1.) Solve the following differential equations.
   a.) \( \frac{dy}{dx} = xe^x \)  
   b.) \( \frac{dy}{dx} = xy\sqrt{y - 4} \)  
   c.) \( \frac{dy}{dx} = \sin^2 x \cos^2 y \)  
   d.) \( \frac{dy}{dx} = y^2(y - 1) \)  
   e.) \( \frac{dy}{dx} = \sin x \cos y \)  
   f.) \( \frac{dy}{dx} = xy - y + 3x - 3 \)  
   g.) \( \frac{dy}{dx} = \frac{x + xy^3 + 1 + y^3}{xy^2 - 2y^2} \)  
   h.) \( \frac{dy}{dx} = e^{2x+3y} \) and \( y(1) = 0 \)

2.) Let \( M \) be the total mass (in grams) of a black bullhead (a sport fish common throughout Minnesota’s lakes with sandy, muddy bottoms) at time \( t \) (in years). Assume that its growth rate is given by \( \frac{dM}{dt} = \frac{(1/100)}{M} (400 - M) \). If \( M(0) = 2 \) grams, solve the D.E. and solve explicitly for mass \( M \). What is the bullhead’s mass in 1 year? in 2 years? Determine an upper limit (asymptotic mass) for the mass of this fish.

3.) Solve Problem B on page 2 of this discussion sheet.

4.) Consider the function \( f(x) = \cos 2x \) on the interval \([0, 1/2]\). What should \( n \) be in order that the Taylor Polynomial of degree \( n \) centered at \( x = 0 \) have a Taylor Error of at most 0.0001?

5.) Consider the function \( f(x) = \frac{x}{x + 1} \) on the interval \([0, 3/4]\). What should \( n \) be in order that the Taylor Polynomial of degree \( n \) centered at \( x = 0 \) have a Taylor Error of at most 0.0001?

******************THE FOLLOWING PROBLEM IS FOR RECREATIONAL PURPOSES ONLY.******************

6.) You have 8 black socks, 12 blue socks, 10 gray socks, and 5 white socks randomly scattered in your bureau drawer. If you reach into the drawer without looking, how many socks must you take out to be sure of having a matching pair of socks? a matching pair of white socks?
1.) The graph of a derivative $f'$ is given below. Set up a sign chart for the second derivative $f''$ and sketch a graph of the function $f$, indicating extrema and inflection points.
The following data are plotted on the semi-log graph. Determine $N$ and the growth rate $\frac{dN}{dt}$ (as a function of $N$).

<table>
<thead>
<tr>
<th>$t$</th>
<th>$N$</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>500</td>
</tr>
<tr>
<td>2</td>
<td>99</td>
</tr>
<tr>
<td>4</td>
<td>79.2</td>
</tr>
<tr>
<td>5</td>
<td>50</td>
</tr>
<tr>
<td>7</td>
<td>19.9</td>
</tr>
<tr>
<td>9</td>
<td>7.9</td>
</tr>
<tr>
<td>10</td>
<td>5</td>
</tr>
</tbody>
</table>
Problem B (Solution)

Assume \( \log N = \log C + nt \) (a line),
then \( C = 500 \) so \( \log N = \log 500 + nt \),
and \( t = 10, \; N = 5 \rightarrow \)

\[
\log 5 = \log 500 + 10n \rightarrow \\
\log 5 - \log 500 = 10n \rightarrow \\
\log \frac{5}{500} = 10n \rightarrow \log \frac{1}{100} = 10n \rightarrow \\
\log 10^{-2} = 10n \rightarrow -2 = 10n \rightarrow \\
n = -\frac{1}{5} \; ; \text{then} \\
\log N = \log 500 - \frac{1}{5} t \rightarrow \\
10^{\log N} = 10^{\log 500 - \frac{1}{5} t} \rightarrow \\
N = 10 \log 500 \cdot 10^{-\frac{1}{5} t} \rightarrow \\
\boxed{N = 500 \cdot 10^{-\frac{1}{5} t}} \; ; \text{then} \\

\[
\frac{dN}{dt} = 500 \cdot 10^{-\frac{1}{5} t} \cdot \ln 10 \cdot -\frac{1}{5} \rightarrow \\

\boxed{\frac{dN}{dt} = -\ln 10 \cdot \frac{1}{5} N}
\]