

# Archaic cuneiform numbers

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## Contents

|          |                                                                |          |
|----------|----------------------------------------------------------------|----------|
| <b>1</b> | <b>Summary</b>                                                 | <b>1</b> |
| <b>2</b> | <b>Proposed changes to the Standard</b>                        | <b>2</b> |
| 2.1      | New characters . . . . .                                       | 2        |
| 2.2      | Properties . . . . .                                           | 2        |
| 2.3      | Names list . . . . .                                           | 2        |
| 2.4      | Core specification . . . . .                                   | 2        |
| <b>3</b> | <b>Rationale for curviform–cuneiform disunification</b>        | <b>2</b> |
| 3.1      | The cuneiform encoding model . . . . .                         | 2        |
| 3.2      | Arguments for curviform–cuneiform unification . . . . .        | 3        |
| 3.3      | Metrology . . . . .                                            | 4        |
| 3.3.1    | Fractions . . . . .                                            | 6        |
| 3.4      | Problems with unification: Early metrology . . . . .           | 6        |
| 3.4.1    | Scholarly publications . . . . .                               | 6        |
| 3.5      | Problems with unification: Non-numeric usage . . . . .         | 6        |
| 3.6      | Limited benefits of diachronic encoding for numerals . . . . . | 6        |
| 3.6.1    | Compatibility with transliteration . . . . .                   | 6        |
| 3.7      | Compatibility considerations . . . . .                         | 6        |
| 3.7.1    | The case of ŠAR <sub>2</sub> . . . . .                         | 6        |
| <b>4</b> | <b>Rationale for ED–Uruk numeral unification</b>               | <b>6</b> |
| <b>5</b> | <b>Considerations on individual numeral series</b>             | <b>6</b> |
| <b>6</b> | <b>Characters not included in this proposal</b>                | <b>7</b> |
| 6.1      | Missing numerals . . . . .                                     | 7        |
| 6.2      | Stacking patterns . . . . .                                    | 7        |
| <b>7</b> | <b>Acknowledgements</b>                                        | <b>7</b> |

## 1 Summary

This document proposes encoding some numerals used in the Uruk and Early Dynastic periods in conjunction with the Sumero-Akkadian cuneiform script<sup>1</sup> and the

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<sup>1</sup>ISO 15924: Xsux, Script property value long name: Cuneiform; encoded since Unicode Version 5.0.

proto-cuneiform script<sup>2</sup>. The proposed characters are listed in section 2.

The non-numeric signs of proto-cuneiform will be the subject of a separate proposal; we need only note here that the divergence between the approaches to character identity in modern scholarship requires that proto-cuneiform be disunified from cuneiform: proto-cuneiform is effectively treated as an undeciphered script. In contrast, the cuneiform encoding model is semantic, requiring an understanding of the text to correctly encode it.

However, the *numerals* used in proto-cuneiform should be unified with ones used in the Early Dynastic period, for the reasons set forth in section 4. The proposed curviform numerals<sup>3</sup> should however *not* be unified with the already-encoded cuneiform numerals<sup>4</sup>. Since the encoding proposals for the cuneiform script twenty years ago provisionally considered the curviform numerals to be glyph variants of the cuneiform numerals, a detailed rationale is provided in section 3, including compatibility considerations in section 3.7.

The overall picture of unifications and disunifications over time is as follows:

|                   | Uruk III & earlier | ED – Ur III                      | OB & later    |
|-------------------|--------------------|----------------------------------|---------------|
| Non-numeric signs | Future Pcun        | Existing Xsux                    |               |
| Numbers           | This proposal      | This proposal<br>+ Existing Xsux | Existing Xsux |

## 2 Proposed changes to the Standard

### 2.1 New characters





### 2.2 Properties

### 2.3 Names list

### 2.4 Core specification





## 3 Rationale for curviform–cuneiform disunification

### 3.1 The cuneiform encoding model


As outlined in, *e.g.*, [UTR56], the cuneiform encoding model is diachronic; each character may have wildly different glyphs depending on time period and region. For instance, the sign IM may resemble  in texts from Early Dynastic IIIa Šuruppag as in the character code charts,  later in the third millennium<sup>5</sup>,  in Old Babylonian cursive,  in Neo-Assyrian, but is always encoded as U+1214E CUNEIFORM SIGN IM.

This encoding model allows for the interoperable representation of editions of diachronic reference works such as sign lists<sup>6</sup> and dictionaries<sup>7</sup>, and of com-

<sup>2</sup>ISO 15924: Pcun, not yet encoded.

<sup>3</sup> 1-9(aš<sup>c</sup> = N<sub>1</sub>),  1-5(u<sup>c</sup> = N<sub>14</sub>),  1-9(ḡeš<sub>2</sub><sup>c</sup> = N<sub>34</sub>),  1-5(ḡeš<sup>c</sup>u<sup>c</sup> = N<sub>48</sub>), etc.

<sup>4</sup> 1-9(aš),  1-5(u),  1-9(ḡeš<sub>2</sub>),  1-5(ḡeš<sup>c</sup>u), etc.

<sup>5</sup>Merging with U+1224E  NI<sub>2</sub>.

<sup>6</sup>Notably [VT+14] and the online edition of [Bor10] in [Jim+23, Signs].

<sup>7</sup>Notably [TJV17] and the online edition of [Sch10] in [Jim+23, Dictionary].

posite texts<sup>8</sup>. By being compatible with similarly diachronic transliteration practice (that is, by avoiding distinctions finer than those made in transliteration), the encoding model also allows for automated conversion of transliterated corpora to cuneiform, which has proven useful as a processing step in analyses such as [Rom24; JJ24]<sup>9</sup>. The diachronic approach is also useful for pedagogical applications<sup>10</sup>.

### 3.2 Arguments for curviform–cuneiform unification

[TODO(egg): Present the argument from L2/04-099 detail, including the artifact cited.]

In this context, the argument was made in [Ando4] as part of ongoing work on the cuneiform encoding<sup>11</sup> that the curviform numerals, which occasionally appear in the Ur III period and are used heavily in the Early Dynastic period, were a stylistic distinction unifiable with the cuneiform digits, and that an archaizing Ur III font or an Early Dynastic font could have curviform glyphs for the appropriate characters; some co-occurrence was known and acknowledged, but considered to be styling rather than plain text. Although they had been part of the preliminary proposal [EFT03], they were therefore removed from [EFT04b] and [EFT04a], which both state that “The distinction between curved numerals and their cuneiform descendants is treated as glyphic for the purposes of the present proposal; this issue will need to be revisited in subsequent encoding phases.”

Indeed, some metrological systems from the Early Dynastic period match the ones previously mentioned. In particular, the discrete counting system used in the Early Dynastic period (and earlier in the Uruk period) clearly mirrors system  $S_{Ur\ III/OB}$  [Fri07, p. 374; DE87, pp. 127, 165]:

$$\odot \xleftarrow{10} \bullet \xleftarrow{6} \text{D} \xleftarrow{10} \text{D} \xleftarrow{6} \bullet \xleftarrow{10} \text{D}. \quad (S)$$

Likewise the area system used in the Early Dynastic IIIb period mirrors system  $G_{Ur\ III/OB}$  [Deimel1922; NDE93, p. 63; Fri07, p. 378; Gom16]:

$$\odot \xleftarrow{10} \bullet \xleftarrow{6} \text{D} \xleftarrow{10} \bullet \xleftarrow{3} \text{D} \xleftarrow{6} \text{D}, \quad (G_{ED\ IIIb})$$

The reader will have noticed that in system  $S$ , the vertical  $\text{D}$  from  $S_{Ur\ III/OB}$  becomes a horizontal  $\text{D}$ . This is noted in [Ando4, p. 4]. It is however far from the only case of such a reallocation of function. The earlier form of System  $G$  was [DE87, pp. 141, 165; Fri07, p. 378]:

$$\bullet \xleftarrow{6} \odot \xleftarrow{10} \bullet \xleftarrow{3} \text{D} \xleftarrow{6} \text{D}, \quad (G)$$

Observe that, as noted in [DE87, p. 142],  $\odot$  changes meaning from  $10\bullet$  in system  $G$  to  $10\bullet$  in system  $G_{ED\ IIIb}$ . System  $G$  is used in the Uruk period, but also in the ED I–II period (it is the “area 2” system in [Chambon2003], whereas  $G_{ED\ IIIb}$  is the “area 1” system).

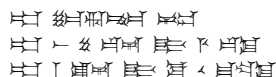
<sup>8</sup>For example, there are Neo-Assyrian and Neo-Babylonian copies parts of the laws of  $\text{𒌦} \text{𒍪} \text{𒍪} \text{𒍪} \text{𒍪} \text{𒍪}$ , as well as Old Babylonian copies in both archaizing and cursive styles. Some sections are known only from those copies. See [Oel22, pp. 110 sqq.].

<sup>9</sup>Attendees may recall the summary given on the third day of UTC #180, as recorded in [Con24]. Other readers may refer to [Svā+24, pp. 242, 148].

<sup>10</sup>For instance, Old Babylonian grammar may be taught in the Neo-Assyrian script, as in [Cap02].

<sup>11</sup>At that time scoped to the repertoire of the Ur III period and later, see [EF03, p. 1], although many disunifications, such as  $\text{𒌦} \neq \text{𒍪}$ , were informed by Early Dynastic distinctions.

### 3.3 Metrology



*I want to write tablets: the tablet of 1 gur of barley to 600 gur; the tablet of 1 shekel of silver to 10 minas [...]*



*Edubha'a D*

Before diving into the usage of the curviform numerals in the Early Dynastic period to explain the contrast with curviform numerals, it is useful to understand the usage of the already-encoded characters in the Ur III and Old Babylonian periods.

As is well known<sup>12</sup> a sexagesimal place value system (SPVS) was used in Mesopotamia from the late third millennium onwards. One should bear in mind, however, that other systems were used; the SPVS was primarily used in calculations, with results being expressed in non-positional systems [Rob08, p. 76; Rob22]. The digits 1–59 of the SPVS have inner structure which is reflected in the encoding: the digits 1–9 are the individual characters  $\text{I}$ – $\text{IX}$ , the multiples of ten (10–50) are  $\text{X}$ – $\text{XL}$ , but the other digits 11–59 are sequences  $\text{XI}$ – $\text{XLIX}$ ; in effect the base-sixty digits are themselves written in base ten, with a different set of symbols for the tens place. This reflects the origin of the sexagesimal place value system; it derives from a *non-positional* system, hereafter the *cuneiform discrete counting system*  $\text{S}_{\text{Ur III/OB}}$ , which had different signs for the units  $\text{I}$ – $\text{IX}$ , tens  $\text{X}$ – $\text{XL}$ , sixties  $\text{I}$ – $\text{XVI}$  (with larger wedges than the units), six hundreds  $\text{K}$ – $\text{KL}$ , three thousand six hundreds  $\diamond$ – $\text{XXXX}$ , and thirty-six thousands  $\diamond$ – $\text{XXXX}$ .

The relations between the values of the signs in the cuneiform discrete counting system may be summarized by the following factor diagram<sup>13</sup>, where the number over arrow indicates the multiple of the preceding sign (right of the arrow) corresponding to the following sign (left).

$$\diamond \xleftarrow{10} \diamond \xleftarrow{6} \blacktriangledown \xleftarrow{10} \blacktriangledown \xleftarrow{6} \blacktriangleleft \xleftarrow{10} \blacktriangledown \quad (S_{\text{Ur III/OB}})$$

For example, the number  $1729 = ((2 \times 10 + 8) \times 6 + 4) \times 10 + 9 = 28 \times 60 + 49$  would be written  in the discrete counting system, and  in the sexagesimal place value system.





The discrete counting system was not the only non-positional system in use in the Ur III and Old Babylonian periods; different systems were in use depending on what was being counted or measured. For instance, field areas were measured using the following system, where for the named units we have provided the name of the unit in transliterated Sumerian, normalized Old Babylonian Akkadian, and the approximate metric equivalent [Fri07, p. 378; Rob19]:

<sup>12</sup>See, e.g., [Uni16, Section 22.3.3 “Non-Decimal Radix Systems”, sub “Cuneiform Numerals”].

<sup>13</sup>These diagrams, which have become standard in discussions of Mesopotamian metrology, originate with [Fri78, p. 10], where they are called *step-diagrams*.

Another such system of note is the one for capacities<sup>16</sup> [Fri07, p. 376; Rob19],

(C<sub>Ur</sub> III/OB)

 354 gur   
  3 ban<sub>2</sub>   
  6   
  sila<sub>3</sub>   
  of grain.

This intertwining of units and numerals explains the large number of already-encoded numeral series:

<sup>14</sup>For areas smaller than a quarter *ikūm*, an overt unit is used, with 1 *mūšarum* (36 m<sup>2</sup>) written 𒄩𒄪, equal to one hundredth of an *ikūm*, then sexagesimally subdivided in 60 𒄩 (shekels). For areas greater than 3600 *būrū*, the  $\blacklozenge$ - and  $\blacklozenge$ -numerals are reused with a suffix 𒂗 (gal, Sumerian: big), as follows [Robo8, p.295 with notes b and c; Fri07, p. 378; Rob19]:

[illegible]

<sup>15</sup>As in the surface of the field of  (the city of Apisal) reported on [P102305](#) r. 1.

<sup>16</sup>Used for volumes of grain, but also oil, dairy products, beer, etc., as well as to express the capacity of boats; volumes of earthworks instead use system  $G_{Ur III/Ob}$  based on a height of one cubit, see [Pow87, p. 488; Rob08, p. 294; Rob19].

<sup>17</sup>From P309594.

<sup>18</sup>A larger unit, the *guru*<sub>7</sub> (*karûm*, grain heap), is sometimes used instead, with 𐎠𐎡𐎢𐎣𐎤𐎥𐎦𐎧𐎨𐎩𐎪𐎫𐎬𐎭𐎮𐎯𐎰𐎱𐎲𐎳𐎴𐎵𐎶𐎷𐎸𐎹𐎺𐎻𐎼𐎽𐎾𐎿𐏀𐏁𐏂𐏃𐏄𐏅𐏆𐏇𐏈𐏉𐏊𐏋𐏌𐏍𐏎𐏏𐏐𐏑𐏒𐏓𐏔𐏕𐏖𐏗𐏘𐏙𐏚𐏛𐏜𐏝𐏞𐏟𐏠𐏡𐏢𐏣𐏤𐏥𐏦𐏧𐏨𐏩𐏪𐏫𐏬𐏭𐏮𐏯𐏰𐏱𐏲𐏳𐏴𐏵𐏶𐏷𐏸𐏹𐏺𐏻𐏼𐏽𐏾𐏿𐐀𐐁𐐂𐐃𐐄𐐅𐐆𐐇𐐈𐐉𐐊𐐋𐐌𐐍𐐎𐐏𐐐𐐑𐐒𐐓𐐔𐐕𐐖𐐗𐐘𐐙𐐚𐐛𐐜𐐝𐐞𐐟𐐠𐐡𐐢𐐣𐐤𐐥𐐦𐐧𐐨𐐩𐐪𐐫𐐬𐐭𐐮𐐯𐐰𐐱𐐲𐐳𐐴𐐵𐐶𐐷𐐸𐐹𐐺𐐻𐐼𐐽𐐾𐐿𐑀𐑁𐑂𐑃𐑄𐑅𐑆𐑇𐑈𐑉𐑊𐑋𐑌𐑍𐑎𐑏𐑐𐑑𐑒𐑓𐑔𐑕𐑖𐑗𐑘𐑙𐑚𐑛𐑜𐑝𐑞𐑟𐑠𐑡𐑢𐑣𐑤𐑥𐑦𐑧𐑨𐑩𐑪𐑫𐑬𐑭𐑮𐑯𐑰𐑱𐑲𐑳𐑴𐑵𐑶𐑷𐑸𐑹𐑺𐑻𐑼𐑽𐑾𐑿𐒀𐒁𐒂𐒃𐒄𐒅𐒆𐒇𐒈𐒉𐒊𐒋𐒌𐒍𐒎𐒏𐒐𐒑𐒒𐒓𐒔𐒕𐒖𐒗𐒘𐒙𐒚𐒛𐒜𐒝𐒞𐒟𐒠𐒡𐒢𐒣𐒤𐒥𐒦𐒧𐒨𐒩𐒪𐒫𐒬𐒭𐒮𐒯𐒰𐒱𐒲𐒳𐒴𐒵𐒶𐒷𐒸𐒹𐒺𐒻𐒼𐒽𐒾𐒿𐓀𐓁𐓂𐓃𐓄𐓅𐓆𐓇𐓈𐓉𐓊𐓋𐓌𐓍𐓎𐓏𐓐𐓑𐓒𐓓𐓔𐓕𐓖𐓗𐓘𐓙𐓚𐓛𐓜𐓝𐓞𐓟𐓠𐓡𐓢𐓣𐓤𐓥𐓦𐓧𐓨𐓩𐓪𐓫𐓬𐓭𐓮𐓯𐓰𐓱𐓲𐓳𐓴𐓵𐓶𐓷𐓸𐓹𐓺𐓻𐓼𐓽𐓾𐓿𐔀𐔁𐔂𐔃𐔄𐔅𐔆𐔇𐔈𐔉𐔊𐔋𐔌𐔍𐔎𐔏𐔐𐔑𐔒𐔓𐔔𐔕𐔖𐔗𐔘𐔙𐔚𐔛𐔜𐔝𐔞𐔟𐔠𐔡𐔢𐔣𐔤𐔥𐔦𐔧𐔨𐔩𐔪𐔫𐔬𐔭𐔮𐔯𐔰𐔱𐔲𐔳𐔴𐔵𐔶𐔷𐔸𐔹𐔺𐔻𐔼𐔽𐔾𐔿𐕀𐕁𐕂𐕃𐕄𐕅𐕆𐕇𐕈𐕉𐕊𐕋𐕌𐕍𐕎𐕏𐕐𐕑𐕒𐕓𐕔𐕕𐕖𐕗𐕘𐕙𐕚𐕛𐕜𐕝𐕞𐕟𐕠𐕡𐕢𐕣𐕤𐕥𐕦𐕧𐕨𐕩𐕪𐕫𐕬𐕭𐕮𐕯𐕰𐕱𐕲𐕳𐕴𐕵𐕶𐕷𐕸𐕹𐕺𐕻𐕼𐕽𐕾𐕿𐖀𐖁𐖂𐖃𐖄𐖅𐖆𐖇𐖈𐖉𐖊𐖋𐖌𐖍𐖎𐖏𐖐𐖑𐖒𐖓𐖔𐖕𐖖𐖗𐖘𐖙𐖚𐖛𐖜𐖝𐖞𐖟𐖠𐖡𐖢𐖣𐖤𐖥𐖦𐖧𐖨𐖩𐖪𐖫𐖬𐖭𐖮𐖯𐖰𐖱𐖲𐖳𐖴𐖵𐖶𐖷𐖸𐖹𐖺𐖻𐖼𐖽𐖾𐖿𐗀𐗁𐗂𐗃𐗄𐗅𐗆𐗇𐗈𐗉𐗊𐗋𐗌𐗍𐗎𐗏𐗐𐗑𐗒𐗓𐗔𐗕𐗖𐗗𐗘𐗙𐗚𐗛𐗜𐗝𐗞𐗟𐗠𐗡𐗢𐗣𐗤𐗥𐗦𐗧𐗨𐗩𐗪𐗫𐗬𐗭𐗮𐗯𐗰𐗱𐗲𐗳𐗴𐗵𐗶𐗷𐗸𐗹𐗺𐗻𐗼𐗽𐗾𐗿𐘀𐘁𐘂𐘃𐘄𐘅𐘆𐘇𐘈𐘉𐘊𐘋𐘌𐘍𐘎𐘏𐘐𐘑𐘒𐘓𐘔𐘕𐘖𐘗𐘘𐘙𐘚𐘛𐘜𐘝𐘞𐘟𐘠𐘡𐘢𐘣𐘤𐘥𐘦𐘧𐘨𐘩𐘪𐘫𐘬𐘭𐘮𐘯𐘰𐘱𐘲𐘳𐘴𐘵𐘶𐘷𐘸𐘹𐘺𐘻𐘼𐘽𐘾𐘿𐙀𐙁𐙂𐙃𐙄𐙅𐙆𐙇𐙈𐙉𐙊𐙋𐙌𐙍𐙎𐙏𐙐𐙑𐙒𐙓𐙔𐙕𐙖𐙗𐙘𐙙𐙚𐙛𐙜𐙝𐙞𐙟𐙠𐙡𐙢𐙣𐙤𐙥𐙦𐙧𐙨𐙩𐙪𐙫𐙬𐙭𐙮𐙯𐙰𐙱𐙲𐙳𐙴𐙵𐙶𐙷𐙸𐙹𐙺𐙻𐙼𐙽𐙾𐙿𐚀𐚁𐚂𐚃𐚄𐚅𐚆𐚇𐚈𐚉𐚊𐚋𐚌𐚍𐚎𐚏𐚐𐚑𐚒𐚓𐚔𐚕𐚖𐚗𐚘𐚙𐚚𐚛𐚜𐚝𐚞𐚟𐚠𐚡𐚢𐚣𐚤𐚥𐚦𐚧𐚨𐚩𐚪𐚫𐚬𐚭𐚮𐚯𐚰𐚱𐚲𐚳𐚴𐚵𐚶𐚷𐚸𐚹𐚺𐚻𐚼𐚽𐚾𐚿𐛀𐛁𐛂𐛃𐛄𐛅𐛆𐛇𐛈𐛉𐛊𐛋𐛌𐛍𐛎𐛏𐛐𐛑𐛒𐛓𐛔𐛕𐛖𐛗𐛘𐛙𐛚𐛛𐛜𐛝𐛞𐛟𐛠𐛡𐛢𐛣𐛤𐛥𐛦𐛧𐛨𐛩𐛪𐛫𐛬𐛭𐛮𐛯𐛰𐛱𐛲𐛳𐛴𐛵𐛶𐛷𐛸𐛹𐛺𐛻𐛼𐛽𐛾𐛿𐜀𐜁𐜂𐜃𐜄𐜅𐜆𐜇𐜈𐜉𐜊𐜋𐜌𐜍𐜎𐜏𐜐𐜑𐜒𐜓𐜔𐜕𐜖𐜗𐜘𐜙𐜚𐜛𐜜𐜝𐜞𐜟𐜠𐜡𐜢𐜣𐜤𐜥𐜦𐜧𐜨𐜩𐜪𐜫𐜬𐜭𐜮𐜯𐜰𐜱𐜲𐜳𐜴𐜵𐜶𐜷𐜸𐜹𐜺𐜻𐜼𐜽𐜾𐜿𐝀𐝁𐝂𐝃𐝄𐝅𐝆𐝇𐝈𐝉𐝊𐝋𐝌𐝍𐝎𐝏𐝐𐝑𐝒𐝓𐝔𐝕𐝖𐝗𐝘𐝙𐝚𐝛𐝜𐝝𐝞𐝟𐝠𐝡𐝢𐝣𐝤𐝥𐝦𐝧𐝨𐝩𐝪𐝫𐝬𐝭𐝮𐝯𐝰𐝱𐝲𐝳𐝴𐝵𐝶𐝷𐝸𐝹𐝺𐝻𐝼𐝽𐝾𐝿𐞀𐞁𐞂𐞃𐞄𐞅𐞆𐞇𐞈𐞉𐞊𐞋𐞌𐞍𐞎𐞏𐞐𐞑𐞒𐞓



## 6 Characters not included in this proposal

### 6.1 Missing numerals

( $N_{17}$ ,  $12N_{14}$ , etc.) 7(diš *tenû*)

### 6.2 Stacking patterns

(... are a mess, vary within Uruk, and are not transliterated/documented by Englund, so let's not go there for now.)

## 7 Acknowledgements

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