Use of books, notes or calculators is **NOT** permitted.

**Please show all your work!** Answers without appropriate supporting work may not receive full credit.

Clearly indicate your answers to each problem by underlining them or placing a box around your answers!

1. Fill in the values of the trigonometric functions in the chart below.

<table>
<thead>
<tr>
<th>$\theta$</th>
<th>0</th>
<th>$\frac{\pi}{6}$</th>
<th>$\frac{\pi}{4}$</th>
<th>$\frac{\pi}{3}$</th>
<th>$\frac{\pi}{2}$</th>
<th>$\pi$</th>
<th>$\frac{3\pi}{2}$</th>
<th>$2\pi$</th>
</tr>
</thead>
<tbody>
<tr>
<td>$\sin \theta$</td>
<td></td>
<td></td>
<td></td>
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<td></td>
<td></td>
<td></td>
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<tr>
<td>$\cos \theta$</td>
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</tr>
<tr>
<td>$\tan \theta$</td>
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</tr>
</tbody>
</table>

2. Given that $\sin \theta = \frac{3}{5}$ and $\pi/2 < \theta < \pi$, find the exact values of the remaining five trigonometric ratios.

3. Find all solutions to the equation $\cos^2(x) + \cos(x) = 0$.

4. Complete the identity using the triangle method.
   
   $$\cos (\tan^{-1}(x)) =$$

5. Determine the exact value without using a calculator.
   
   $$\sin^{-1}\left(\frac{\sqrt{3}}{2}\right) =$$

6. Evaluate the following limits:
   
   $$\lim_{x \to 3} \frac{x^2 - 2x}{x + 1}$$

   $$\lim_{x \to 2} \frac{x^2 - 4x + 4}{x^2 + x - 6}$$

   $$\lim_{\theta \to 0} \frac{\sin (3\theta)}{\theta}$$
\[
\lim_{x \to -1^-} f(x) \text{ where } f(x) = \begin{cases} 
2x + 1 & \text{if } x < -1 \\
3 & \text{if } -1 < x < 1 \\
2x + 1 & \text{if } x > 1 
\end{cases}
\]

\[
\lim_{x \to 2} \frac{x^2 - x - 2}{x^2 - 4}
\]

\[
\lim_{x \to \pi} \sin \left(\frac{x}{3}\right) + x^2
\]

7. Given \( f(x) = -2x^3 + 16 \) and \( g(x) = \cos(x) \):

   (a) What is the domain and range of \( f(x) \) and \( g(x) \)?
   (b) Let \( h(x) = g(x)/f(x) \). Write the formula for \( h(x) \) and state the domain of \( h(x) \).
   (c) Find the formula for \( f^{-1}(x) \) and state the domain of \( f^{-1}(x) \).
   (d) What is \( f(g(x)) \)?
   (e) If \( g(x) \) is vertically stretched by a factor of 2 and then shifted down 2 units, call this new function \( k(x) \) and write it in the space below.

8. Given \( f(x) = \sqrt{x+1} \) and \( g(x) = x^2 - 4 \),

   (a) Find the composite function \( f \circ g \) and identify the domain.
   (b) Find the composite function \( g \circ f \) and identify the domain.
   (c) Find \( \frac{f(x)}{g(x)} \) and identify the domain.

9. Solve each of the following equations for \( x \):

   \[
   \ln \left(\frac{1}{x}\right) + \ln (2x^3) = \ln 3
   \]

   \[
   3e^{-2x} = 5
   \]

   \[
   2 \ln (4x) - 1 = 6
   \]

10. Use the limit definition of derivative to find the derivative of \( f(x) = 5x^2 - 3 \).

11. The function \( f(t) = 3t^2 + t \) represents the position given in feet of an object at time \( t \) seconds. Include units in all of your answers.

   (a) Find the average velocity between \( t = 1 \) and \( t = 2 \).
   (b) Find the instantaneous velocity at \( t = 2 \).
   (c) Find the acceleration of the object at \( t = 2 \).
12. Find an equation of the tangent line to \( y = x^3 + 3x^2 \) at \( x = 1 \).

13. Find the indicated derivatives. You may need to rewrite the function before taking the derivative.

\[
\begin{align*}
f(x) &= x(3x^2 - \sqrt{x}), \text{ find } f'(x) \\
g(x) &= x^3 + \frac{4}{x^2}, \text{ find } \frac{d^2g}{dx^2} \\
h(t) &= (2t + 3)^{\frac{3}{2}}, \text{ find } h'(t)
\end{align*}
\]

14. Given \( f(2) = -3, f(4) = 2, g(0) = 1, g(2) = 5, f'(0) = 0, f'(1) = -1, f'(2) = 3, g'(0) = 2, g'(1) = -6, g'(2) = 7, \)

(a) Find \( H'(2) \) given that \( H(x) = 5f(x) - 2g(x) \).

(b) Find \( F'(0) \) given that \( F(x) = f(g(x)) \).

15. Sketch a graph of a function with the properties \( f(-1) = 2, \lim_{x \to -1} f(x) = -3 \) and \( \lim_{x \to 1^+} f(x) = \infty \).

16. Sketch the graph of a function \( f \) that satisfies the conditions that \( f \) is continuous everywhere except at \( x=1 \) and at \( x=3 \). Sketch your graph in such a way that the two-sided limit at \( x=1 \) DOES NOT exist while the two-sided limit at \( x=3 \) DOES exist. Label a few tickmarks to show the scale you are using on your graph.

17. GIVEN A GRAPH OF \( F \): be able to determine:

(a) all \( x \) values where the \( f(x) \) is discontinuous.

(b) the limit of \( f(x) \) at a specified \( x \) value.

(c) all \( x \) values where the limit of \( f(x) \) does not exist.

(d) all horizontal and vertical asymptotes of \( f(x) \).

(e) all \( x \) values where the derivative of \( f(x) \) is undefined.

(f) roughly sketch \( f'(x) \) given the graph of \( f(x) \).