Worksheet 3. Understanding the Relationships Among Velocity, Speed, and Acceleration

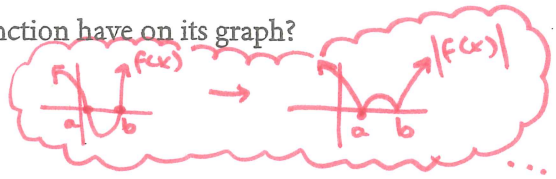
Speed is the absolute value of velocity. It tells you how fast something is moving without regard to the direction of movement.

1. What effect does absolute value have on numbers?

   makes numbers positive

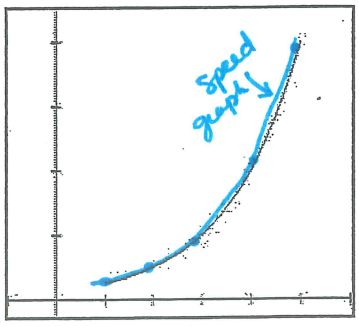
2. What effect does taking the absolute value of a function have on its graph?

   y-values are all positive



For each situation below, the graph of a differentiable function giving velocity as a function of time t is shown for $1 \le t \le 5$, along with selected values of the velocity function. In the graph, each horizontal grid mark represents 1 unit of time and each vertical grid mark represents 4 units of velocity. For each situation, plot the speed graph on the same coordinate plane as the velocity graph and fill in the speed values in the table. Then, answer the questions below based on both the graph and the table of values.

Situation 1: Velocity graph



time	velocity	speed
1	1	1
2	2	2
3	4	4
4	8	8
5	16	16

In this situation, the velocity is positive and increasing.
(Positive or negative? Increasing or decreasing?)

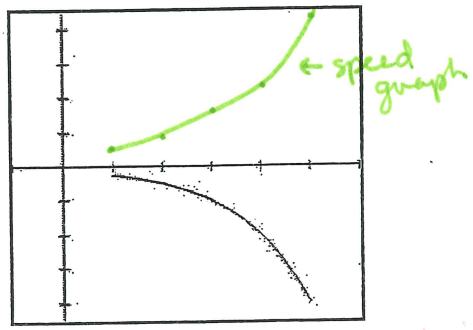
v(t) > 0

Because velocity is increasing, we know acceleration is positive.
(Increasing or decreasing? Positive or negative?)

v(t) inc → v'(t) > 0, a(t) > 0

By examining the graph of speed and the table of values, we can conclude that speed is increasing.
(Increasing or decreasing?)

Situation 2: Velocity graph



time	velocity	speed
1	-1	1
2	-2	2
3	-4	4
4	-8	8
5	-16	16

v(t)<0 ... ☺

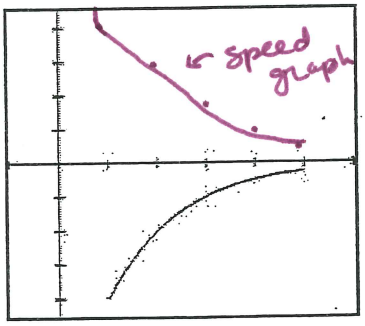
v(t) dec
↳ v'(t)<0
a(t)<0

In this situation, the velocity is negative and decreasing.
Positive or negative? Increasing or decreasing?

Because velocity is decreasing, we know acceleration is negative.
Increasing or decreasing? Positive or negative?

By examining the graph of speed and the table of values, we can conclude that speed is increasing.
Increasing or decreasing?

Situation 3: Velocity graph



time	velocity	speed
1	-16	16
2	-8	8
3	-4	4
4	-2	2
5	-1	1

v(t)<0 ... ☺

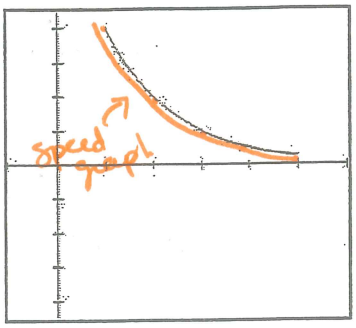
v(t) inc
↳ v'(t)>0
a(t)>0

In this situation, the velocity is negative and increasing.
Positive or negative? Increasing or decreasing?

Because velocity is increasing, we know acceleration is positive.
Increasing or decreasing? Positive or negative?

By examining the graph of speed and the table of values, we can conclude that speed is decreasing.
Increasing or decreasing?

Situation 4: Velocity graph



time	velocity	speed
1	16	16
2	8	8
3	4	4
4	2	2
5	1	1

In this situation, the velocity is positive and decreasing.
Positive or negative? Increasing or decreasing?

v(t) > 0 ☺

v(t) dec ⇒ v'(t) < 0, a(t) < 0

Because velocity is decreasing, we know acceleration is negative.
Increasing or decreasing? Positive or negative?

By examining the graph of speed and the table of values, we can conclude that speed is decreasing.
Increasing or decreasing?

Conclusion:

In which situations was the speed increasing? Situation 1 & Situation 2

When the speed is increasing, the velocity and acceleration have same signs.
Same or opposite?

speed inc
v(t) & a(t) are both > 0 or both < 0

In which situations was the speed decreasing? Situation 3 & Situation 4

When the speed is decreasing, the velocity and acceleration have opposite signs.
Same or opposite?

speed dec
v(t) & a(t) have different signs

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Assessing Students' Understanding (A Short Quiz):

1. If velocity is negative and acceleration is positive, then speed is decreasing
   ($v(t) < 0$, $a(t) > 0$)

2. If velocity is positive and speed is decreasing, then acceleration is negative.
   ($v(t) > 0$; speed dec (different signs); $a(t) < 0$)

3. If velocity is positive and decreasing, then speed is decreasing.
   ($v(t) > 0$; $v(t)$ dec $\hookrightarrow a(t) < 0$; (different signs))

4. If speed is increasing and acceleration is negative, then velocity is negative.
   (speed inc (same signs); $a(t) < 0$; $v(t) < 0$)

5. If velocity is negative and increasing, then speed is decreasing.
   ($v(t) < 0$; $v(t)$ inc $\hookrightarrow a(t) > 0$; (different signs))

6. If the particle is moving to the left and speed is decreasing, then acceleration is positive.
   ($\hookrightarrow v(t) < 0$; $\hookrightarrow$ different signs; $a(t) > 0$)

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