Packet #2: Absolute Value Equations and Inequalities; Quadratic Inequalities; Rational Inequalities

Name:__________________________________________

Teacher:________________________________________

Pd: ______
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- **Day 3:** SWBAT: Solve and graph Quadratic Inequalities  
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- **Day 4:** SWBAT: Solve Rational Inequalities  
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**HW Answer Keys – Page 23 in Packet**
Day 1: Solving Absolute Value Equations

Warm – Up:

Simplify: \( | -5 | = \)

Simplify: \( | -10 | = \)

**Graphical Definition of Absolute Value:** The absolute value of a number is the number’s distance from zero on the number line.

![Number line](image)

**Examples:**

\[ | -5 | = \_ \quad | 5 | = \_ \quad | 0 | = \_ \]

Please note that “just making the inside positive” does no work when there are algebraic expressions inside the absolute value symbols.

**Examples:**

\[ | -2x | \quad | x + 5 | \quad | x - 5 | \]

*Does not always equal* 2x  \quad *Does not always equal* x + 5  \quad *Generally does not equal* x + 5
Example 1:
Determine, by inspection (this means just looking at what you have and figuring it out!) the TWO solutions to each of the following absolute value equations. Think about what values would have to be inside the absolute value symbol in order to make the statement true.

<p>| | | | |</p>
<table>
<thead>
<tr>
<th></th>
<th></th>
<th></th>
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</tr>
</thead>
<tbody>
<tr>
<td>a)</td>
<td>(</td>
<td>x</td>
<td>= 6)</td>
</tr>
<tr>
<td></td>
<td>({,})</td>
<td></td>
<td>({,})</td>
</tr>
<tr>
<td>c)</td>
<td>(</td>
<td>x + 1</td>
<td>= 4)</td>
</tr>
<tr>
<td></td>
<td>({,})</td>
<td></td>
<td>({,})</td>
</tr>
</tbody>
</table>

Solving Absolute Value Equations Algebraically

Step 1: ____________________________

Step 2: ____________________________

Step 3: ____________________________

Step 4: ____________________________

Example 2: What is the solution set of the equation \(|2x - 3| = 17\)?
Practice: What is the solution set of the equation $|4x - 2| = 10$?

Example 3: What is the solution set of the equation $|5n - 4| + 18 = 8$?
Example 4: What is the solution set of the equation $|2x + 5| = x + 4$?

Practice: What is the solution set of the equation $|4 - x| = 3x$?
Example 5: What is the solution set of the equation \(|y - 4| - 3y = 6|\)?

Practice: What is the solution set of the equation \(|x + 6| - 18 = 2x|\)?
Challenge:

Solve $|x - 3| = |x + 2|$

Summary:

Example: $2x - 1| + 3 = 4x$

\[
\begin{align*}
|2x - 1| + 3 &= 4x \\
-3 &= -3 \\
|2x - 1| &= 4x - 3 \\
\end{align*}
\]

Isolate the absolute value.

$2x - 1 = 4x - 3$

\[
\begin{align*}
\pm 1 &= \pm 1 \\
2x &= 4x - 2 \\
\end{align*}
\]

$-4x = -4x$

\[
\begin{align*}
\pm 2 &= \pm 2 \\
x &= \pm 2 \\
\end{align*}
\]

$\pm 3 = \pm 3$

$\pm 3 = \pm 3$

Check each in the ORIGINAL equation. Use parentheses around each substitution.

$2 - 1 = 4(1)$

$|2 - 1| + 3 = 4$

$1 + 3 = 4$

$|1| + 3 = 4$

$|\frac{1}{3}| + 3 = \frac{8}{3}$

$\frac{1}{3} + 3 = \frac{8}{3}$

$\frac{10}{3} = \frac{8}{3}$

REJECT

In this case, one solution gets rejected. The solution set is $\{4\}$.

Exit Ticket:

What is the solution set of $|4n + 8| = 16$?

(1) $\{-6\}$

(2) $\{2\}$

(3) $\{-6, 2\}$

(4) $\{\}$
Day 2: Solving Absolute Value Inequalities

Warm-Up:

Solve for $x$: $|2x - 6| - x = 3$.

(1) $x = 1$ or $x = 9$  (3) $x = 1$
(2) $x = 9$ or $x = -1$  (4) $x = 9$

Yesterday we discussed that the absolute value of a number is the number’s distance from zero on the number line.

So, $|a|$ is defined as the distance from $a$ to 0.

$|x| < 4$  $|x| > 4$

So,

Use these facts to solve:

- Less Than
  - Re-write as a compound AND statement
  - Interval and Graph will be between two numbers

- Greater Than
  - Re-write as an OR statement
  - Interval and Graph will be Union of two sets
Solve and graph each of the following inequalities:

Example 1: $|2x + 3| < 7$

<table>
<thead>
<tr>
<th>Step 1: Is the absolute value isolated?</th>
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<tbody>
<tr>
<td>Step 2: Is the number on the other side negative?</td>
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<td>Step 3: Set up a compound inequality</td>
</tr>
<tr>
<td>Step 4: Solve the compound inequality and graph.</td>
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Example 2: $\left| \frac{n}{2} - 4 \right| \geq 3$

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</table>
Solve and graph each of the following inequalities:

Practice: \(|x - 2| > 7\)

\[ \left| \frac{5d + 2}{3} \right| \leq 4 \]
Solve and graph each of the following inequalities:

Example 3:  $7 + |x - 2| < 18$

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Example 2: $-2|3x + 2| \geq -16$

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<th>Step 4:</th>
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</table>
Solve and graph each of the following inequalities:

Practice: \(-3|x - 8| < 24\)

\[4 + |3m - 6| < 22\]
Special Cases:
  o If the **Absolute value** is greater than a negative number
    o This is ALWAYS TRUE
    o Solution is \((-\infty, \infty)\) or All Real Numbers

\[|3x - 4| + 9 > 5\]

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<td></td>
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  o If the **Absolute value** is less than zero
    o This is NEVER TRUE
    o No Solution or \{ \}

\[|5x + 6| + 4 < 1\]

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**Challenge**
Solve and graph the following inequality.

\[ x^2 - x - 12 \geq 0 \]

**Summary:**

**Example:**  \[ |2x - 1| \leq 5 \]

\[
|2x - 1| = 5
\]

\[
\begin{align*}
2x - 1 &= 5 \\
x &= 3 \\
\text{YES} \\
\hline
2x - 1 &= -5 \\
x &= -2 \\
\text{NO}
\end{align*}
\]

1. **PRETEND** the problem is an absolute value equation. This gives you the **BOUNDARY POINTS** of the solution set. (Do not check... I will not give you a problem that doesn’t “work”)

2. **Graph** these boundary points on a number line.

3. **Pick ANY value in EACH REGION** of the number line and test it in the **ORIGINAL** inequality. If it is true, put a check. If it is false, put an “X”.

4. **The solution set** is where the “yes” is/are. Graph it, and write the solution set using **AND** or **OR** notation, whichever is appropriate for the problem.

5. **Use open circles for <** and **closed circles for \( \leq \).**

**Exit Ticket**

Which is the graph of the solution set of \[ |10x - 20| \geq 30? \]

(1) ![Graph 1](image1)  
(2) ![Graph 2](image2)  
(3) ![Graph 3](image3)  
(4) ![Graph 4](image4)
**Warm-Up:**

The solution set of \(|8x - 4| > 20\) is

1. \(|x| \quad x < -2 \text{ or } x > 3\)
2. \(|x| \quad x < -3 \text{ or } x > 2\)
3. \(|x| \quad -2 < x < 3\)
4. \(|x| \quad -3 < x < 2\)

---

**Solving Quadratic inequalities by factoring**

Set the quadratic to 0, with the 0 on the RIGHT side of the inequality.

Factor the quadratic and solve it.

- If the inequality is < or ≤, then the solution set is all of the values BETWEEN the roots.
  
  \[ \text{root}_1 < x < \text{root}_2 \]
  \[ \text{root}_1 \leq x \leq \text{root}_2 \]

- If the inequality is >, then the solution set is all of the values OUTSIDE OF the roots.
  
  \[ x < \text{root}_1 \quad \text{OR} \quad x > \text{root}_2 \]
  \[ x \leq \text{root}_1 \quad \text{OR} \quad x \geq \text{root}_2 \]

Example: What is the solution set of the inequality \(-2x^2 + 3x + 5 > 0\) ?

\[-2x^2 + 3x + 5 > 0\]
\[-1(2x^2 - 3x - 5) > 0\]
\[2x^2 - 3x - 5 < 0\]
\[(2x - 5)(x + 1) < 0\]

*roots are \(\frac{5}{2}\) and \(-1)\]

\(|x| \quad -1 < x < 2.5\)

*Quadratic Inequalities are solved and graphed almost exactly like absolute value inequalities.*
Find the solution set for the inequality and graph the solution set.

\[ x^2 - 2x - 15 < 0 \]

**Step 1:** Is the quadratic inequality in standard form?

**Step 2:** Factor the quadratic and solve the quadratic for the roots. These will be the *critical* points.

**Step 3:** Is the inequality a conjunction or a disjunction?

**Step 4:** Write your answer

**Practice:** Find the solution set for the inequality and graph the solution set.

\[ x^2 + 6x + 8 \geq 0 \]
$x^2 - 2x - 20 > 4$

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<th>Step 1: Is the quadratic inequality in standard form?</th>
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**Practice:** Find the solution set for the inequality and graph the solution set.

$x^2 - 3x - 3 \leq 7$
$2x^2 > -7x - 3$

<table>
<thead>
<tr>
<th>Step 1: Is the quadratic inequality in standard form?</th>
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</table>

Practice: Find the solution set for the inequality and graph the solution set.
$3x^2 > -4x - 1$
Regents Questions/Exit Ticket

1. The solution set for the inequality $x^2 + 4x - 5 \geq 0$ is

1) $-5 \leq x \leq 1$
2) $x \leq -1$ or $x \geq 5$
3) $x \leq -5$ or $x \geq 1$
4) $-1 \leq x \leq 5$

2. What is the solution set for the inequality $x^2 - 2x - 3 \leq 0$?

1) $-2 \leq x \leq 3$
2) $x \leq -2$ or $x \geq 3$
3) $x \leq -3$ or $x \geq 2$
4) $-3 \leq x \leq 2$

Challenge:
Solve and Graph: $\frac{3}{x - 2} \leq -1$

Summary:

| $x^2 - x - 6 < 0$ | $x - 3 < 0$ AND $x + 2 > 0$
| $(x - 3)(x + 2) < 0$ | $x < 3$ AND $x > -2$

For the product of these binomials to be negative, either:
1. $(x - 3)$ must be negative AND $(x + 2)$ must be positive; or
2. $(x - 3)$ must be positive AND $(x + 2)$ must be negative

CASE 1
The answer is the first case, $-2 < x < 3$.
The second case is not possible, as $x$ cannot be both greater than 3 and less than -2.

CASE 2

Key Concept
If the quadratic is $ax^2 + bx + c < 0$, then the solution set is \(x|r_1 < x < r_2\)
If the quadratic is $ax^2 + bx + c \leq 0$, then the solution set is \(x|r_1 \leq x \leq r_2\)
If the quadratic is $ax^2 + bx + c > 0$, then the solution set is \(x|x < r_1 \text{ or } x > r_2\)
If the quadratic is $ax^2 + bx + c \geq 0$, then the solution set is \(x|x \leq r_1 \text{ or } x \geq r_2\)
**Day 4: Solving Rational Inequalities**

**Warm – Up:**
Which graph represents the solution of the inequality $x^2 - x - 6 \geq 0$?

1) ![Graph 1]
2) ![Graph 2]
3) ![Graph 3]
4) ![Graph 4]

*** Inequalities are usually solved with the same procedures that are used to solve equations.
***Remember that we divide or multiply by a negative number, the inequality is reversed.

**Example 1:** Solving Simple Rational Inequalities (No Variable in Denominator)

\[- \frac{17}{8} > \frac{1}{2} - \frac{3v}{2}\]

<table>
<thead>
<tr>
<th>Step 1: Is there a variable in your denominator?</th>
</tr>
</thead>
<tbody>
<tr>
<td>Step 2: Find the LCD of your denominators</td>
</tr>
<tr>
<td>LCD =</td>
</tr>
<tr>
<td>Step 3: Multiply each term by the LCD</td>
</tr>
<tr>
<td>Step 4: Solve the inequality.</td>
</tr>
</tbody>
</table>
Practice: Solve the Inequalities below.

Practice 1: \( \frac{5}{3} + \frac{p}{3} \leq \frac{23}{12} \)

Practice 2: \( \frac{x + 7}{8} \geq \frac{x - 3}{10} \)
Example 2: Solving Rational Inequalities (Variables in Denominator)

Solve and Graph the following inequality: \( \frac{x+1}{x-5} \leq 0 \)

<table>
<thead>
<tr>
<th>Step 1: Is there a variable in your denominator?</th>
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</thead>
<tbody>
<tr>
<td>Step 2: Write the inequality in the correct form. <strong>One side must be zero</strong> and the other side can have only one fraction, so simplify the fractions if there is more than one fraction.</td>
</tr>
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<td>Step 3: Find the key or critical values. To find the key/critical values, set the numerator and denominator of the fraction equal to zero and solve.</td>
</tr>
<tr>
<td>Step 4: Make a sign analysis chart. To make a sign analysis chart, use the key/critical values found in Step 2 to divide the number line into sections.</td>
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<td>Step 5: Perform the sign analysis. To do the sign analysis, pick one number from each of the sections created in Step 3 and plug that number into the polynomial to determine the sign of the resulting answer.</td>
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<td>Step 6: Use the sign analysis chart to determine which sections satisfy the inequality.</td>
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<td>Step 7: Write the final answer.</td>
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Example 3: Solve and Graph the following inequality: \( \frac{x}{x-4} - \frac{3}{x-4} \leq 2 \)

<table>
<thead>
<tr>
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Example 4: Solve and Graph the following inequality: \(6 - \frac{5}{p+2} > 2 - \frac{9}{p+2}\)

<table>
<thead>
<tr>
<th>Step 1:</th>
<th>Is there a variable in your denominator?</th>
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**Example 5:** Solve and Graph the following inequality: $\frac{x-8}{x} \leq 3 - x$

<table>
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Summary:
Solve, graph the solution, and express the solution in interval notation.

\[
\frac{3x + 1}{x - 1} \geq 2
\]

<table>
<thead>
<tr>
<th>Step 1: Write the inequality in the correct form. One side must be zero and the other side can have only one fraction, so simplify the fractions if there is more than one fraction.</th>
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</table>
| \[
\frac{3x + 1}{x - 1} - 2 \geq 0
\]
| \[
\frac{3x + 1 - 2(x - 1)}{x - 1} \geq 0
\]
| \[
\frac{3x + 1 - 2x + 2}{x - 1} \geq 0
\]
| \[
\frac{x + 3}{x - 1} \geq 0
\] |

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| \[
x + 3 = 0 \quad \text{and} \quad x - 1 = 0
\]
| \[
x = -3 \quad \quad x = 1
\] |

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<td><img src="chart.png" alt="Sign Analysis Chart" /></td>
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<tr>
<td><img src="table.png" alt="Sign Analysis Table" /></td>
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</table>

<table>
<thead>
<tr>
<th>Step 5: Use the sign analysis chart to determine which sections satisfy the inequality. In this case, we have greater than or equal to zero, so we want all of the positive sections. Notice that (x \neq 1) because it would make the original problem undefined, so you must use an open circle at (x = 1) instead of a closed circle to draw the graph.</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="graph.png" alt="Graph" /></td>
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</table>

<table>
<thead>
<tr>
<th>Step 6: Use interval notation to write the final answer.</th>
</tr>
</thead>
<tbody>
<tr>
<td>((\infty, -3] \cup (1, \infty))</td>
</tr>
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</table>
HOMEWORK ANSWERS
Day 1/2 HW Answers:

1-4 Solving Absolute Value Equations and Inequalities (pages 16–17)

Developing Skills

3. \{-7, 17\}  
4. \{-2, -14\}  
5. \{-1, 6\}  
6. \{-3, 7\}  
7. \{1, 7\}  
8. \{3, -4\}  
9. \{5, 9\}  
10. \{3, -3\}  
11. \{2, -10\}  
12. \{-3, 8\}  
13. \emptyset  
14. \{-3, 17\}

15. \(x < -9\) or \(x > 9\),
   \(\{\ldots, -12, -11, -10, 10, 11, 12, \ldots\}\)
16. \(x < -9\) or \(x > 5\), \(\{\ldots, -12, -11, -10, 10, 6, 7, 8, \ldots\}\)
17. \(-11 \leq b \leq -1\), \(\{-11, -10, -9, \ldots, -3, -2, -1\}\)
18. \(-1 < y < 7\), \(\{0, 1, 2, 3, 4, 5, 6\}\)
19. \(y < -19\) or \(y > 7\),
   \(\{\ldots, -22, -21, -20, 8, 9, 10, \ldots\}\)
20. \(b \leq -1\) or \(b \geq 8\), \(\{\ldots, -3, -2, -1, 8, 9, 10, \ldots\}\)
21. \(-3 < x < 7\), \(\{-2, -1, 0, 1, 2, 3, 4, 5, 6\}\)
22. The set of integers
23. \(0 < b < 10\), \(\{1, 2, 3, 4, 5, 6, 7, 8, 9\}\)
24. \(b < -3\) or \(b > 14\), \(\{\ldots, -6, -5, -4, 15, 16, 17, \ldots\}\)
25. \emptyset
26. \(-3 \leq b \leq 17\), \(\{-3, -2, -1, \ldots, 15, 16, 17\}\)
27. \(\{253, 254, 255, 256, 257, 258, 259\}\), \(253 \leq x \leq 259\)
28. \(\{150, 151, 152, 153, \ldots, 297, 298, 299, 300\}\)
   \(150 \leq t \leq 300\)
29. \(|c - 200| \leq 28\), solution = \(172 \leq c \leq 228\),
   \(\{172, 173, 174, \ldots, 226, 227, 228\}\)

3-1 The Real Numbers and Absolute Value (page 83)

In 15–26, answers will be graphs of number lines.

15. \(-7 < x < 7\)  
16. \(a \geq 8\) or \(a \leq 2\)  
17. \(y > 2\) or \(y < -7\)  
18. \(-1 \leq b \leq 2\)  
19. \(a < -9\) or \(a > -1\)  
20. \(-4 < x < 2\)  
21. \(x > \frac{2}{5}\) or \(x < -\frac{1}{5}\)  
22. \(\{\}\) or \(\emptyset\)  
23. all real numbers  
24. \(x = \frac{-4}{5}\)  
25. all real numbers  
26. all real numbers
Day 3 Answers:

1-8 Quadratic Inequalities (page 35)

Developing Skills
3. \(-3 < x < -2, \emptyset\)
4. \(x < -6 \text{ or } x > 1, \{ \ldots, -9, -8, -7, 2, 3, 4, \ldots \}\)
5. \(1 \leq x \leq 2, \{1, 2\}\)
6. \(x < 2 \text{ or } x > 5, \{ \ldots, -1, 0, 1, 6, 7, 8, \ldots \}\)
7. \(-2 < x < 3, \{-1, 0, 1, 2\}\)
8. \(x \leq -2 \text{ or } x \geq 10, \{ \ldots, -4, -3, -2, 10, 11, 12, \ldots \}\)
9. \(-4 < x < 3, \{-3, -2, -1, 0, 1, 2\}\)
10. \(x < 1 \text{ or } x > 5, \{ \ldots, -2, -1, 0, 6, 7, 8, \ldots \}\)
11. \(x \leq 0 \text{ or } x \geq 2, \{ \ldots, -2, -1, 0, 2, 3, 4, \ldots \}\)
12. \(-2 < x < 3, \{-1, 0, 1, 2\}\)
13. \(x < 2 \text{ or } x > 2, \{ \ldots, -1, 0, 1, 3, 4, 5, \ldots \}\)
14. The set of integers
15. \(-2 < x < 1, \{-1, 0\}\)
16. \(-3 \leq x \leq 4, \{-3, -2, -1, 0, 1, 2, 3, 4\}\)
17. \(x < -3 \text{ or } x > 4, \{ \ldots, -6, -5, -4, 5, 6, 7, \ldots \}\)

Day 4 Answers:

2-8 Solving Rational Inequalities (pages 73–74)

3. \(a < -24\)
4. \(y < 8\)
5. \(b > \frac{2}{3}\)
6. \(d < 2\)
7. \(a > \frac{153}{5}\)
8. \(0 < x < 1\)
9. \(0 < y < 4\)
10. \(a < -2 \text{ or } a > -1\)
11. \(\frac{5}{3} < x < 4\)
12. \(x < 0 \text{ or } x > \frac{1}{2}\)
13. \(-7 < x < -5\)
14. \(-5 < a < -1\)