Problem 1. From the suggested homework:

[3.2 #60] The average speed (in meters per second) of a gas molecule is

\[ v_{avg} = \sqrt{\frac{8RT}{\pi M}} \]

where \( T \) is temperature (in kelvins), \( M \) is molar mass (in kilograms per mol), and \( R = 8.31 \frac{m^2 kg}{s^2 K \text{ mol}} \). Calculate \( \frac{dv_{avg}}{dT} \) at \( T = 300 \, ^\circ K \) for oxygen, which has a molar mass of 0.032 \( \frac{kg}{mol} \).

\[ v_{avg} = \sqrt{\frac{8R}{\pi M}} \times T^{-1/2} \]

\[ \frac{dv_{avg}}{dT} = \sqrt{\frac{8R}{\pi M}} \times \frac{1}{2} T^{-1/2} \]

\[ \left. \frac{dv_{avg}}{dT} \right|_{T=300} = \sqrt{\frac{8(8.31)}{\pi(0.032)}} \times \frac{1}{2} \left( \frac{1}{300} \right) \text{ m/s/K} \approx 0.742 \text{ m/s/K} \]

Problem 2. From an old exam:

What does the limit

\[ \lim_{h \to 0} \frac{\ln(x + 1 + h) - \ln(x + 1)}{h} \]

represent?

\[ f'(x) = \lim_{h \to 0} \frac{f(x+h) - f(x)}{h} \]

So \( f(x) = \ln(x+1) \)

Answer: The derivative of \( \ln(x+1) \), aka

\[ \frac{d}{dx}(\ln(x+1)) \]

aka

\( (\ln(x+1))' \)
Problem 3. For in-class discussion:

On the planet Quirk, a 1-foot mini cell phone tower is on top of a 9-foot green mound whose outline is described by the parabolic equation \( y = 9 - x^2 \). An ant climbs up the mound starting from sea level \( (y = 0) \). At what height \( y \) does the ant begin to see the tower?

\[
\begin{align*}
y & = 9 - x^2 \\
y' &= -2x \\
y'(a) &= -2a = m \\
(\alpha, 9-a^2) & \text{ Pt } (\alpha, 9-a^2)
\end{align*}
\]

Tangent Line:
\[
y - (9-a^2) = -2a(x-\alpha) \\
y - (9-a^2) = -2a(x-\alpha)
\]

Must go through pt \((0,10)\)
\[
10 - (9-a^2) = -2a(0-\alpha) \\
1 + a^2 = 2a^2 \\
1 = a^2 \\
\pm 1 = a \\
f(\alpha) = 9 - 1 = 8 \text{ feet}
\]