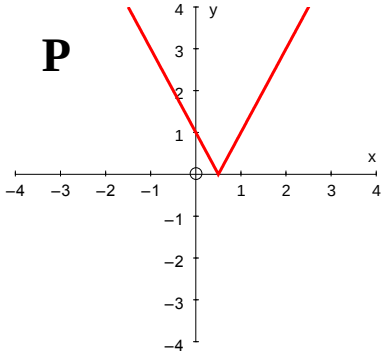
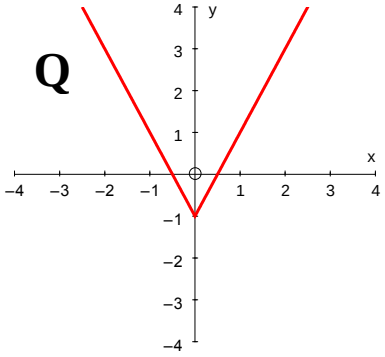
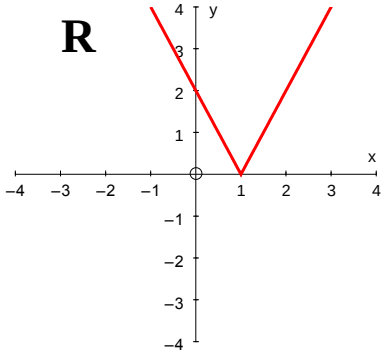
Section 3: The modulus function

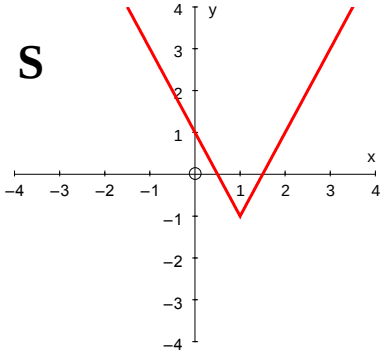
Section test

1. Four graphs are shown below.









Which graph shows the function $y = 2|x| - 1$?
Which graph shows the function $y = 2|x - 1| - 1$?
Which graph shows the function $y = |2x - 1|$?
Which graph shows the function $y = 2|x - 1|$?

2. The inequality $-3 < x < 5$ can be expressed as:

(a) $|x-4| > 1$ (b) $|x-4| < 1$

(c) $|x-1| > 4$ (d) $|x-1| < 4$

3. Solve the equation $|x-2| = 2x-3$.

4. Solve the equation $|2x+1| = x+3$.

5. Solve the equation $|3x-1| = |2x+3|$.

6. Solve the inequality $|2x+3| > 9$.

7. Solve the inequality $|x| \geq |2x-1|$.

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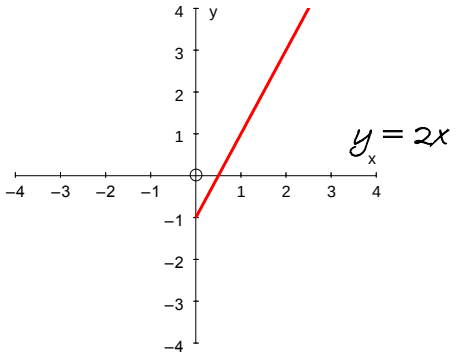
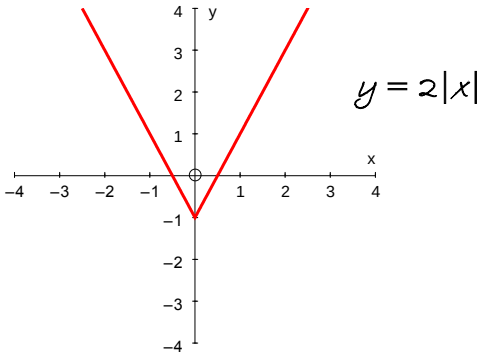
Solutions to section test

1. To sketch the graph of $y = 2|x| - 1$, first sketch the graph of $y = 2x - 1$ for positive values of x, and then reflect in the y-axis.

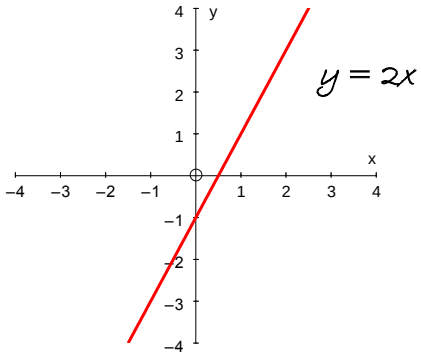


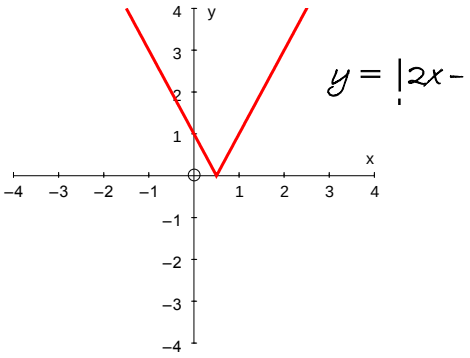


This is graph Q.

The graph of $y = 2|x - 1| - 1$ can be obtained by translating the graph of $y = 2|x| - 1$ (obtained in question 7) 1 unit horizontally to the right.
This is graph S.

To sketch the graph of $y = |2x - 1|$, first sketch the graph of $y = 2x - 1$, and then reflect negative parts in the x-axis.





This is graph P.

To obtain the graph of $y = 2|x - 1|$, start with the graph of $y = |x|$, translate 1 unit horizontally to the right, then stretch parallel to the y-axis, scale factor 2. This is graph R.

2. $-3 < x < 5$

$-3 - 1 < x - 1 < 5 - 1$

$-4 < x - 1 < 4$

$|x - 1| < 4$

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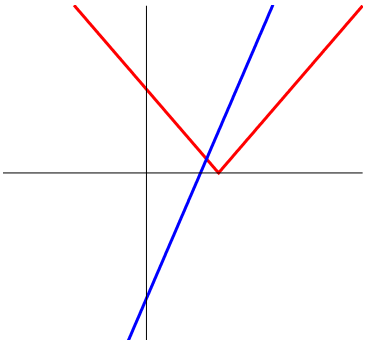
3. Sketch the graphs of $y = |x - 2|$ and $y = 2x - 3$:



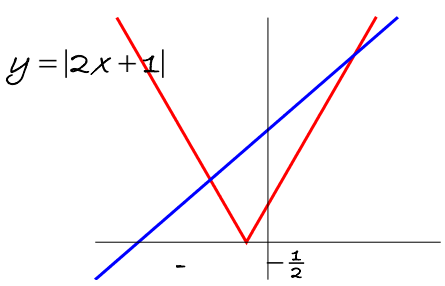
The graph shows that there is just one solution, and this is where $y = 2x - 3$ meets the part of $y = |x - 2|$ which has been reflected in the x-axis, so this is the line $y = 2 - x$.

At intersection, $2x - 3 = 2 - x$

$3x = 5$

$x = \frac{5}{3}$

4.



The graph shows that there are two solutions.

$2x + 1 = x + 3$

$x = 2$

$-(2x + 1) = x + 3$

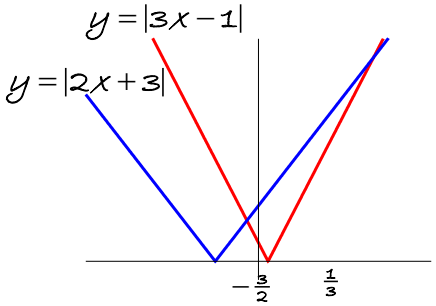
$-2x - 1 = x + 3$

$-4 = 3x$

$x = -\frac{4}{3}$

The solutions are $x = -\frac{4}{3}$ and $x = 2$.

5.



The graph shows that there are two solutions, both on the right-hand branch of

$y = |2x + 3|$.

$2x + 3 = 3x - 1$ $\qquad$ $2x + 3 = -(3x - 1)$

$4 = x$ $\qquad$ $2x + 3 = -3x + 1$

$5x = -2$

$x = -\frac{2}{5}$

The solutions are $x = -\frac{2}{5}$ and $x = 4$.

6. $|2x + 3| > 9$

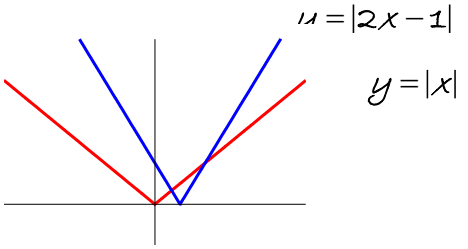
$2x + 3 > 9$ or $2x + 3 < -9$

$2x > 6$ $\qquad$ $2x < -12$

$x > 3$ $\qquad$ $x < -6$

The solution is $x < -6$ or $x > 3$.

7. $|x| \geq |2x - 1|$



There are two intersection points, both on the right-hand branch of $y = |x|$.

$x = 2x - 1$ $\qquad$ $x = -(2x - 1)$

$1 = x$ $\qquad$ $x = -2x + 1$

$3x = 1$

$x = \frac{1}{3}$

The solution of the inequality is the set of points for which the red graph lies above the blue graph.

This is $\frac{1}{3} \leq x \leq 1$.