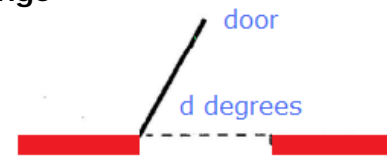


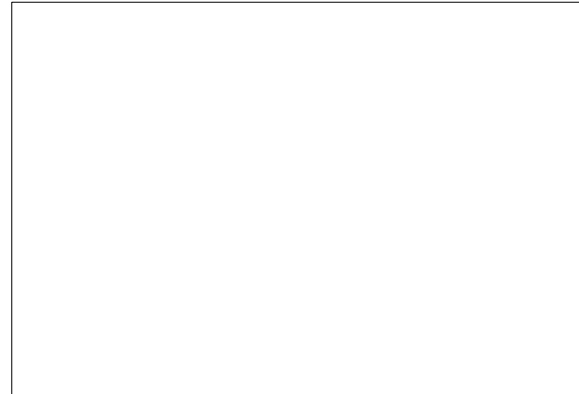
## Introducing Instantaneous Rate of Change

The diagram shows a door with an automatic closer.



At time  $t = 0$  seconds someone pushes the door. It swings open, slows down, stops, starts closing, then closes quietly at time  $t = 7$  seconds. As the door is in motion the number of degrees,  $d$ , it is from its closed position depends on  $t$ .

Sketch a reasonable graph of  $d$  versus  $t$ .

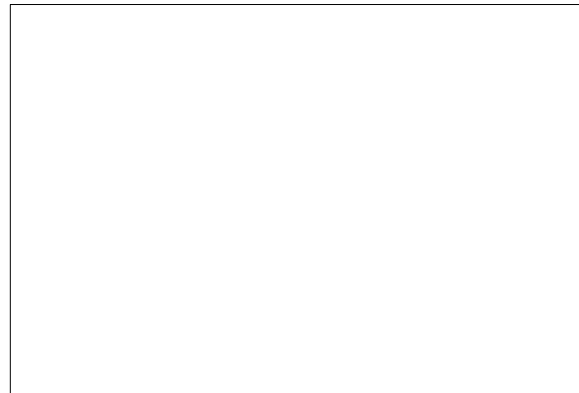


Compare your graph with a graph drawn by a neighbor.

What characteristics are possessed by both graphs.

How do your graphs differ?

Suppose that  $d$  is given by the equation  $d = 200t(2^{-t})$ . Use your calculator to graph this function for  $0 \leq t \leq 7$ .



What common characteristics does this graph have to your graph?

Does your range make sense?

Make a table of values of  $d$  for each second from  $t = 0$  through  $t = 10$ . Round to the nearest 0.10 degree.

Time	Degrees
0	
1	
2	
3	
4	
5	
6	
7	
8	
9	
10	

Looking at only the chart, does the door appear to be opening, closing, or standing still at  $t = 1$  second? Explain your reasoning.

Using the graph, does the door appear to be opening, closing, or standing still at  $t = 1$  second? Explain your reasoning.

During the time interval  $[0, 1]$  seconds, what is the average rate of change of the door's angle?

Create a table of values for the angle of the door's opening over the interval  $[0, 1]$  seconds with steps of 0.1, what is the average rate of change of the angle of door.

Time	Degrees
0	
0.1	
0.2	
0.3	
0.4	
0.5	

Time	Degrees
0.6	
0.7	
0.8	
0.9	
1.0	

During the time interval  $[0.9, 1]$  seconds, what is the average rate of change of the door's angle?

How does this average rate of change compare with the average rate of change on the interval  $[0,1]$ ? Does this make sense?

Are you surprised by the amount of difference? Explain your reasoning.

Create a table of values for the angle of the door's opening over the interval  $[0.9, 1]$  seconds with steps of 0.01, what is the average rate of change of the angle of door.

Time	Degrees
0.9	
0.91	
0.92	
0.93	
0.94	
0.95	
0.96	
0.97	
0.98	
0.99	
1.00	

During the time interval  $[0.99, 1]$  seconds, what is the average rate of change of the door's angle?

How does this average rate of change compare with the average rate of change on the interval  $[0.9,1]$ ? Does this make sense?

Are you surprised by the amount of difference? Explain your reasoning.

Can you predict the rate of change of the opening of the door's angle at time  $t = 1$ ?

How could you get a better approximation?

Continue until you can predict the door's rate of change of the angle to a hundredths of a second.

Describe in your own words how you can find the instantaneous rate of change of the door at exactly time 1 second.