Section 2.3: Discovery of Decimal Fractions

The main contribution of the Islamic Civilization to the modern number system is the discovery of decimal fractions. What is the earliest known source that contains decimal fractions? Who is the author?

What was the observation that led to this invention?

…half of 1 (or any odd number) in any place is 5 before it. Accordingly, when we halve an odd number we set the half as 5 before it, the units place being marked by a sign above it, to denote the place. The units place becomes tens to what is before it (p. 110).

Example: Let us halve 19 three times.

Another method from al-Uqlidisi: Compute $72(1 + \frac{1}{10})^3$.

Some later history: Al-Uqlidisi's (920-980) use of decimal fractions is unsystematized and unnamed. Al-Samawal (1130-1180) introduced them more carefully and theoretically in a treatise in 1172. Still no name, notation not as good. It was Jamshid al-Kashi (1380-1429) who really perfected the system in his *The Key to Arithmetic*.

It was not until a full century later that European scholars began using decimal fractions, first seen in Simon Stevin's (1549-1620) *The Art of Tenths* in 1585. His awkward notation was nowhere near so good as al-Uqlidisi's. Then came John Napier (1550-1617), who improved Stevin's decimal notation. For a long time, researchers thought that Stevin was the first to use the decimal point. This false information is repeated in books published in the 21st century and by some "experts".

Section 2.4: Muslim Sexagesimal Arithmetic

One major reason for the delay in the development and perfection of the decimal system was that Muslim scientists already had a complete place value system for both whole numbers and fractions in base 60.

A History of the Sexagesimal System

Babylonian System: Write the numerals 3, 25, 133, 3752, 1/5, and 7/360 in this system.

Problems with the Babylonian system:

One improvement in 4th century B.C.E.:

Greek Sexagesimal System: Their own method for the integral part, and different notation for the fractional part. What does IZ K represent in this system? (*Hint:* see table, page 40.) How about PNA Λ? What would this be if the system were consistent?

Sexagesimal System in the Islamic World: Cipherized and consistent.
Write 95 and $23\frac{1}{5}$ according to this system (refer to the table on page 41).

Solutions to the ambiguity in the system:

Sexagesimal Addition and Subtraction:
Example: Add/subtract 51 degrees and 27 seconds to/from 5 first elevates, 45 degrees, and 38 seconds.

Methods of Sexagesimal Multiplication

Method 1: Multiplication by Levelling
Example:

Method 2: Using a Multiplication Table (pages 45, 46)
Example:

Method 3: Lattice/Gelosia Method of Multiplication

Note: This method works for decimal numbers as well. Pay attention to this on the homework.

Example:

Sexagesimal Division:
Example: