1. **Multiple Choice** Which statement is false?
   A. $|x| = \sqrt{x^2}$ for $x \in \mathbb{R}$  
   B. $x = \sqrt{x^2}$ for $x \geq 0$  
   C. $|x| = \sqrt{x^2}$ for $x \in \mathbb{R}$  
   D. $x = \sqrt{x^2}$ for $x \geq 0$

2. **Multiple Choice** Which is the correct simplification of $\sqrt{12x}$?
   A. $2\sqrt{3x}$, $x \geq 0$  
   B. $2x\sqrt{3x}$, $x \in \mathbb{R}$  
   C. $2x\sqrt{3x}$, $x \geq 0$  
   D. $2|\sqrt{3x}|$, $x \in \mathbb{R}$

   a) $\sqrt{72} - 5\sqrt{2} + 3\sqrt{8}$  
   b) $(\sqrt{3} - \sqrt{5})(\sqrt{3} + \sqrt{5})$
   c) $(2\sqrt{6} + 3\sqrt{5})^2$
   d) $\frac{1}{\sqrt{7} - \sqrt{3}}$
   
   a) $\sqrt{72} - 5\sqrt{2} + 3\sqrt{8} = \sqrt{36 \cdot 2} - 5\sqrt{2} + 3\sqrt{4 \cdot 2} = 6\sqrt{2} - 5\sqrt{2} + 6\sqrt{2} = 7\sqrt{2}$
   
   b) $(\sqrt{3} - \sqrt{5})(\sqrt{3} + \sqrt{5}) = \sqrt{3}^2 - \sqrt{5}^2 = 3 - 5 = -2$
   
   c) $(2\sqrt{6} + 3\sqrt{5})^2 = (2\sqrt{6} + 3\sqrt{5})(2\sqrt{6} + 3\sqrt{5}) = 2\sqrt{6}(2\sqrt{6} + 3\sqrt{5}) + 3\sqrt{5}(2\sqrt{6} + 3\sqrt{5}) = 24 + 6\sqrt{30} + 3\sqrt{30} + 45 = 69 + 12\sqrt{30}$
   
   d) $\frac{1}{\sqrt{7} - \sqrt{3}} = \frac{1}{\sqrt{7} - \sqrt{3}} \cdot \frac{\sqrt{7} + \sqrt{3}}{\sqrt{7} + \sqrt{3}} = \frac{\sqrt{7} + \sqrt{3}}{(\sqrt{7})^2 - (\sqrt{3})^2} = \frac{\sqrt{7} + \sqrt{3}}{4}$

4. Identify the values of the variable for which each radical is defined where necessary, then simplify.
   a) $(\sqrt{x} + 2)(\sqrt{x} - 3)$  
   b) $6\sqrt{a^2} + 2a$

   a) The radicands cannot be negative, so $x \geq 0$.
   
   $(\sqrt{x} + 2)(\sqrt{x} - 3) = \sqrt{x}(\sqrt{x} - 3) + 2(\sqrt{x} - 3) = x - 3\sqrt{x} + 2\sqrt{x} - 6 = x - \sqrt{x} - 6$

   b) $6\sqrt{a^2} + 2a$
   
   $\sqrt{a^2} \in \mathbb{R}$ when $a^2 \geq 0$.  
   $a^2 \geq 0$, so $\sqrt{a^2}$ is defined for $a \in \mathbb{R}$.
   
   $6\sqrt{a^2} + 2a = 6|a| + 2a$
Which equations have real roots? If the root is real, determine its value. If the equation has no real roots, explain how you know.

a) \( \sqrt{2x + 3} = 3 \)
\[
2x + 3 \geq 0; \text{ that is, } x \geq -\frac{3}{2}
\]
\[
\sqrt{2x + 3} = 3
\]
\[(\sqrt{2x + 3})^2 = 3^2
\]
\[2x + 3 = 9
\]
\[2x = 6
\]
\[x = 3
\]
x = 3 lies in the set of possible values for x. So, the equation has a real root.

b) \( \sqrt{5x - 1} = \sqrt{2x + 5} \)
\[
5x - 1 \geq 0; \text{ that is, } x \geq \frac{1}{5}
\]
\[
2x + 5 \geq 0; \text{ that is, } x \geq -\frac{5}{2}
\]
So, for both radicals to be defined, \( x \geq \frac{1}{5} \)
\[
\sqrt{5x - 1} = \sqrt{2x + 5}
\]
\[(\sqrt{5x - 1})^2 = (\sqrt{2x + 5})^2
\]
\[5x - 1 = 2x + 5
\]
\[3x = 6
\]
\[x = 2
\]
x = 2 lies in the set of possible values for x. So, the equation has a real root.

c) \( \sqrt{3x + 2} + 5 = 2 \)
\[
3x + 2 \geq 0; \text{ that is, } x \geq -\frac{2}{3}
\]
\[
\sqrt{3x + 2} + 5 = 2
\]
\[
\sqrt{3x + 2} = -3
\]
The left side of the equation is greater than or equal to 0.
The right side of the equation is negative, -3.
So, no real solutions are possible.
The equation has no real roots.

d) \( 2\sqrt{x - 8} = 3\sqrt{x + 2} \)
\[
x - 8 \geq 0; \text{ that is, } x \geq 8
\]
\[
x + 2 \geq 0; \text{ that is, } x \geq -2
\]
So, for both radicals to be defined, \( x \geq 8 \)
\[
2\sqrt{x - 8} = 3\sqrt{x + 2}
\]
\[(2\sqrt{x - 8})^2 = (3\sqrt{x + 2})^2
\]
\[4(x - 8) = 9(x + 2)
\]
\[4x - 32 = 9x + 18
\]
\[-50 = 5x
\]
\[x = -10
\]
x = -10 does not lie in the set of possible values for x. So, the equation has no real roots.
6. To make a picture frame, a square with area 40 cm\(^2\) is cut from a square with area 90 cm\(^2\). Serena wants to put a thin gold ribbon around the inside and outside edges of the frame. How much ribbon does Serena need?

\[
A = 40 \text{ cm}^2
\]

The side length of a square is the square root of its area. 
So, the side length of the square with area 40 cm\(^2\) is:
\[
\sqrt{40} = 2\sqrt{10} \text{ cm}
\]

The side length of the square with area 90 cm\(^2\) is:
\[
\sqrt{90} = 3\sqrt{10} \text{ cm}
\]

The length of ribbon needed = perimeter of large square
+ perimeter of small square 
\[
= 4(2\sqrt{10}) + 4(3\sqrt{10})
= 8\sqrt{10} + 12\sqrt{10}
= 20\sqrt{10}
\]

Serena needs 20\sqrt{10} cm of ribbon.

7. The formula \(t = \sqrt{\frac{2d}{9.8}}\) gives the time, \(t\) seconds, for an object at rest to fall \(d\) metres. It took 2.5 s for a ball dropped from a roof to hit the ground. To the nearest metre, from what height was the ball dropped?

\[
t = \sqrt{\frac{2d}{9.8}}
\]

Substitute: \(t = 2.5\)

\[
2.5 = \sqrt{\frac{2d}{9.8}}
\]

\[
(2.5)^2 = \left(\sqrt{\frac{2d}{9.8}}\right)^2
\]

\[
6.25 = \frac{2d}{9.8}
\]

\[
61.25 = 2d
\]

\[
d = 30.625
\]

The ball was dropped from a height of about 31 m.