Experimental Design!

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Design and conduct your own experiments with projectiles!

Log onto http://phet.colorado.edu/simulations/sims.php?sim=Projectile_Motion *Press **RUN NOW** button.

1) Write your best understanding of the word projectile:

A projectile is any object that is launched by the exertion of a force.

2) Name all of the factors you think affect projectile movement (try to list at least five factors):

- Height of the launch.
- Angle of the launch.
- Speed of the launch.
- Gravity.
- Air resistance.

Experiment 1:

3) With your lab partner, choose **one** of the factors you've just listed above and propose a question to test that factor. Your goal is to hit the target!

   a) Factor: _Height of the launch_

   b) Question:

How high does a cannon, positioned at an angle of zero degrees, need to be in order to hit a target that is 15 m away with a projectile that has an initial speed of 15 m/s?

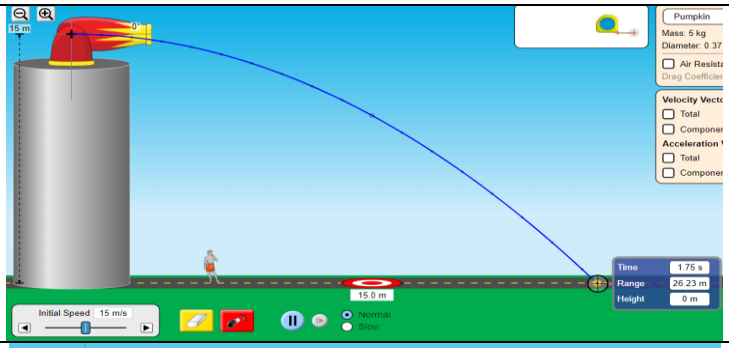
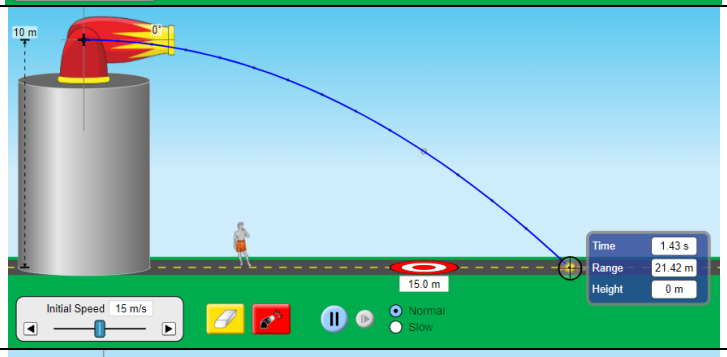
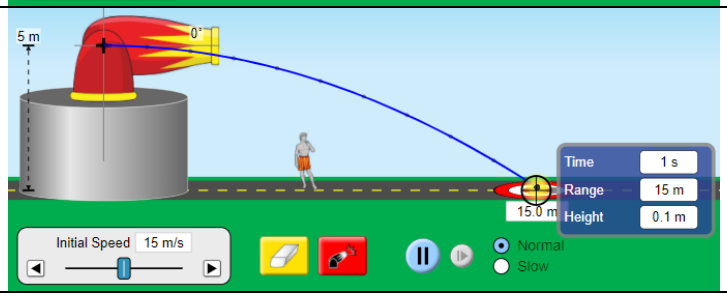
4) Write your hypothesis regarding how the factor you've chosen will affect your ability to hit the target (If…then…because):

If I position the cannon up high then the projectile will hit the target because it will be in the air longer.

5) What is your test variable? _Height of the launch_ Outcome variable? _Distance of the launch_

6) What variables should you keep constant? _Launch Angle, Target distance, Initial Launch Speed_

7) Once you have put all variables in place, fire away! Did you hit your target? Write a conclusion statement explaining your results.

Test Variable (Height of Launch)	Experiment	Output Variable (Distance of Launch)
15 m		26.23 m
10 m		21.42 m
5 m		15.0 m

Conclusion: Based on my three trials of different launch heights (15m, 10m, and 5m), I have determined that the higher the launch height is from the ground the farther the projectile will travel. I hit my target of 15 meters away from a height of 5 meters.

Experiment 2:

1) With your lab partner, choose a **different** factor than the one above and propose a question to test that factor. Your goal is to hit the target!

   a) Factor: Angle of the launch

   b) Question:

   At what angle does a cannon (placed on the ground), need to be set at to launch a projectile with an initial speed of 15 m/s to hit a target only 5 meters away?

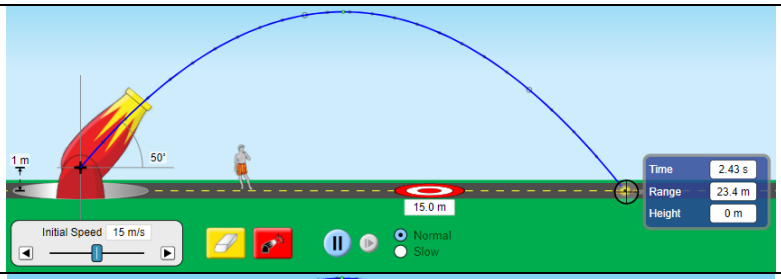
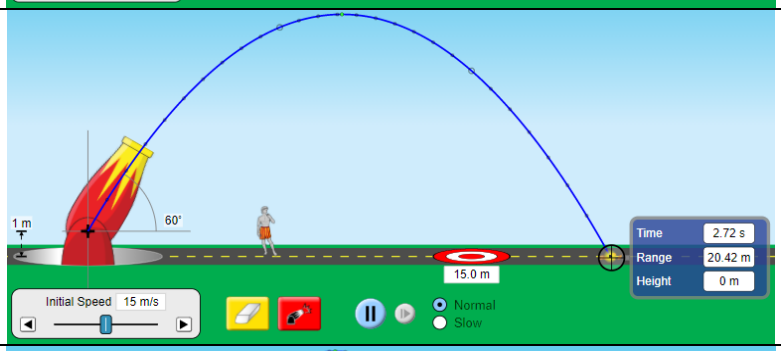
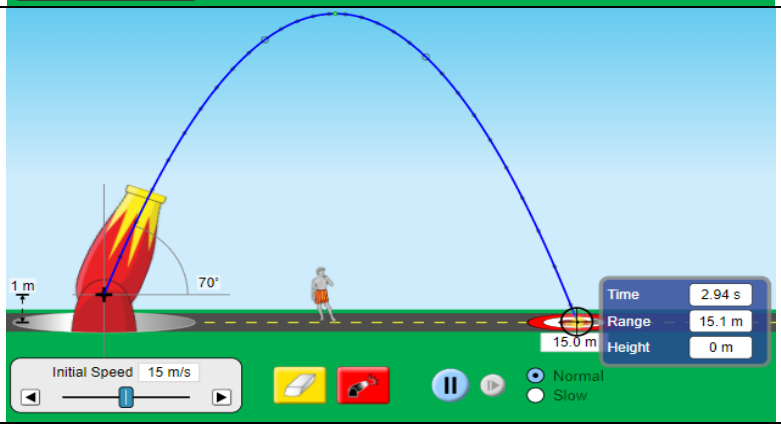
2) Write your hypothesis regarding how the factor you've chosen will affect your ability to hit the target (If…then…because):

If the angle of the cannon is set to a steep angle (50 – 80 degrees) then the projectile will hit the target 15 meters away because the projectile will fall faster after having been projected higher into the air.

3) What is your test variable? _Angle of the launch_ Outcome variable? _Distance of the launch_

4) What variables should you keep constant? _Launch height, Target distance, Initial Launch Speed_

5) Once you have put all variables in place, fire away! Did you hit your target? Write a conclusion statement explaining your results.

Test Variable (Angle of Launch)	Experiment	Outcome Variable (Distance of Launch)
50 degrees		23.4 m
60 degrees		20.42 m
70 degrees		15.1 m

Conclusion: Based on my three trials of different cannon angles (50°, 60°, and 70°), I have determined that the steeper the cannon angle the shorter the distance the projectile will travel. I hit my target of 15 meters from an angle of 70 degrees.

Experiment 3:

1) With your lab partner, choose a **different** factor than the one above and propose a question to test that factor. Your goal is to hit the target!

   a) Factor: __Initial Speed of the launch__

   b) Question:

What initial speed does the projectile in a cannon need to be set at to hit a target that is 15 meters away if the angle of the cannon is set at 45 degrees?

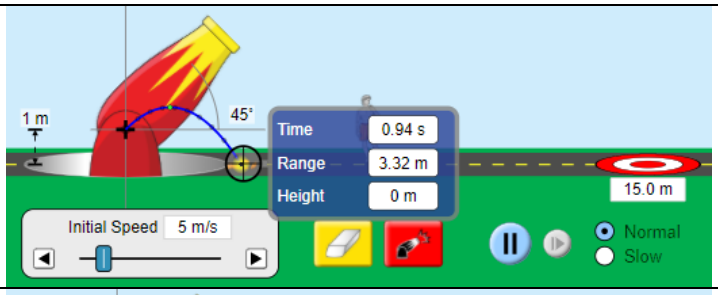
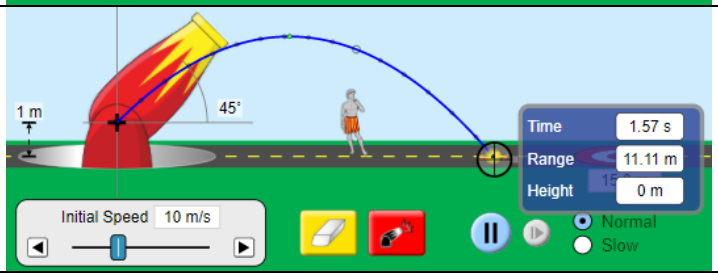
2) Write your hypothesis regarding how the factor you've chosen will affect your ability to hit the target (If…then…because):

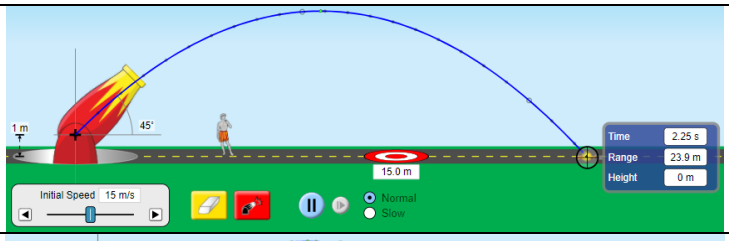
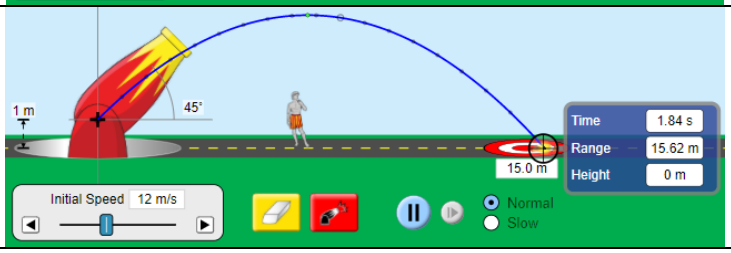
If the initial speed of the projectile launched by the cannon is set to a slower speed (5 – 15 meters per second) then the projectile will hit the target 15 meters away because a steep angle and less speed equates to a shorter distance traveled.

3) What is your test variable? _Initial Speed of the launch _ Outcome variable? _Distance of the launch_

4) What variables should you keep constant? _Launch height, Target distance, Launch Angle_

5) Once you have put all variables in place, fire away! Did you hit your target? Write a conclusion statement explaining your results.

Test Variable (Initial Speed of Launch)	Experiment	Outcome Variable (Distance of Launch)
5 m/s		3.32 m
10 m/s		11.11 m

15 m/s		23.9 m
12 m/s		15.62 m

Which factor appears most important in projectile motion? Explain your answer!

Based on the data from my three experiments it appears that changing the initial speed of the projectile is more impactful than changing the height or angle of the cannon. The variance in the outcome data (launch distance) for experiment #3 (initial speed) was far greater than the variance for experiment #1 (launch height) and experiment #2 (launch angle). When I doubled the initial speed of my launch in experiment #3 from 5 m/s to 10 m/s, my overall launch distance was almost three times greater.