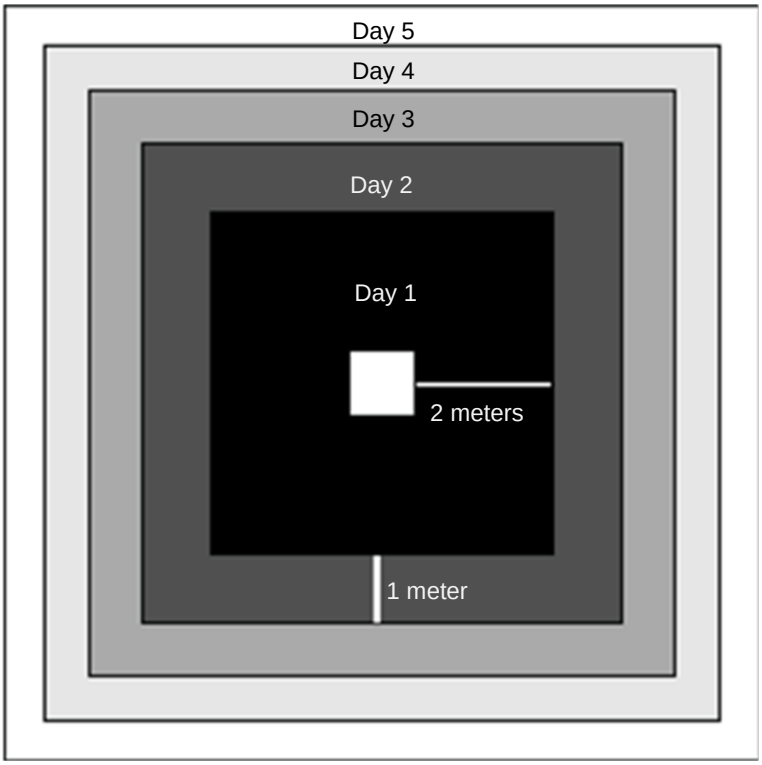
Name: _____ Date: _____

Guided Learning: Power and Motion (Part 3)

Running versus falling … a closer look
In the last set of exercises, you investigated the mathematical differences between systems whose motion depends on an external force versus those relying on an internal power source. Thinking about painting can help you understand the fundamental reason runners accelerate faster at the beginning of a race and more slowly later on. (Note: A set of questions on the next page links this analogy to power and energy.)

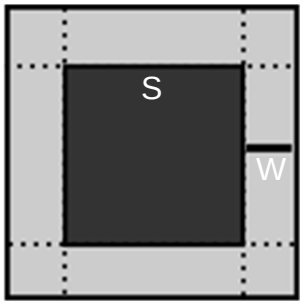
Maria is a painter hired to paint by hand the floor of a museum as it is being built. She can paint 24 square meters of flooring per day. The floor is 11 meters square, but there is a fountain in the middle 1 meter square, leaving 11 x 11 -1 = 120 square meters to paint. The architect asks her to work outward from the center. This maximizes the amount of time carpenters have to work on the walls before her painting reaches their space.



The fountain takes up one square meter (m^2), and she can paint 24 m^2 a day, so this means on the first day she can paint out 2 meters from the fountain, forming a 5 x 5 square with an area of 25 m^2.

On the second day, she enlarges the painted region by 24 m^2. Since 25 m^2 + 24 m^2 = 49 m^2, she can only enlarge the painted region by 1 meter on each side, forming a 7 x 7 square.

On each successive day, she enlarges the width of the painted region less and less, as shown on the figure to the right.



On a separate piece of paper, in your journal, or in an interactive notebook, explain in your own words why the width (W) Maria adds each day goes down as the side length (S) of the square increases. You might want to start with a drawing like the one shown to the left. How does the area of the enlarged section relate to S and W?

Connecting painting to energy

In this exercise you will connect Maria's task of painting the museum floor to the acceleration of an internally-powered system to see why its acceleration decreases more rapidly than a dropped object.

Imagine you are taking a brisk walk (speed = 1 m/s) with your dog, a miniature pinscher puppy named Benji, whose mass is 2 kg.

Benji is walking with you, matching your speed, when he sees a cat and shoots off after it. His muscles accelerate him with a power of 24 watts.

In the questions below, you will relate Benji's motion to Maria's painting.

1. Benji's body generates 24 watts of power, so every second his kinetic energy is increased by 24 joules. How does this relate to Maria's painting job?

   _____

2. Benji's initial kinetic energy is $E_k = \frac{1}{2}mv^2 = \frac{1}{2}(2)(1)^2 = 1$ joule. How does this relate to Maria's painting job?

   _____

3. What does Benji's total speed after t seconds compare to in Maria's story?

   _____

4. What does Benji's velocity relate to in Maria's story?

   _____

5. What does Benji's acceleration relate to in Maria's story?

   _____

6. In your own words, explain why Benji's velocity increases less and less each second even though his kinetic energy is going up at a constant rate.

   _____

   _____

   _____