

## UNIT 2 | HOW POPULATIONS GROW

# DOUBLE TAKE

### METHOD

Students listen to a mathematical folktale and mathematical riddles and solve related word problems.

### MATERIALS

#### Part 1:

- *One Grain of Rice: A Mathematical Folktale* by Demi\*
- *One Grain of Rice* Student Worksheet
- Calculators

#### Part 2:

- *Doubling Riddles* Student Worksheet
- Calculators

\*available in libraries, bookstores, and at online retailers

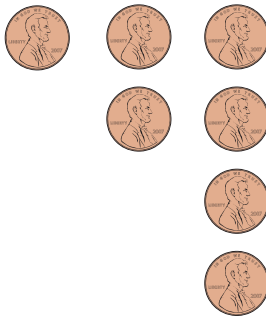
## INTRODUCTION

Doubling is an important concept in mathematics and in understanding trends in biology, ecology, and economics.

Populations can grow **exponentially**, doubling over and over until a very small amount becomes a very large amount. In this activity, students will see how the doubling pattern works in a classic folktale, *One Grain of Rice*, and in two math riddles.

Before starting the activity on doubling, pose this question to your students:

“Would you rather have \$1,000 right now or receive one penny today and double it every day for 30 days?” Ask them to write their answers in their math journals and explain their reason.



## PART 1: ONE GRAIN OF RICE

### PROCEDURE

1. Introduce *One Grain of Rice* by Demi and ask students if they are familiar with the term **folktale**. Explain that it is a story that is passed down through the generations. The details may change in the retelling but the essential message of the story remains the same. *One Grain of Rice* is a version of an ancient folktale from India.



### CONCEPT

A small amount, when continually doubled, can grow into a very large amount very quickly.

### GRADE LEVEL

Upper elementary

### SUBJECTS

Math, Social Studies, Language Arts, Science

### OBJECTIVES

Students will be able to:

- Calculate doubling and appreciate how small amounts build quickly with multiple doublings.
- Extend their learning about doubling of various items to understand how it applies to world population.
- Explain the importance of rice to the world's diet and food supply.

### SKILLS

Problem solving, multiplying and dividing multi-digit whole numbers, doubling large numbers, multiplying fractions, simplifying fractions into mixed fractions, using a calculator, listening comprehension

2. Begin reading the book to the class. Stop after the seventh page of text (there are no page numbers) to ask students if they know what a **famine** is and why it was such a dire situation that the Raja was not sharing his rice. Continue reading the book. You may want to stop after the 16th page of text – before the doubling of the rice grains gets very large – and have students fill in the *One Grain of Rice* chart on the Student Worksheet. They can work on this individually or in pairs. Encourage them to do all of the calculations and then check it with a calculator (or just use the calculator to save time).
3. Finish reading the story, showing the pictures, so that students can visualize all of that rice. Now students will see what it means to have over a billion grains of rice, in terms of feeding people. The second page of the *One Grain of Rice* worksheet includes word problems about rice consumption around the world and how many people could be fed with Rani's rice.

Note: You may want to share with students the following Rice Facts:

- Rice represents 20 percent ( $1/5$ ) of the world's per person consumption of calories.
- More than half of the world's population is dependent on rice for 80 percent ( $4/5$ ) of their diet.
- Rice is grown in more than 100 countries and on every continent except Antarctica.
- Much of the world's rice crop is dependent on annual rainfall. Changes in weather patterns can dramatically affect the rice harvest from year to year.
- In 2011, there were 457 million metric tons of rice produced worldwide, equal to 144 lbs. of rice for every person in the world (about one cup of uncooked rice per person per day or three cups of cooked rice).

## ONE GRAIN OF RICE WORKSHEET ANSWERS

See last page of book for completed chart

1. 1,073,741,823
  2. 100,000
  3. 100,000; 3,333
  4.  $1\frac{1}{2}$  cups;  $4\frac{1}{2}$  cups
- Bonus: 8,592,000,000

## DISCUSSION QUESTIONS

1. How did Rani outsmart the Raja and avoid a famine in the kingdom?
2. At what point in the story did the Raja realize that she had outsmarted him?

# PART 2: DOUBLING RIDDLES

## PROCEDURE

Have students revisit the question you posed at the start of the activity. Have they changed their answer about which amount of money they would rather have? The *Doubling Riddles* Student Worksheet includes two riddles that can reinforce their understanding of doubling. These could be used for assessment, especially since the chart from the *Double the Money* riddle is similar to the one on the *One Grain of Rice* Student Worksheet. The difference is that instead of doubling grains of rice, students are doubling money.

## DOUBLING RIDDLES WORKSHEET ANSWERS

### Double the Money Riddle:

- a. *The son.*
- b. *\$10,737,418.24. This does not count how much he received on all the previous days. This is a good example of how doubling even a small amount over time can really add up.*
- c. *Day 13. By then, he would've received a total of \$40.95. His entire allowance for 4 weeks under the old rule was \$40.00.*

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 \$1,310.72	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				

### Lily Pond Riddle:

- a. *Day 19*
- b. *Day 18*
- c. *1/16*
- d. *Answers vary.*
- e. *Answers vary.*
- f. *2,097,152*

## MEASURING LEARNING

Present *One Grain of Rice* (the book and worksheet) as a classroom activity and have students complete the *Doubling Riddles* worksheet on their own to reinforce learning. These can be collected and graded.

Data sources: Producers Rice Mill, Inc., <http://producersrice.com/rice/facts.html>; USDA, Foreign Agricultural Service, Grain: World Markets and Trade; University of Arkansas, Department of Agricultural Economics and Agribusiness, World Rice Outlook, International Rice Baseline Projections, 2011-2020.

# ONE GRAIN OF RICE

## STUDENT WORKSHEET 1

Name: \_\_\_\_\_

Date: \_\_\_\_\_

Fill in the chart below showing how many grains of rice Rani would receive each day. Remember that you are doubling the amount in each previous square. Once you have filled in the chart, add up all of the grains for each day to get the total number of grains she received in all.

<b>Day 1</b> 1 Grain of rice	<b>Day 2</b> 2 Grains of rice	<b>Day 3</b> 4 Grains of rice	<b>Day 4</b>  Grains of rice	<b>Day 5</b>  Grains of rice	<b>Total After 5 Days</b>  <b>Grains of rice</b>
<b>Day 6</b>  Grains of rice	<b>Day 7</b>  Grains of rice	<b>Day 8</b>  Grains of rice	<b>Day 9</b>  Grains of rice	<b>Day 10</b> 512 Grains of rice	<b>Total After 10 Days</b>  <b>Grains of rice</b>
<b>Day 11</b>  Grains of rice	<b>Day 12</b>  Grains of rice	<b>Day 13</b>  Grains of rice	<b>Day 14</b>  Grains of rice	<b>Day 15</b>  Grains of rice	<b>Total After 15 Days</b>  <b>Grains of rice</b>
<b>Day 16</b>  Grains of rice	<b>Day 17</b> 65,536 Grains of rice	<b>Day 18</b>  Grains of rice	<b>Day 19</b>  Grains of rice	<b>Day 20</b>  Grains of rice	<b>Total After 20 Days</b>  <b>Grains of rice</b>
<b>Day 21</b>  Grains of rice	<b>Day 22</b>  Grains of rice	<b>Day 23</b>  Grains of rice	<b>Day 24</b>  Grains of rice	<b>Day 25</b>  Grains of rice	<b>Total After 25 Days</b>  <b>Grains of rice</b>
<b>Day 26</b>  Grains of rice	<b>Day 27</b>  Grains of rice	<b>Day 28</b>  Grains of rice	<b>Day 29</b>  Grains of rice	<b>Day 30</b>  Grains of rice	<b>Total After 30 Days</b>  <b>Grains of rice</b>

1. How many grains of rice did Rani receive all together? (Hint: You will need to add up the grains for each of the 30 days.) \_\_\_\_\_

2. If there are 10,000 grains of rice in a cup, approximately how many cups of rice would Rani have received in all? (Hint: For answer #1, round to the nearest billion.)

\_\_\_\_\_ cups



3. The average amount of rice eaten per person each day around the globe is one cup. (Note: This expands to 3 cups of rice to eat when it's cooked in water.)
- a. If each person in Rani's kingdom eats that amount, how many people can eat for a day with the rice she received? \_\_\_\_\_
- b. How many could eat for 30 days? \_\_\_\_\_ (round to nearest whole number)
4. Rice is a staple of the diet for most people living in Asia. In China, a country in Asia, the average person eats six times as much rice as the average person in the U.S.
- a. If a person in the U.S. eats an average of  $\frac{1}{4}$  cup of uncooked rice per day, how much does the average person in China eat per day? \_\_\_\_\_ cups (mixed fraction)
- b. How much cooked rice is this? \_\_\_\_\_ cups (And when you consider that there are 1.3 billion people in China, that's a lot of rice!)

**BONUS:**

Rani started with one grain of rice, which was doubled 29 times. On Day 30, she received approximately 537 million grains of rice. Since the first human walked the earth, our population has doubled nearly 33 times. What would be the total number of people after 33 doublings?

\_\_\_\_\_ (This is our projected world population for 2035.)

# DOUBLING RIDDLES

## STUDENT WORKSHEET 2

Name: \_\_\_\_\_

Date: \_\_\_\_\_

### 1. Double the Money Riddle:

A father complained that his son’s allowance of \$10 per week was too much. The son replied, “Okay, Dad. How about this? Let’s change my weekly allowance for one month using this rule: You give me a penny on the first day of the month, two cents on the next day, four cents on the next, eight cents on the next, and so on for every day of the month.” The father readily agreed.

- a. Who was more clever? \_\_\_\_\_
- b. What would be the son’s allowance on Day 31? \_\_\_\_\_
- c. By which day of the month would the son have surpassed his old allowance amount for a month? (Assume the month has 4 weeks.) \_\_\_\_\_

<b>1</b> \$.01	<b>2</b> \$.02	<b>3</b> \$.04	<b>4</b>	<b>5</b>	<b>6</b>	<b>7</b>
<b>8</b>	<b>9</b>	<b>10</b>	<b>11</b>	<b>12</b>	<b>13</b>	<b>14</b>
<b>15</b>	<b>16</b>	<b>17</b>	<b>18</b>	<b>19</b>	<b>20</b>	<b>21</b>
<b>22</b>	<b>23</b>	<b>24</b>	<b>25</b>	<b>26</b>	<b>27</b>	<b>28</b>
<b>29</b>	<b>30</b>	<b>31</b>				

## 2. Lily Pond Riddle:

You are a lily pad on a pond. Today you have only one fellow lily pad living on the pond with you. But the lily pad population is growing. Its doubling time (the time it takes for the number to double) is one day. So each day the population is twice as big as the day before.



Tomorrow there will be four of you. It will take exactly 20 days for your pond to be completely full of lily pads.

- On what day will the pond be one-half full? \_\_\_\_\_
- On what day will the pond be one-quarter full? \_\_\_\_\_
- How full will the pond be on Day 16? \_\_\_\_\_
- Do you think you and your fellow lily pads will feel concerned on Day 16 about running out of space? Why or why not? \_\_\_\_\_  
\_\_\_\_\_
- Lily pads are living plants. How will the pond filling up affect you and your fellow lily pads? Give at least three effects. \_\_\_\_\_  
\_\_\_\_\_  
\_\_\_\_\_
- What is the maximum population of the pond? \_\_\_\_\_ (Population on Day 20)
- Predict what is going to happen next. \_\_\_\_\_  
\_\_\_\_\_