PFS 26-3 10/15/12 ____________________

Falling!

"A piece of wooden molding or scantling, about 12 cubits [twenty-three feet] long, half a cubit [about one foot] wide and three finger-breadths thick, was taken; on its edge was cut a channel a little more than one finger in breadth; having made this groove very straight, smooth, and polished, and having lined it with parchment, also as smooth and polished as possible, we rolled along it a hard, smooth, and very round bronze ball."

--Galileo, *Two New Sciences*

Galileo is often thought of as the father of modern science. He accomplished many things, such as discovering the moons of Jupiter, but perhaps his most important work involved understanding how objects move in a gravitational field. When Galileo was a child, schools taught that heavier objects fall faster than lighter ones. Galileo showed that this was not true, and he discovered the mathematical function that describes how objects speed up as they fall. To help him understand how things fall, he "slowed down" gravity by rolling balls down ramps. (Sounds like fun doesn't it?!)

Galileo learned from his ramp experiment that an object that rolls one unit of distance in one second will roll three units during the second second, five units during the third second, and so on. As soon as he saw this pattern of odd numbers, he must have said to himself, "Aha! Square numbers!"

1) Explain the connection between square numbers and odd numbers.

Galileo's discovery was correct. A stone will fall 16 feet in one second. During the second second of falling, it will fall three times that distance, 48 feet. And so on.

2) Make a function chart that shows how far an object falls during each second of its fall. Give your chart a title and do five rows. Your chart should start like this:

seconds	feet
1	16
2	48

3) Now make a function chart that shows the total distance an object falls after a certain number of seconds. Your chart should start:

seconds	feet
1	16
2	64

In modern terms we would say the distance an object falls is proportional to the square of the time it's falling. If we write it as an algebraic formula, we could say $d = 16 t^2$. A similar formula would hold true in different gravitational fields. For example, on the moon, a stone will fall only 2.7 feet in one second. For the moon, the formula would be $d = 2.7 t^2$.

4) Now make a function chart showing how far a stone will fall on the moon after a certain number of seconds. Your chart should begin:

seconds	feet
1	2.7
2	10.8

5) Make a graph showing how far a stone will fall after a certain number of seconds (on earth). Your horizontal axis should be time, going from, say, zero to eight seconds. Your vertical axis should be distance, from zero to 1,024 feet. (Please note that in our charts and graphs we're "neglecting air resistance.")

6) A baseball is thrown horizontally from a height of, say, sixteen feet. At the exact same time another baseball is dropped from the same height. Which will hit the ground first? Explain your answer! I don't think Galileo did this experiment, but I think he knew the right answer!

7) Learn more about Galileo. Remember: report on research in your own words, and cite specific sources.

8) Learn more about gravity!

9) Isaac Newton said he "stood on the shoulders of giants," meaning he was able to make scientific discoveries based on earlier thinkers such as Galileo and Kepler. He took Galileo's discoveries about gravity and showed that gravity works not only on earth, but throughout the universe. According to a famous story, he looked at a falling apple and at the moon, and he realized that the moon was falling to the earth *but not getting any closer.* Explain how the moon can be falling towards the earth but not getting closer!

Have fun!