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# Projectile Motion Model Worksheet

## Projectile Motion Model Discussion

What Galileo proposed and Newton essentially proved is that all objects fall toward the Earth at the same increasing rate (in a vacuum). That is, all objects will accelerate toward the Earth equally, regardless of their mass. In a vacuum, where there is no drag, or friction due to air, a heavy hammer will fall at exactly the same rate as a light feather. (This was demonstrated during the Apollo 15 moon landing, when David Scott dropped a hammer and feather at the same time and watched them hit the lunar surface at the same time and proudly announced that Galileo was correct!) At the surface of the Earth, the acceleration toward the center of the Earth experienced by all objects is measured to be (on average) 9.8 $m/s^2$ (32 $ft/s^2$).

The distance an object will fall under the influence of gravitational acceleration can be calculated using Equation 1.

$$d = \tfrac{1}{2}gt^2 \qquad \textit{Equation 1}$$

d = distance traveled
g = acceleration due to gravity (981 $cm/s^2$)
t = time

The Projectile Motion Model illustrates the constant acceleration due to gravity of any moving body. Each position of the fishing sinker represents a 0.05-second interval of the horizontal and vertical positions of a dropped sinker. A falling fishing sinker accelerates so the falling distance for each 0.05-second interval is longer than the previous one.

When used to demonstrate the parabolic motion of a projectile, the model also shows that the speed of an object in the horizontal direction does not change when acted on only by the force due to gravity. The force of gravity affects only vertical motion, and not the horizontal motion. By lining up the time interval positions to match the parabola of a projectile, the Projectile Motion Model can be used to measure the speed of a projectile. Each line must be spaced equally apart along the meter stick to produce the proper parabolic shape to represent the motion of the projectile.

## Analysis Questions

1. What shape do all projectiles follow?

2. Starting from rest, how far will an object fall in one second?

3. How far does an object with a constant horizontal speed fall in one second?

4. What is the best angle for launching a projectile in order to achieve the greatest distance?

5. What is the best angle for launching a projectile in order to achieve the greatest height?

6. *(Optional)* Show the calculations needed to determine the horizontal speed of a projectile using the "dial in" method.