Free Fall Lab

Distance fallen and gravitational acceleration

Name _____ Period _____ Date _____

Compare drops of different masses. Then test how distance fallen depends on time and use a graph to find g.

Time 50 minutes • Open buildphysics.com/?experiment=free-fall

Model and measurements

Up is positive. Air resistance is off.

$y = y_0 + v_{y0}t + \frac{1}{2}a_y t^2$ $\Delta y = y - y_0$ $a_y = -g$

Position y refers to the ball's center. Distance fallen is $d = y_0 - y$. The positive quantity g is the magnitude of gravitational acceleration.

Predict before running

Two masses are dropped from rest at the same position. After the same time, will they have fallen different distances? Predict and explain.

Part A Compare different masses

1. In Explore this setup, set Release y position to 20.0 m and Initial vertical velocity to 0 m/s. Test the masses below. Reset between trials.

2. Open Properties → Bowling Ball → Live values.

3. Pause near 1.0 s using Auto-pause after (clock beside Run) or Step. Record displayed time and y (second Position value). Calculate $d = y_0 - y$.

Mass (kg)	Read time t (s)	Read position y (m)	Distance fallen d (m)
0.5			
2.0			
5.0			

A1. Compare distances fallen for two masses. Use masses, times, and distances as evidence.

A2. What do your results suggest about mass and free-fall acceleration? Explain.

Part B Design and collect

Suggested time 16 minutes

Investigation question How does distance fallen depend on elapsed time for a drop from rest?

Keep y_o = 20.0 m and initial vertical velocity at 0 m/s. Choose one fixed mass from 0.5 to 5.0 kg and at least five times from 0.3 to 1.8 s, spread across the range.

B1. Identify the independent and dependent variables.

B2. What will you keep constant? How will you do this?

B3. List your times and fixed mass. Why is this set of times useful?

B4. How will you find distance fallen from the position reading?

B5. Write a procedure another group could follow.

Record your measurements

Release center y_o = 20.0 m Initial v_{yo} = 0 m/s Fixed mass _____ kg

Drop	Elapsed time t (s)	Position y (m)	Distance fallen d (m)
1			
2			
3			
4			
5			
Extra			

Part C Build and analyze a linear graph

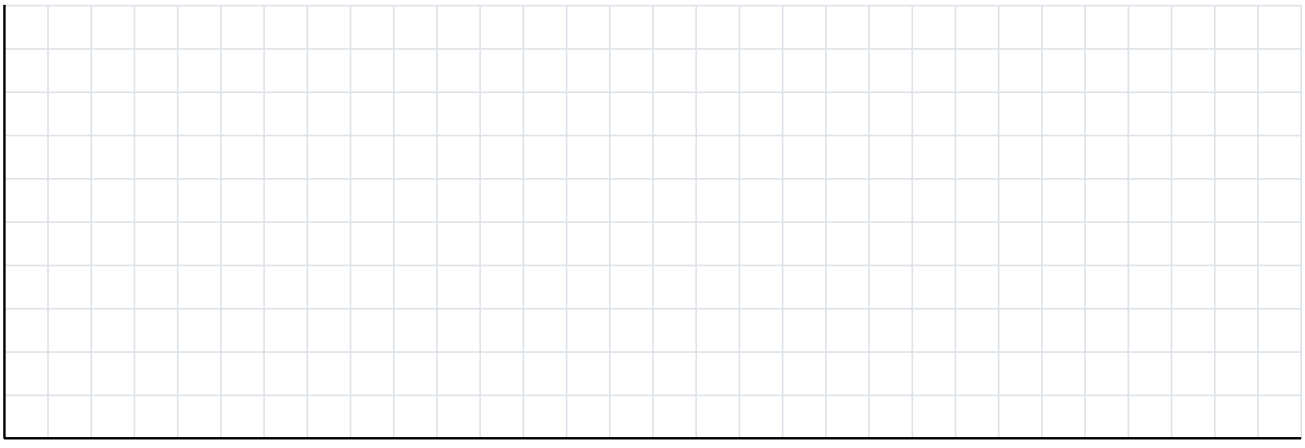
Suggested time 14 minutes

C1. The relationship is $d = \frac{1}{2}gt^2$. Describe how distance fallen depends on time for a drop from rest.

C2. Choose quantities for a straight-line graph. Label the table with your choices and units, and calculate the transformed values.

Drop	_____ Units _____	_____ Units _____
1		
2		
3		
4		
5		
Extra		

C3. Plot your transformed data and draw a best-fit line. Label both axes with quantities and units.



C4. Calculate your line's slope with units. Use it to find g. Write the fitted equation and interpret the intercept.

Part D Explain and predict

Suggested time 8 minutes

D1. A student claims, “Doubling fall time doubles distance fallen.” Evaluate this claim using your model and numerical evidence.

D2. Compare graph-based g with 9.8 m/s². Do the graph’s shape, slope, and intercept support your model? Distinguish d from y.

D3. Choose an unused time within your measured range. Use your fitted equation to predict d, then measure d at that time and compare.

Actual time t (s)	Predicted d (m)	Measured d (m)

Comparison