1. $$\begin{aligned} f'(x) &= \lim_{h\to 0}\frac{f(x+h)-f(x)}{h} \\ &= \lim_{h\to 0}\frac{(x+h)^2+2(x+h)-(x^2+2x)}{h} \\ &= \lim_{h\to 0}\frac{x^2+2xh+h^2+2x-2h-x^2-2x}{h} \\ &= 2x+2 \end{aligned}$$
$$f'(-3)=-4 \longrightarrow m_T=-4$$

2. $$\begin{aligned} \frac{dy}{dx}=f'(x) &= \lim_{h\to 0}\frac{f(x+h)-f(x)}{h} \\ &= \lim_{h\to 0}\frac{[1-2(x+h)-3(x+h)^2]-(1-2x-3x^2)}{h} \\ &= -2-6x \end{aligned}$$
$$\left.\frac{dy}{dx}\right|_{x=-2}=10 \longrightarrow m_T=10$$

3. $$\begin{aligned} \frac{dy}{dx}=f'(x) &= \lim_{h\to 0}\frac{f(x+h)-f(x)}{h} \\ &= \lim_{h\to 0}\frac{\frac{1}{(x+h)^2}-\frac{1}{x^2}}{h} \\ &= \lim_{h\to 0}\frac{1}{h}\left[\frac{1}{(x+h)^2}-\frac{1}{x^2}\right] \\ &= -\frac{2}{x^3} \end{aligned}$$
$$\left.\frac{dy}{dx}\right|_{x=-2}=\frac{1}{4} \longrightarrow m_T=\frac{1}{4}$$

4. $$\begin{aligned} \frac{dy}{dx}=f'(x) &= \lim_{h\to 0}\frac{f(x+h)-f(x)}{h} \\ &= \lim_{h\to 0}\frac{\frac{2}{(x+h)+3}-\frac{2}{x+3}}{h} \\ &= \lim_{h\to 0}\frac{1}{h}\left[\frac{2}{(x+h)+3}-\frac{2}{x+3}\right] \\ &= -\frac{2}{(x+3)^2} \end{aligned}$$
$$\left.\frac{dy}{dx}\right|_{x=-1}=-\frac{1}{2} \longrightarrow m_T=-\frac{1}{2}$$

5. Use the definition of derivative to get $\frac{dy}{dt} = 40 - 32t$

   Since $\left.\frac{dy}{dt}\right|_{t=2} = -24 \longrightarrow$ the velocity at $t = 2$ is -24 feet per second.

6. Average Velocities

   - On $[3, 4] \longrightarrow \frac{s(4) - s(3)}{4 - 3} = -1$
   - On $[3.5, 4] \longrightarrow \frac{s(4) - s(3.5)}{4 - 3.5} = -.5$
   - On $[4, 5] \longrightarrow \frac{s(5) - s(4)}{5 - 4} = -1$
   - On $[4, 4.5] \longrightarrow \frac{s(4.5) - s(4)}{4.5 - 4} = .5$

   Instantaneous velocity at $t = 4$

   $\frac{ds}{dt} = 2t - 8$

   $\left.\frac{ds}{dt}\right|_{t=4} = 0 \longrightarrow$ the instantaneous velocity at $t = 4$ is 0 meters per second.