**Lesson 6 Notes: Numeration Systems**

**ANSWER KEY**

\* *Teachers have a very important role to play in helping students develop facility with computation. By allowing students to work in ways that have meaning for them, teachers can gain insight into students’ developing understanding and give them guidance*.

*- NCTM’s Standards for School Mathematics*

Number System

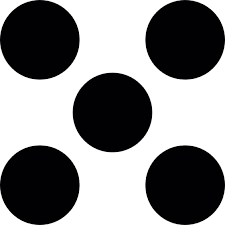
A numeral system (or system of numeration) is a writing system for expressing numbers; that is, a mathematical notation for representing numbers of a given set, using digits or other symbols in a consistent manner.



Why is this important?

Students will connect numerals to the quantities they represent!

Example: Describe this image in other ways!



A screenshot of a computer

Description automatically generatedGSE: Georgia Standards of Excellence

<https://www.georgiastandards.org/Pages/default.aspx>

Click on Math ---- Under New Mathematics Curriculum and Instruction Resources, click on K-5 ---- Under Kindergarten, click on Comprehensive Grade Level Overview

READ through these objectives and criteria.

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Numeration System: A logically organized collection of numerals

Number Bases and Grouping

Base – The number of objects used in the grouping process

Base 10–grouping is done by 10’s. It is called base ten numeration 102 101 100.

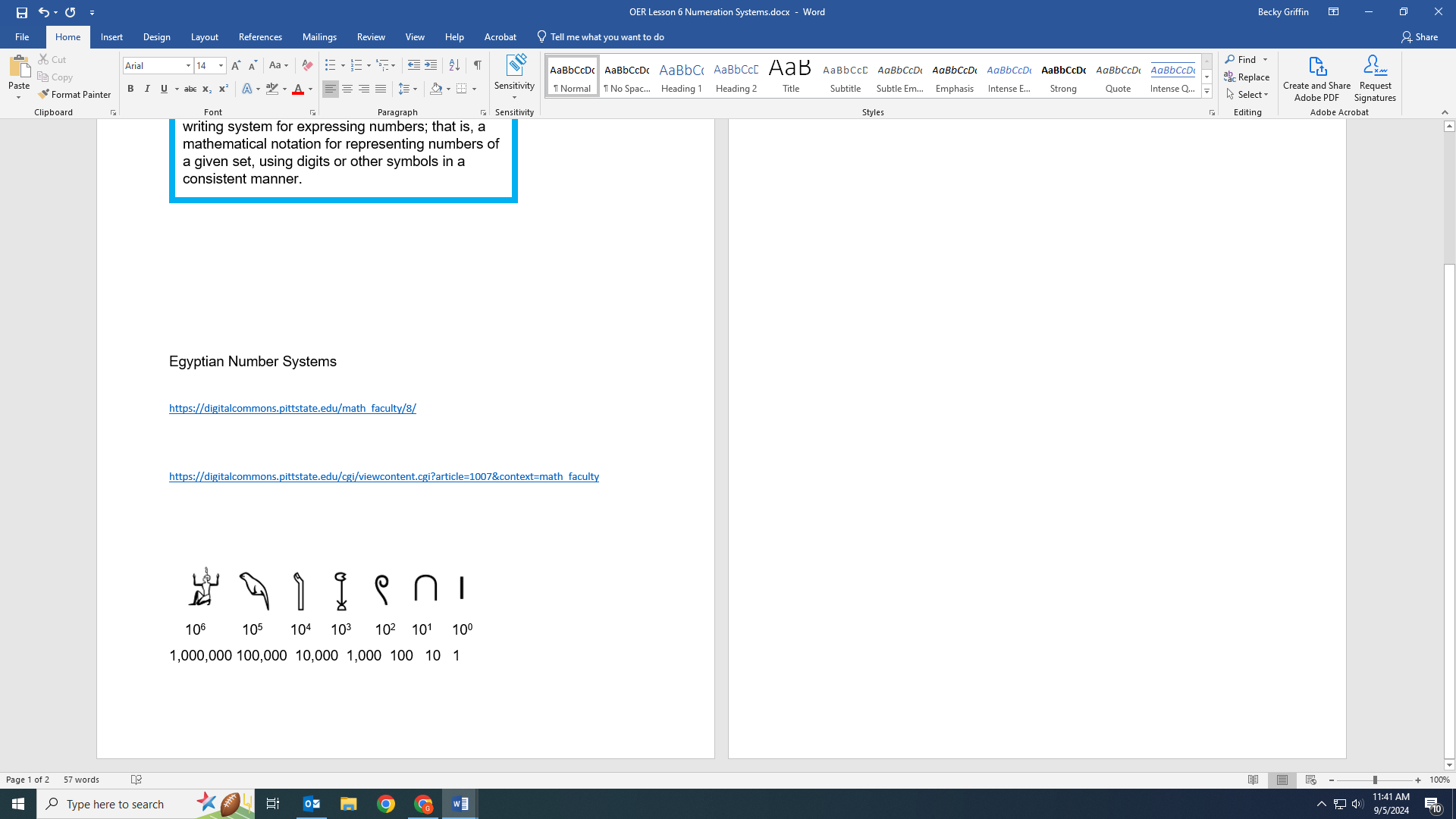
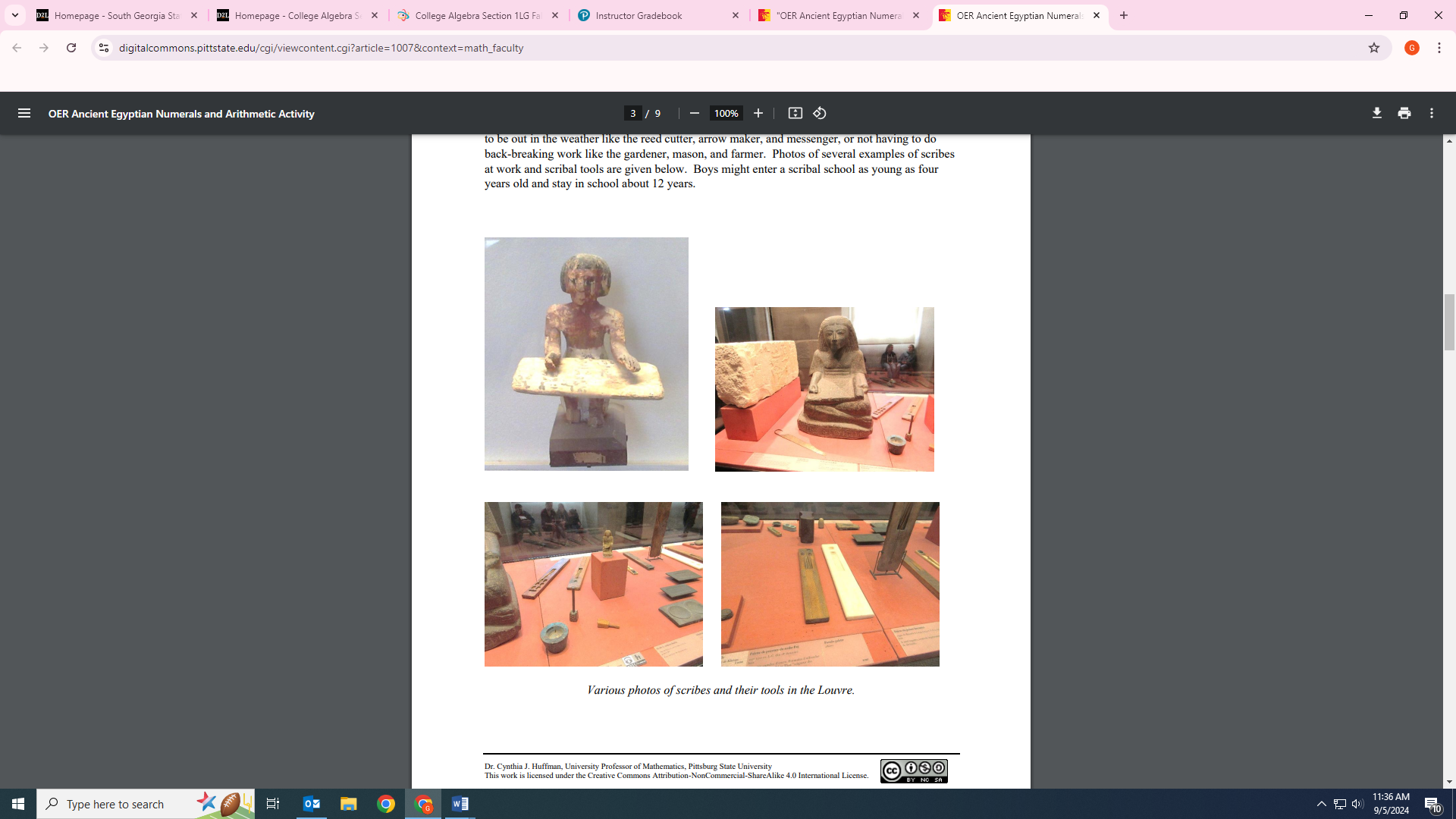
We will explore symbols for the following Numeration Systems:

1. Egyptian
2. Roman
3. Babylonian
4. Mayan
5. Hindu Arabic – OUR NUMERATION SYSTEM

**Egyptian Numeration**

* The ancient Egyptian numeration system used picture symbols called hieroglyphics. This is a base-ten system in which each symbol represents a power of ten.

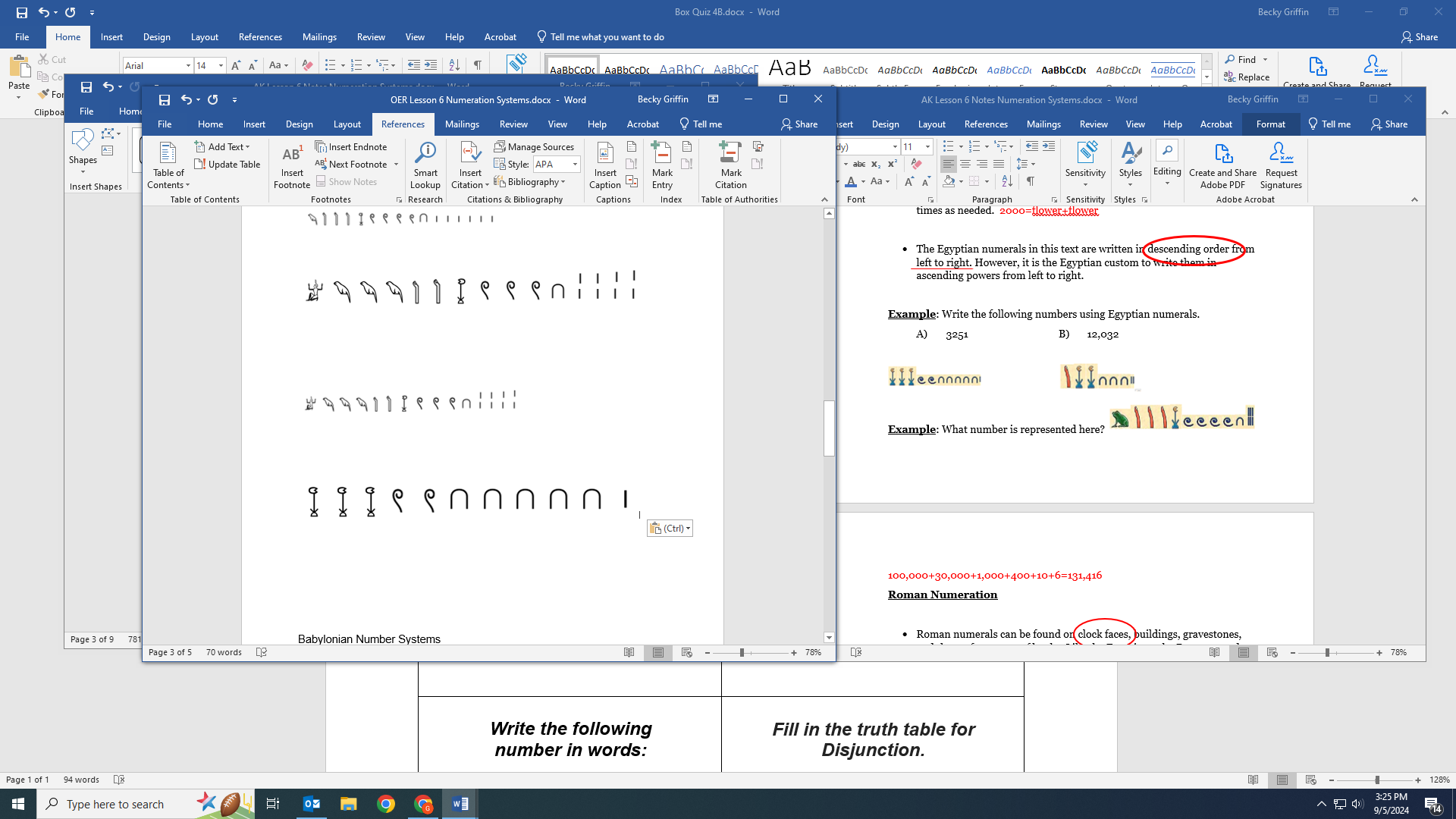
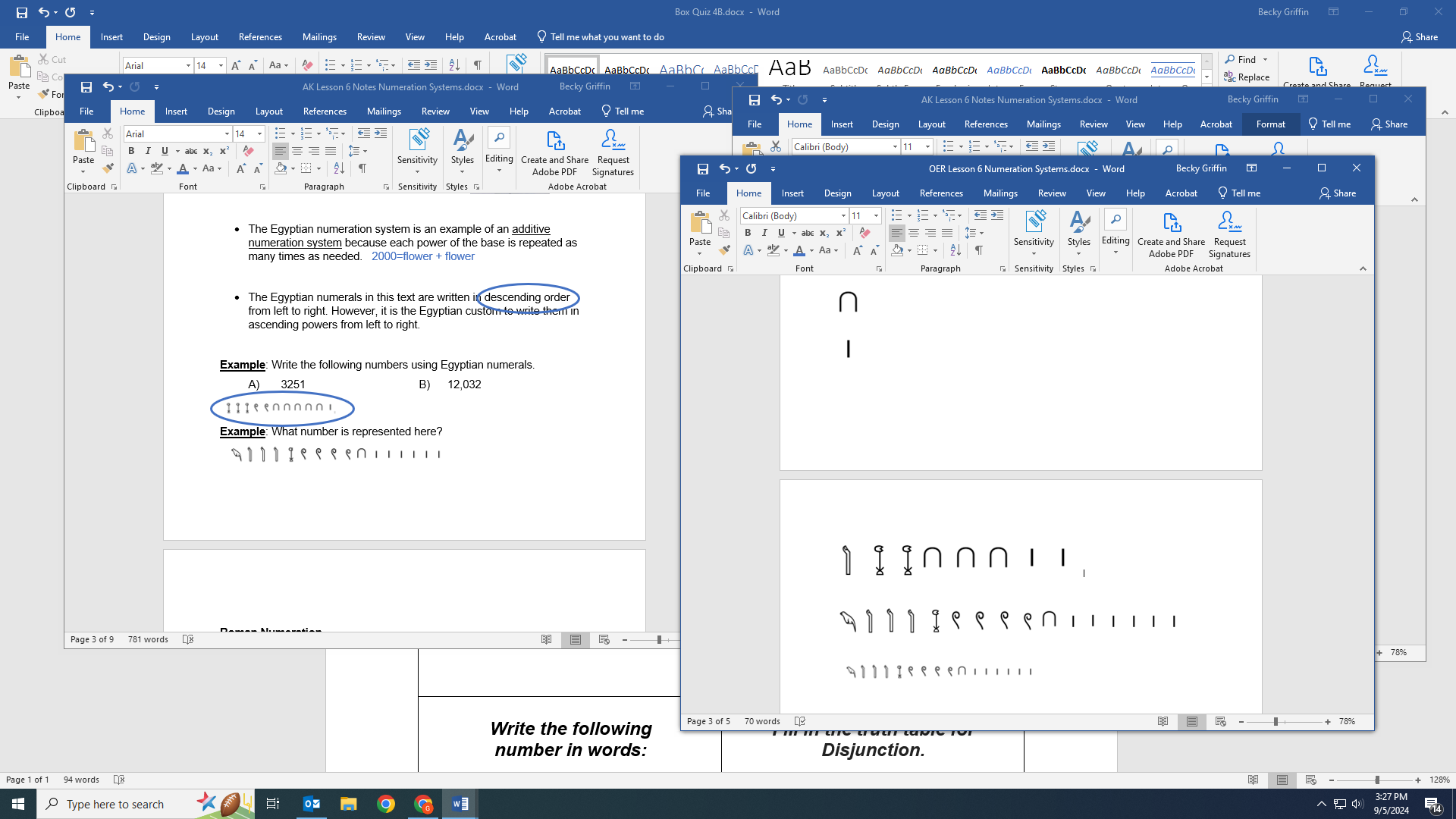
1 = stick; 10 = heel bone; 100 = coiled rope; 1,000 = flower; 10,000 = pointing finger; 100,000 = frog; 1,000,000 = man

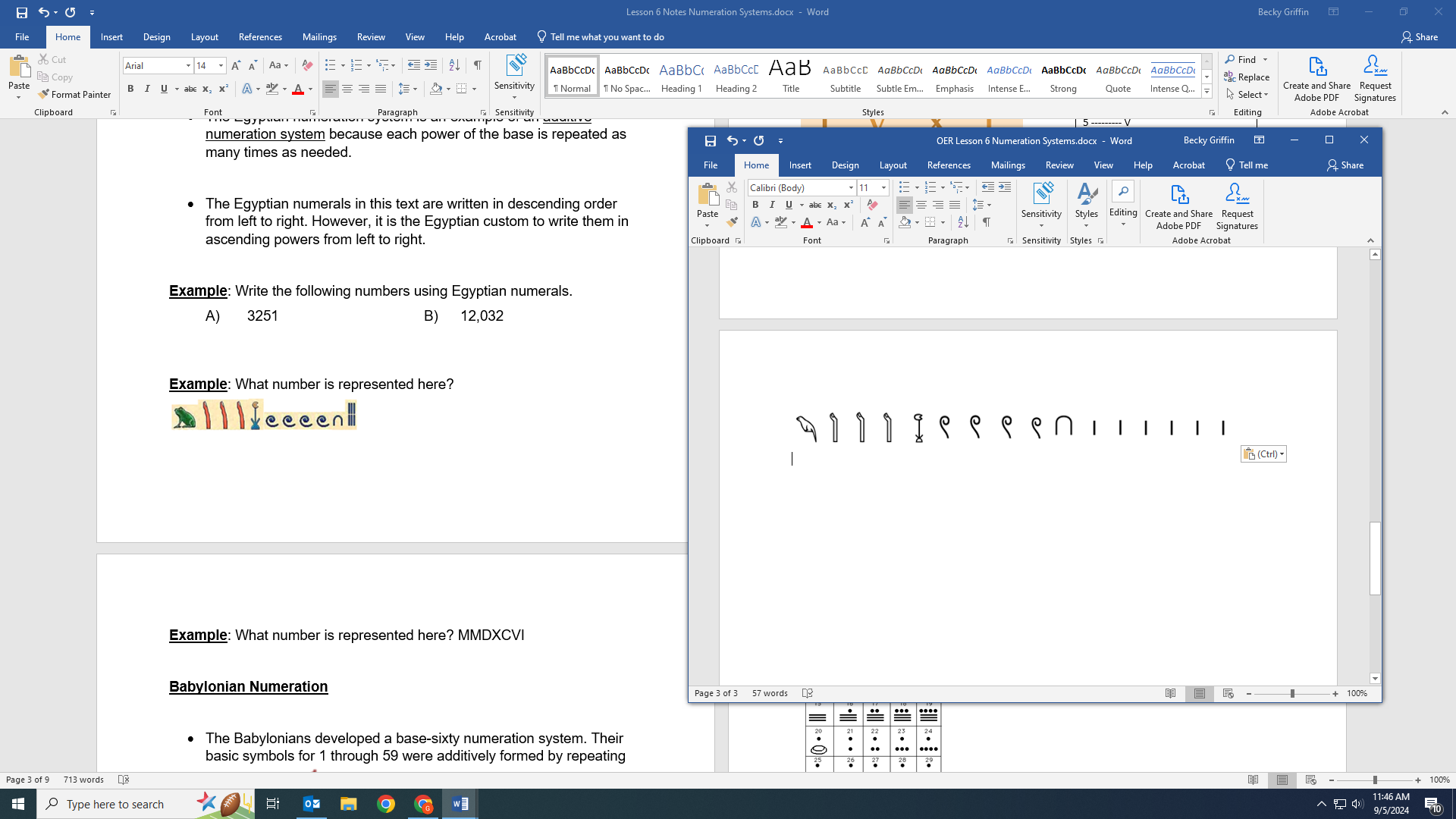
 

* The Egyptian numeration system is an example of an additive numeration system because each power of the base is repeated as many times as needed. 2000 = flower + flower
* The Egyptian numerals in this text are written in descending order from left to right. However, it is the Egyptian custom to write them in ascending powers from left to right.

**Example**: Write the following numbers using Egyptian numerals.

1. 3251 B) 12,032

**Example**: What number is represented here? 

100,000 + 30,000 + 1,000 + 400 + 10 + 6 = 131,416

**Roman Numeration**

* Roman numerals can be found on clock faces, buildings, gravestones, and the preface pages of books. Like the Egyptians, the Romans used base ten.
* They had a modified additive numeration system, because in addition to the symbols for powers of the base (base ten), there are symbols for 5, 50, and 500.
* The seven common symbols for Roman numerals are listed below:

One 1 ---------- I 100

Five 5 --------- V

Ten 10 -------- X 101

Fifty 50 -------- L

One Hundred 100 ------- C 102

Five Hundred 500-------- D

One Thousand 1000 ------ M 103

* The Romans wrote their numerals so that the numbers they represented were in decreasing order from left to right. IV = 5 – 1 = 4

Only a single smaller number can be placed to the left of a larger number.

If a “smaller” symbol is to the left of a “larger” symbol, this means subtraction.

**Example**: Write the following using Roman numerals.

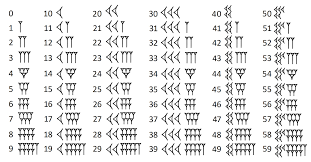
1. 3541 B) 1995

MMMDXXXI or MMMDXLI MCMXCV

**Example**: What number is represented here? MMDXCVI

2000 + 500 + 90 + 6 = 2596

**Babylonian Numeration**

* The Babylonians developed a base-sixty numeration system. Their basic symbols for 1 through 59 were additively formed by repeating https://www.open.edu/openlearn/pluginfile.php/59910/mod_oucontent/oucontent/375/e8b91980/c6d3e3cf/ma290_2_i001i.jpgfor 1 and https://www.open.edu/openlearn/pluginfile.php/59910/mod_oucontent/oucontent/375/e8b91980/6ac32a1d/ma290_2_i002i.jpg for 10.

… 603 602 601 600

* To write numbers greater than 59, the Babylonians used their basic symbols for 1-59 and the concept of place value. Place value is a power of the base, and the Babylonian place values were 1, 60, 602, 603, etc. For example, to write 135……..

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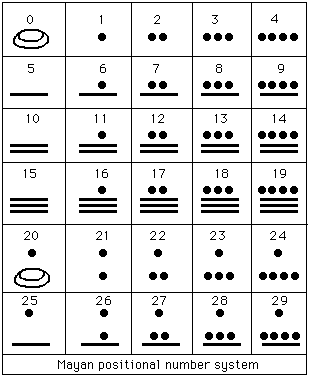
601 600 = 2(60) + 15(1)

= 120 + 15 = 135

**Mayan Numeration**

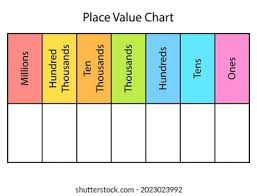
* The Mayas used a modified base-twenty numeration system that included a symbol for zero. Mayans wrote their numbers vertically with one numeral above the other, with the powers of the base increasing from bottom to top.

203 202 201 200



**Hindu-Arabic Numeration**

* Much of the world now uses this system.
* It is the source of *our* digits. 104 103 102 101 100 PLACE VALUE!
* It is a base-ten numeration system in which place value is determined by the position of the digits 0, 1, 2, 3, 4, 5, 6, 7, 8, and 9. Each digit in a numeral has a name that indicates its position.



**Example**: Here are the names and values of the digits in 75,063.

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7 x 104 = ten thousands digit = 70,000

5 x 103 = thousand digit = 5,000

0 x 102 = hundreds digit=0

6 x 101 = tens digit = 60

3 x 100 = ones digit = 3

**Example**: Given the following numeral 75,063:

1. Write it in words. (How would you verbally say this?)

seventy-five thousand, sixty-three

1. Write it in **expanded notation** *with exponents.*

7 x 104 + 5 x 103 + 0 x 102 + 6 x 101 + 3 x 100

1. Write it in **expanded notation** *without exponents.*

7 x 10,000+ 5 x 1,000+ 0 x 100+ 6 x 10+ 3 x 1

**Example**: Given the following numeral 5,267:

1. Write it in words. (How would you verbally say this?)

five thousand, two hundred, sixty-seven

1. Write it in expanded notation *with exponents.*

5 x 103 + 2 x 102 + 6 x 101 + 7 x 100

1. Write it in expanded notation *without exponents.*

5 x 1,000+ 2 x 100+ 6 x 10+ 7 x 1

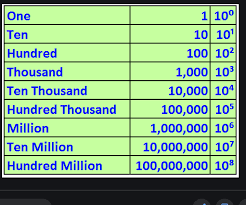
**Example**: Given the following number 543,786,210, write it in words.

five hundred forty-three million, seven hundred eighty-six thousand, two hundred ten

*It is absolutely essential that students learn place value and base ten concepts by Grade 2.*

*--NCTM Standard*

**Determining the value of digits and their place value**



**Example**: Determine the value of each underlined digit and its place value.

1. 8490 Place Value: Value:

Hundreds 400

1. 579,164 Place Value: Value:

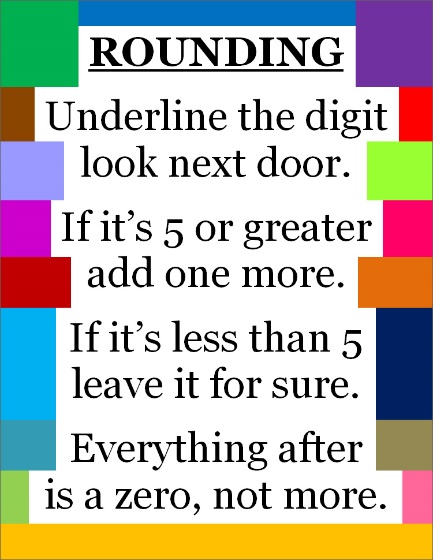
Ten thousands 70,000

1. 52,438 Place Value: Value:

Tens 30

**Rounding Numbers**

**Example**: Round 92,831,254 to the following place values.

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1. Ten thousands place 92,830,000
2. Thousands place 92,831,000
3. Hundreds place 92,831,300
4. Millions 93,000,000