1. Find the derivative of each function.

(a) \( y = \frac{x - 1}{x^2 - x} = \frac{\sqrt{x^2 - 1}}{\sqrt{x(x - 1)}} \)
\[ y' = \frac{1}{x^2} \]

(b) \( y = \frac{1}{x \ln x} \)
\[ y' = \frac{1}{x \ln x} \cdot (\ln x + 1) \]
\[ y' \rightarrow \frac{1}{2 \cdot \frac{1}{x^2 + 1} \cdot 2x} \]
\[ \frac{\ln x + 1}{(\ln x)^2} \]

(c) \( g(x) = \ln \sqrt{x^2 + 1} \)
\[ y' = \frac{1}{2} \ln (x^2 + 1) \]

2. Kate invests $2000 at 5% compounded quarterly.
   (a) Find the formula for the balance of the account as a function of time.
   \[ B = 2000 \left( 1 + \frac{0.05}{4} \right)^{4t} \]

   (b) By what percentage each year (APR) is Kate’s money increasing?
   \[ B = 2000 \left( 1 + 0.0125 \right)^{4t} \]
   \[ = 2000 \left( 1.0509 \right)^t \quad \rightarrow \quad \text{APR} \approx 5.1\% \]

   (c) How quickly is the amount of money in Kate’s account increasing when \( t = 6 \) years?
   \[ \frac{dB}{dt} = 2000 \cdot \ln (1.0509) \cdot (1.0509)^6 \]
   \[ = 2000 \cdot 0.0497 \cdot (1.0509)^6 \]
   \[ \approx \$133.90/\text{yr} \]
3. The deer population of an island is modeled by the logistic function \( P(t) = \frac{70}{1 + 15e^{-0.34t}} \), where \( t \) is measured in years.

a) How quickly is the population increasing when \( t = 9 \) years?

\[
P(t) = 70 \left( 1 + 15e^{-0.34t} \right)^{-1}
\]
\[
P'(t) = -70 \left( 1 + 15e^{-0.34t} \right)^{-2} \cdot (-0.34) \cdot 15e^{-0.34t}
\]
\[
= \frac{357e^{-0.34t}}{(1 + 15e^{-0.34t})^2}
\]
\[
P'(9) = \frac{357e^{-0.34 \cdot 9}}{(1 + 15e^{-0.34 \cdot 9})^2} \approx 5.769.
\]

About 6 deer/yr.

b) Consider the graph of \( P \). What value does \( \frac{dp}{dt} \) approach as \( t \to \infty \)?

\[
\frac{dp}{dt} \to 0.
\]

4. The daily cost, \( C \), of running an air conditioner in Arizona depends on the temperature, \( H \), as shown in the first table. The temperature in turn increases with the time of day, \( t \), as shown in the second table. Determine the rate at which cost changes with time when \( t = 10 \) and interpret the result.

<table>
<thead>
<tr>
<th>( H ) (in °F)</th>
<th>90</th>
<th>95</th>
<th>100</th>
<th>105</th>
<th>110</th>
</tr>
</thead>
<tbody>
<tr>
<td>( C(H) ) ($)</td>
<td>4</td>
<td>4.75</td>
<td>6</td>
<td>7.50</td>
<td>9.15</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>( t ) (in hours past 00:00)</th>
<th>6</th>
<th>8</th>
<th>10</th>
<th>12</th>
<th>14</th>
</tr>
</thead>
<tbody>
<tr>
<td>( H(t) ) (in °F)</td>
<td>90</td>
<td>97</td>
<td>100</td>
<td>112</td>
<td>119</td>
</tr>
</tbody>
</table>

\[
\frac{dc}{dt} = \frac{dc}{dH} \cdot \frac{dH}{dt}
\]
\[
\approx \frac{7.5 - 4.75}{10} \cdot \frac{112 - 97}{4}
\]
\[
\approx \$1.031/\text{hr}
\]
The graph of \( g(x) = x^3 e^{-x} \) is shown below. Your friend Duane tells you that even though the function appears to approach \( y = 0 \), he thinks that it may have a local maximum somewhere farther down the \( x \)-axis. What would you tell Duane about the local extremes of \( g \)? Provide support for your argument.

\[
g'(x) = 3x^2 e^{-x} - x^3 e^{-x} = x^2 e^{-x} (3 - x)
\]

Since \( g(x) = 0 \) at \( x = 0 \) and \( x = 3 \), the only local extrema of \( g \) occur at \( x = 0 \) and \( x = 3 \).

\[ g(0) = 0 \text{ is neither max nor min} \]
\[ g(3) = \frac{27}{e^3} \approx 1.34 \text{ is a local (not global) maximum.} \]

The demand for Barbie with Kung Fu Grip (in thousands) is given as a function of price (in dollars) by \( q(p) = 4000 - 30p - 0.1p^2 \). For what price will revenue be maximized and what will the maximum revenue be? (Use two different methods to determine your answer.)

\[
R(p) = 4000p - 30p^2 - 0.1p^3
\]
\[
R'(p) = 4000 - 60p - 0.3p^2
\]
\[
0 =
\]

\[ \Rightarrow p = \frac{52.75}{-252.75} \]
\[ \Rightarrow p = \frac{52.75}{-252.75} \]

\[ q(52.75) = f_{112,845} \]

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Extra Credit: \$5000 is deposited in an account where interest is \$750.70/yr. when \( t = 5 \) years, what is the interest rate of the account? (Fill in the equation for credit).

Trivia: Who was the first TV married couple to share a bed (instead of two singles)?