How Fast Does a Penny Fall from the Empire State Building?

A penny is dropped from the top of the Empire State Building, from a height of 1,250 feet. The height of the penny, in feet, t seconds after it is dropped is given by the function $H(t) = 1250 - 16t^2$.

1. Complete the table to show the height of the penny at each of the given times.

t (seconds)	0	2	4	6	8
$H(t)$ (feet)					

2. Find the exact time t when the penny reaches the ground.

3. Find the average rate of change in the penny's height during the total length of its drop.

4. Determine how many feet the penny fell during each two second interval. What do you notice?

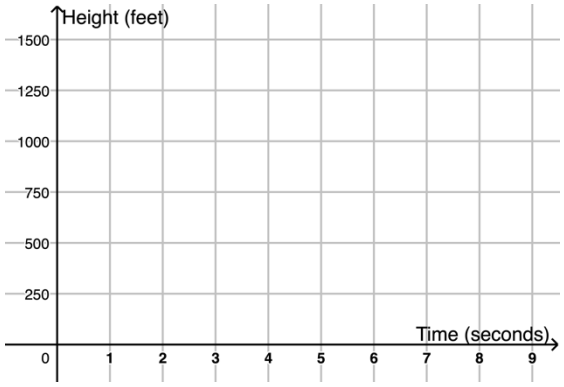
5. Complete the table with the average rate of change of the height of the penny.

Time interval	$0 \le t \le 2$	$2 \le t \le 4$	$4 \le t \le 6$	$6 \le t \le 8$
Average rate of change of H over that interval				

6. Is the penny speeding up, slowing down, or falling at a constant speed? How do you know?

7. Graph $y = H(t)$.

8. Is the graph of H concave up or concave down? What does this mean in the context of the problem?

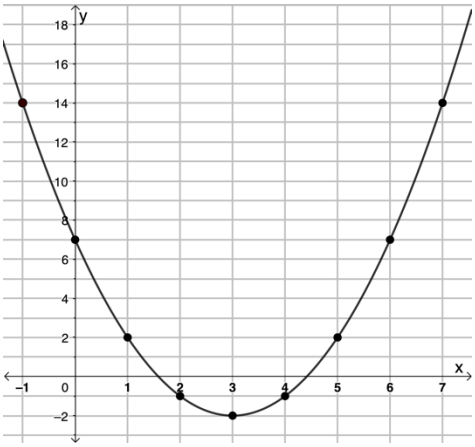


Lesson 1.6 – Change in Quadratic Functions

QuickNotes

Check Your Understanding

1. The quadratic function $y = f(x)$ is shown.



   a. Find the average rate of change of f on each of the following intervals:
      - [-1,0]
      - [0,1]
      - [1,2]
      - [2,3]
      - [3,4]
      - [4,5]
      - [5,6]
      - [6,7]

   b. Find the rate of change of the average rates of change.

   c. Is the graph of f concave up or concave down? How does this support your answer in part b?

2. Selected values of a function g are given. Complete the table so that g is a quadratic function.

x	-8	-4	0	4	8	12	16	20
$g(x)$	1		24	31	35			

Geri's Greeting Cards

The greeting card selections at stores are regularly updated and new displays are set up each season. Each style of card comes in a multi-pack with the corresponding envelopes. These packages must be opened and then placed in the correct slot. Geri's job is to stock greeting cards at a variety of stores.

1. Geri has already stocked 3 packages by the time her shift officially starts. Additional information about the number of packages she has stocked at various times in her shift is given in the table.

Time (Hours)	Number of packages stocked
0	3
0.5	38
1	73
1.5	108
2	143
2.5	178

   a. What do you notice about the information in the table? Describe any patterns you see.

   b. At what rate is Geri stocking the packages?

2. Write an equation for $P(x)$, the number of packages Geri will have stocked x hours after her shift begins.

3. If Geri has to stock 150 packages of cards, how long will it take her?

4. The greeting card industry is on the decline. In 2020, Americans purchased approximately 6.5 billion greeting cards each year. Between 2018 and 2023, this number has continued to decrease at approximately 2.8% per year. According to this estimate, how many greeting cards were purchased in 2021?

5. What is the ratio of greeting card purchases from 2021 compared to 2020?

6. Complete the table.

Year	Annual number of greeting cards purchased (in billions)
2018	
2019	
2020	6.5
2021	
2022	
2023	

7. Is the number of greeting cards purchased annually decreasing by the same amount each year? Explain.

8. Write an equation for $G(x)$, the number of annual greeting cards purchased x years after 2018.

9. Compare your expressions for $P(x)$ and $G(x)$ from this activity. What makes them different? What similarities do they have?