The Lexical and Structural Heritage of the Late Babylonian Astronomical Procedure Texts

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1 Introduction

The Babylonian astronomical achievement reached its zenith in the Late Period, with the development of mathematical methods that allowed for the computation and prediction of various mathematical quantities. In the dateable corpus, these astronomical texts are evidenced from around the reign of Artaxerxes I, c. 450 B.C.E., until the Parthian era, c. 49 B.C.E.[1] Of special interest are the procedure texts that provide instructions for the calculation of the various columns of the astronomical data tables. These texts prescribe algorithms for the computation of astronomical quantities, and have been analyzed in conjunction with the astronomical table-texts to render a comprehensive representation of the underlying mathematical mechanisms.

The texts boast many features that are uncommon in other bodies of mathematical cuneiform work, such as named variables with undefined values, and conditional variation of parameters. Unlike many of the Old Babylonian problem texts, there are often no specific numeral values used as inputs to the procedures, except for the fixed numbers that are used as constants and control points. Most importantly, though, the texts share many characteristics with other texts, both mathematical and from other categories. These characteristics are the focus of this paper, which will treat the lexical and structural relatives of the astronomical procedure texts, and the nature of their similarities and differences.

The textual antecedents of the genre are myriad, consisting of mathematical texts, procedure texts, and many other genres from across the corpus of Babylonian texts. Here we will treat several documents from some of these categories; namely, problem texts and non-astronomical procedure texts from a range of periods of Babylonian history. The mathematical and astronomical texts will be compared to look for lexical traits that are shared with the astronomical procedure texts, while the procedure texts will be analyzed for structural features that appear in the astronomical procedure texts. In this paper, all abbreviations shall be per the *CAD* bibliographic abbreviations.

2 Astronomical Procedure Texts

The astronomical procedure texts (Akk. *epūšu*) contain mathematical procedures used for computing lunar, astral, solar, and planetary data tables. The texts come in many different shapes and sizes, as can be seen in figure 1. As an exemplar, a type F tablet, no. 65 in Ossendrijver,[2] was chosen.

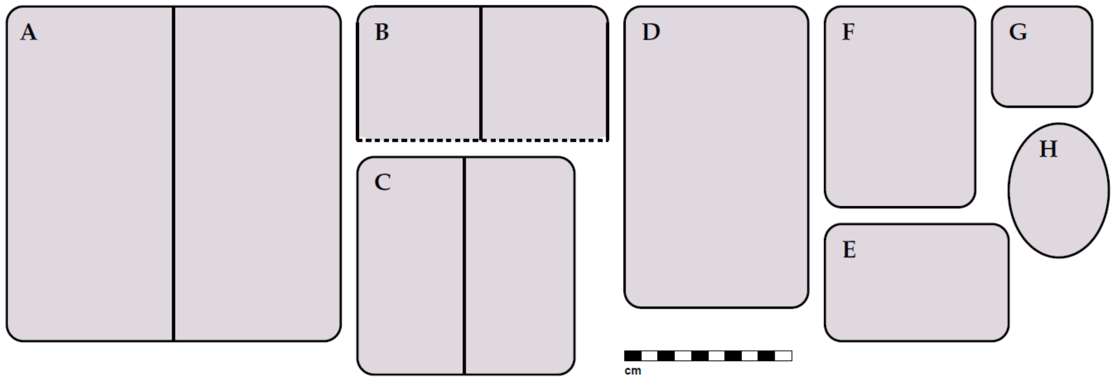

Figure 1: Schematics of Procedure Text Tablets, from Ossendrijver[3]

2.1 BM 34079+35152+35324

This particular text was first published by Neugebauer,[4] and is undated, like most procedure texts.[5] It gives a method for computing several of the values of Lunar System A, specifically $E, \Psi, \Phi, F,$ and B. The oldest table-texts computed completely with System A date to the first decade of the reign of Philip Arrhidaeus, c. 318-316 B.C.E.,[6] so this text could date anywhere from then to the later years of the Late Period. It is well-preserved for the most part, and is composed of three fragments from the British Museum.

The text is divided by Ossendrijver into eight parts, the topics of which are listed in table 1. Each part deals with a different set of values, calculated under different conditions. This structure is common in the procedure texts, and many of the Late Period procedure texts compiled by Ossendrijver[7] and Neugebauer[8] conform to this general structure. Despite the occasionally poor preservation of the texts, the overall format carries through across the corpus. Organizationally, similar procedures are grouped, with variation of conditions and parameters clumped.

In this text, the first four parts are devoted to the two values E and Ψ, while the later parts focus on other parameters. In some of the parts, specific numbers are listed as control points for interpolation; these are the parameters mentioned in table 1.

Overall, the text is composed mainly of logograms - in the first part, P1, over sixty percent of words, not counting numbers, are written logographically, with a total of around thirty logograms and around twenty syllabically written words. These logograms are fairly common across the body of astronomical procedure texts, and for the most part provide a simple concise way of notating mathematical operations.

3 Problem Texts

Problem texts, preserved in large numbers from both the Old and Late Babylonian Periods, form the more verbal part of the Babylonian mathematical corpus. The less verbal category, table texts, are preserved in larger numbers,[10] but are for the most part simpler lists of numbers with a prescribed relation to each other. As examples of the problem text genre, A 24195[11] and YBC 6967,[12] from the Old Period, and AO 6484,[13] from the Late Period, were chosen. YBC 6967 is a single **igi-igi.bi**, or reciprocal, problem, while A 24195 is a longer list of other kinds of short arithmetic problems. AO 6484 is also a larger compilation text, but with a wider variety of problems. These types of texts were thought by Neugebauer to be "school products intended to illustrate the rules for dealing with problems" that belonged to

Table 1: Part Division of *BMAPT* No. 65, after Ossendrijver[9]

Part	Description	Parameters
P1	Computing E (distance to the ecliptic) from Ψ (eclipse magnitude) and vice versa, valid if the Moon is above the ecliptic and ascending, or below the ecliptic and descending.	$\Psi_0 = 0, E_0 = 1,44;24$
P2	Same as part 1, but for values of Ψ greater than 17;24. This is for cases where the Moon is above the ecliptic and *descending*, or below the ecliptic and *ascending*. It includes some numerical examples, but certain breaks render the math confusing	Unclear
P3	Computing E from Ψ. The inverse case is not mentioned. It is possible that it includes instructions for Ψ both greater than and less than 17;24.	$\Psi_0 = 17;24, E_0 = 0$
P4	Computing E from Ψ and vice versa.	$\Psi_0 = 1, E_0 = 1,38;24$
P5	Computing F (Moon's daily displacement from the ecliptic) from Φ (the duration of 223 synodic months).	
P6	Relations between Φ^{fm} and Φ^{nm}.	
P7	Computing B^{fm} from B^{nm}; net displacements for various intervals	
P8	Compting E^{nm} from E^{fm}; net differences of E.	

a higher level of the education of the scribe.[14] Robson[15] gives a more in-depth treatment of "word problems" in the Old Babylonian period, noting their use of 'practical' pretexts to introduce and evaluate what we in the modern day would term more abstract problems. Scribes would use the solution of problems related to field size, worker pay, and reed length to teach both terms from praxis and the methods of solving problems used by their society. Høyrup terms the methods used "naive geometry," as it uses straightforward manipulation of shapes and geometries, without proof, to act as the underlying substratum for the solution of mathematical problems.

3.1 A 24195[16]

This large multi-tablet text (Problem Text U in *Mathematical Cuneiform Texts*) lists a total of 177 problems. Similarly to the previous problem text, T, in *Mathematical Cuneiform Texts*, each problem is laid out in an extremely laconic fashion which, in isolation, "would be extremely ambiguous."[17] The text as a whole is almost entirely logographic, with lines consisting of little more than a number or two and the operations upon them. The text consists of problems and their variants, with a main problem being stated, and each subsequent line indicating some variation on the form of the function and the resulting number. The text is divided into several sections by Neugebauer based on the form of the variants present in the section.

3.2 YBC 6967[18]

This text (Problem Text Ua in *Mathematical Cuneiform Texts*) deals with the problem defined by the expressions

$$xy = 60 \tag{1}$$

$$x - y = 7 \tag{2}$$

Here, x and y are the *igibūm* and *igūm*, respectively – numbers that multiply to 60. The text carries out a short set of operations, which give in the end the answers $x = 12$ and $y = 5$.

As is more common for Old Babylonian texts, the writings in this text are for the most part syllabic rather than logographic. There are a few logograms, however, that are used widely in this specific genre of problem text; namely, **igi** and **igi.bi**, which are endemic to this type of problem. Another is the **ugu** sign, which is approximately the Akkadian word *eli*, or "on, above."

3.3 AO 6484[19]

This text is a compilation volume that lists a total of 13 problems. It is a mix of problems that has several practical problems and several "supra-utilitarian" problems, to use the term of Høyrup.[20] The feel of the text is significantly different from that of the Old Babylonian problem text corpus. Many more logographic writings are used, beyond the two or three used in YBC 6967 and other singleton problem texts, although the text does not approach the level of saturation of A 24195. The wide variety of problems is striking, especially when compared to another Late Period problem text, treated by Friberg.[21] In that text, labeled by Friberg as W 23 291-x, the problems use a wide range of mathematical topics to treat the problem of metrology, centered around the seed and reed units of measure. Many other texts, such as those in *Mathematical Cuneiform Texts*, collect large amounts of one or two types of problem. This focus on a particular field of practical application, or a particular kind of arithmetic, is not seen in AO 6484.

3.4 Discussion

There are some differences between the Old and Late Period practice of mathematics, including some of their methods of solution. In a few tablets of calculation work found in the house of the Šangû-Ninurta family of Late Babylonian Uruk, there are nine calculations of regular reciprocals, an operation that in the Old Babylonian period was conducted via the "cut and paste" method, to use the term of Høyrup. This was a method that involved the construction of rectangles based on a number to find the reciprocal.[22] In these texts, however, this archetypal problem is solved using a method based on repeated factorization, a practice that does not appear for this use in the OB mathematical corpus.

Robson provides another example of the difference between the means of solving problems in the two periods: in both eras, a certain type of problem is well-attested: "given the area of a rectangle, and the sum of its lengh and width, the length and width must be found."[23] In the Old Babylonian period, a method analogous to completing the square was used; this method was still known and used for other problems in Seleucid Uruk. However, for this particular type of problem, a different method was used: a square was constructed with the sum of the two unknowns, and the known area of the rectangle was subtracted from this square four times, leaving a square with a side that is the difference between length and the width. This side is subtracted from the original sum, giving twice the width, then added to the width in order to find the length. These are but two examples of the different kinds of methods used in the Late Periods for problems attested equally well in both periods.

4 Procedure Texts

The Babylonian procedure text was not limited to astronomical fields. Procedure texts are preserved from a wide range of time periods, and come from disciplines as disparate as music and glassmaking. Presented here are three procedure texts: UET VI/3 899, an Old Babylonian musical text that deals with the tuning or modulation of a *šammûm*-instrument; BM 120960, a Middle Babylonian glass-making text that contains instructions for manufacturing Akkadian and Assyrian 'red-stone glass;' YOS 11 26, an Old Babylonian culinary compilation text; and GCCI 2 394, a Neo-Babylonian text that has a sauce recipe. These texts cover fields that differ greatly from the mathematical astronomy discussed in the other procedure texts; as such, no attempt was made to account for lexical or orthographic similarities. Rather, structural parallels and organizational similarities were the focus.

4.1 UET VI/3 899[24]

This is an interesting text that provides a method for the modulation/re-tuning of a *šammûm*-instrument (interpreted by Mirelman and Krispijn as a lyre[25]). The text is a formulaic text composed of a series of protasis-apodosis pairs, each preceded by the conjunction *šumma*. Unlike the Mesopotamian law codes, which are essentially large compilations of *šumma*-headed protasis-apodosis clauses, these are all stated in the second-person, using the second-person present tense conjugation for all verbs.

In terms of structure, the text as reconstructed by Mirelman and Krispijn is very formulaic, with a set of standard words and a standard structure. Each section is basically identical in format, and follows the form of "If the lyre is x and y is not clear, you [loosen/tighten] the z string and y will become clear," where x and y are tunings, and z is a number, in this case between one and five. On a larger scale, the text, grouped with a similar text UET VII 74 into a whole, is divided into two parts, followed by chapter titles that label the preceding entries: first, tightening, then loosening. Mirelman and Krispijn posits that this text forms a sort of tuning cycle for the *šammûm* instrument. Each step provides, given a current tuning-state and the next tuning-state in the cycle, one or two strings to tighten or loosen. Each step also, as part of the protasis, requires the end state of the previous entry in the cycle, and in the apodosis produces the required state of the next entry. The entries at the beginning and end are no exception; they are connected via the tuning *išartum*.

4.2 BM 120960[26]

This text is divided into four sections, and discusses the production of two types of red-colored glass. I will use Oppenheim et al.'s divisions:[27]

1. Ingredients for "Assyrian red-stone glass"
2. Ingredients for "Akkadian red-stone glass"
3. Manufacturing
4. "Troubleshooting"

The key unique structural component of this text is the division into separate classes of section, namely, ingredient and procedure sections. Interestingly, this is a feature that does not appear in the culinary texts below. The text is also unique, and often commented on, due to its odd choices for sign readings; some of the readings are found in no other texts, and some workers have proposed a cryptographic intent on the behalf of the scribe. Oppenheim attributes this feature instead to the scribe's goal of presenting an air of erudition,[28] a familiar justification for orthographic oddities.

At the end of the procedure section, the text provides reassurance to the reader, instructing them not to worry if a certain texture is viewed in the *dīpu*-openings of the crucible. The text also includes after the end of the procedure section what Oppenheim describes as advice for an "accident." It describes what one should do if "copper dust" and "copper exudation" form inside your kiln, providing a short list of reagents to mix into the glass, and a short procedure to complete the remedy.

This feature, a "troubleshooting" section, is seen in some of the other glass texts from Nineveh.[29]

4.3 YOS 11 26[30]

This text is a compilation text that consists of several recipes for various birds; the text is a very good example of what might be termed a cookbook. Each entry is headed with a simple title indicating the recipe, such as *šum-ma me*-[*e ka*]-*am-ka-am tu-ša-ab-ša-a*[*l*!], "To prepare *kamkam*-birds in broth," for entry E. This text dates to the Old Babylonian Period, and is part of the group of similar texts held in the Yale Babylonian Collection.

Each text combines several elements: the aforementioned title, textual notes (e.g., noting that one recipe is similar to another), cooking steps, and finishing steps. These may appear in different orders, and some are not present in some recipe entries. The recipes are very spare, without specified amounts for any ingredients, beyond unitless quantities. The recipes are in places complex, with various platters and complex cooking procedures specified, but some recipes are in themselves simply put, relying on intratextual references to other recipes in the text.

4.4 GCCI 2 394[31]

This is a short single recipe for a meat sauce that prescribes several spices and a cooking method–basic reduction. It dates to the Old Babylonian Period, and is a much shorter format of recipe than the longer bird recipes of YOS 11 26 above. It gives several amounts in its instruction section, which is rare for the Old Babylonian recipes, specifying 1 **bán** (*šût*) of water and 2 **gín** (*šiqil*) of what is translated as cucumber.

4.5 Discussion

The comparison between the non-mathematical and astronomical procedure texts provides a contrast to the comparison between the latter and the mathematical problem texts. In the case of the problem texts and the astronomical procedure texts, it is clear that, during the Late Period, the two types of text were written by the same kinds of people. For the procedure texts, no such assurance exists, due to both the lack of provenience data for most of the tablets, and also due to the fact that the professions involved in the non-mathematical procedure texts (glass-maker, cook, etc) may have had less overlap with the professions involved in the creation of the astronomical procedure texts. However, the profession treated by the procedure text is not necessarily the same as the profession involved in writing it. Oppenheim, discussing the Middle-Babylonian glass-making text, notes that in the colophons of the text the procedure is credited to *Lē'e-kali*-^{d}ŠÀ.ZU, a person who may not be the scribe themselves, but a "master" whose credibility supports the text. While Oppenheim stresses that this person may or may not be a fiction, designed to lend an aura of authority, it suggests an extra-scribal origin for the glass texts. This parallels a similar feature in the glass texts from Nineveh.[32]

5 Lexicon: Similarities and Differences

This section will only focus on the mathematical texts, as the lexicon cannot be expected to be similar across disciplines as diverse as glassmaking, cookery, and astronomy. Despite that limitation, the words used in the texts vary greatly, as do the means of their representation. In some of the Old Babylonian texts, such as YBC 6967, relatively few logograms are used, whereas in others, such as A 24195, the text is almost entirely logographic. Høyrup provides a helpful summary of the Old Babylonian mathematical lexicon,[33] while Ossendrijver provides a similar work for the Late Babylonian astronomical procedure texts. A partial list, combining the lexical lists of both workers, is provided below in table 2.

Table 2: Old/Late Babylonian Mathematical Word List.[2]

Operation	**Word**	**Orthography**	**Specific Meaning**	**OB**	**LB**
Addition	*waṣābum*	**daḫ**	to append[1]	X	X
	kamārum	**gar-gar**, UL.GAR	to accumulate[1]	X	X
	ṭepû	**tab**	to attach[2]		X
Subtraction	*mala* x *eli* y *itter*		difference of x and y[1]	X	
	nasāḫum	**zi**	to tear out[1]	X	x
	naḫāsum	**la**$_2$	to subtract[2]		X

	muṭṭû	**la**$_2$[2]	to diminish[2]		X
	ḫarāṣum		to cut off[1]	X	
	šūlû	**e**$_{11}$	to deduct[2]		X
	šūlû(?[34])	**nim**	”[2]		X
Multiplication		*x* **a-rá** *y*	“*x* steps of *y*”[1]	X	
		x **a-rá** *y* **du** (*alāku*)	As above, but more general.[2]		X
	eṣēpum	**tab**	to double[1]	X	
	našûm	**íl**[1], **GIŠ**[2]	to raise[1], to compute[2]	X	X
	*ullûm**	**nim**	to lift[1]	X	
	šutākulum	**ì-kú-kú, i-kú**, UL.UL, UR.UR	to make eat/hold each other[1]	X	
Squaring and Square Roots		si$_8$	to be equal[1]	X	
	maḫārum		to correspond to[1]	X	
Halving	*ḫepûm*	occas. **gaz**	to break in two[1]	X	
Division	x *ana* y *aḫḫe* zâzu	x *ana* y **šeš.meš bar**/SE$_3$	to divide *x* into *y* parts[2]		X
Variable names	*šiddum*	**uš**	length[1]	X	

	occas. *pūtum*	**sag**	width (lit. head, front)[1]	X	
	eqlum	**a-šà**	surface[1]	X	
‘Structuration’	*epēšum*	**kì**	to make[1]	X	
	kīma		as much as; equality[1]	X	
	šá reḫi	*šá* **tag**$_4$	what remains[2]		X
	šá illi(ka)	*šá* **e**$_{11}$**-(*ka*)**	what comes out (for you)[2]		X
Comparison	*atāru*	**diri**	to exceed[2]	X	X
	maṭû	**la**$_2$	to lack[2]	X	X

A small number of words are carried over from the OB mathematical texts to the LB astronomical procedure texts. Many are not. Some are words that were replaced by others in an almost identical capacity: take for example the substitution of *ṭepû* for the OB word for addition *waṣābum*. Others are simply dropped as the concepts they represent are rolled into more general terms, such as the elimination of *šutākulum* (used to represent the construction of a rectangle) in favor of the generalization of the *x* **a-rá** *y* **du** construction to almost all cases of multiplication.[35]

Ossendrijver discusses the differences between the OB and LB mathematical texts briefly in *BMA:PT*, and remarks on the main differences between the two periods. One key development he sees in the Late Period is the possible “manifestation of a new level of abstraction.”[36] This is evidenced in the reduction of the use of specific operations such as the aforementioned *šutākulum*, *nasāḫum*, and others, in favor of a more general set of operations. These operations were written mostly logographically, in a variety of contexts, which differs from the OB case, which used logogram-heavy writing only for cases where the type of text made the meanings unambiguous (see A 24195 above).

One key distinction must be made between the words used in the LB procedure texts and the words used in the LB problem texts. In the LB procedure texts, a larger set of logographic writing is present due to the astronomical nature of the texts. This includes words that describe astronomical phenomena, such as **nim** (height) and **sig** (depth), used to express position in the sky, as well as some words that are written logographically more often in the procedure texts, such as *kīma*, written **gin$_7$** (like, when, as, that). In addition, the use of parameter names in the astronomical texts is a drastic difference from the almost exclusively numeric operations described in the problem texts. However, there do exist strong ties between the two genres. Two Late Babylonian astronomical texts have within them mathematical problems regarding the area of trapezoids,[37] and there is little doubt that the same people were writing both kinds of text.

6 Structure: Similarities and Differences

The main similarity between the structures of the non-mathematical procedure texts chosen from a wide range of time periods is the second-person present tense framing of the actions of the procedure. Recipes, glass-making texts, musical texts, and the astronomical procedure texts all present the steps in the familiar fashion "you do this." This is held across all genres of procedure; the Late Babylonian protective ritual BM 42273[38] has a similar format, despite having a drastically different set of lexical components. This feature is present also in the mathematical problem texts, and is one of the common features across almost all Babylonian instructional literature, a category which here contains both those mathematical problem texts that Høyrup terms "procedure texts"[39] and the procedure texts that I have treated above. Høyrup defines "procedure texts" as problem texts that have a problem statement followed by a step-by-step solution of the problem, such as parts of AO 6484 and YBC 6967.

Additionally, all of the examined procedure texts possess some degree of conditionality, with "if this, then that" protasis-apodosis statements being the simplest example. The musical text UET VI/3 899 is composed entirely of a cyclic chain of such statements, and the glass-making text BM 120690 provides "troubleshooting" instructions to follow in case of the miscarriage of the procedure, also couched in a similar fashion.

The astronomical texts also feature conditionality, but approach it from a different angle; in *BMAPT* 65, the first and second parts provide the same procedure, but for two different cases where a certain parameter (eclipse magnitude Ψ) is greater than or less than 17;24. This is done using the form **en** 17.24 $\textbf{gin}_7$ *an-nam* $\textbf{du}_3$ ("until 17;24 like this you do"), and a similar form (**ta** 17.24) is used for the other case.

7 Conclusions

Clear lines can be drawn between the Old and Late Period mathematical traditions; this much is evident in the types of problems addressed in the problem texts and in the vocabulary that is carried over into the Late Period. Friberg[40] draws a line from the OB problem texts to a LB scribal school where "mathematics was taught in a methodical and insightful way," based on his study of W 23 291-x, a so-called metro-mathematical text. However, the Late Period astronomical procedure texts were likely produced in a different context, as the result of concentrated scholarly activity. The *ṭupšar Enūma Anu Enlil* ("scribe of *Enūma Anu Enlil*") and *kalû* (lamentation priests) of Babylon during the Late Period were the main practitioners of mathematical astronomy in that city, and some were employed by the Esagila temple. In Uruk, a similar situation occurs, whereby nearly all of the known astronomical tablets from the city derive from a scholarly library in the *bīt Rēš* (Rēš temple).[41] While it is not known in exactly which contexts the process of learning relatively simple **igi-igi.bi** problems and the like took place, the problem texts had fundamentally different purposes than the procedure texts: the problem texts were educational, while the procedure texts were rooted in praxis. The aforementioned differences between the problem and procedure texts were likely a result of this distinction.

The non-mathematical and astronomical procedure texts also share many traits, such as the use of the 2nd person present and the implementation of conditionality, but it is not clear whether this represents a common heritage or tradition, or whether it is simply a consequence of the language. Ultimately, the distinction is difficult to discern, but similarities do exist between the astronomical procedure texts and the non-mathematical procedure texts. However, the significant differences that do exist between the two genres, namely the different approach to conditionality used in the astronomical texts, point to a kind of procedure more descended from the Old Babylonian numerical "procedure texts" of Høyrup[42] than the non-mathematical procedure texts of other crafts.

Notes

[1]Ossendrijver, *Babylonian Mathematical Astronomy: Procedure Texts*, 6.

[2]Ibid., 426.

[3]Ibid., 11.

[4]Otto Neugebauer, ed., *Astronomical cuneiform texts : Babylonian ephemerides of the Seleucid period for the motion of the sun, the moon, and the planets* (New York: Springer-Verlag, 1983).

[5]Ossendrijver, *Babylonian Mathematical Astronomy: Procedure Texts*, 6.

[6]Ibid., 116.

[7]Ibid.

[8]Neugebauer, *Astronomical cuneiform texts : Babylonian ephemerides of the Seleucid period for the motion of the sun, the moon, and the planets*.

[9]Ossendrijver, *Babylonian Mathematical Astronomy: Procedure Texts*, 429-431.

[10]Otto Neugebauer, ed., *Mathematical Cuneiform Texts* (New Haven: American Oriental Society, 1945), 1.

[11]Ibid., 119.

[12]Ibid., 129.

[13]Otto Neugebauer, *Mathematische Keilschrift-Texte*, 2nd (Berlin and New York: Springer, 1973), 96.

[14]Neugebauer, *Mathematical Cuneiform Texts*, 1.

[15]Eleanor Robson, *Mathematics in ancient Iraq : a social history* (Princeton, N.J. : Princeton University Press, 2008), 86-97.

[16]Neugebauer, *Mathematical Cuneiform Texts*, 119.

[17]Ibid., 116.

[18]Ibid., 129.

[19]Neugebauer, *Mathematische Keilschrift-Texte*, 96.

[20]Jens Høyrup, *Lengths, Widths, Surfaces: A Portrait of Old Babylonian Algebra and Its Kin* (New York: Springer New York, 2002), 390.

[21]Jöran Friberg, "Seeds and reeds: A metro-mathematical topic text from Late Babylonian Uruk," *Baghdader Mitteilungen* 21 (1990): 483–557.

[22]Robson, *Mathematics in ancient Iraq : a social history*, 108-109.

[23]Ibid., 227.

[24]Sam Mirelman and Theo J. H. Krispijn, "The Old Babylonian Tuning Text UET VI/3 899," *Iraq* 71 (2009): 43–52.

[25]Ibid.

[26]A. Leo Oppenheim et al., *Glass and glassmaking in ancient Mesopotamia. An edition of the cuneiform texts which contain instructions for glassmakers with a catalogue of surviving objects.* (Corning, N. Y., The Corning Museum of Glass, 1970), 59; R. Campbell Thompson C. J. Gadd, "A Middle-Babylonian Chemical Text," *Iraq* 3, no. 1 (1936): 87–96.

[27]Oppenheim et al., *Glass and glassmaking in ancient Mesopotamia. An edition of the cuneiform texts which contain instructions for glassmakers with a catalogue of surviving objects.*, 64.

[28]Ibid., 60.

[29]Ibid., 65.

[30]Jean Bottéro, *Textes culinaires Mésopotamiens: Mesopotamian culinary texts* (Winona Lake: Eisenbrauns, 1995), 11.

[31]Bottéro, *Textes culinaires Mésopotamiens: Mesopotamian culinary texts*; E. Ebeling, "Ein Rezept zum Würzen von Fleisch," *Orientalia* 18, no. 2 (1949): 16.

[32]Oppenheim et al., *Glass and glassmaking in ancient Mesopotamia. An edition of the cuneiform texts which contain instructions for glassmakers with a catalogue of surviving objects.*, 61.

[33]Høyrup, *Algebra and naive geometry : an investigation of some basic aspects of old Babylonian mathematical thought*.

[34]Ossendrijver, *Babylonian Mathematical Astronomy: Procedure Texts*, 24.

[35]Ibid., 27.

[36]Ibid.

[37]Robson, *Mathematics in ancient Iraq : a social history*, 220.

[38]Jana Matuszak, "A New Version of the Babylonian Ritual Against the Evil Portended by a

Lightning Strike (BM 42273)," *Die Welt des Orients* 42, no. 2 (2012): 135–152.

[39]Jens Høyrup, *Old Babylonian mathematical procedure texts : a selection of "algebraic" and related problems with concise analysis*, ed. Jens Høyrup and Dirk J. Struik (Berlin: Max-Planck-Institut fur Wissenschaftsgeschichte, 1994).

[40]Friberg, "Seeds and reeds: A metro-mathematical topic text from Late Babylonian Uruk," 547.

[41]Ossendrijver, *Babylonian Mathematical Astronomy: Procedure Texts*, 8.

[42]Høyrup, *Old Babylonian mathematical procedure texts : a selection of "algebraic" and related problems with concise analysis*.

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