Math Path to 7 Billion

Materials:

Part 1: Student Worksheets ("Feel the Rhythm" and "Millions and Billions")
Metronome (free online metronomes are available if you do not own one)

Part 2: 1,000 sheets, or 2 reams, of copy paper
Meter sticks
Student Worksheet ("Measuring a Million") if desired

Part 3: Student Worksheets ("Bacteria Bottles" and "Calendar Riddle")

Part 1: The Meaning of Millions

Procedure:

Distribute Student Worksheets 1 and 2 to each of the students. Depending on the level of experience with conversion, you can provide either Version A, which walks students through the process step by step, or Version B, which allows them to do conversions without guidance. Give the students time to complete Student Worksheet 1, **Feel the Rhythm**, and then go over the answers. Once they understand the math concepts, make the population connection using a metronome (free "web metronomes" are available online) and the script below:

"This metronome shows how many people are added to the planet each minute. One tick of the metronome indicates one person being added to our world. (*Set the metronome to 148 ticks per minute.*) Currently, we are adding about 148 people per minute, like you calculated on your worksheet. (*Turn off the metronome.*) When Columbus arrived in the Americas in 1492, the world population was relatively stable, growing by about one million people per year, or 2 ticks per minute. As death rates dropped dramatically after the Industrial Revolution, human populations began to grow. By 1940, we were adding 40 people per minute (*Set the metronome to 40, or the slowest setting.*); 88 per minute by 1950 (*Set the metronome to 88 ticks per minute.*); 138 per minute by 1970 (*Set the metronome to 138 ticks per minute.*); and 148 per minute today (*Set the metronome to 148 ticks per minute.*). This seems really fast, but our rate of growth has actually slowed: just 15 years ago, it stood at 176 per minute (*Set the metronome to 176 ticks per minute.*)"

World of 7 Billion

Concept:

To understand the implications of a world population over seven billion, it is important for students to be able to conceptualize large numbers.

Objectives:

Students will be able to:
- Work with fractions to solve conversion problems.
- Develop and implement a strategy for solving a geometry problem in a cooperative learning group.
- Solve riddles illustrating the difference between millions and billions.

Subjects:

Economics, Math

Skills:

Calculating with large numbers, estimating, measuring length/area/volume, averaging, using scientific notation

Method:

Through riddles, cooperative learning activities, and a demonstration, students work through problems to calculate and visualize large numbers.

Now, instruct the students to complete Student Worksheet 2, **Millions and Billions.** This will expand what they learned about conversion in **Feel the Rhythm** with different word problems. After giving the students time to complete the question, go over the answer on the board or out loud.

If you have time, you may also ask the following questions as an extension:

- How old are you if you are a million seconds old?
- How old are you if you are a billion seconds old?

Part 2: Measuring a Million

Procedure:

Now that your students understand how large millions and billions are, divide them into groups of three or four. Have a representative from each group come to the front of the room, count out 100 sheets of paper and collect a meter stick. Distribute Student Worksheet 3, **Measuring a Million**, which asks the students to complete the following assignment:

How tall would a million sheets of paper be? How about a billion sheets of paper?

Note: Answers may vary depending on the type of paper measured. A stack of 100 sheets of standard 20 lb. photocopy paper is approximately 1.3 cm high, so a stack of one million is approximately 130 meters high and a stack of one billion is approximately 130,000 meters high, or 130 km.

Discussion Questions:

1. Can you think of anything that is about the same height as a million sheets of paper? How about a billion sheets of paper?

   A million sheets of copy paper would be about 130 meters high, or the height of a tall building over 40 stories. A billion sheets of paper would be over 72 miles high, or nearly as high as the boundary to outer space!

2. As of the fall of 2011, there are seven billion people living on Earth. Is this a little or a lot? How does this compare with the 310 million people that lived in the U.S. in the same year?

   The world population is nearly 23 times the size of the U.S. population. The United States is the third most populated country in the world.

3. If you lived in a city with a million people, what might there also be a million of?

   Answers vary; may include houses, cars, televisions, tables, etc.

Follow-Up Activity:

Have the student groups come up with their own measurement project and share it with the class. To facilitate, you may provide different classroom objects, such as a box of markers, a chalkboard eraser, or a math textbook, and allow them to choose one. Then, the students can take measurements to determine how high or wide a stack of 1 million of those objects would be. You could also give them the volume or dimensions of the room and have the groups determine how many of their objects could fit in the classroom.

Part 3: Doubling Time and Exponential Growth

Procedure:

Hand out copies of Student Worksheets 4 and 5, **Bacteria Bottles** and **Calender Riddles**, and instruct the students to complete them. You may choose to have the students complete the questions individually or in groups. If you are tight on time, have each group work on a different problem and then present their answer to the class on the board. You may also choose to use these two problems in different lessons if you'd like to focus solely on doubling time or exponential growth.

Name: ______________________________ Date:__________________________

Math Path to 7 Billion

Student Worksheet 1 - Version A: Feel the Rhythm

1. If the population was growing by about 1 million people per year, as it was in 1492 when Columbus arrived in the Americas, about how many people would be added to the planet each minute?

- What is 1 million in scientific notation? ________________
- I would estimate that ___________ people are being added to the planet each minute.

Process (round to the nearest whole number):

a. First, change the number of people/year into the number of people/day by dividing by 365.

$$\frac{1{,}000{,}000 \text{ people}}{\text{year}} \times \frac{\text{year}}{365 \text{ days}} = \text{\_\_\_\_\_\_\_\_\_\_\_\_\_\_ people/day}$$

b. Change the number of people added/day into the number of people/hour by dividing by 24 hours.

$$\frac{\text{Answer to (a)}}{\text{day}} \times \frac{\text{day}}{24 \text{ hours}} = \text{\_\_\_\_\_\_\_\_\_\_\_\_\_\_ people/hour}$$

c. Change the number of people/hour into the number of people/minute by dividing by 60 minutes.

$$\frac{\text{Answer to (b)}}{\text{hour}} \times \frac{\text{hour}}{60 \text{ minutes}} = \text{\_\_\_\_\_\_\_\_\_\_\_\_\_\_ people/minute}$$

2. Using the same process as you used in #1, answer the following question. If the population is growing by 78 million people per year, as it is currently, about how many people are being added to the planet each minute?

- What is 78 million in scientific notation? _____________
- I would estimate that __________ people are being added each minute.

Answer: ____________________ people/minute

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Math Path to 7 Billion

Student Worksheet 1 - Version B: Feel the Rhythm

1. If the population was growing by about 1 million people per year, as it was in 1492 when Columbus arrived in the Americas, about how many people would be added to the planet each minute?

   - What is 1 million in scientific notation? _________________
   - I would estimate that ___________ people are being added to the planet each minute.

   Now do the calculations. Show your work.

   Answer: ______________________ people/minute

2. If the population is growing by 78 million people per year, as it is currently, about how many people are being added to the planet each minute?

   - What is 78 million in scientific notation? _____________
   - I would estimate that ___________ people are being added each minute.

   Now do the calculations, rounding to the nearest whole number. Show your work.

   Answer: ______________________people/minute

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Math Path to 7 Billion

Student Worksheet 2 - Version A: Millions and Billions

The scale of large numbers can be hard to understand. The world's population is over seven billion, and the population of the United States is over 300 million. Is that a little or a lot? This exercise will help you appreciate the difference between millions and billions:

> Your rich uncle has just died and has left you one million dollars. If you accept the money you must count it for eight hours a day at the rate of one dollar per second. When you are finished counting, the million dollars will be yours and only then may you begin to spend it.

How long would it take to count a million dollars at this rate?

Process (round to the nearest tenth):

1. As you learned in *Feel the Rhythm*, problems like these are all about using multiplication and division to convert the units you have into the units you want. Start by identifying the information given in the problem.

   The problem says that I have ____________ dollars to count at a rate of _________ dollars/sec for ___________ hours/day.

2. Knowing this, calculate the number of seconds it will take you to count $1,000,000.

   $$\$1{,}000{,}000 \times \frac{\text{second}}{\$1} = \_\_\_\_\_\_\_\_\_\_\_\_\_ \text{ seconds}$$

3. Now, figure out how long in minutes, hours, and days it would take to count $1,000,000.

   60 seconds= 1 minute 60 minutes= 1 hour 8 hours of counting= 1 day

   It would take ___________________ minutes to count $1,000,000.

   It would take ___________________ hours to count $1,000,000.

   It would take ___________________ days to count $1,000,000.

4. Using the same process, how many years would it take to count a billion dollars at the same rate? (This time, you'll need to convert all the way to years. Remember: 365 days=1 year.)

   ____

   Do you accept your uncle's offer? Why or why not?

   ____

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Student Worksheet 2 - Version B: Millions and Billions

The scale of large numbers can be hard to understand. The world's population is over seven billion, and the population of the United States is over 300 million. Is that a little or a lot? This exercise will help you appreciate the difference between millions and billions:

> Your rich uncle has just died and has left you one billion dollars. If you accept the money you must count it for eight hours a day at the rate of one dollar per second. When you are finished counting, the billion dollars will be yours and only then may you begin to spend it.

How long (in minutes, hours and days) would it take to count a million dollars at this rate? (Show your work, rounding to the nearest tenth).

Answers: ______________ minutes
______________ hours
______________ days

How many years would it take to count a billion dollars at the same rate? (Show your work, rounding to the nearest tenth.)

Answers: ______________ years

Do you accept your uncle's offer? Why or why not?

____

____

Name: ________________________________ Date:____________________________

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Student Worksheet 3 - Measuring a Million

Problem: How tall would a million sheets of paper be? A billion sheets of paper?

Process:

1. I would estimate that the height of a stack of a million sheets of paper would be ______ cm.

2. The average estimate for my group is _____ cm.

3. The height of 100 sheets of paper is _______ mm or _________ cm.

4. Based on the information in #3, the height of 1,000,000 sheets of paper is _____ mm or _______ cm or _______ meters. Remember: 1,000,000 = 100 x 10,000.

5. Based on the information in #4, the height of 1,000,000,000 sheets of paper is ______ meters, or ________ kilometers.

6. Based on the information in #5, the height of 1,000,000,000 sheets of paper is _____ miles. (1 km=0.62 miles)

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Student Worksheet 4 - Bacteria Bottles

Doubling Time is the time it takes a population to double at a constant rate of growth. Bacteria, for instance, multiply by division. One bacterium becomes 2. Then 2 divide into 4; the 4 divide into 8, and so on. For a certain strain of bacteria, the time for this division process is one minute.

1. If you put one of this bacterium in a bottle at 11:00 p.m., the entire bottle will be full by mid night. When would the bottle be half full?

2. How do you know?

3. Suppose you were a bacterium in this bottle. At what time would you first realize that you were running out of space? ________________________ Suppose that at 11:58 p.m. some bacteria realize that they are running out of space in the bottle. So they launch a search for new bottles. They look far and wide, and finally, offshore in the Arctic Ocean, they find three new empty bottles. Great sighs of relief come from all the bacteria. This is three times the number of bottles they've known. Surely, they think, their space problems are over. Is that so?

4. Since their space resources have quadrupled, how long can their growth continue?

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Student Worksheet 5 - Calender Riddle

Exponential Growth is a constant rate of growth applied to an increasing base. Doubling a small number over and over means doubling ever-larger numbers.

> Jimmy's father complained that his son's allowance of $5 per week was too much. Jimmy replied, "Okay, Dad. How about this? You give me a penny for the first day of the month, 2 cents for the second, 4 cents for the next, 8 cents for the next, and so on for every day of the month." Jimmy's father agreed to his son's plan.

1. Who was more clever?

2. What would the Jimmy's allowance be on day 31? (You may use a calculator to help you find the answer.)

3. What would be Jimmy's total allowance received over the course of the entire month?

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Student Worksheet Answers

PART 1:

Student Worksheet 1: Feel the Rhythm

1. 1×10^6; 2,740 people/day; 114 people/hour; 1.9 or 2 people/minute
2. 7.8×10^7; 148 people/minute

Student Worksheet 2: Millions & Billions

1. $1,000,000; $1; 8
2. 1,000,000 seconds
3. 16,666.7 minutes; 277.8 hours; 34.7 days
4. 95.1 years; No, because it would take over 95 years to count the money.

Extension Answers:

At a million seconds old, you are about 11.5 days old.
At a billion seconds old, you are about 31.5 years old.

PART 2:

Student Worksheet 3: Measuring a Million

Answers will vary depending on what kind of paper students measure.

PART 3:

Student Worksheet 4: Bacteria Bottles

1. 11:59 pm
2. Because the bottle is full at midnight and the doubling time is one minute.
3. Answers will vary. To clarify, ask students: "At 11:55 p.m. when the bottle was only 3% full and 97% empty, would it be easy to see that there was a space problem?"; No.
4. The bacteria's growth can continue at its current rate for two more minutes, or until 12:02 a.m.:

> At 11:58, the first bottle is one-quarter full. By 11:59, the bacteria will have doubled to fill the first bottle halfway. By midnight, bottle 1 will be completely full. By 12:01, the bacteria in bottle 1 will have doubled and will fill up bottle 2. By 12:02, the bacteria in bottles 1 and 2 will each have doubled, to fill bottles 3 and 4.

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Student Worksheet Answers cont.

Student Worksheet 4: Bacteria Bottles (cont.)

11:54 p.m.	*Bottle 1 is 1.5% full.*
11:55 p.m.	*Bottle 1 is 3% full.*
11:56 p.m.	*Bottle 1 is 6.25% full.*
11:57 p.m.	*Bottle 1 is 12.5% full.*
11:58 p.m.	*Bottle 1 is 25% full.*
11:59 p.m.	*Bottle 1 is 50% full.*
Midnight	*Bottle 1 is 100% full.*
12:01 a.m.	*Bottles 1 and 2 are full.*
12:02 a.m.	*Bottles 1, 2, 3 and 4 are all full.*

Student Worksheet 5: Calendar Riddle

1. Jimmy was more clever.
2. On day 31 alone, his allowance would be $10,737,418.24. His total allowance for the month would be $21,474,836.47.

1 $.01	2 $.02	3 $.04	4 $.08	5 $.16	6 $.32	7 $.64
8 $1.28	9 $2.56	10 $5.12	11 $10.24	12 $20.48	13 $40.96	14 $81.92
15 $163.84	16 $327.68	17 $655.36	18 $1,210.72	19 $2,621.44	20 $5,242.88	21 $10,485.76
22 $20,971.52	23 $41,943.04	24 $83,886.08	25 $167,772.16	26 $335,544.32	27 $671,088.64	28 $1,342,177.28
29 $2,684,354.56	30 $5,368,709.12	31 $10,737,418.24				