$(f \circ f)(x) = f(x^2) = (x^2)^2 = x^4$, and the domain is $(-\infty, \infty)$.

$(g \circ g)(x) = g\left(\sqrt{x-3}\right) = \sqrt{\sqrt{x-3}-3}$. For the domain we must have $\sqrt{x-3} \geq 3 \quad \Rightarrow$ $x - 3 \geq 9 \quad \Rightarrow \quad x \geq 12$, so the domain is $[12, \infty)$.

36. $f(x) = x - 4$ has domain $(-\infty, \infty)$. $g(x) = |x+4|$ has domain $(-\infty, \infty)$.

$(f \circ g)(x) = f(|x+4|) = |x+4| - 4$, and the domain is $(-\infty, \infty)$.

$(g \circ f)(x) = g(x-4) = |(x-4)+4| = |x|$, and the domain is $(-\infty, \infty)$.

$(f \circ f)(x) = f(x-4) = (x-4) - 4 = x - 8$, and the domain is $(-\infty, \infty)$.

$(g \circ g)(x) = g(|x+4|) = ||x+4|+4| = |x+4|+4$ ($|x+4|+4$ is always positive). The domain is $(-\infty, \infty)$.

38. $f(x) = \dfrac{1}{\sqrt{x}}$ has domain $\{x \mid x > 0\}$; $g(x) = x^2 - 4x$ has domain $(-\infty, \infty)$.

$(f \circ g)(x) = f(x^2 - 4x) = \dfrac{1}{\sqrt{x^2 - 4x}}$. $(f \circ g)(x)$ is defined whenever $0 < x^2 - 4x = x(x-4)$.
The product of two numbers is positive either when both numbers are negative or when both numbers are positive. So the domain of $f \circ g$ is $\{x \mid x < 0 \text{ and } x < 4\} \cup \{x \mid x > 0 \text{ and } x > 4\}$ which is $(-\infty, 0) \cup (4, \infty)$.

$(g \circ f)(x) = g\left(\dfrac{1}{\sqrt{x}}\right) = \left(\dfrac{1}{\sqrt{x}}\right)^2 - 4\left(\dfrac{1}{\sqrt{x}}\right) = \dfrac{1}{x} - \dfrac{4}{\sqrt{x}}$. $(g \circ f)(x)$ is defined whenever both $f(x)$ and $g(f(x))$ are defined, that is, whenever $x > 0$. So the domain of $g \circ f$ is $(0, \infty)$.

$(f \circ f)(x) = f\left(\dfrac{1}{\sqrt{x}}\right) = \dfrac{1}{\sqrt{\dfrac{1}{\sqrt{x}}}} = x^{1/4}$. $(f \circ f)(x)$ is defined whenever both $f(x)$ and $f(f(x))$ are defined, that is, whenever $x > 0$. So the domain of $f \circ f$ is $(0, \infty)$.

$(g \circ g)(x) = g(x^2 - 4x) = (x^2 - 4x)^2 - 4(x^2 - 4x) = x^4 - 8x^3 + 16x^2 - 4x^2 + 16x$
$= x^4 - 8x^3 + 12x^2 + 16x$, and the domain is $(-\infty, \infty)$.

40. $f(x) = \dfrac{2}{x}$ has domain $\{x \mid x \neq 0\}$; $g(x) = \dfrac{x}{x+2}$ has domain $\{x \mid x \neq -2\}$.

$(f \circ g)(x) = f\left(\dfrac{x}{x+2}\right) = \dfrac{2}{\dfrac{x}{x+2}} = \dfrac{2x+4}{x}$. $(f \circ g)(x)$ is defined whenever both $g(x)$ and $f(g(x))$ are defined; that is, whenever $x \neq 0$ and $x \neq -2$. So the domain is $\{x \mid x \neq 0, -2\}$.

$(g \circ f)(x) = g\left(\dfrac{2}{x}\right) = \dfrac{\dfrac{2}{x}}{\dfrac{2}{x} + 2} = \dfrac{2}{2 + 2x} = \dfrac{1}{1+x}$. $(g \circ f)(x)$ is defined whenever both $f(x)$ and $g(f(x))$ are defined; that is, whenever $x \neq 0$ and $x \neq -1$. So the domain is $\{x \mid x \neq 0, -1\}$.

$(f \circ f)(x) = f\left(\dfrac{2}{x}\right) = \dfrac{2}{\dfrac{2}{x}} = x$. $(f \circ f)(x)$ is defined whenever both $f(x)$ and $f(f(x))$ are defined; that is, whenever $x \neq 0$. So the domain is $\{x \mid x \neq 0\}$.