Arik Petracci

Mr. Johansen

Physics

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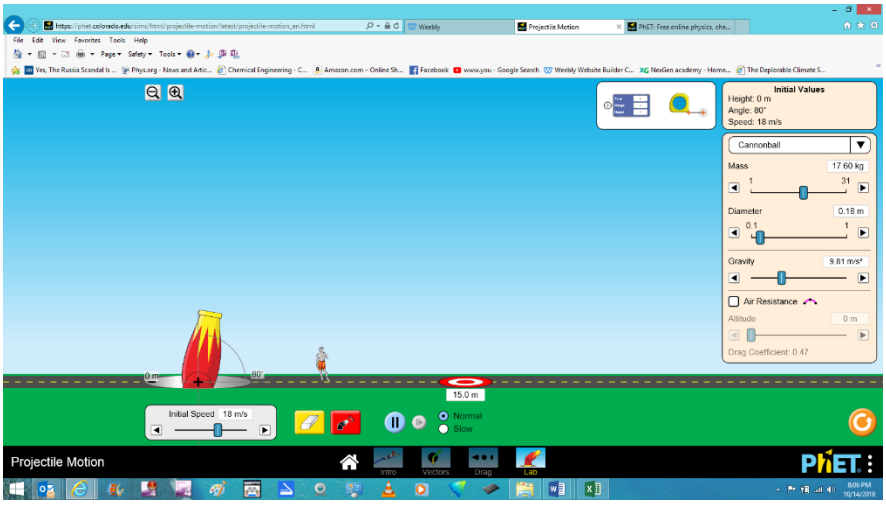
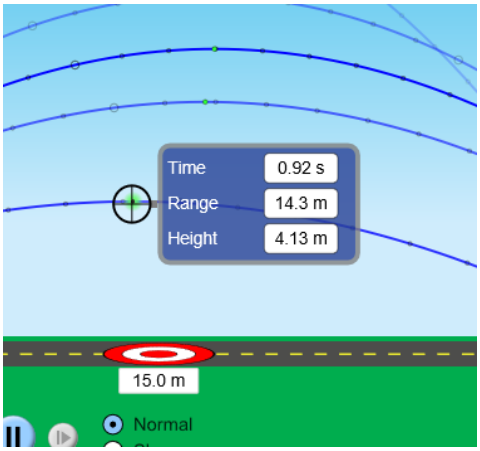
Projectile Motion Web-lab

Go to https://phet.colorado.edu/ and find the “Projectile Motion” simulation. At the time of writing, it was located here https://phet.colorado.edu/en/simulation/projectile-motion

Hit the “play” button (you don’t need to download the app) and select the “Lab” option.



Keep the initial values at 18 m/s initial speed, 17.6 kg mass, 0.18 m diameter, 9.81 m/s^2 gravity,



and zero air resistance.

Experiment 1: How does "firing angle" affect projectile motion?

1. Use the blue "range finder" tool (shown in the picture above) to fill out the following table:

Firing angle	Maximum height reached	Range
80°	16.02 m	11.3 m
70°	14.58 m	21.23 m
60°	12.38 m	28.6 m
50°	9.69 m	32.53
45°	8.26 m	33.03 m
40°	6.82 m	32.53 m
30°	4.13 m	28.6 m

2. What angle results in the maximum range?

   45 degrees

3. What angle results in the maximum height?

   80 degrees resulted in the maximum height. Presumably, 90 degrees (straight up) would be even higher

4. Plot the angles vs. ranges on the graph below. List the angles on the ‘x’ axis, and the ranges on the ‘y’ axis. (You will end up with a curve plotted on the graph).

5. Use your graph to estimate the required firing angle needed for a range of 30.0 meters. What is it?

   ~30 degrees

6. Test your prediction above, using the simulation. Were you correct? Explain…

   Correct ~= 32.5 I was very close to correct. More data points may have changed the shape of the best fit curve, thus potentially giving a more accurate answer.

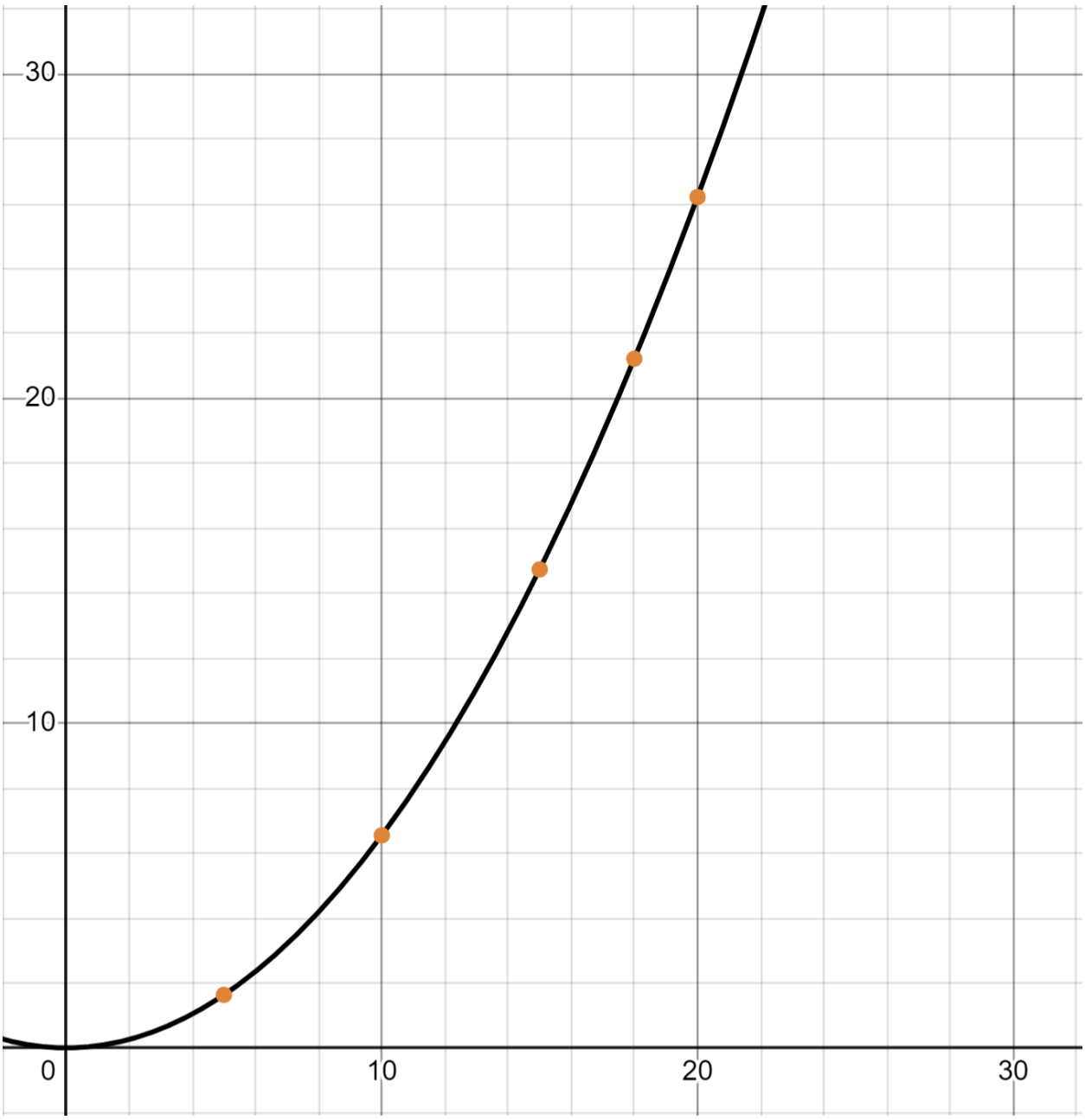
Experiment 2: How does "initial speed" affect projectile motion?

On the simulation, clear the results and start over. Use the eraser icon to clear the screen.

7. Keep all the constraints the same as the first experiment. Same mass, diameter, and so forth. Set the firing angle at 70°. Using the blue "range finder" tool, fill out the following table. Use the +/- buttons to resize your screen if necessary:

Initial speed	Range
5 m/s	1.64 m
10 m/s	6.55 m
15 m/s	14.74 m
18 m/s	21.23 m
20 m/s	26.21 m

8. Plot the ranges vs. initial speeds on the graph below. List the initial speeds on the ‘x’ axis, and the ranges on the ‘y’ axis. (You will end up with a curve plotted on the graph).



9. Use your graph to estimate the required initial speed needed for a range of 20.0 meters. What is it?

   Around 17.5 degrees

10. Test your prediction above, using the simulation. Were you correct? Explain…

    Correct ~= 17.5 m/s The predicted and correct values were the same

Experiment 3: How does the "projectile mass" affect the range?

On the simulation, clear the results and start over. Use the eraser icon to clear the screen.

11. Keep all the variables the same. Select a firing angle and initial speed (for example 70° and 20 m/s, but you may use whatever you want). Fire several cannonballs with different masses. (Vary the mass of the projectile!). What do you observe? Does the *mass of the projectile* affect the maximum height or the range, as long as there is no wind resistance?

    No, the mass of the projectile has no effect on the maximum height or range

Experiment 4: How does "gravity" affect projectile motion?

12. Now experiment with the "gravity" slider button. Fire the projectile several times, varying the acceleration of gravity over the whole range, from 5 m/s^2 to 20 m/s^2. What conclusions can you make? Write a paragraph explaining what you observe with respect to height, range, and gravitational acceleration.

    The higher the force of gravity on a launched projectile, assuming all other variables do not change, the more the maximum height the projectile attains, as well as the maximum range achieved, will decrease. The height decreases with higher gravity, because the downward acceleration on the projectile is greater,

causing it to not travel as high. The maximum range of the projectile also decreases with higher gravitational pull, because the projectile has less time in the air, due to it being pulled to the ground faster.

Experiment 5: How does “air resistance” affect projectile motion?

13. Now experiment with the “air resistance” slider and the “diameter” slider. Fire the projectile several times, varying the diameter and air resistance over their whole ranges, from 0.1 to 1.0 meter, and from 0 to 5000 meters. What conclusions can you make? Write a paragraph explaining what you observe with respect to maximum height and range.

    By keeping the air resistance, the same, and increasing the diameter of the projectile, the maximum height and range will decrease. When keeping the projectile diameter static, and decreasing air resistance (by increasing altitude,) the maximum height and range of the projectile are increased, but at a negligible amount compared to changing diameter and keeping air resistance static.