1. [10 points] The dogs Elvis and Judy are playing with their owner.

At time $t=0$ seconds, Elvis starts to run in a straight line away from his owner. After running 110 feet, Elvis turns around and runs back to his owner along the same straight line. Some values of the differentiable function $E(t)$, which gives Elvis's distance from his owner, in feet, at time $t$ seconds, are recorded in the table below. Assume that Elvis's velocity is positive when he is moving away from his owner.

| $t$ | 2 | 5 | 7 | 10 | 12 | 15 | 17 | 18 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $E(t)$ | 33 | 78 | 98 | 98 | 74 | 44 | 34 | 10 |

a. [2 points] What was Elvis's average velocity between times $t=12$ and $t=17$ ? Include units.

Solution:

$$
\frac{E(17)-E(12)}{17-12}=\frac{34-74}{5}=-8
$$

Answer: $\quad-8 \mathrm{ft} / \mathrm{sec}$
b. [2 points] Estimate Elvis's instantaneous velocity at $t=5$. Include units.

Solution:

$$
E^{\prime}(5) \approx \frac{E(7)-E(5)}{7-5}=\frac{98-78}{2}=10
$$

Answer:
$10 \mathrm{ft} / \mathrm{sec}$
c. [2 points] For which of the following time interval(s) must $E^{\prime}(t)=0$ for some value of $t$ in that time interval? Give your answer as a list of one or more of these intervals, or write none.
$(7,10)$

Judy is also running along a straight line, sometimes away from and sometimes back toward her owner. The function $J(t)$ gives Judy's distance from her owner, in feet, at time $t$ seconds. Some values of $J^{\prime}(t)$, the derivative of $J(t)$, are given in the table below. Assume that $J^{\prime}(t)$ is continuous, decreasing on the interval $(4,11)$, and increasing on the interval $(11,22)$.

| $t$ | 4 | 7 | 8 | 11 | 15 | 17 | 20 | 22 |
| :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: | :---: |
| $J^{\prime}(t)$ | 10 | 2 | 0 | -12 | -3 | 0 | 1 | 9 |

d. [2 points] On which of the following time interval(s) is Judy running away from her owner? Give your answer as a list of one or more of these intervals, or write NONE.
$(4,7)$
$(8,11)$
$(20,22)$
e. [2 points] At which of the following times is Judy's speed the greatest? Write the one correct answer.

$$
t=4 \quad t=11 \quad t=17 \quad t=20
$$

