Grade Level/Course: 4th & 5th Grade Math and Science

Lesson/Unit Plan Name: The Power of Ten: Building a Magnitude Model

Rationale/Lesson Abstract: Students will create linear representations of powers of ten, from 1/100 to 100 using adding machine tape, (from 1 to 100 for 4th grade). This linear model shows the magnitude of each power more dramatically than an area model. It shows the concepts of replicating (copying) ten times and/or partitioning ten times depending on the direction. It can be mounted on the wall or ceiling for reference throughout the year.

Timeframe: 2 – 3 days

Common Core Standard(s):

4.NBT.1: Recognize that in a multi-digit whole number, a digit in one place represents ten times what it represents in the place to its right. *For example, recognize that 700 ÷ 70 = 10 by applying concepts of place value and division.*

5.NBT.2: Powers of Ten
Explain patterns in the number of zeroes of the product when multiplying a number by powers of 10, and explain patterns in the placement of the decimal point when a decimal is multiplied or divided by a power of 10. Use whole-number exponents to denote powers of 10.

5.MD.1: Convert measurements
Convert among different-sized standard measurement units within a given measurement system (e.g. convert 5 cm to 0.05m), and use these conversions in solving multi-step, real world problems.

5-ESS1-1: Earth's Place in the Universe
Support an argument that differences in the apparent brightness of the Sun compared to other stars is due to their relative distances from Earth.

Instructional Resources/Materials:
For each pair of students:

- 50" strips of **adding machine tape** (plain, **not:** chemically treated or pressure sensitive)
- A 3x5 card cut to 10 cm (in the 5" direction)
- Scissors and a marker
- Ruler (marked in centimeters)

Poster paper or chart paper (a color on which the white tape will show well) – about 24" x 50"
Place Value labels (p. 7 & 8 of this lesson)
Glue stick and clear tape
Warm-ups (p. 5 & 6 of this lesson)
Extension lesson:
Roll of twine
Sidewalk chalk

Lesson: Build linear place value strips out of adding machine tape in order to show the magnitude of change between each place value.

Prerequisites:

- multiply by 10, 100, etc.
- place value lessons on exponents, showing powers of 10

Video: Powers of Ten (1977) by Charles & Ray Eames
https://www.youtube.com/watch?v=0fKBhvDjuy0
(these are zeroes-0, not the letter O)
You my want to watch just the first few minutes as an introduction and then watch the whole video as a conclusion to the lesson.

Day 1

Materials

- Warm up I (p. 5)
- Adding machine tape – about 50" per pair
- Scissors
- Pencils
- A 3x5 card cut to 10 cm (in the 5" direction)
- Poster paper or chart paper (a color on which the white tape will show well) – about 24" x 50"
- Place Value labels (p. 7 & 8 of this lesson)

Warm-up I (p. 5): Debrief, paying special attention to the question in quadrant IV about patterns. They might mention: adding zeros, one place value larger or smaller, x1 is the same as x 10^0, etc.

T: Today we will be building a model of our place value system that is based on multiplying by 10 or dividing by 10. What happens when you multiply by 10?
S: Gets one place value bigger, there's another zero, the numbers move over to the left by one place value.

T: So, if a number is one place value greater, what was it multiplied by?
S: 10

T: How many of the original number do you have to add together to get to the new number?
S: 10

T: This card (cut to 10 cm) represents 1 – it is your reference segment. Each pair will use this card as the reference segment for each place value.
You will cut a length of adding machine tape that represents 1 and one that represents 10.

T: Mark one card length on the adding machine tape and cut it out – this is your 1.
Then mark 10 card lengths, or reference segments, (be sure to draw the lines clearly and darkly with your marker), on another piece of adding machine tape and cut that out.

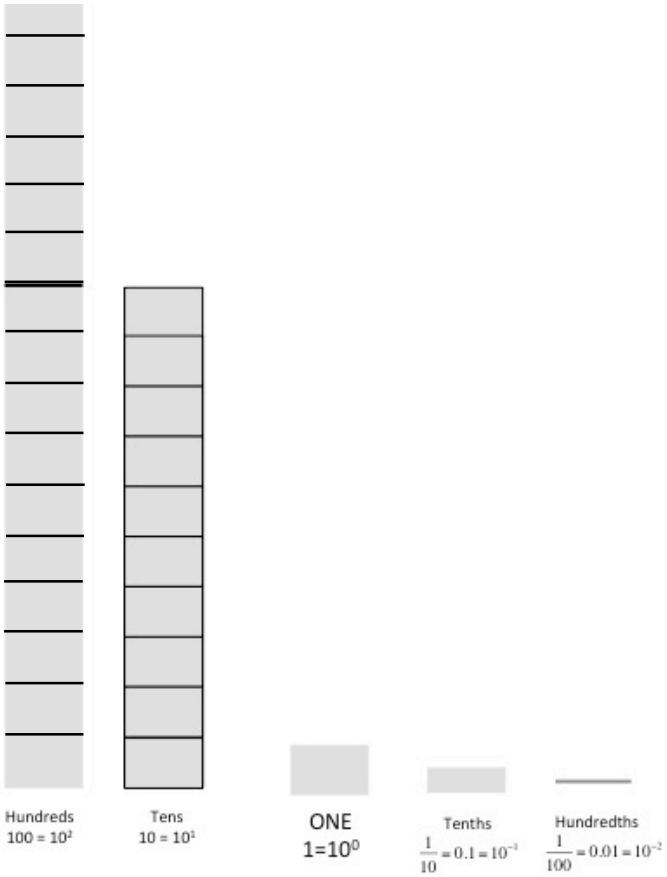
T: You may begin working when you receive your materials.

Organize the students into pairs & pass out materials:

- cards
- adding machine tape
- scissors
- markers

Once all of the pairs have their 2 pieces cut, randomly choose 2 pairs – one will bring their 1 up and the other will bring their 10 up to be put on the poster.

*Begin with the **ONE***
it is the center of our poster, it is the center of our number system!



- Glue the **one** on the poster/chart paper with it's label under.
- Glue the **ten** on with it's label also.
- Glue the **hundred** label on and begin a discussion on how to make the 100.

Find a place to mount the chart on the wall, either from the floor up (make sure there is open space to run it across the ceiling) or from a corner of the room where it can wrap around the room. Do this before making the hundred

T: Now, you need to make a strip that represents 100. How will you do that?

S: Make 10 more 10s, mark 100 of the reference segment, etc. Use the 10s we already have for the 100.

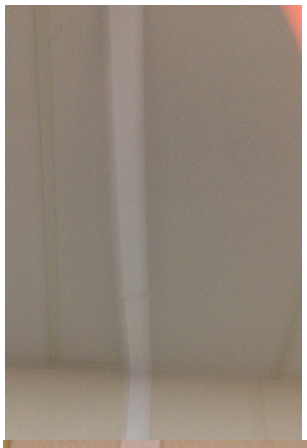
Select 10 groups to bring their 10-strip to a place in the room with long open space, or use the hallway, and have them tape the 10 together. Have a student use a marker to draw a dark line where each 10 is taped to the next. Now mount it on the poster in the correct position and run it as far as it needs to go.

This concludes day one's activity.

Exit Ticket: Explain how you made the strip that represents 10.

Day 2
Materials:

- Adding machine tape – about 3" per group
- 10 cm card (the Unit) from day 1
- Scissors, pencils, cm rulers



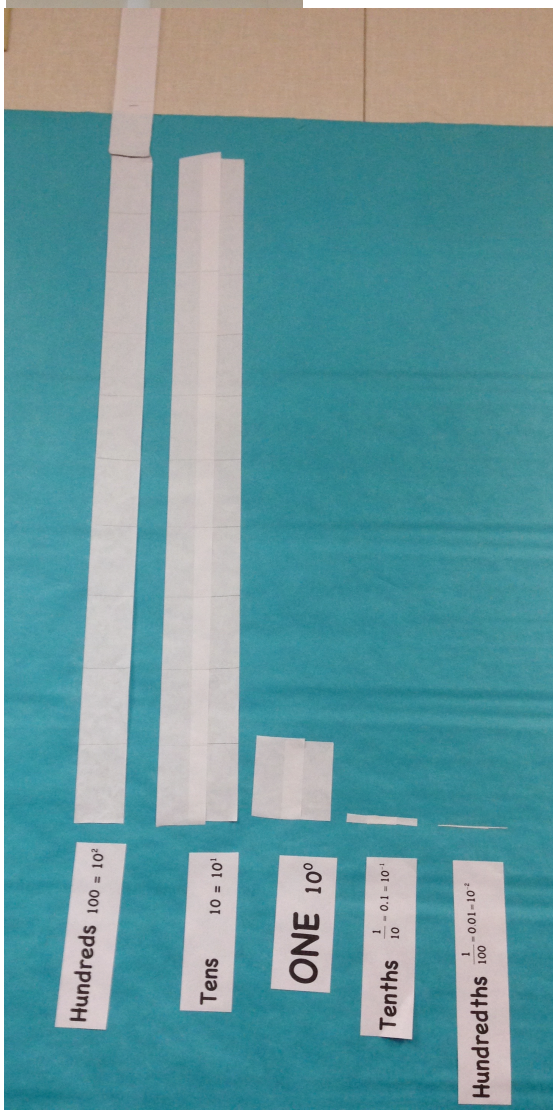
Warm-Up II (p. 6) Debrief warm-up, emphasizing division. Each place is partitioned into 10 parts to get to the next smaller place value.

T: Today we will continue building the model of our place value system that is based on multiplying by 10 or dividing by 10. What happens when you divide by 10?
S: It gets one place value smaller, has one less zero, the numbers move to the right by one place value.

T: We have three place values on our poster, what else do we need?
S: 1/10, 1/100, etc.

T: How will you make a length that represents $1/10^{th}$?
To get to the next larger place value you multiplied by 10, so how do you get to a smaller place value?
S: Divide by 10

T: How can you divide the ONE into 10 equal pieces to get the $1/10^{th}$?
S: Fold the paper, guess, use a ruler, etc.



Pass out the cm rulers and ask them to discuss with their partner, a way to get 1/10 of the one.
Share ideas - They should discover the unit card is 10 cm, so 1 cm would be $1/10^{th}$ of 10 cm

T: Demonstrate measuring with the cm ruler with the document camera, by marking 1 cm on the tape – draw a straight line and cut it carefully.
T: Next you need to cut a $1/100^{th}$. How many pieces do you need to divide $1/10^{th}$ into to represent $1/100^{th}$? S: 10

T: Look carefully at the 1 cm on the ruler – how many tiny segments are there between 0 and 1?
S: 10 to go one place value smaller than 1/10, we have to divide the $1/10^{th}$ into 10 pieces. The ruler has it divided for us – we just have to carefully mark and cut that very tiny piece.

Mount the $1/100^{th}$ and $1/10^{th}$ on the chart.

Exit Ticket: Explain how you made the piece representing 1/100.

Activity Extension: Making the 1,000

Materials:

- 1 ball of twine (about $3 each)
- sidewalk chalk
- meter stick

Measure 10 meters of twine (use meter stick, measuring tape, etc.) – a meter stick is nice because you can just name it the 10 and not worry about the actual measurement.

Ask the students to verify that it seems to be the same as the 100 you have mounted.
Activity will be done outside. Find a long open space (it's best not to turn corners).

Explain that 10 people will carry the string for a while, then the next 10 get a turn, and then the final 10 get a turn. Those paying attention may get to write on the ground with the chalk.

It's important to begin exactly at the 0 – draw a heavy line there and write 0. The 10 "string holders" need to stretch the string tightly on the ground and mark a line and a "100" at the end. Motion for the whole line to move in the same formation, with the end stopping at the "100" - mark a line and a "200" at the new end. Switch out students carrying the line, so everyone gets a turn. The two ends are the most important, but everyone in between must make sure the string is pulled tightly and resting on the ground before the next mark is made. Continue until you get to 1000!

Conclude by showing the remainder of the video: Powers of Ten

Assessment:

Debrief the lesson with some of these questions.

What did you do here?
Why is that one so long? So short?
What does it show & how will it be useful?
How did you know how much bigger or smaller to make them?
What do you notice about these strips?
Describe the relationship between the strips.
What are some ways to write the quantities that each strip represents?

Name _____

Warm-Up I

4.NBT.1

$25 \times 1 =$

$25 \times 10 =$

$25 \times 100 =$

5.NBT.1

$25 \times 10^0 =$

$25 \times 10^1 =$

$25 \times 10^2 =$

5.NBT.2

$250 \div 1 =$

$250 \div 10 =$

$250 \div 100 =$

5.NBT.2

What patterns do you notice in the 3 sets of problems?

Name _____

Warm – Up II

5.NBT.3

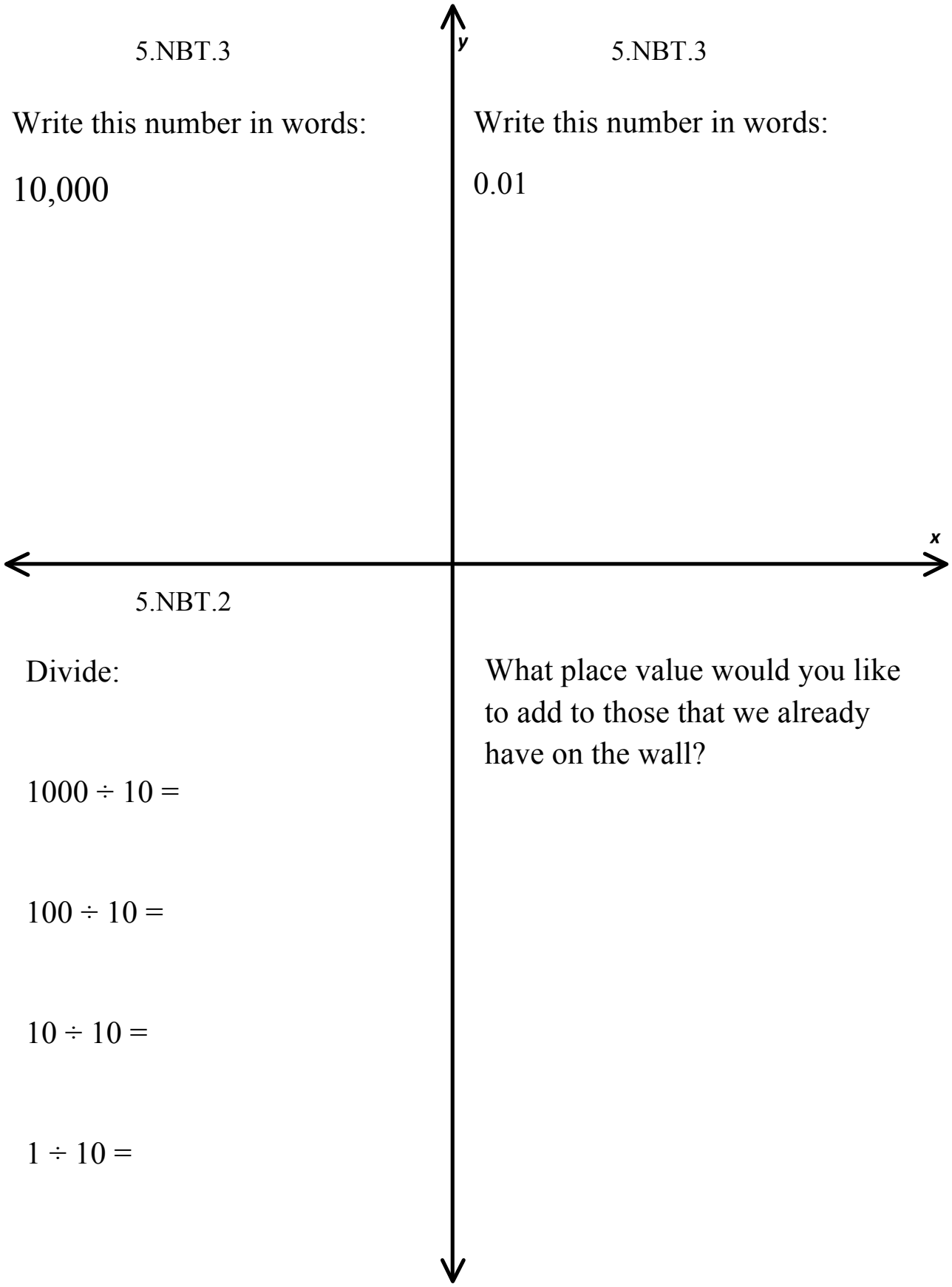
Write this number in words:

10,000

5.NBT.3

Write this number in words:

0.01



5.NBT.2

Divide:

1000 ÷ 10 =

100 ÷ 10 =

10 ÷ 10 =

1 ÷ 10 =

What place value would you like to add to those that we already have on the wall?

ONE 10^0

Tens $10 = 10^1$

Hundreds $100 = 10^2$

Tenths $\frac{1}{10} = 0.1 = 10^{-1}$

Hundredths $\frac{1}{100} = 0.01 = 10^{-2}$

One Thousand $1000 = 10^{3}$