
7  constant \AVG_MONTHS_PER_YEAR = MONTHS_PER_YEAR_CYCLE /
8      YEARS_PER_YEAR_CYCLE;
9  constant \MONTHS_PER_MONTH_CYCLE = 136;
10 constant \DAYS_PER_MONTH_CYCLE = 4053;
11
12 # COMPUTATION
13 # For each year, take as many months as are needed
14 # in order to cycle to the next.
15
16 my $c = 0;
17 my @k = (0);
18
19 for 0 ..^ YEARS_PER_YEAR_CYCLE -> $i {
20     my $need = 1 - ($c - floor($c));
21     my $objs = ceiling($need * AVG_MONTHS_PER_YEAR);
22     @k[$i + 1] = $objs;
23     $c += $objs / AVG_MONTHS_PER_YEAR;

```

```

23 }
24
25 my @cumk = [\+] @k;
26
27 sub months-before-year($year) {
28     my $whole-cycles = $year div YEARS_PER_YEAR_CYCLE;
29     my $remainder = $year % YEARS_PER_YEAR_CYCLE;
30     return $whole-cycles * MONTHS_PER_YEAR_CYCLE + @cumk[$remainder];
31 }
32
33 my @m = (0);
34
35 for 0 .. ^ MONTHS_PER_MONTH_CYCLE -> $i {
36     @m.push: ($i % 5 == 2) ?? 29 !! 30;
37 }
38
39 my @cumm = [\+] @m;
40
41 sub days-before-month($month) {
42     my $whole-cycles = $month div MONTHS_PER_MONTH_CYCLE;
43     my $remainder = $month % MONTHS_PER_MONTH_CYCLE;
44     return $whole-cycles * DAYS_PER_MONTH_CYCLE + @cumm[$remainder];
45 }
46
47 sub days-before-date($d2, $m, $y) {
48     my $d = $d2 - 1; # d is 0-indexed
49     my $bm = months-before-year($y) + $m;
50     return days-before-month($bm) + $d;
51 }
52
53 sub MAIN($d2, $m, $y) {
54     say days-before-date($d2, $m, $y);
55 }

```

workfiles/7/count-days.pl6



## B | Arithmetic in base $v$

This chapter describes algorithms for performing arithmetic operations in Lek-Tsaro's number system.

## B.1 | Operations on small numbers

### B.1.1 | Additions

If both addends are smaller than 4199, then it is sufficient to use mixed-base addition:

$$\begin{array}{r} \begin{array}{ccc} & 1 & \\ \begin{array}{ccc} \mathfrak{D} & F & L \\ 9 & ? & A \end{array} & & \\ \hline F & A & \mathfrak{C} \end{array} \\ \begin{array}{ccc} 1 & 1 & \\ & \mathfrak{J} & \mathfrak{C} \quad \mathfrak{P} \\ & \mathfrak{L} & \mathfrak{U} \quad ? \end{array} \\ \hline 1 & \mathfrak{J} & \mathfrak{D} \quad A \end{array}$$

### B.1.2 | Subtraction

If both of the operands are smaller than 4199, then it is sufficient to use mixed-base subtraction.

9	12.	
9	7	A
0	F	L
1	£	P

### B.1.3 | Determining parity

A number less than 4199 is even iff the sum of its digits in base  $v$  is even – that is, either none of its digits are odd, or if exactly two are.

### B.1.4 | Dividing by two

If a number's base- $v$  representation contains only even digits, then divide each digit by two.

If the representation has two odd digits, then take advantage of the identities

$$11_v/2 = 9_v$$

$$101_v/2 = 99_v$$

$$110_v/2 = T0_v$$

This operation is written as  $\langle \triangleright \rangle$ , short for  $\langle \triangleright \text{yine} \rangle$  “one half”. Thus, in hacm:

- $\triangleright 11 = L$
- $\triangleright 101 = LL$
- $\triangleright 110 = F0$

### B.1.5 | Multiplication

With the previous two operations, it is now possible to use peasant multiplication to multiply small numbers.

## B.2 | Operations on larger numbers

### B.2.1 | Addition

For some  $i \in \mathbb{N}$ , and two numbers number  $a = x_a :^i y_a$  and  $b = x_b :^i y_b$ , we take advantage of the fact that

$$x_a :^i y_a + x_b :^i y_b = (x_a + 1) :^i y_a + (x_b - 1) :^i y_b + (x_a - x_b + 1) \quad (\text{B.1})$$

$$x_a :^i y_a + x_b :^i y_b = (x_a + x_b) :^i y_a + 0 :^i y_b + x_a \cdot x_b \quad (\text{B.2})$$

$$= (x_a + x_b) :^i (y_a + y_b) + x_a \cdot x_b \quad (\text{B.3})$$



## Romanisation

In this text, the romanisation is used only to transcribe names into English. Whenever possible, the hacmisation should be used.

Table B.1: The consonants of Lek-Tsaro.

	Bilabial	Alveolar	Palatal	Velar	Glottal
Nasal	m	n	ɲ	ŋ	
Plosive	p b	t d	tʃ dʃ	k g	ʔ
Fricative	f	s	ʃ	h	
(coarticulated)	ɸh	ʃh		fʃ	
Affricate		ts	tʃ		
Lateral fricative		ɬ			
Approximant		r	j	w	
Lateral approximant		l			
Trill		ʀ			

Table B.2: The vowels of Lek-Tsaro.

Spread	Half-rounded	Rounded
i	y	ɥ
ĩ	u	ũ
e		ö
ẽ		o
a		

Rod signs are represented by the Arabic digits <1 2 3 4 5 6 7 8> attached to the end of the verbs they encompass. Proper words are preceded by a backslash <\>.

<ɲ> should be capitalised as <N> only if one can depend on the majuscule glyph appearing like an N with a hook. Otherwise, it should be spelled <Ng>.



## C | Dictionary

| .

.c]jpi desc new  
 .cna desc hot  
 .cbe ninanim house  
 .c<sup>a</sup>rc<sup>a</sup>.cn v (S) perceives, detects, finds (O)  
 .a<sup>a</sup>rc nabst perception, detection  
 .a<sup>a</sup>rc nabst sadness, grief

| f

f]u] ninanim river  
 f]u] v (S) fights (O)  
 f]rc]cn v (S) falls on (O)  
 f]cp]cn v (O) breaks (S)  
 f]u] ninanim flower  
 f]e]d desc sufficient, wanted, wished-for  
 f]e] desc complete, full, mature  
 f]e] nsent who?  
 f]id nabst power, magic, motivation  
 f]c]cn v (S) stabs, stings (O)  
 f]cl]in v (S) wants (O), benefactive  
 f]u] ninanim fruit  
 f]ij]cn v (S) answers to (O)  
 f]ej] nsent child (young person)  
 f]u] ninanim cloud  
 f]u] v (S) loses, frees (O); (O) escapes  
 f]b] desc heavy  
 f]a] ninanim tree

f]a] nined wood  
 f]e]a<sup>c</sup> nedib ice  
 f]edcn v (S) buys (O)  
 f]ep]c<sup>a</sup> nedib beef  
 f]ep] v rain (S = other)  
 f]a] nsent coward, knave  
 f]a]c<sup>a</sup> nined blood vessels

| j

j]u]f<sup>a</sup> nsent warrior  
 j]u] ninanim stairs  
 j]a]e] desc potent, powerful not in a physical sense  
 j]c]d nabst south  
 j]u] v (S) makes a loud noise  
 j]nedc<sup>a</sup> ninanim mirror  
 j]u] v (S) is at (O), locational verb  
 j]u] nmeas subdivision of the day  
 cf Grammar / Calendar / Subdivisions of the day / Modern timekeeping  
 j]u]c<sup>a</sup> ninanim moon  
 j]u] ninanim era  
 j]u] nined stone  
 j]c] desc all, every  
 j]u] desc whole, entire  
 j]e] ninanim tooth  
 j]a].u] v (S) needs (O)  
 j]a]f] desc old

| l

l]e]ncn v (S) hunts for (O)  
 l]cn v (S) shoots an arrow to (O)  
 l]c nabst nature, disposition

## J

jɿɿɿ *ninanim* ring  
 jɿɿ v (S) is (O)  
 jɿɿɿ v (S) attaches to, loves (O)  
 jɿɿ *nmeas* subdivision of the day  
 cf Grammar / Calendar / Subdivisions of  
 the day / Modern timekeeping  
 jɿɿ *nanim* fox  
 jɿɿ *nmeas* subdivision of the day  
 cf Grammar / Calendar / Subdivisions of  
 the day / Traditional timekeeping  
 jɿɿ *ninanim* table  
 jɿɿ v (S) knows (O) answers (last  
 clause)  
 jɿɿ v (S) describes (O)  
 jɿɿ v (S) is worried by (O)  
 jɿɿ *nabst* daytime  
 jɿɿ *ninanim* essay  
 jɿɿ *ninanim* land, country  
 jɿɿ *desc* many, again  
 jɿɿ *ninanim* day, sun

j<sup>h</sup>

j<sup>h</sup>ɿɿ *nsent* magician  
 j<sup>h</sup>ɿɿ v (S) goes toward (O)  
 j<sup>h</sup>ɿɿ v (S) creates (O)  
 j<sup>h</sup>ɿɿ *nabst* how many?  
 j<sup>h</sup>ɿɿ v (S) befriends (O)  
 j<sup>h</sup>ɿɿ *nabst* how much?

## n

nɿɿ *nanim* cat  
 nɿɿ v (S) waits for/until (O), tem-  
 poral verb, if  
 nɿɿ v (S) covers, spans (O)  
 nɿɿ *ninanim* face  
 nɿɿ v (S) dances around (O)  
 nɿɿ *ninanim* group, organisation,  
 order  
 nɿɿ *ninanim* point nɿɿ-ɿɿ  
 halfway point  
 nɿɿ v (S) swims in (O)  
 nɿɿ *nined* fire  
 nɿɿ *desc* male  
 nɿɿ v (S) gives something to (O)

nɿɿ v (S) hides from (O)  
 nɿɿ *desc* sudden  
 nɿɿ *nabst* nature, temperament,  
 disposition  
 nɿɿ *nsent* mind, brain  
 nɿɿ v (S) kills (O), (O) dies  
 nɿɿ v (S) steals from (O)  
 nɿɿ *nsent* thief

n<sup>ɸ</sup>

n<sup>ɸ</sup>ɿɿ v (S) thinks, ponders about (O)

## u

uɿɿ *nfluid* poison

## a

aɿɿ *ninanim* coin  
 aɿɿ *nabst* centre, origin  
 aɿɿ v (S) obeys (O)  
 aɿɿ v (S) joins (O), and  
 aɿɿ *desc* early  
 aɿɿ v touch  
 aɿɿ *nabst* what  
 aɿɿ *nabst* light  
 aɿɿ *desc* female  
 aɿɿ *ninanim* stick, rod  
 aɿɿ *ninanim* spoon  
 aɿɿ v (S) plays with (O)  
 aɿɿ v stand, get up  
 aɿɿ.ɿɿ *nabst* description  
 aɿɿ *ninanim* event, occurrence

a<sup>l</sup>

a<sup>l</sup>ɿɿ *nabst* quote, words, speech  
 a<sup>l</sup>ɿ *ninanim* what  
 a<sup>l</sup>ɿɿ *nfluid* water

a<sup>h</sup>

a<sup>h</sup>ɿɿ *nabst* empathy

## D

- Ծյւն *nabst* one half  
 Ծօլմ *v* (S) eats (O)  
 Ծօլութիւն *desc* empty  
 Ծիլ *nsent* person  
 Ծօն *nedib* rice  
 Ծօլ *desc* far  
 Ծռոյ *ninanim* wall  
 Ծաւ *nsent* child (offspring)  
 Ծափ *v* (S) serves (O)  
 Ծափք *nanim* tongue  
 Ծափք *nabst* evening  
 Ծափն *v* (S) produces (O)  
 Ծափն *v* (S) is destroyed to make, for  
 (O)  
 Ծոն *nanim* head  
 Ծօք *nanim* scorpion  
 Ծելն *v* (S) gives birth to (O), (O) is  
 born (S) is not necessarily the mother;  
 this can be either parent  
 Ծեյն *v* (S) raises, takes care of,  
 tends to (O)  
 Ծընն *v* begin, start  
 Ծըն *nabst* morning  
 Ծաւն *v* (S) stands on, is on (O)  
 Ծափն *v* (S) drowns in (O), (O) fills  
 (S)  
 Ծեմ *desc* in return  
 Ծեմն *v* (S) succeeds at (O), (S)  
 does something to (O)  
 Ծեմն *v* err, miss  
 Ծեք *nabst* shape, structure  
 Ծեք–ծեք *nabst* grammar  
 Ծեք *nanim* opposite side  
 Ծեմ *nmeas* volume in expressions  
 such as Ծեմ–պայ *“cupful”*  
 Ծըն *desc* similar  
 Ծընն *v* (S) imitates (O)  
 Ծընն *v* (S) recalls (O)  
 Ծըն *nanim* rabbit

## Ռ

- Ռոմն *v* (S) is inside (O)  
 Ռօշ *ninanim* back (body part)  
 Ռօշ *nabst* life, existence  
 Ռեմ *nfluid* nitrogen  
 Ռեմն *v* (S) sleeps

Ռօշ *ninanim* pathway

## Փ

- Փայ *v* (S) laughs at (O)  
 Փայն *v* (S) founds (O)  
 Փակ *desc* well (not sick)  
 Փայ *nabst* five

## Ժ

- Ժրկ *nabst* ground, floor  
 Ժրն *nanim* owl  
 Ժրն *v* (S) passes (O)  
 Ժրն *v* hold, carry, instrumental  
 verb  
 Ժրն *ninanim* city  
 Ժրն *v* (S) sits at (O)  
 Ժրն *v* (S) dislikes, objects to, disap-  
 proves of (O)  
 Ժրն *ninanim* landmass, domain  
 Ժրն *v* (S) chases away (O), (O) flees  
 from (S)  
 Ժրն *v* (S) wears, experiences (O)  
 Ժրն *nedib* noodles  
 Ժրն *nabst* sentence, utterance  
 Ժրն *nanim* large animal  
 Ժրն *ninanim* knee

## Բ

- Բն *ninanim* year  
 Բրն *nmeas* subdivision of the day  
 cf Grammar / Calendar / Subdivisions of  
 the day / Modern timekeeping  
 Բրն *v* (S) walks to (O)  
 Բրն *nfluid* sea  
 Բրն *nabst* future, next (time period)  
 Բրն *v* (S) succumbs to their im-  
 pulses  
 Բրն *nsent* adult person

## | h

hɪcœn *ninanim* book  
 hi.ɪp *nabst* spring (season)  
 hiɲɔ *ninanim* nose  
 hiɲde *ninanim* leaf  
 hiɲdɔ *ninanim* statue  
 hcn v (S) claims that (O)  
 hcɪcn v (S) is named (O)  
 hcʰɔɪ *nedib* food  
 hɔɪ *ninanim* cart  
 heɪn v (S) asks for, requests (O)  
 heɪfɪ *desc* large  
 hæɔɪ *desc* evil, malicious

ɪɪɪn v (S) climbs, rises in (O)  
 ɪcɪɲcn v (S) is (O) old  
 ɪcʰɪ *ninanim* star  
 ɪeɪn v (S) speaks to (O), (S) asks  
 (O)  
 ɪeɪcn v (S) spreads (O)  
 ɪeɪɪ *ninanim* place  
 ɪeɔɪ *desc* friendly, kind, consider-  
 ate, nice  
 ɪeɪɪ *desc* late  
 ɪeɪɔʰ *nabst* nighttime  
 ɪeɪɔʰ *ninanim* cup  
 ɪeɪɔʰ *nmeas* tidal day  
 ɪeɔʰɔ *nined* gold

## | ɥ

ɥɪn v (S) sees (O), because  
 ɥɪn[O=jəɪ] (“see the sun”) = “wish”

## | s

siɔɲcn *nfluid* soup  
 siɪde *nanim* fish  
 seɪɪɪn v (S) perceives (O) non-  
 visually

## | d

diɪn v discipline, punish, constrain  
 dcn v (S) allows (O)

## | o

oelɲe *nined* forest

## | p

pi.cɪɪn v (S) is beside (O)  
 piɪfɪ *nined* grass  
 piɪfɪɪ *ninanim* blade of grass

## | l

leɪ *nabst* language  
 leɪeɪɪ *ninanim* a language