Parent Functions

Name: ______________________ | Date: ______________ | Score: _____ / 33

Quick Review

A **parent function** is the simplest member of a family — no shifts, stretches, or reflections applied. Every other member of the family is a transformation of the parent. Learning the parents by shape lets you recognize transformed graphs at a glance.

The core parents. Linear: $f(x) = x$ (straight line through the origin, slope 1). Quadratic: $f(x) = x^2$ (upward parabola, vertex at origin, y-axis symmetric). Cubic: $f(x) = x^3$ (S-curve, origin-symmetric). Square root: $f(x) = \sqrt{x}$ (half-parabola, starts at origin, domain $x \geq 0$). Cube root: $f(x) = \sqrt[3]{x}$ (S-curve, defined for all reals). Absolute value: $f(x) = |x|$ (V-shape, vertex at origin). Reciprocal: $f(x) = \frac{1}{x}$ (hyperbola; asymptotes $x = 0$ and $y = 0$).

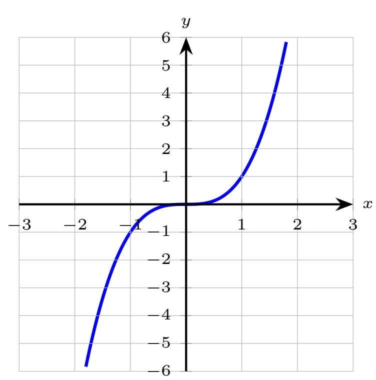
Symmetry. x^2, $|x|$, and any even-power function are even (symmetric about the y-axis). x^3, $\sqrt[3]{x}$, and $\frac{1}{x}$ are odd (symmetric about the origin). $\sqrt{x}$ is neither.

Identifying a parent from a transformed expression: strip away shifts ($x + h$ or $x - h$), stretches/reflections (a coefficient on the outside or inside), and vertical shifts. $f(x) = -3\sqrt{x-4} + 2$ keeps the square-root shape — the parent is $\sqrt{x}$. $g(x) = -2(x+1)^2 - 3$ keeps the parabola shape — parent is x^2. **Common trap**: thinking $\frac{1}{x+2}$ is built from $x + 2$. It's not — the reciprocal structure makes $\frac{1}{x}$ the parent, and $+2$ is a horizontal shift.

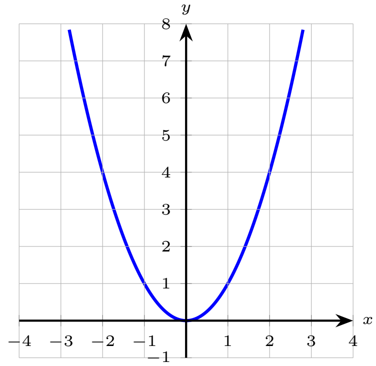
PRACTICE

Identify the parent function or use parent-function facts as asked.

1. Parent of $f(x) = x$ ________
2. Parent of $g(x) = -2(x+3)^2 + 5$ ________
3. Parent of $f(x) = \sqrt{x-4} + 2$ ________
4. Parent of $h(x) = 2|x-1| - 3$ ________
5. Domain of parent $f(x) = \sqrt{x}$ ________
6. Range of parent $f(x) = x^2$ ________
7. Parent of $r(x) = \frac{2}{x-5} - 1$ ________
8. The graph of the parent $f(x) = x^3$ is shown. State its symmetry. ________



9. The graph of the parent $f(x) = x^2$ is shown. State its symmetry. ________



10. Asymptotes of parent $f(x) = \dfrac{1}{x}$ ________

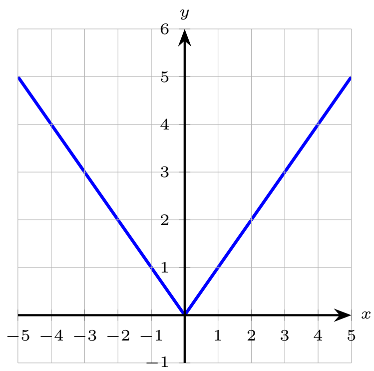
11. Parent of $f(x) = (x-1)^3$ ________

12. Vertex of $y = |x|$ ________

13. Domain of $f(x) = \dfrac{1}{x}$ ________

14. Parent of $p(x) = 3\sqrt[3]{x+2}$ ________

15. The graph of the parent $f(x) = |x|$ is shown. State its range. ________



16. $p(x) = -3\sqrt{x-4} + 2$; parent function ________

17. $r(x) = \dfrac{2}{x-5} - 1$; vertical asymptote ________

18. Parent of $f(x) = -2(x+1)^2 - 3$ ________

19. Domain of parent $f(x) = \sqrt[3]{x}$ ________

20. $|x|$ has a horizontal asymptote at $y = 0$. True or false? ________

Word Problems

21. A bouncing ball's height after t seconds follows $h(t) = -16t^2 + 48t + 5$. Identify the parent function and name two transformations applied to it. ____

22. A flashlight's brightness at distance d feet from the bulb is $B(d) = \frac{120}{d^2}$ (in some unit). Identify the parent shape and explain what the formula says about behavior near $d = 0$ and as d grows. ____

23. A skateboard ramp is modeled by $y = \sqrt{x}$ for $0 \le x \le 9$ (in feet). A redesigned ramp is $y = 2\sqrt{x} + 1$ over the same domain. Identify the parent function, state the domain and range of the redesigned ramp, and explain in plain English how it differs from the original. ____

24. A walking-path designer uses $f(x) = |x|$ as the footprint of a sharp turn. To soften the turn, she replaces it with $g(x) = |x - 3| + 2$. State the new vertex, and explain how the path moves. ____

Additional Practice

25. If $f(x) = 2x - 5$, find $f(4)$. ________

26. If $g(x) = x^2 + 1$, find $g(-3)$. ________

27. For $f(x) = 3x + 2$, solve $f(x) = 14$. ________

28. Find $(f + g)(x)$ if $f = x + 1$, $g = 2x - 5$. ________

29. Find $(fg)(x)$ if $f = x - 2$, $g = x + 3$. ________

30. Find $f(g(x))$ if $f(x) = 2x$, $g(x) = x + 7$. ________

31. Find the inverse of $f(x) = x - 9$. ________

32. Find the inverse of $f(x) = 3x + 1$. ________

33. Domain of $f(x) = \sqrt{x - 4}$. ________

Answer Keys

1. $\boxed{f(x)=x}$
2. $\boxed{f(x)=x^2}$
3. $\boxed{f(x)=\sqrt{x}}$
4. $\boxed{f(x)=|x|}$
5. $\boxed{[0,\infty)}$
6. $\boxed{[0,\infty)}$
7. $\boxed{f(x)=\frac{1}{x}}$
8. origin (odd)
9. y-axis (even)
10. $\boxed{x=0,\ y=0}$
11. $\boxed{f(x)=x^3}$
12. $\boxed{(0,0)}$
13. $\boxed{\{x : x \neq 0\}}$
14. $\boxed{f(x)=\sqrt[3]{x}}$
15. $\boxed{[0,\infty)}$
16. $\boxed{f(x)=\sqrt{x}}$
17. $\boxed{x=5}$
18. $\boxed{f(x)=x^2}$
19. $\boxed{\mathbb{R}}$
20. false
21. parent $f(t)=t^2$
22. parent $f(d)=\frac{1}{d^2}$ (a reciprocal-square family)
23. parent $\sqrt{x}$; domain $[0,9]$, range $[1,7]$
24. vertex $(3,2)$

Additional Practice Answers

25. $\boxed{3}$
26. $\boxed{10}$
27. $\boxed{x=4}$
28. $\boxed{3x-4}$
29. $\boxed{x^2+x-6}$
30. $\boxed{2x+14}$
31. $\boxed{f^{-1}(x)=x+9}$
32. $\boxed{f^{-1}(x)=\frac{x-1}{3}}$
33. $\boxed{x\geq 4}$

Additional Practice: Answers for all numbered items, including the added practice, are shown in the grid above.

Step-by-Step Explanations

1. A careful way to see it: $f(x)=x$ is itself the simplest linear function — it IS the linear parent. That gives a quick check on the answer.
2. Strip the -2 (vertical stretch/reflection), the $(x+3)$ (horizontal shift), and the $+5$ (vertical shift). What's left is x^2.
3. Inside the radical is just $x-4$ (a shift), and $+2$ is another shift. The radical structure stays — parent is $\sqrt{x}$.
4. Start with the key idea: The $|x-1|$ keeps the V-shape. 2 stretches, -3 shifts down. Parent: $|x|$. That gives a quick check on the answer.
5. A careful way to see it: Square root needs nonneg input. So domain is $x \geq 0$. This is the part to check before moving on, because it keeps the answer tied to the original question.
6. Keep the rule visible: $x^2 \geq 0$ always, and every nonneg value is hit. Range $y \geq 0$. That gives a quick check on the answer.
7. The reciprocal shape is preserved. Parent: $\frac{1}{x}$. (The vertical asymptote is at $x=5$ from the shift; the horizontal asymptote is at $y=-1$ from the -1.)
8. The S-curve looks the same after a 180° turn about the origin: $(-x)^3=-x^3$, so $f(-x)=-f(x)$. That is origin symmetry — an odd function.
9. Fold the parabola along the y-axis and the two halves match: $(-x)^2=x^2$. That is y-axis symmetry — an even function.
10. Vertical asymptote $x=0$ (denominator zero); horizontal $y=0$ (function decays as $|x|\to\infty$).
11. One steady path is: Cube of a shifted input. Parent is x^3; the -1 shifts right. That gives a quick check on the answer.
12. Start with the key idea: The V-shape has its corner at the origin. This is the part to check before moving on, because it keeps the answer tied to the original question.
13. A careful way to see it: All reals except 0. The reciprocal blows up at zero. This is the part to check before moving on, because it keeps the answer tied to the original question.
14. Keep the rule visible: Cube root keeps its shape under any scaling or shift. Parent: $\sqrt[3]{x}$. That gives a quick check on the answer.
15. The V sits on the x-axis and opens upward, so outputs start at 0 and climb with no ceiling. The range is $[0,\infty)$.
16. The square-root structure is unchanged by the outside coefficients and shifts.
17. A careful way to see it: Denominator zero at $x=5$. (The horizontal asymptote sits at $y=-1$.) That gives a quick check on the answer.
18. Keep the rule visible: Squared expression of a shifted input. Parent: x^2. This is the part to check before moving on, because it keeps the answer tied to the original question.
19. One steady path is: Cube root is defined for all real numbers, including negatives. (Unlike $\sqrt{x}$.) That gives a quick check on the answer.
20. Start with the key idea: $|x|$ grows without bound as $|x|\to\infty$. No horizontal asymptote. That gives a quick check on the answer.
21. The squared expression marks this as a quadratic family member, so the parent is t^2. The -16 flips the parabola upside-down and stretches it (so it opens downward and is narrower); rewriting in vertex form would expose the horizontal shift to $t=\frac{3}{2}$ and a vertical shift up to the maximum height. Several transformations are bundled in those three coefficients.
22. The reciprocal-of-power structure puts this in the rational family with parent $\frac{1}{d^2}$. Near $d=0$ the value blows up (vertical asymptote), which matches the physical fact that brightness is enormous very close to the bulb. As $d\to\infty$ the value approaches 0 (horizontal asymptote $y=0$) — far from the bulb, the light fades to almost nothing.
23. Parent is $\sqrt{x}$. The redesigned ramp starts 1 foot higher (the $+1$ shifts the whole curve up by 1) and rises twice as fast (the 2 vertically stretches it). At $x=0$: $y=1$. At $x=9$: $y=2(3)+1=7$. So the new ramp begins at height 1 and ends at height 7, while the original begins at 0 and ends at 3 — steeper and taller throughout.
24. The parent vertex at $(0,0)$ shifts right by 3 (from $x-3$) and up by 2 (from $+2$), landing at $(3,2)$. The shape (a V opening upward with slope ±1) is unchanged; only the position moved. The turn happens at the new vertex.

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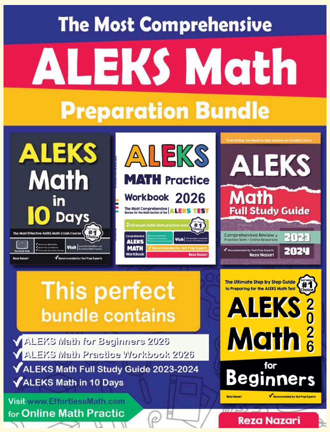

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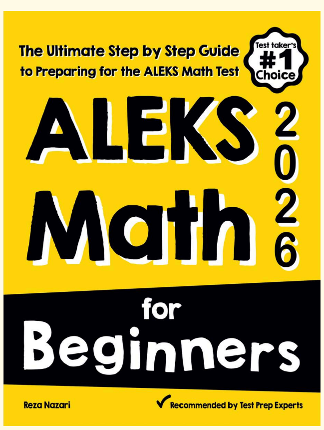

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