Two-step Inequality Practical Problems

Strand: Patterns, Functions, and Algebra

Topic: Write verbal sentences as algebraic inequalities, and vice versa. Solve practical problems involving two-step linear inequalities in one variable.

Primary SOL: 7.13 The student will solve one- and two-step linear inequalities in one variable, including practical problems, involving addition, subtraction, multiplication, and division, and graph the solution on a number line.

Related SOL: 7.12

Materials

- Situations with Inequalities activity sheet (attached)
- Number Line activity sheet (attached)
- Inequalities and Properties activity (attached)
- Round hard candies
- Roll candies
- Pieces of licorice
- Dry-erase markers

Vocabulary

equation, expression, greater than, greater than or equal to, inequality, inverse operations, less than, less than or equal to, one-step equation, order of operations, properties, variable (earlier grades)

two-step equation (7.12)

algebraic equation, algebraic expression, at most, at least, maximum, minimum, no more than, numerical expression, variable expression, verbal expression, verbal sentence (7.13)

Student/Teacher Actions: What should students be doing? What should teachers be doing?

Note: Before the lesson, laminate the Number Line activity sheet.

1. Present students with the following situation: "Kirk has a B in his mathematics class. Name the percent that could be Kirk's grade." Have students write down at least three possible percentages for Kirk's grade.
2. As a group, have the students share possible percentages and make a record of them on the board or using a document tool (e.g., document camera, digital display). Possible statements may be between 80–89 (for students on a 10-point grading scale). Write g = 80 next to answers and ask the students if this is sufficient to describe all of the grades that represent Kirk's grade. Ask them whether he could have a grade of 81.7, or 82½, etc.
3. Review with students the four inequality symbols. Distribute the Situations with Inequalities activity sheet. As a group, discuss each scenario, and guide students through writing an inequality for each situation. Be sure to emphasize the key words in each

sentence and what inequality symbol they represent (maximum, minimum, no more than, at most, and at least). Then go back to Kirk's grade and have the students write an inequality to represent his grade algebraically and in words.

4. Display the equation $3x - 4 = 8$, and have students work individually to solve it. Discuss the solution to the equation. Then, change the equal sign to a less than sign, $3x - 4 < 8$. Have students discuss with partners how this change affects the solution.
5. Model how to solve the inequality. Have each student select a possible solution and check it. List all possible solutions on the board, and lead a discussion about how to represent all possible solutions to this inequality.
6. Distribute the laminated Number Line activity sheet, one round hard candy to represent a closed circle, one roll candy to represent an open circle, and one piece of licorice to represent the shaded section of the number line. Display various inequalities for students to solve (e.g., $13 < 1 + 6x$, $3x + 5 \leq 20$, $5 \underline{<} 2x - 3$). As the problems are being solved, discuss the properties of inequalities. After they have solved the inequalities, have them graph their answers on their number lines, using the two candies and a piece of licorice. Students may use the dry-erase marker to label each number line. They may also use the white space below the number line to work out each inequality. Walk around and check their solutions and number line graphs.
7. Introduce dividing by a negative with this series of questions:
    - $4 < 8$. Is this true?
    - Add 2 to both sides (now $6 < 10$). Is it still true? YES
    - Subtract 2 from both sides (now $2 < 6$). Is it still true? YES
    - Subtract 9 from both sides (now $-5 < -1$). Is it still true? YES
    - Multiply by 3 on both sides. (now $12 < 24$). Is it still true? YES
    - Multiply by ½ on both sides (now $2 < 4$). Is it still true? YES
    - Divide by 4 on both sides (now $1 < 2$). Is it still true? YES
    - Multiply by –5 on both sides. (now $-20 < -40$). Is it still true? NO
    - Divide by –2 on both sides, (now $-2 < -4$). Is it still true? NO
    - Can you make up a rule about multiplying and dividing by negatives?
9. Give students the inequality $-3x \geq 9$ to solve. Observe how the students solve this inequality based on the previous discussion. Have the students solve the problem again if they did not get it correct the first time, flipping the sign when they divide by –3. After they have solved the inequality, have them graph their answers on their number lines, using the candies and licorice. Repeat with more examples that require changing the sign (e.g., $13 < -6x + 1$, $-3x + 5 \leq 20$)
10. Distribute the Inequalities and Properties Sheet for additional student practice on applying properties.

Assessment

- **Questions**
    - When do you have to change the sign in an inequality to solve it? Why?
    - How is the solution to an inequality different from that of an equation?

- **Journal/writing prompts**
    - What are the differences and similarities between solving a two-step equation and solving a two-step inequality?
    - Explain when a situation calls for a single solution (equation) vs. many solutions (inequality). Provide an example.
- **Other Assessments**
    - Have students create their own two-step inequality problem. Students should solve the problem applying the properties of inequality. Have students find five different solutions to the inequality. Require that the solutions vary to represent rational numbers (fraction, decimal, whole, integer, natural).
    - Provide students with the graphed solutions of inequalities on a number line, and have them write the inequalities indicated by the graphs, and at least three solutions that are graphed. Write a problem that can result in the same solution.

Extensions and Connections

- When completing the Situations with Inequalities activity sheet, have students draw an artistic picture for each scenario.
- Have students create word problems that represent two-step inequalities.

Strategies for Differentiation

- Use different types of manipulatives and online resources to assist students with solving inequalities.
- Highlight the key words when completing the Situations with Inequalities activity sheet.
- Have students create a vocabulary card for each of the inequality symbols, listing words that describe that symbol.
- Review essential vocabulary and symbols with certain students before introducing the lesson.
- Assign students to small groups to either four or six for activities 1–9, ensuring that each group is comprised of students with varying ability. They can then pair up within their groups for the individual activities.

Note: The following pages are intended for classroom use for students as a visual aid to learning.

Situations with Inequalities

Name _____ **Date** _____

Read each situation below and write an inequality sentence for each.

1. You must be at least 18 years old to vote.

2. Mrs. Jordan has textbooks for no more than 25 people.

3. Mrs. Wilson must have less than 13 students in the school choir.

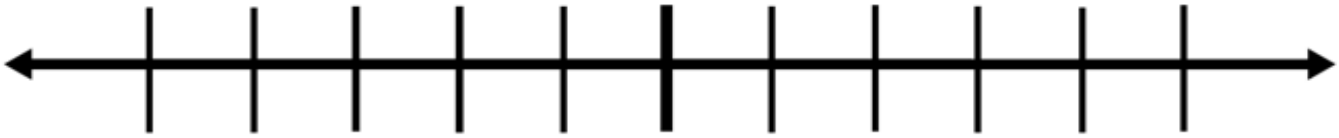
4. The gas tank can hold a maximum of 18 gallons of gas.

5. To attend the reading goal reward party, students must read a minimum of 12 books.

6. There were at most 150 people in the audience at the singer's concert.

7. The temperature on Friday will be above 65 degrees.

Number Line



Inequalities and Properties

Directions: Fill in the blanks to correctly apply the properties of inequality to solve the inequality.

$-3x + 9 \leq 18$ $-3x + 9 - \_\_\_\_ \leq 18 - \_\_\_\_\_$ $\frac{-3x}{-3} \leq \frac{\_\_}{-3}$ $x \geq \_\_\_\_$	$2(w + 3) < 10$ $2 \cdot \_ + 2 \cdot \_\_ < 10$ $2w + 6 < 10$ $2w + 6 - \_\_\_\_ < 10 - \_\_\_\_$ $\frac{2w}{2} < \frac{\_\_}{2}$ $w < \_\_\_\_$