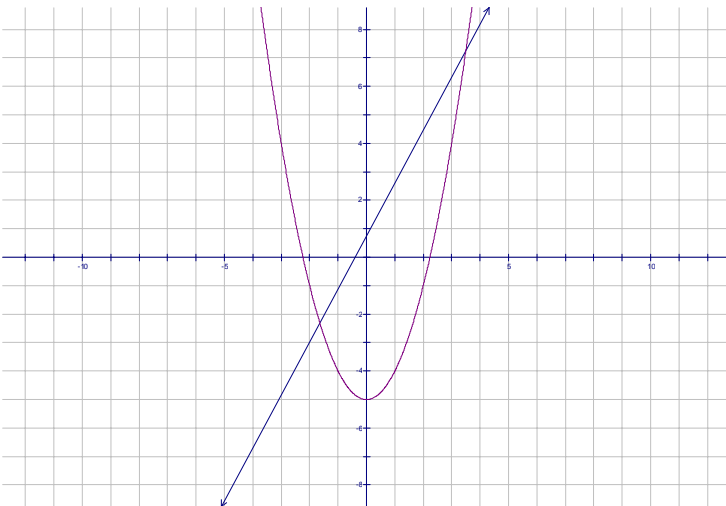
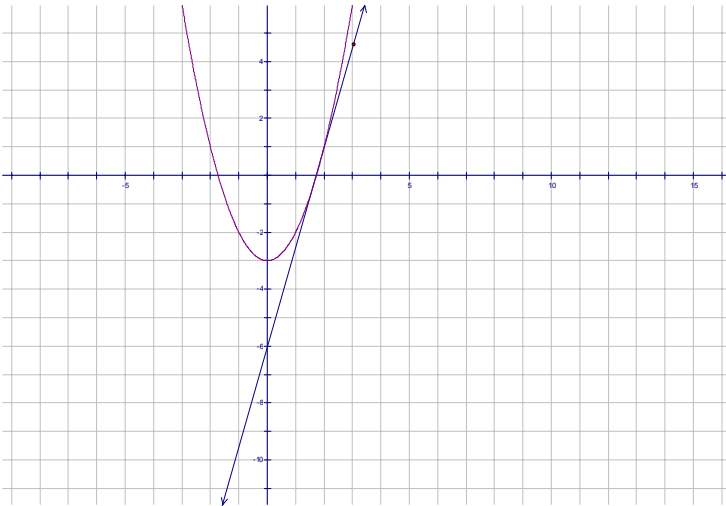


## Section 2.1

### Secant Lines and Tangent Lines



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**Example 4 (Page 97 #2)**

A cardiac monitor is used to measure the heart rate of a patient after surgery. It compiles the number of heartbeats after  $t$  minutes. When the data in the table are graphed, the slope of the tangent lines represents the heart rate in beats per minute.

$t$ (min)	36	38	40	42	44
Heartbeats	2530	2661	2806	2948	3080

Use the data to estimate the patient's heart rate after 42 minutes using the secant line between the points with the given values of  $t$ .

a)  $t = 36$  and  $t = 42$

$$m = \frac{2948 - 2530}{42 - 36} = \frac{418}{6} = 69.7$$

b)  $t = 38$  and  $t = 42$

$$m = \frac{2948 - 2661}{42 - 38} = \frac{287}{4} = 71.75$$

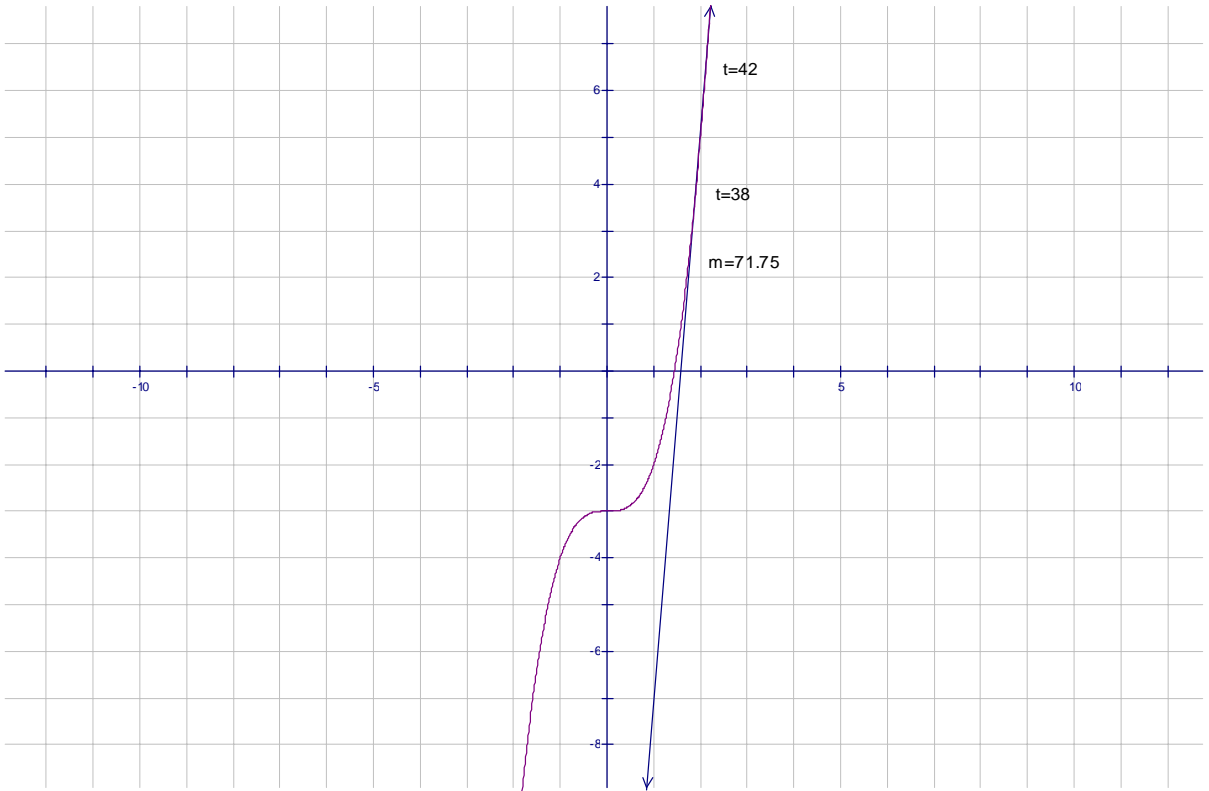
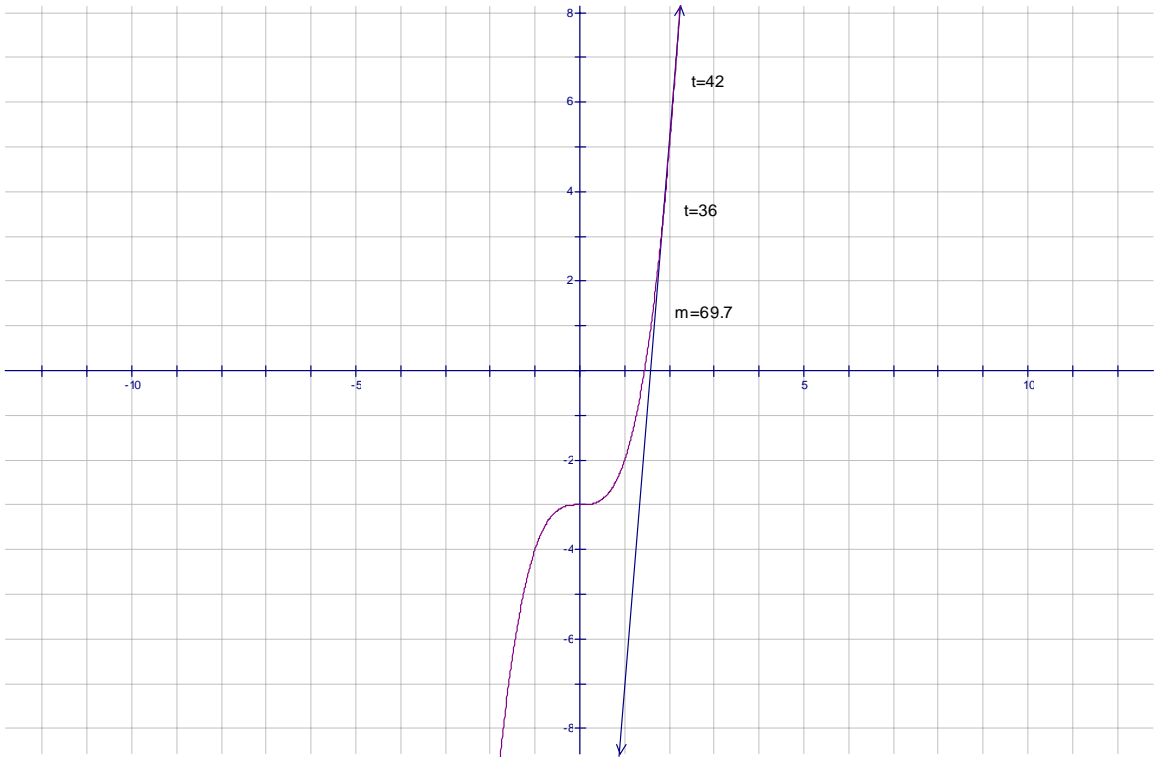
c)  $t = 40$  and  $t = 42$

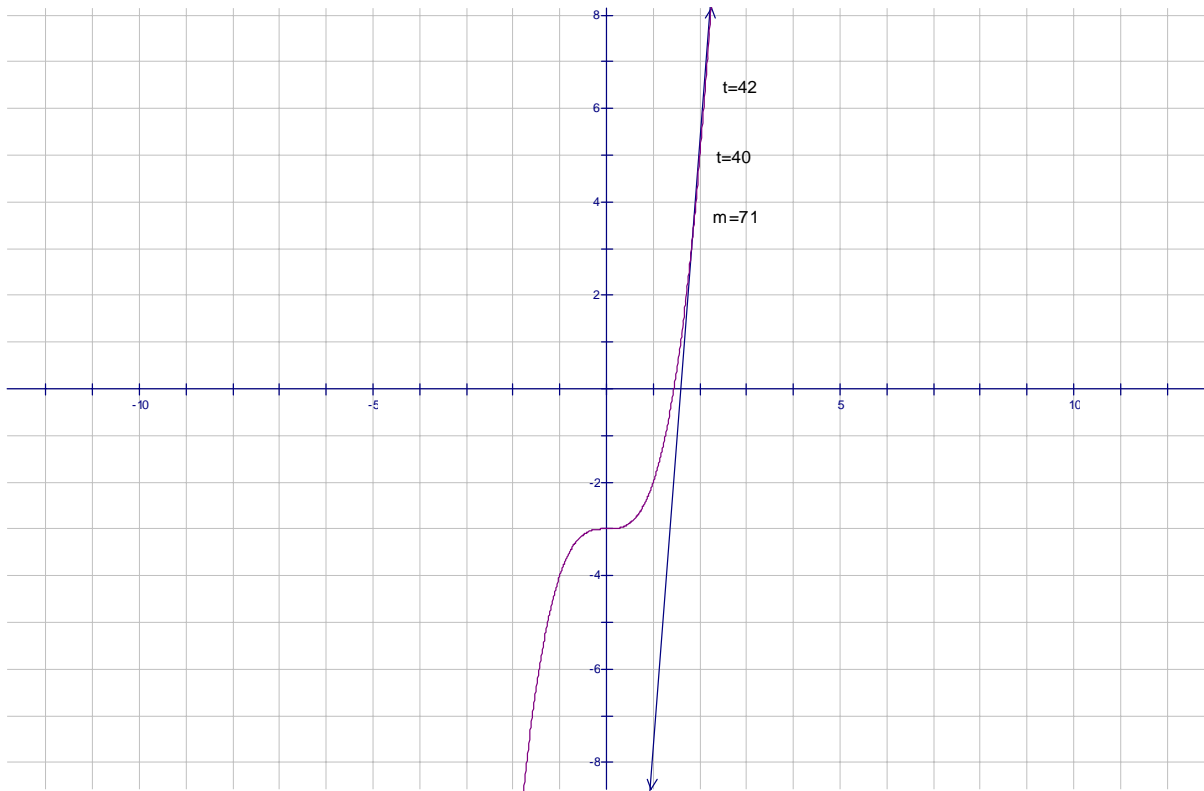
$$m = \frac{2948 - 2806}{42 - 40} = \frac{142}{2} = 71$$

d)  $t = 42$  and  $t = 44$

$$m = \frac{3080 - 2948}{44 - 42} = \frac{142}{2} = 71$$

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### Example 5

The point  $P(3,1)$  lies on the curve  $y = \sqrt{x-2}$

- a) If  $Q$  is the point  $(x, \sqrt{x-2})$ , use your calculator the slope of the secant line  $PQ$  for the following values of  $x$ :

i) 2.5

$$y = \sqrt{x-2} = \sqrt{2.5-2} = \sqrt{.5} = .707107 \Rightarrow (2.5, .707107)$$

$$m = \frac{1 - .707107}{3 - 2.5} = \frac{.292893}{.5} = .585786$$

ii) 2.9

$$y = \sqrt{x-2} = \sqrt{2.9-2} = \sqrt{.9} = .948683 \Rightarrow (2.9, .948683)$$

$$m = \frac{1 - .948683}{3 - 2.9} = \frac{.051317}{.1} = .51317$$

iii) 2.99

$$y = \sqrt{x-2} = \sqrt{2.99-2} = \sqrt{.99} = .994987 \Rightarrow (2.9, .994987)$$

$$m = \frac{1 - .994987}{3 - 2.99} = \frac{.5013}{.001} = .5013$$

iv) 2.999

$$y = \sqrt{x-2} = \sqrt{2.999-2} = \sqrt{.999} = .999500 \Rightarrow (2.9, .999500)$$

$$m = \frac{1 - .9995}{3 - 2.999} = .5$$

v) 3.5

$$y = \sqrt{x-2} = \sqrt{3.5-2} = \sqrt{1.5} = 1.22474 \Rightarrow (3.5, 1.22474)$$

$$m = \frac{1.22474 - 1}{3.5 - 3} = \frac{.22474}{.5} = .44948$$

vi) 3.1

$$y = \sqrt{x-2} = \sqrt{3.1-2} = \sqrt{1.1} = 1.048809 \Rightarrow (3.1, 1.048809)$$

$$m = \frac{1.048809 - 1}{3.1 - 3} = \frac{.048809}{.1} = .48809$$

vii) 3.01

$$y = \sqrt{x-2} = \sqrt{3.01-2} = \sqrt{1.01} = 1.004988 \Rightarrow (3.01, 1.004988)$$

$$m = \frac{1.004988 - 1}{3.01 - 3} = .4988$$

viii) 3.001

$$y = \sqrt{x-2} = \sqrt{3.001-2} = \sqrt{1.001} = 1.000500 \Rightarrow (3.001, 1.000500)$$

$$m = \frac{1.000500 - 1}{3.001 - 3} = .5$$

b) Using the values of part a), guess the value of the slope of the tangent line to the curve of  $P(3,1)$

$$m = \frac{1}{2}$$

c) Using the slope from part b), find the equation of the line passing P(3,1)

$$y - y_1 = m(x - x_1)$$

$$y - 1 = \frac{1}{2}(x - 3)$$

$$y - 1 = \frac{1}{2}x + \frac{3}{2}$$

$$y = \frac{1}{2}x + \frac{3}{2}$$

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### Example 6

If an arrow is shot upward on the moon with a velocity of  $55 \frac{m}{s}$  its velocity is given by the model  $h = 55t - .83t^2$

a) Find the average velocity over the given time intervals

i) [1,2]

$$t = 1: h = 55(1) - .83(1)^2 = 55 - .83 = 54.17$$

$$t = 2: h = 55(2) - .83(2)^2 = 110 - 3.32 = 106.68$$

$$m = \frac{106.68 - 54.17}{2 - 1} = \frac{52.51}{1} = 52.51$$

ii) [1,1.5]

$$t = 1: h = 55(1) - .83(1)^2 = 55 - .83 = 54.17$$

$$t = 1.5: h = 55(1.5) - .83(1.5)^2 = 82.5 - 1.87 = 80.63$$

$$m = \frac{80.63 - 54.17}{1.5 - 1} = \frac{26.46}{.5} = 52.92$$

iii) [1,1.1]

$$t = 1: h = 55(1) - .83(1)^2 = 55 - .83 = 54.17$$

$$t = 1.1: h = 55(1.1) - .83(1.1)^2 = 59.50$$

$$m = \frac{59.50 - 54.17}{1.1 - 1} = \frac{5.33}{.1} = 53.3$$