1. Here are the graphs of $y = f(x)$ and $y = g(x)$. What graph below is the graph of $y = f(x) \cdot g(x)$?
2. Given \( f(x) = 4x - 3 \) and \( g(x) = 2x - 4 \), what is an explicit equation for \( h(x) = f(x) + g(x) \)? For non-MC, expand and simplify.
   \[
   \begin{array}{ll}
   \text{A. } & h(x) = -6x - 7 \\
   \text{B. } & h(x) = 6x + 7 \\
   \text{C. } & h(x) = 6x - 7 \\
   \text{D. } & h(x) = -6x + 7 \\
   \end{array}
   \]

3. Given \( f(x) = 3x - 2 \) and \( g(x) = x^2 - 4x - 3 \), what is an explicit equation for \( d(x) = g(x) - f(x) \)? For non-MC, expand and simplify.
   \[
   \begin{array}{ll}
   \text{A. } & d(x) = -x^2 + 7x - 5 \\
   \text{B. } & d(x) = x^2 - x - 5 \\
   \text{C. } & d(x) = -x^2 - 7x - 1 \\
   \text{D. } & d(x) = x^2 - 7x - 1 \\
   \end{array}
   \]

4. Given \( f(x) = 3x - 2 \) and \( g(x) = 2x^2 - 4 \), what is an explicit equation for \( p(x) = f(x) \cdot g(x) \)? For non-MC, expand and simplify.
   \[
   \begin{array}{ll}
   \text{A. } & p(x) = 6x^2 - 16x + 8 \\
   \text{B. } & p(x) = 2x^2 + 3x - 6 \\
   \text{C. } & p(x) = 5x^3 + 4x^2 - 12x + 8 \\
   \text{D. } & p(x) = 6x^3 - 4x^2 - 12x + 8 \\
   \end{array}
   \]

5. Given \( f(x) = x + 4 \) and \( g(x) = x^2 - 49 \), what is the domain of \( q(x) = \frac{f(x)}{g(x)} \)?
   \[
   \begin{array}{ll}
   \text{A. } & x \neq 7, x \neq -7 \\
   \text{B. } & x \in \mathbb{R} \\
   \text{C. } & x \neq 49 \\
   \text{D. } & x \neq -4 \\
   \end{array}
   \]

6. Given \( f(x) = \sqrt{3 - x} \) and \( g(x) = 6 - 4x \), what is an explicit equation for \( f(g(x)) \)? For non-MC, expand and simplify.
   \[
   \begin{array}{ll}
   \text{A. } & f(g(x)) = 6 - \sqrt{3 - 4x} \\
   \text{B. } & f(g(x)) = \sqrt{-3 - 4x} \\
   \text{C. } & f(g(x)) = -3 - \sqrt{3 - 4x} \\
   \text{D. } & f(g(x)) = \sqrt{4x - 3} \\
   \end{array}
   \]

7. Given \( h(x) = 2x^2 + 6x - 5 \), which pair of equations below are possible equations for \( f(x) \) and \( g(x) \) so that \( h(x) = f(x) - g(x) \)? Avoid trivial if non-MC.
   \[
   \begin{array}{ll}
   \text{A. } & f(x) = x^2 \\
   & g(x) = x^2 + 6x - 5 \\
   \text{B. } & f(x) = 2x^2 \\
   & g(x) = -6x + 5 \\
   \text{C. } & f(x) = 2x^2 \\
   & g(x) = 6x - 5 \\
   \text{D. } & f(x) = x^2 \\
   & g(x) = -x^2 - 6x - 5 \\
   \end{array}
   \]
8. Given \( h(x) = x^2 + x - 42 \), which pair of equations below are possible equations for \( f(x) \) and \( g(x) \) so that \( h(x) = f(x) \cdot g(x) \)? Avoid trivial if non-MC.

A. \( f(x) = x - 6 \)  
   \( g(x) = x - 7 \)  
B. \( f(x) = x + 6 \)  
   \( g(x) = x - 7 \)  
C. \( f(x) = x - 6 \)  
   \( g(x) = x + 7 \)  
D. \( f(x) = x + 6 \)  
   \( g(x) = x + 7 \)

9. Given the graphs of \( y = f(x) \) and \( y = g(x) \), what is the value of \( g(f(-1)) \)?

![Graph of y = f(x) and y = g(x)]

A. \(-2\)  
B. \(-4.5\)  
C. \(-3.5\)  
D. \(-5\)

10. Use these tables. What is the value of \( f(f(0)) \)?

<table>
<thead>
<tr>
<th>( x )</th>
<th>( f(x) )</th>
</tr>
</thead>
<tbody>
<tr>
<td>-3</td>
<td>18</td>
</tr>
<tr>
<td>-2</td>
<td>11</td>
</tr>
<tr>
<td>-1</td>
<td>6</td>
</tr>
<tr>
<td>0</td>
<td>3</td>
</tr>
<tr>
<td>1</td>
<td>2</td>
</tr>
<tr>
<td>2</td>
<td>3</td>
</tr>
<tr>
<td>3</td>
<td>6</td>
</tr>
</tbody>
</table>

A. \(-2\)  
B. \(2\)  
C. \(6\)  
D. \(0\)
11. The function \( h(x) = g(f(x)) \) is the composite of \( f(x) = 2 - x \) and \( g(x) = \frac{1}{\sqrt{x}} \). What is the domain of \( h(x) \)?

A. \( x < -2 \) or \( x > 0 \)  
B. \( x > 0 \)  
C. \( x < 2 \)  
D. \(-2 < x < 0\)

12. For the function \( h(x) = (6 - x)^2 \), what are possible functions \( f \) and \( g \) so that \( h(x) = f(g(x)) \)? Avoid trivial if non-MC.

A. \( f(x) = x \) \( g(x) = 6 - x^2 \)  
B. \( f(x) = 6 - x^2 \) \( g(x) = x \)  
C. \( f(x) = 6 - x \) \( g(x) = x^2 \)  
D. \( f(x) = x^2 \) \( g(x) = 6 - x \)

13. Given the functions \( f(x) = \sqrt{2 - x} \) and \( g(x) = x^2 + 3x \), what expression is \( g(f(x)) \)? For non-MC, expand and simplify.

A. \( x^2 - 2x + 2 \)  
B. \( (x^2 + 3x)\sqrt{2 - x} \)  
C. \( \sqrt{2 - 3x + x^2} \)  
D. \( 2 - x + 3\sqrt{2 - x} \)

Moderate (Show work for non-MC)

14. Use the graphs of \( y = f(x) \) and \( y = g(x) \). What are the domain and range of \( y = f(x) - g(x) \)?

A. Domain: \( x \in \mathbb{R} \)  
   Range: \( y \leq -6 \)  
B. Domain: \( x \geq -6 \)  
   Range: \( y \in \mathbb{R} \)  
C. Domain: \( x \geq -6 \)  
   Range: \( y \leq 12 \)  
D. Domain: \( x \leq -6 \)  
   Range: \( y \leq 12 \)
15. Use the graphs of \( y = f(x) \) and \( y = g(x) \). What are the domain and range of \( y = f(x) \cdot g(x) \)?

\[
\begin{array}{ll}
\text{A. Domain: } x \in \mathbb{R} & \text{C. Domain: } x \geq 4 \\
\text{Range: } y \leq 2 & \text{Range: } y \in \mathbb{R}
\end{array}
\]

\[
\begin{array}{ll}
\text{B. Domain: } x \in \mathbb{R} & \text{D. Domain: } x \in \mathbb{R} \\
\text{Range: } y \leq 4 & \text{Range: } y \in \mathbb{R}
\end{array}
\]

16. Given \( f(x) = |x - 5| \) and \( g(x) = \frac{1}{x} \), what is the domain and range of \( h(x) = f(x) + g(x) \)?

\[
\begin{array}{ll}
\text{A. Domain: } x \neq 0 & \text{C. Domain: } x \neq 5 \\
\text{Range: } y \leq 5 & \text{Range: } y \in \mathbb{R}
\end{array}
\]

\[
\begin{array}{ll}
\text{B. Domain: } x \neq 0 & \text{D. Domain: } x \geq 5 \\
\text{Range: } y \in \mathbb{R} & \text{Range: } y \leq 5
\end{array}
\]

17. For the functions \( f(x) = x + 2 \) and \( g(x) = x^2 - 5 \), which expression has the greatest value?

\[
\begin{array}{ll}
\text{A. } g(f(3)) & \text{B. } f(g(5)) \\
\text{C. } g(f(-2)) & \text{D. } f(g(-2))
\end{array}
\]

18. For the function \( h(x) = (x - 2)(x - 4) \), what are possible functions \( f \) and \( g \) so that \( h(x) = f(g(x)) \)? Avoid trivial if non-MC.

\[
\begin{array}{ll}
\text{A. } f(x) = x - 4 & \text{B. } f(x) = x - 2 \\
\text{ } g(x) = x^2 - 2 & \text{ } g(x) = x - 4
\end{array}
\]
19. Here are the graphs of \( y = f(x) \) and \( y = g(x) \). What graph below is the graph of \( y = \frac{f(x)}{g(x)} \)?

![Graphs of \( f(x) \) and \( g(x) \)]

A. ![Graph A]
B. ![Graph B]
C. ![Graph C]
D. ![Graph D]

20. Given the functions \( f(x) = 2x + 4 \) and \( g(x) = \sqrt{x + 3} \), what is the value of \( a \) for which \( f(g(a)) = 4? \)

A. 6  
B. 0  
C. 1  
D. −3
21. For the function \( h(x) = \frac{x - 1}{x^2 + 2} \), what are possible functions \( f \) and \( g \) so that \( h(x) = f(g(x)) \)? Avoid trivial if non-MC.
   A. \( f(x) = x - 1 \)
      \( g(x) = \frac{1}{x^2 + 2} \)
   B. \( f(x) = x - 1 \)
      \( g(x) = \frac{x}{x^2 + 2} \)
   C. \( f(x) = \frac{1}{x^2 + 2} \)
      \( g(x) = x - 1 \)
   D. \( f(x) = \frac{x}{x^2 + 2} + 3 \)
      \( g(x) = x - 1 \)

22. The function \( h(x) = g(f(x)) \) is the composite of \( f(x) = x^2 \) and \( g(x) = \frac{1}{x - 8} \). Which is an explicit equation for \( h(x) \), and what are the restrictions on \( x \)?
   A. \( h(x) = \frac{1}{x^2 - 8} \)
      \( x < -\sqrt{8} \) or \( x > \sqrt{8} \)
   B. \( h(x) = \frac{1}{x^2 - 8} \)
      \( x \neq -\sqrt{8} \) and \( x \neq \sqrt{8} \)
   C. \( h(x) = \frac{1}{(x - 8)^2} \)
      \( x > 8 \)
   D. \( h(x) = \frac{1}{(x - 8)^2} \)
      \( x < 8 \)

23. Given \( f(x) = (x - 4)^2 \), and \( g(x) = \sqrt{x} \), what is an explicit equation for \( g(f(x)) \)? For non-MC, expand and simplify.
   A. \( g(f(x)) = x - 8\sqrt{x} + 16 \)
   B. \( g(f(x)) = x - 4 \)
   C. \( g(f(x)) = |x - 4| \)
   D. \( g(f(x)) = x + 8\sqrt{x} - 16 \)

24. Given \( f(x) = \sqrt{6 - x} \) and \( g(x) = x^2 + 4x - 2 \), which is an explicit equation for the composite function \( h(x) = g(f(x)) \), and what is its domain? For non-MC, expand and simplify.
   A. \( h(x) = 4 - x \)
      \( x \in \mathbb{R} \)
   B. \( h(x) = \sqrt{4 - x} \)
      \( x \leq 4 \)
   C. \( h(x) = 4 - x + 4\sqrt{6 - x} \)
      \( x \leq 6 \)
   D. \( h(x) = \sqrt{-x^2 - 4x + 8} \)
      \( x \geq 0 \)
Short Answer

Easy

25. Given the functions \( f(x) = 2x - 3 \) and \( g(x) = x^2 - 1 \), determine each value below.
   a) \( g(f(-1)) \)
   b) \( g(g(-1)) \)

26. Given \( f(x) = -5x - 4 \) and \( g(x) = 3x - 3 \), write an explicit equation for \( p(x) = f(x) \cdot g(x) \). Expand and simplify.

27. Given the functions \( f(x) = 3x + 6 \) and \( g(x) = \sqrt{x + 6} \), determine an explicit equation for \( f(g(x)) \), then state its domain. Expand and simplify.

28. Given the functions \( f(x) = 6x + 6 \) and \( g(x) = \sqrt{x + 2} \), determine an explicit equation for \( g(f(x)) \), then state its domain. Expand and simplify.

29. Given the functions \( f(x) = \sqrt{x} \) and \( g(x) = 5x^2 + 8x \), determine an explicit equation for \( g(f(x)) \), then state its domain. Expand and simplify.

Moderate (Show work for non-MC)

30. Given \( f(x) = \sqrt{3 - x} \) and \( g(x) = \sqrt{x + 2} \), write an explicit equation for \( d(x) = f(x) - g(x) \), then determine its domain.

31. Given the function \( y = \frac{\sqrt{x + 2}}{x} \), determine possible functions \( p \), \( q \), and \( r \) so that \( y = p(x) \cdot q(r(x)) \).

32. Given the functions \( f(x) = 2 - x^2 \), \( g(x) = \frac{1}{x + 3} \), and \( k(x) = \sqrt{x} \), determine an explicit equation for \( q(x) = f(x) \cdot k(g(x)) \), then state its domain. Expand and simplify.
33. Given the functions \( f(x) = x^2 + 3x + 2 \) and \( g(x) = \frac{5x - 2}{x - 1} \), determine each value below.
   
a) \( f(g(2)) \)
   
b) \( g(f(-3)) \)

34. Use composition of functions to determine whether the functions \( f(x) = \frac{1}{2} x + 8 \) and \( g(x) = 2x - 16 \) are inverse functions.

35. Given the functions \( f(x) = |4 - x| \), \( g(x) = (x - 4)^2 \), and \( h(x) = \sqrt{x} \), determine each value below. Expand and simplify.
   
a) \( h(g(f(2))) \)
   
b) \( f(g(h(2))) \)

36. Given \( f(x) = \frac{x - 2}{4} \) and \( g(x) = 2x^2 + 4 \), determine an explicit equation for \( f(g(x)) \), then state its domain and range. Expand and simplify.

Problem

Moderate (Show work for non-MC)

37. Given \( f(x) = 2x + 1 \) and \( g(x) = x^3 - 3 \), determine an explicit equation for each composite function, then state its domain and range. Expand and simplify.
   
a) \( f(g(x)) \)
   
b) \( g(f(x)) \)

Show your work.
38. Given \( f(x) = -x + 2 \) and \( g(x) = 2x^2 - 3x \), determine an explicit equation for each composite function, then state its domain and range. Expand and simplify.
   a) \( f(\{g(x)\}) \)
   b) \( g(\{f(x)\}) \)
   c) \( f(\{f(x)\}) \)
   d) \( g(\{g(x)\}) \)

Show your work.

39. Use the graphs of \( y = f(x) \) and \( y = g(x) \).
   a) State the domain and range of \( y = f(x) \).
   b) State the domain and range of \( y = g(x) \).
   c) Sketch the graph of \( y = f(x) \cdot g(x) \).
   d) What is the domain of \( y = f(x) \cdot g(x) \)? How is it related to the domain of \( y = f(x) \) and \( y = g(x) \)?
40. Use the graphs of \( y = f(x) \) and \( y = g(x) \).
   a) Determine the value of \( a \) for which \( f(g(a)) = -2 \)
   b) Determine the value of \( b \) for which \( g(f(b)) = 2 \)
   Show your work.

   ![Graphs of \( y = f(x) \) and \( y = g(x) \)]

41. Explain why the composition of two linear functions \( f(x) = ax + b \) and \( g(x) = cx + d \) is also a linear function. Give a numerical example to illustrate your answer.

**Difficult** (Show work for non-MC)

42. Given the function \( y = \sqrt{x^2 + 6x + 5} \), determine possible functions \( f, g, \) and \( h \) so that \( y = f(g(h(x))) \). Describe your strategy.