sake, but because of its value when properly integrated with a more practical mathematical methodology.

## NOTES AND REFERENCES

[1] The author is indebted to Temple University for a research grant which aided in the preparation of this paper.

[2] Cf. M. LEVEY, "Beginnings of Early Chemical Equipment: Some Apparatus of Ancient Mesopotamia", *J. Chem. Educ.*, 32, 180-184 (1955); "Evidences of Ancient Distillation, Sublimation and Extraction in Mesopotamia", *Centaurus*, IV, 23-33 (1955).

[3] An excellent example of this may be found in Maqbūl Aḥmad, "A Persian Translation of the Eleventh Century Arabic Alchemical Treatise 'Ain Aṣ-ṣan'ah Wa 'Aun Aṣ-ṣana'ah." (*Mem. As. Soc. Bengal*, VIII, No. 7, pp. 419-460 (1929); STAPLETON, Azo and HUSAIN, "Chemistry in 'Iraq and Persia in the Tenth Century A. D.", *idem*, VIII, No. 6, pp. 317-418 (1927); also STAPLETON, "Alchemical Equipment in the Eleventh Century, A.D.", *idem*, Vol. I, No. 4, pp. 47-70 (1905) for apparatus used and its implication for the importance of experimental work in chemistry (p. 65 bot.).

[4] Almost half of al-Khwārizmī's *Algebra* is devoted to problems arising directly from the inheritance laws of the Muslims.

[5] Alfred North WHITEHEAD, "Science and the Modern World", p. 48, gives another viewpoint, ". . . the utmost abstractions are the true weapons with which to control our thought of concrete fact".

[6] Thomas L. HEATH, "The Thirteen Books of Euclid's Elements", I, p. 382 ff. (1908).

[7] BESTHORN and HEIBERG, "Codex Leidensis 399, 1. Euclidis Elementa Ex Interpretatione Al-Hadschdschadschii Cum Commentariis Al-Narizii", Partis II, Fasc. I (Hauniae: 1900), pp. 27, 29. Translated by the present author from the Arabic with errors corrected. Corrected figure is given.

[8] BESTHORN and HEIBERG, p. 29, incorrectly have, "Sed ex II, 2 summa duorum spatiorum . . ." The figure for this demonstration is incorrectly given. G should be placed in the center of Line AB as a step of the proof would require.

[9] Cod. Heb. 225-2, Staatsbibliothek München, fol. 112*a*.

[10] München Cod. Heb. 225.2, fol. 113*a*.

[11] *Ibid.*, fols. 113*a*, 113*b*.

[12] For a full discussion of root and its practical significance, cf. S. GANDZ, "The Origin of the Term 'Root'", *Am. Math. Monthly*, *33*, pp. 261-5 (1926); *35*, pp. 67-75 (1928). Cf. also Solomon GANDZ, "The Mishnat Ha Middot, The First Hebrew Geometry of About 150 C.E.", in Quellen und Studien zur Geschichte der Math., A. Quellen, II (Berlin, 1932), *passim*. The term "root" in most cases meant "square basis", that by whose multiplication we get the square area.

[13] More literal translation by the author from the Arabic edited by F. ROSEN, "The Algebra of Mohammed Ben Musa" (London,

1831), pp. 11, 12, 13 Arabic, checked with the MS photostat. Cf. also Rosen's translation, pp. 16, 17, 18 Eng.

[14] S. GANDZ, The Origin and Development of Quadratic Equations in Babylonian, Greek and Early Arabic Algebra, *Osiris III*, p. 542 (1937).

[15] S. GANDZ, The Sources of Al-Khwārizmī's Algebra, *Osiris*, I, pp. 268-9 (1936).

[16] München Cod. Heb. 225.2, fols. 98*b*, 99*a*, 99*b*. The Hebrew has been translated anew because of difficulties found in the German translation of Weinberg. Further, the translation has been redone to recapture the original flavor and approach of the Hebrew version. Enough of this passage has been given so that it may be compared with the corresponding section in al-Khwārizmī, and those of Heron and Euclid.

[17] Text incorrectly reads XG.

[18] Text incorrectly reads BB.

[19] Corrected from KX in Josef WEINBERG, *op. cit.*, p. 27.

[20] Corrected from NB.

[21] Weinberg here omitted a line in his translation, *op. cit.*, p. 28.

[22] S. GANDZ, *Osiris*, I, p. 263 (1936).

[23] HEATH, *op. cit.*, I, p. 377.

[24] Cf. also Abū Kāmil's treatise on the pentagon and decagon for their algebraic treatment. Gustavo SACERDOTE, Il trattato del pentagono e del decagono, "Festschrift... Moritz Steinschneider's" (Leipzig: 1897), pp. 169-194.

[25] Abū Kāmil's algebra, as compared with al-Khwārizmī's presentation, has a very full description of fundamental algebraic operations. Cf. the elaborate and carefully ordered series of problems dealing with irrationals in Simon Motot (G. SACERDOTE, transl., *Revue Etudes juives*, 1893/4). Also similar passages to that in Abū Kāmil found in al-Karkhī (F. WOEPCKE, "Extrait du Fakhrî" (Paris, 1853), pp. 57-9) and in Leonardo FIBONACCI (Boncompagni, ed., "Scritti di Leonardo Pisano", I, pp. 363-5.

[26] München Cod. Heb. 225.2, fol. 110*a*.

[27] Text has sixteen.

[28] Text has thirty two.

[29] Text has AB.

[30] Text has AX.

[31] WOEPCKE, *op. cit.*

[32] LEONARDO, *op. cit.*

[33] Cf. the sixteenth century algebra edited by M. CURTZE, "Die Algebra des Initius Algebras as Ylem geometram magistrum suum", *Urkunden z. Gesch. d. Math. (Abhandl. z. Gesch. d. Math. Wiss.)*, XIII (1902).

[34] *Vide* by the present author, "Abraham Savasorda and his Algorism: A Study in Early European Logistic", *Osiris*, XI (1954).

[35] Cf. Martin LEVEY, The Encyclopedia of Abraham Savasorda: "A Departure in Mathematical Methodology", *Isis*, 43, pp. 257-64 (1952).

[36] Johannes TROPFKE, "Gesch. d. Elementar-Mathematik" (Berlin: 1937), Vol. I, p. 108.