

## Day 17: Making a New Offer

The change in the number of rubas in last class show **exponential growth**. These relationships are called **exponential relationships**. You can find the value for any square by multiplying the value for the previous square by a fixed number. This fixed number is called the growth factor. The general equation for an exponential relationship or function is:

$$y = b \cdot m^x$$

where  $b$  is the y-intercept and  $m$  is the growth factor.

What was the growth factor for "Plan 1" from worksheet #16?

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The king told the queen about the reward that he had promised the peasant. The queen said, "You have promised her more money than we have in the entire royal treasury! You must convince her to accept a different reward."

After much thought, the king came up with a second plan. With plan 2, he would make a new board with only **16 squares**. He would place 1 ruba on the first square and 3 rubas on the second. He drew a graph to show the number of rubas on the first five squares. He would continue this pattern until all 16 squares were filled.

The queen wasn't convinced about the king's new plan, so she devised a third plan. Under plan 3, the king would make the board only **12 squares**. He would put 3 rubas on the first square. He would use the equation  $y = 4x - 1$  to figure out how many rubas to put on each of the other squares. In the equation, the  $y$  is the number of rubas on square number  $x$ .

1. In the table below, Plan 1 is the reward requested by the peasant (from last class). Plan 2 is the king's new plan and Plan 3 is the queen's plan. **Complete the table to show the number of rubas on squares 1 through 10 for each plan.**

# square	# rubas		
	Plan 1	Plan 2 (3 times the rubas on the previous square)	Plan 3 (Uses the equation $y = 4x - 1$ )
1	1	1	3
2	2	3	7
3	4	9	11
4	8	27	15
5	16	81	19
6	32	243	23
7	64	729	27
8	128	2187	31
9	256	6561	35
10	512	19683	39

2. Compare Plans 1 and 2. How are Plans 1 and 2 similar? How are they different?

They are both exponential, but plan 1 has a growth factor of 2 while plan 2 has a factor of 3.

3. Compare Plans 1 and 3. How are Plans 1 and 3 similar? How are they different?

Both change consistently, but plan 1 consistently multiplies while 3 consistently adds.

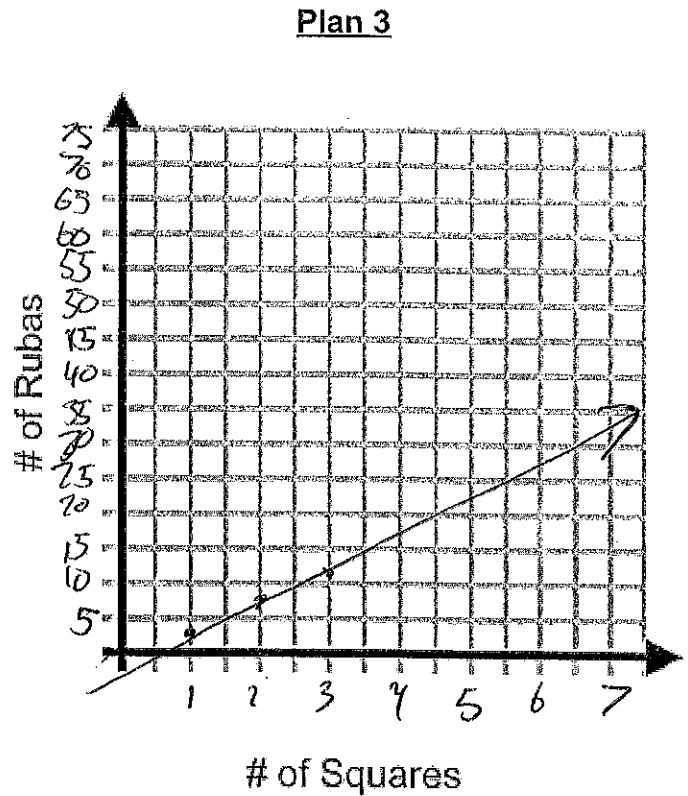
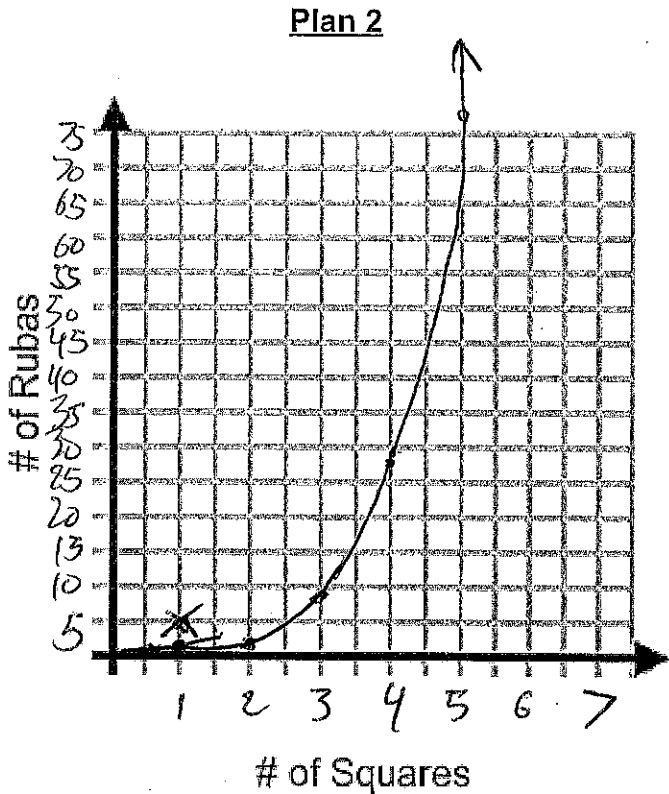
4. Are the growth patterns for plans 1 and 2 exponential or linear? How do you know? If so, what is the growth factor for each?

Exponential: Factors of 2 & 3 respectively

5. Write an equation for the relationship between the square number,  $x$ , and the number of rubas,  $y$ , for Plan 2.

$$y = \left(\frac{1}{3}\right) 3^x \quad \text{OR} \quad y = 3^{x-1}$$

6. Graph Plan 2 and Plan 3 below (graph  $x$ -values 1 through 7 only). Compare these graphs to your graph for Plan 1 on worksheet #16.



Write 1-2 sentences explaining the similarities and differences.

Straight line vs curve. Both increase.  
One has a constant slope

7. For Plans 2 and 3, how many rubas would be in the last square? Use the equations for each plan to calculate this! Remember: Plan 2 has 16 squares and Plan 3 has 12 squares.

$$y = \left(\frac{1}{3}\right) 3^{16}$$

14,348,907

$$y = 4(12) - 1$$

47

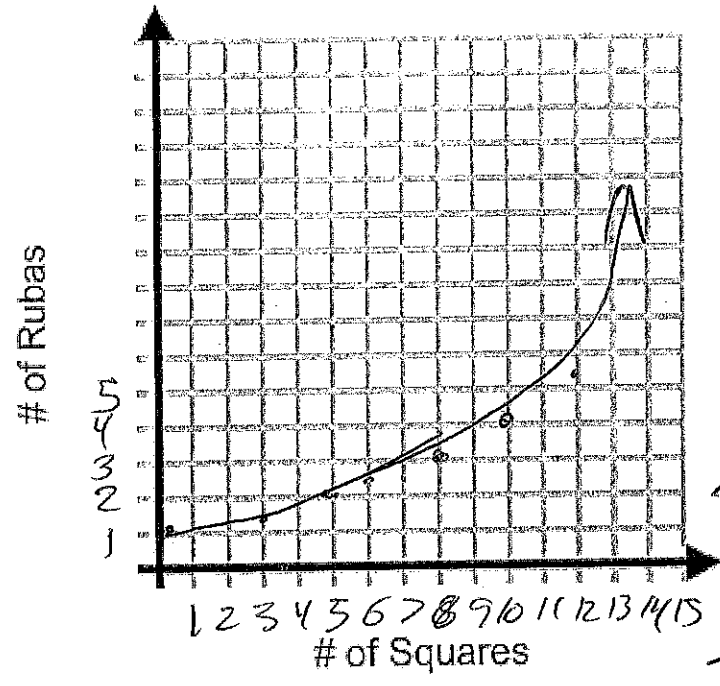
8. Which Plan is better for the King? Which plan is better for the peasant?

The King should choose Plan 3, the peasant should choose 2

9. After reviewing the Plans 2 and 3 the peasant is not satisfied with either. She asks the king to create another plan. The king asks you to propose a compromise. Write an equation for a plan that is fair to both the peasant and the king. Graph your equation on the same graph. Explain why this is a fair compromise.

Equation of Your Plan:  $y = \text{[scribble]} (1.15)^x$

Your Plan



THERE IS NO "CORRECT" ANSWER

Explain why this is a fair compromise:

Because the peasant still gets over 7667 rubas, but the king isn't bankrupt.

**Extension (optional):** Look-up Arithmetic and Geometric Sequences. We are interested in the sum of each plan. Create a formula to find the sum of rubas the king will pay the peasant for each Plan 2 and Plan 3. You **cannot** just add the numbers up, you must create an equation.