What is Pamela's Current Speed?

Name: Key

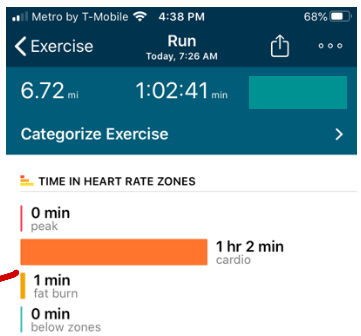
Activity trackers and smartwatches can help you gain valuable data about your exercise routine. Runners often use them to keep track of mileage, pace, calories, and steps. Today we will explore some of the measurements in greater detail.

average vs. instantaneous

1. In the middle of her run, Pamela looks down at her Fitbit screen and sees that she is currently running at a pace of 8'45". The next screen shows an average pace of 9'48". How is this possible? Why might these two numbers differ?

   Currently she is running at a faster rate than she has been on average. The time it would take her to complete a mile at the current rate is less.

2. Look at the summary report of Pamela's run. What is her average speed, in miles per minute?



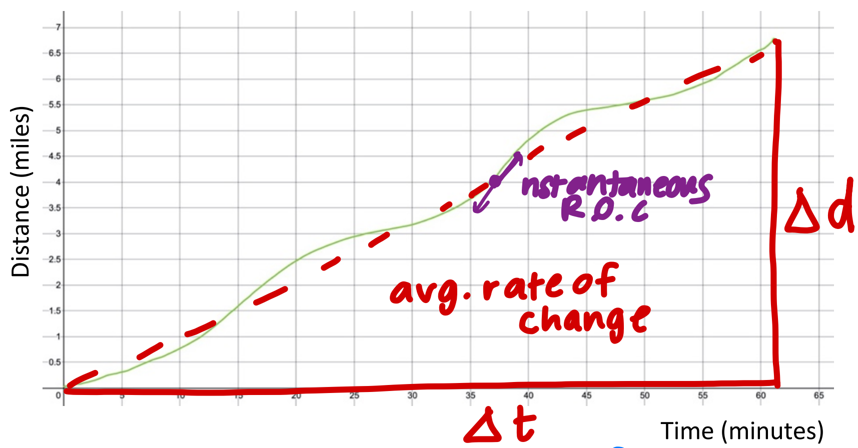
$$\frac{\text{distance}}{\text{time}} = \frac{6.72 \text{ mi}}{62.683 \text{ min}} = 0.107 \text{ mi/min}$$

1 hr 2 min = 62 sec

41 seconds = 0.683 min

$$\text{Average speed} = \frac{\Delta \text{distance}}{\Delta \text{time}}$$

Below is a graph showing Pamela's distance traveled with respect to time (in minutes).



3. How could you use this graph, instead of the summary report, to calculate Pamela's average speed?

   Find the slope between t = 0 and t = 62.

4. Was Pamela running at a constant speed? How do you know?

   No, the graph is not linear so there's no constant rate of change.

instantaneous r.o.c = slope at a pt.

5. What time does it look like Pamela is running the fastest? How can you tell?

   around 38 minutes into her run
   The slope is the steepest

$\Delta t \to 0$

6. How do you think Fitbit is able to capture a current speed at any time during the run?

   Look at the change in distance on a very short interval of time around the current moment.

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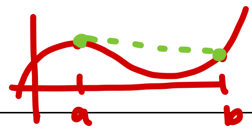
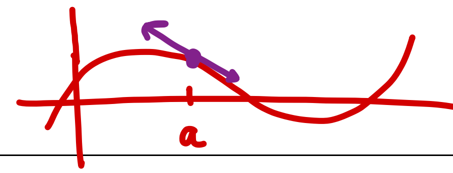
Section 9.1—Average versus Instantaneous Rate of Change

Important Ideas:

Average R.O.C	Instantaneous R.O.C
• over an interval [a,b]	• at a pt.
• $\frac{\Delta y}{\Delta x} = \frac{f(b)-f(a)}{b-a}$	• $\Delta x \to 0$
• slope of a secant line	• slope of a tangent line
	

Check Your Understanding!

1. The temperature of a pot of tea as it is cooling is given by the function $H(t)$, measured in ˚Celsius. Time, t, is measured in minutes.

t (minutes)	0	2	5	9	10
$H(t)$ (degrees Celsius)	66	60	52	44	43

a. How fast is the tea cooling, on average, over the ten minute interval? Show work and include units.

$$\frac{\Delta H(t)}{\Delta t} = \frac{43-66}{10-0} = \frac{-23}{10} = -2.3\ °C/min$$

b. Estimate the rate at which the temperature of the tea is changing at $t = 3.5$. Explain your method.

Inst. ROC at $t = 3.5 \approx \frac{H(5)-H(2)}{5-2} = \frac{52-60}{5-2} = \frac{-8}{3}$

I took the t-values closest to $t=3.5$ on either side and found the R.O.C.

2. Find the average rate of change of $f(x) = \sqrt{3x+4}$ on the interval [-1, 4].

$$\frac{f(4)-f(-1)}{4-(-1)} = \frac{\sqrt{16}-\sqrt{1}}{4+1} = \frac{4-1}{5} = 3/5$$

3. Which is greater: the instantaneous rate of change of $f(x) = \sqrt{3x+4}$ at $x = 0$ or at $x = 4$? How do you know?

At $x=0$ because the square root function gets flatter as x increases

4. The graph of $g(x)$ is shown to the right.

a. Find the average rate of change of $g(x)$ on the interval [0,2]. Show work.

$$\frac{g(2)-g(0)}{2-0} = \frac{4-0}{2} = 2$$

b. Order the following from 1=least to 4=greatest:

3 Average rate of change on $[0, 3.5]$ pos

2 Instantaneous rate of change at $x = 1$ 0

1 Average rate of change on $[1,3]$ neg

4 Instantaneous rate of change at $x = 0.5$ very pos