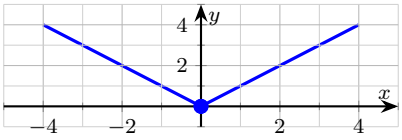
Piecewise Functions

Name: _____ Date: _____ Score: _____ / 28

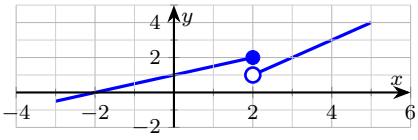
Quick Review

A **piecewise function** uses different rules on different intervals of the domain. The classic example is the absolute value: $|x| = x$ if $x \geq 0$, and $|x| = -x$ if $x < 0$. Two rules, glued together at $x = 0$ (shown below).



How to evaluate. Find which interval the input belongs to, then apply that piece's rule. For $f(x) = \begin{cases} 2x+1, & x < 2 \\ x^2, & x \geq 2 \end{cases}$, $f(0)$ uses the first rule (since $0 < 2$): $f(0) = 1$. $f(2)$ uses the second rule (since $2 \geq 2$): $f(2) = 4$. The choice at the boundary point depends on which inequality is non-strict.

Reading a piecewise graph. A **closed dot** means the function value at that x *is* the marked y; an **open dot** means the function value at that x is *not* that y (it's wherever the closed dot is, or undefined). At each break point, exactly one dot should be closed — otherwise the function isn't well-defined there. Example with a jump:



Continuity at a break. A piecewise function is continuous at $x = c$ if the two pieces agree there. Otherwise there's a jump (as above) or a hole (one piece left out). Common traps: forgetting to flip the inequality side; reading the open dot as the value; assuming continuity when the heights don't match.

PRACTICE

Evaluate or interpret each piecewise function. Watch the boundary cases.

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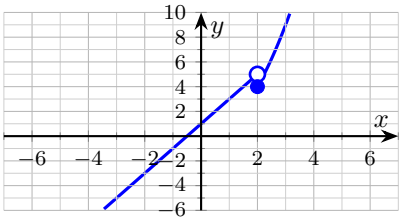
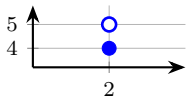
1. $f(x) = \begin{cases} 2x+1 & x < 2 \\ x^2 & x \geq 2 \end{cases}$. Find $f(0)$. _____



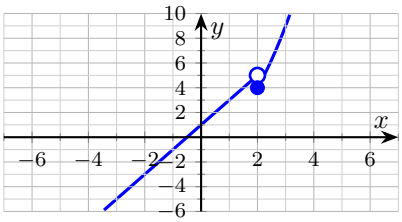
Closeup of the break at $x = 2$:



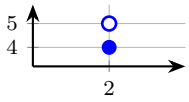
Input table. Evaluate each x-value.

x	-2	-1	0	1
$f(x)$	0	1	0	1

2. Same f. Find $f(2)$. _____



Closeup at $x = 2$:



Input table. Evaluate each x-value.

x	-3	-1	0	2
$g(x)$	-5	-1	2	6

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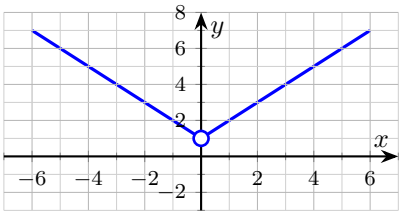
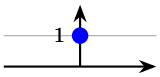
3. $g(x) = \begin{cases} -x+1 & x \leq 0 \\ x+1 & x > 0 \end{cases}$. Find $g(-3)$. _____



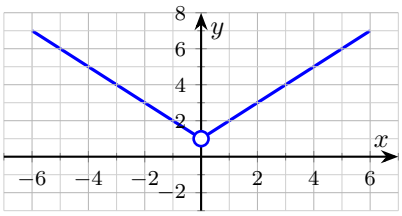
Closeup at $x = 0$:



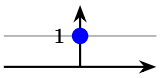
Input table. Evaluate each x-value.

x	-2	0	1	3
$h(x)$	4	0	1	9

4. Same g. Find $g(5)$. _____



Closeup at $x = 0$:

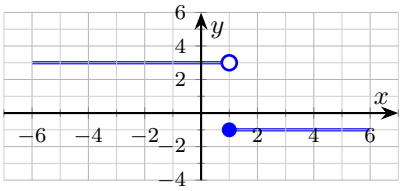


Input table. Evaluate each x-value.

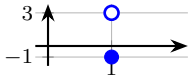
x	-4	-2	1	2
$p(x)$	1	3	3	4

Scan Me

5. $h(x) = \begin{cases} 3 & x < 1 \\ -1 & x \geq 1 \end{cases}$. Find $h(1)$. _____



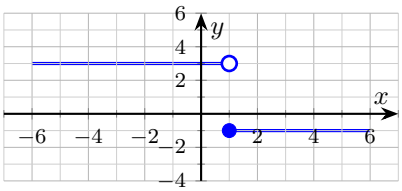
Closeup at $x = 1$:



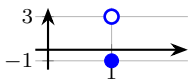
Input table. Evaluate each x-value.

x	-1	0	2	4
$q(x)$	-2	0	4	8

6. Same h. Find $h(0)$. _____



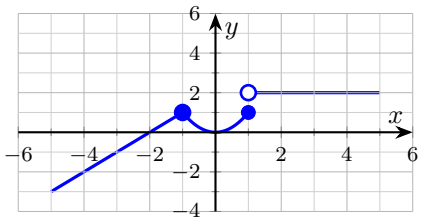
Closeup at $x = 1$:



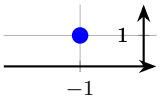
Input table. Evaluate each x-value.

x	-3	-2	0	2
$r(x)$	6	4	0	2

7. $f(x) = \begin{cases} x+2 & x < -1 \\ x^2 & -1 \le x \le 1 \\ 2 & x > 1 \end{cases}$. Find $f(-2)$. _____



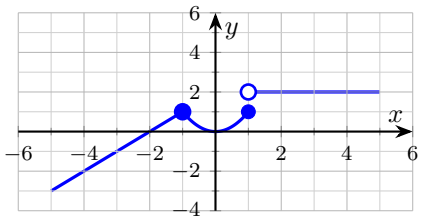
Closeup at $x = -1$:



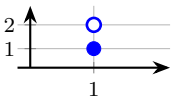
Input table. Evaluate each x-value.

x	-2	1	2	5
$s(x)$	-1	2	5	11

8. Same three-piece f. Find $f(0)$. _____



Closeup at $x = 1$:

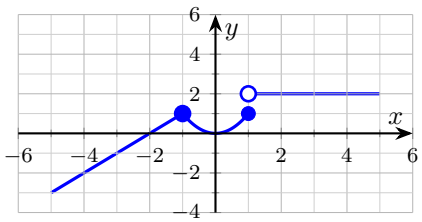


Input table. Evaluate each x-value.

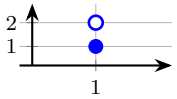
x	-5	-1	0	3
$t(x)$	2	2	-1	8

Scan Me

9. Same three-piece f. Find $f(3)$. _____



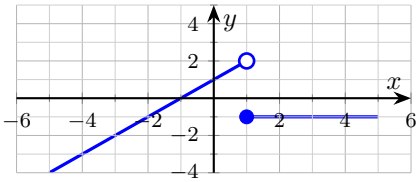
Closeup at $x = 1$:



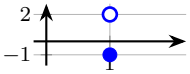
Input table. Evaluate each x-value.

x	-4	-2	1	4
$u(x)$	16	4	-2	1

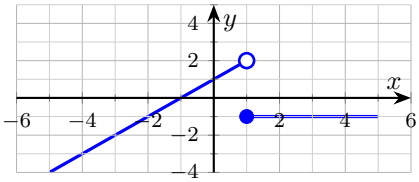
10. Read $f(1)$ from the graph below. _____



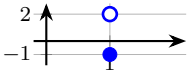
Closeup at $x = 1$:



11. Read $f(-2)$ from the graph below. _____



Closeup at $x = 1$:



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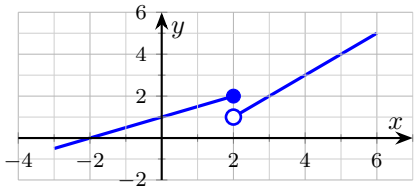
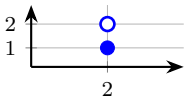
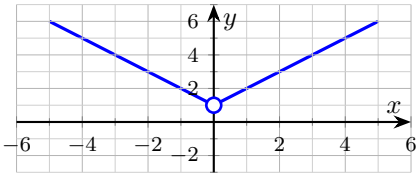
12. Is the function below continuous at $x = 2$? _____



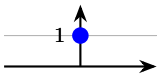
Closeup at $x = 2$:



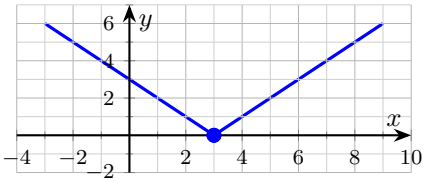
13. Is the function below continuous at $x = 0$? _____



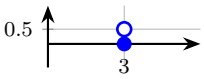
Closeup at $x = 0$:



14. For $f(x) = |x - 3|$, write the piecewise form (no absolute value bars). _____



Closeup at vertex $x = 3$:



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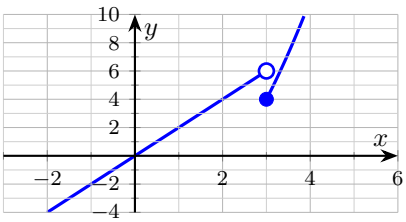
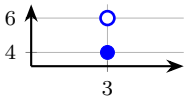
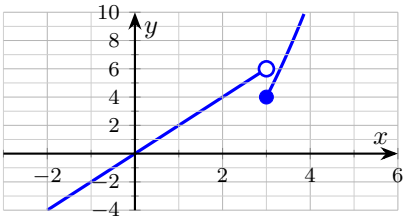
15. Find $f(4)$: $f(x) = \begin{cases} 2x & x < 3 \\ x^2 - 5 & x \geq 3 \end{cases}$.



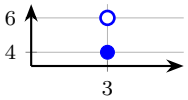
Closeup at $x = 3$:



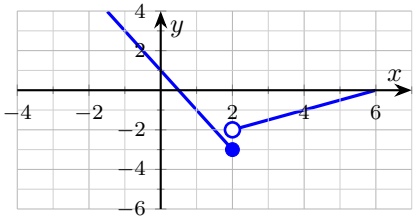
16. Same f. Find $f(1)$.



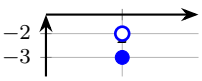
Closeup at $x = 3$:



17. From the graph, find $f(0)$ and $f(2)$.



Closeup at $x = 2$:



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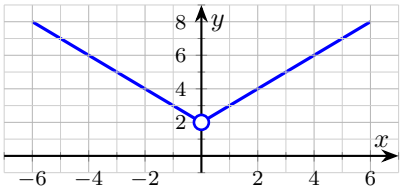
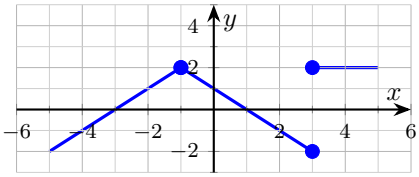
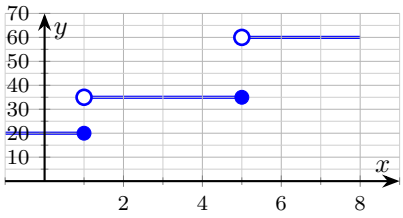
18. For the absolute-value function $f(x) = |x| + 2$, find $f(-5)$ from its piecewise form. _____



19. Read off the value of f at $x = -1$ from the graph. _____

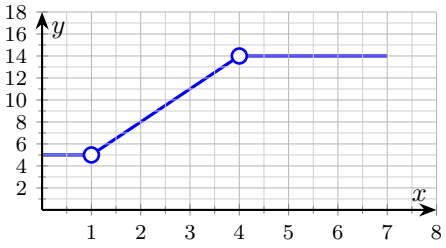


20. For the step-priced cell plan: $P(t) = \begin{cases} 20 & t \le 1 \\ 35 & 1 < t \le 5 \\ 60 & t > 5 \end{cases}$, find $P(3)$. _____



♦ Word Problems

21. A parking garage charges according to $P(h) = \begin{cases} 5 & 0 < h \le 1 \\ 5 + 3(h-1) & 1 < h \le 4 \\ 14 & h > 4 \end{cases}$ dollars, where h is hours parked. Compute $P(2.5)$ and explain. ____



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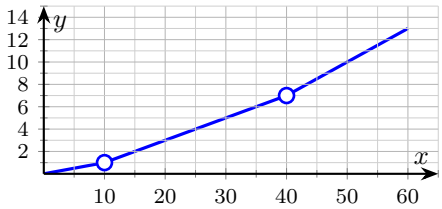
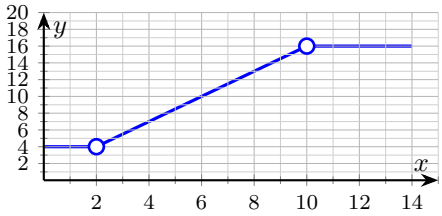
22. Federal income tax on a single filer's *taxable* income (simplified):

$$T(I) = \begin{cases} 0.10I & 0 \le I \le 10{,}000 \\ 1{,}000 + 0.20(I - 10{,}000) & 10{,}000 < I \le 40{,}000 \\ 7{,}000 + 0.30(I - 40{,}000) & I > 40{,}000 \end{cases}$$

Find $T(25{,}000)$. ____

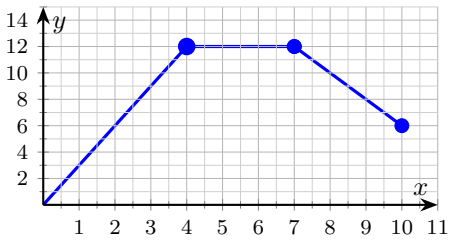


23. A shipping company's per-package fee: $F(w) = \begin{cases} 4 & 0 < w \le 2 \\ 4 + 1.50(w - 2) & 2 < w \le 10 \\ 16 & w > 10 \end{cases}$ dollars, where w is weight in pounds. Find the fee for a 7-pound package. ____



24. An object's velocity (in meters/second) during a 10-second motion is $v(t) = \begin{cases} 3t & 0 \le t < 4 \\ 12 & 4 \le t \le 7 \\ 12 - 2(t - 7) & 7 < t \le 10 \end{cases}$. ____

Find $v(2)$, $v(5)$, and $v(9)$, and sketch the motion.



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 $f = x + 1$, $g = 2x - 5$. _____

Scan Me

Answer Keys

1. $\boxed{1}$
2. $\boxed{4}$
3. $\boxed{4}$
4. $\boxed{6}$
5. $\boxed{-1}$
6. $\boxed{3}$
7. $\boxed{0}$
8. $\boxed{0}$
9. $\boxed{2}$
10. $\boxed{-1}$
11. $\boxed{-1}$
12. $\boxed{\text{no (jump)}}$
13. $\boxed{\text{yes}}$
14. $\boxed{\begin{cases} -(x-3) & x < 3 \\ x-3 & x \geq 3 \end{cases}}$
15. $\boxed{11}$
16. $\boxed{2}$
17. $\boxed{f(0) = 1,\ f(2) = -3}$
18. $\boxed{7}$
19. $\boxed{2}$
20. $\boxed{\$35}$
21. $\boxed{P(2.5) = \$9.50}$
22. $\boxed{T(25{,}000) = \$4{,}000}$
23. $\boxed{\$11.50}$
24. $\boxed{v(2) = 6,\ v(5) = 12,\ v(9) = 8 \text{ m/s}}$

Additional Practice Answers

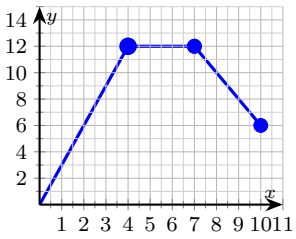
25. $\boxed{3}$
26. $\boxed{10}$
27. $\boxed{x = 4}$
28. $\boxed{3x - 4}$

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: $0 < 2$, so use the first piece: $f(0) = 2(0) + 1 = 1$. (Open dot at $(2, 5)$ shows that line's $y = 5$ is NOT the value at $x = 2$; the closed dot at $(2, 4)$ gives $f(2) = 4$.) That gives a quick check on the answer.
2. Keep the rule visible: $2 \geq 2$, so use the second piece: $f(2) = 4$. This is the part to check before moving on, because it keeps the answer tied to the original question.
3. One steady path is: $-3 \leq 0$: use $-x+1$. $g(-3) = 3+1 = 4$. The two pieces meet at $(0, 1)$ — continuous. That gives a quick check on the answer.
4. Start with the key idea: $5 > 0$: use $x + 1$. $g(5) = 6$. This is the part to check before moving on, because it keeps the answer tied to the original question.
5. A careful way to see it: $1 \geq 1$, so use the second piece: $h(1) = -1$. Step function with a jump at $x = 1$. That gives a quick check on the answer.
6. Keep the rule visible: $0 < 1$, so use the first piece: $h(0) = 3$. This is the part to check before moving on, because it keeps the answer tied to the original question.
7. One steady path is: $-2 < -1$: use $x+2$. $f(-2) = 0$. This is the part to check before moving on, because it keeps the answer tied to the original question.
8. Start with the key idea: $-1 \leq 0 \leq 1$: use x^2. $f(0) = 0$. This is the part to check before moving on, because it keeps the answer tied to the original question.
9. A careful way to see it: $3 > 1$: use the constant piece. $f(3) = 2$. This is the part to check before moving on, because it keeps the answer tied to the original question.
10. At $x = 1$: open dot at $(1, 2)$ is not the value; closed dot at $(1, -1)$ is. So $f(1) = -1$.
11. One steady path is: $-2 < 1$: use the slanted line $x + 1$. $f(-2) = -1$. This is the part to check before moving on, because it keeps the answer tied to the original question.
12. Left piece reaches $(2, 2)$; right piece starts at $(2, 1)$ with an open dot. Heights don't match — jump discontinuity.
13. A careful way to see it: Both pieces meet at $(0, 1)$ — the V shape of $|x| + 1$. This is the part to check before moving on, because it keeps the answer tied to the original question.
14. Keep the rule visible: $|x-3|$ is $x-3$ when $x \geq 3$, and $-(x-3)$ when $x < 3$. Vertex at $(3, 0)$. That gives a quick check on the answer.
15. One steady path is: $4 \geq 3$: use $x^2 - 5$. $f(4) = 16 - 5 = 11$. This is the part to check before moving on, because it keeps the answer tied to the original question.
16. Start with the key idea: $1 < 3$: use $2x$. $f(1) = 2$. This is the part to check before moving on, because it keeps the answer tied to the original question.
17. At $x = 0$ use the steeper line: $-2(0) + 1 = 1$. At $x = 2$ the closed dot at $(2, -3)$ gives the value.
18. Keep the rule visible: $f(x) = |x| + 2 = \begin{cases} -x+2 & x < 0 \\ x+2 & x \geq 0 \end{cases}$. At $x = -5$: $f(-5) = -(-5) + 2 = 7$. That gives a quick check on the answer.
19. One steady path is: Both pieces meet at $(-1, 2)$ — one closed dot is enough. Reading: $f(-1) = 2$. That gives a quick check on the answer.
20. Start with the key idea: $1 < 3 \leq 5$: use the middle piece. $P(3) = 35$. This is the part to check before moving on, because it keeps the answer tied to the original question.
21. Since $1 < 2.5 \leq 4$, use the middle piece: $P(2.5) = 5 + 3(2.5 - 1) = 5 + 3(1.5) = 5 + 4.50 = 9.50$. So 2.5 hours costs $\$9.50$. The graph shows the flat $\$5$ first hour, then a $\$3$-per-hour ramp to a ceiling of $\$14$. (Day maximum is $\$14$, no matter how long you stay.)
22. Keep the rule visible: $25{,}000$ sits in the middle bracket. $T(25{,}000) = 1{,}000 + 0.20(25{,}000 - 10{,}000) = 1{,}000 + 0.20(15{,}000) = 1{,}000 + 3{,}000 = 4{,}000$. So the tax is $\$4{,}000$. The graph is piecewise linear: slopes $0.10, 0.20, 0.30$ on the three pieces. (Plotted in thousands of dollars.) That gives a quick check on the answer.
23. One steady path is: $2 < 7 \leq 10$, so use the middle rule: $F(7) = 4 + 1.50(7 - 2) = 4 + 1.50(5) = 4 + 7.50 = 11.50$ dollars. The fee climbs at $\$1.50$ per pound between 2 and 10 pounds, then plateaus at $\$16$ for everything heavier. That gives a quick check on the answer.
24. Start with the key idea: $v(2)$: $0 \leq 2 < 4$, use $3t$. $v(2) = 6$. $v(5)$: $4 \leq 5 \leq 7$, use 12. $v(5) = 12$. $v(9)$: $7 < 9 \leq 10$, use $12 - 2(t - 7)$. $v(9) = 12 - 2(2) = 8$. Physical story: the object accelerates from rest to 12 m/s over four seconds, cruises at 12 m/s for three seconds, then decelerates back to 6 m/s by the end. The graph reflects that — ramp up, plateau, ramp down. That gives a quick check on the answer.

Answer graph



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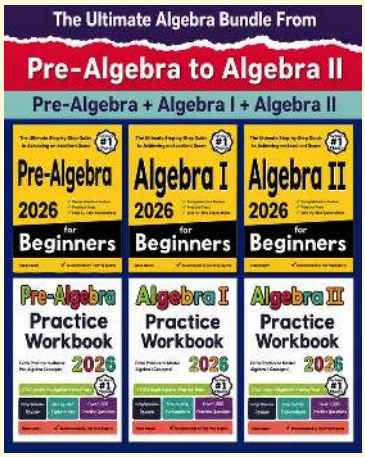

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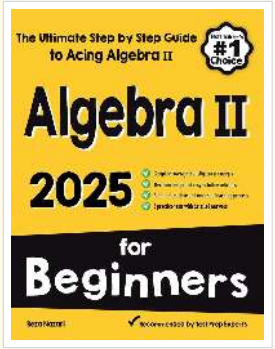

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