

Today you will be playing with two new simulators!

The first is a ball falling in an “ideal” world, this means that there is no air resistance and the only thing that causes the ball to move is gravity.

The second is a ball falling in a “real” world, this means that air resistance is included! This means that gravity causes the ball to fall, but you have a second force that pushed the ball up, slowing how the ball falls!

It will be your job to investigate exactly what is different about the two (other than one ball falls faster than the other!).

Who Needs Reality

To use the ideal world simulator, go to:

Ball Drop Energy (No Air Resistance): <https://trinket.io/glowscript/1635f03141>

This will again pull up our trinket platform. Where you will have the code on the left side of the screen, and the simulator on the right side of the screen. Just like before, it is best to run the simulator in full screen, and the play button near the top right will start and restart the simulation!

In the simulation window you have a few inputs. The radius of our ball (how big it is in size), the mass of our ball (how big its mass is), and the starting height of the ball.

When you hit “P” the ball will fall, and you will see a bar graph evolve as the ball falls.

First describe the graph, what the bars stand for, and what happens to each bar as the ball falls.

Additionally, as the ball falls you should note that the height box updates with the ball's current position!

Next, you want to see what which of the inputs change how the ball falls! To do this you will need to measure sometimes which the simulator does not provide!

You will begin by only changing the height (REMEMBER NUMB PAD DOES NOT WORK!) to 30 m. Before letting the ball drop, describe what changes in the simulation window. Note the graphs and the values of each bar on the graph. Also record all the inputs used.

You will now hit “P” to let the ball drop but with the intent to only let it fall to 20 m! Use the built in timer to record the time of this interval. Additionally, record the new positions of the bars on the graph. You will repeat this process as the ball falls from 20 m to 10 m and finally from 10 m to 0 m (remember for the time interval you will need to find Δt , which is the difference between the starting and ending time!).

- 1) Which of the three distance intervals, was the time of travel greatest?
- 2) Which was slowest?
- 3) Why do you think the answers to the first two questions are true?
- 4) What do the above answers tell you about the average velocity of the ball in the three sections?
- 5) What is the total fall time?

- 6) What happens to the two bars as the ball falls?
- 7) Can you say anything about comparing the PE bar on the graph before the fall to the KE bar on the graph after the fall?

Still using 30 m for a starting height you now want to see if the mass of the ball has any effect on how long it takes the ball to fall. Repeat the 3 distance interval method for timing when you have chosen a new mass. You will repeat this 3 times for 3 different mass values of the ball. Record the bar values on the graphs each trial.

- 8) Did changing the mass change the time intervals?
- 9) Did changing the mass change the total time?
- 10) Did changing the mass change anything on the graphs? If so what did it change?
- 11) Does changing the mass change the relationships between the PE and KE bars on the graph before and after the fall?

You will still use 30 m for the initial height but go back to 10 kg in mass. You now want to see if the radius of the ball has any effects on our measurements. You will repeat the 3 distance interval process for a total of 3 different radii (Keep radii beneath 10 m otherwise things get screwy) . Record these radii and all appropriate measurements at each stage.

- 12) Did changing the radii of the ball change the time intervals?
- 13) Did changing the radii of the ball change anything on the graph?
- 14) Do you think in real life the size (volume) of the ball affects how the ball drops? Why or why not?
- 15) Does changing the size of the ball change the relationships between the PE and KE bars on the graph before and after the fall?

Finally, you want to test what effects distance has on the falling ball. You want the mass of the ball to be 10 kg and the radius of the ball to be 0.5 m. You will start with a height of 5 m, and during this trial you are only concerned with the total time, not any specific time interval. After this test 20 m, 45 m, and finally 80 m. Note that to rescale the simulation use the scroll wheel, this will be necessary with the bigger heights!

- 16) Divide each bigger height time, by the time of the 5 m drop. Do you see any patterns?
- 17) From the above pattern determine a relationship between the time something drops and the distance it drops. For example, if the time doubles, does the distance double? If you are still stuck on this one graphing the position versus time data could be useful!
- 18) Does changing the starting height of the ball change the relationships between PE and KE the bars on the graph before and after the fall?

Out of this world!

All of the above has been done assuming you are on earth. Lets imagine that instead you are on mars. The acceleration due to gravity is smaller on mars than earth (as mars is a little bit smaller and less massive than earth!), and is 3.7 m/s^2 .

You want to change this value, but there is no input that allows us to change the acceleration due to gravity. This means you must edit the code!

Click onto the box with the code (remember that accidentally changing things here usually breaks the simulators, but only temporarily).

You want to click `ctrl+f` to open the search box. There are several ways you can locate the correct line. You can search for the numerical value of g (remember the real value is $9.8!$), you can search for g 's proper name, if you are struggling ask for help!

Once you have located the line that defines the value of g for earth you want to change it so that $g = - 3.7$ instead.

With the change complete hit the run button and drop the ball from the 30 m height with a mass of 10 kg and radius of 0.5 m. Measure the total time of the fall, and record the values of the bar graph at the start and end.

Now that you know how to change the value of g , you can travel to any planet you want and run the simulator there! Google the acceleration due to gravity on a planet that is bigger than earth (record which planet) and repeat the above process.

- 19) How does being on mars compare to being on Earth both in time of fall and with the numbers on the graphs
- 20) How does being on the bigger planet compare to being on Earth both in time of fall and with the numbers on the graphs
- 21) What is something else that you could do to change/edit/add to the code to simulate something new?
- 22) Does changing the planet the ball is on change the relationships between the PE and KE bars on the graph before and after the fall?



This work is licensed under the Creative Commons Attribution 4.0 International License.
To view a copy of the license, visit <https://creativecommons.org/licenses/by/4.0/>.