Show all work: unjustified answers may receive less than full credit.

1. A Dodge Viper is sitting at a stoplight and hits the accelerator when the light turns green. The position \( s \) at time \( t \) is \( s(t) = 7t^2 + 3t \), where \( t \) is measured in seconds and \( s \) is measured in feet. Find the average velocity over the time interval \([2, 2.1]\). Also find the average velocity over the time interval \([1.99, 2]\), and use those two answers to estimate the instantaneous velocity at \( t = 2 \).

\[ \begin{align*}
V_{\text{ave}} \text{ at } t = 2 &= \frac{34.17 - 34}{2.1 - 2} = \frac{3.17}{0.1} = 31.7 \text{ ft/s} \\
V_{\text{ave}} \text{ at } t = 2 &= \frac{34 - 33.697}{2 - 1.99} = \frac{0.303}{0.01} = 30.3 \text{ ft/s}
\end{align*} \]

**I estimate the inst. velo. to be 31 ft/s at \( t = 2 \).**

2. Calculate the following limits. For parts a and c state what those limits are computing.

\[ \begin{align*}
a. \lim_{h \to 0} \frac{\frac{1}{2}h - 2\left(\frac{1}{2}h\right)}{h} &= \lim_{h \to 0} \frac{-2h}{h} = \lim_{h \to 0} -2 = -2 \\
b. \lim_{t \to 4} \frac{t^2 - 4t}{t^2 - 3t - 4} &= \lim_{t \to 4} \frac{t(t-4)}{(t-4)(t+1)} = \lim_{t \to 4} \frac{t}{t+1} = \lim_{t \to 4} \frac{4}{5} = \frac{4}{5} \\
c. \lim_{h \to 0} \frac{\sqrt{1 + h} - 1}{h} &= \lim_{h \to 0} \frac{(\sqrt{1+h} - 1)(\sqrt{1+h} + 1)}{h(\sqrt{1+h} + 1)} = \lim_{h \to 0} \frac{\sqrt{1+h} - 1}{h} = \lim_{h \to 0} \frac{1}{2} = \frac{1}{2}
\end{align*} \]

\[ \begin{align*}
&\text{Slope of tan line to } f(x) = \frac{1}{x} \text{ at } a = \frac{1}{2} \\
&\text{Slope of tan line to } f(x) = \sqrt{x} \text{ at } a = 1.
\end{align*} \]

3. Use the Intermediate Value Theorem to find a root of the equation \( e^x = 6 - x \). Explain how the theorem is used.

\[ \begin{align*}
e^x - 6 + x &= 0 \\
e^x - 6 + x &= e^x - 6 + x \\
\frac{e^x - 6 + x}{e^x - 6} &= 0 \\
\frac{e^x - 6}{e^x - 6} &= 0 \\
\frac{e^x - 6}{e^x} &= 0 \\
\frac{e^x}{e^x} &= 0 \\
\frac{1}{e^x} &= 0 \\
1 &= 0
\end{align*} \]

The function \( e^x - 6 + x \) is continuous everywhere. \( f(1) < 0, f(2) > 0 \) \( \Rightarrow \) by the IVT there is a \( c \) between 1 & 2 so that \( e^c - 6 + c = 0 \).