



Lesson 24: True and False Number Sentences

Student Outcomes

- Students identify values for the variables in equations and inequalities that result in true number sentences.
- Students identify values for the variables in equations and inequalities that result in false number sentences.

Lesson Notes

Beginning in the previous lesson and continuing here, the language used in answering questions has been carefully chosen. We have purposefully elicited responses from students in the form of numbers, quantities, or sentences. Soon, students will see that another way to report an answer to an equation or inequality *is another equation or inequality*. For example, the solution to $3x \geq 15$ can be reported as $x \geq 5$.

During this lesson, students will discover that solutions and solution sets can be represented by a sentence description, leading to (or followed by) the use of equations or inequalities. This discussion will provide students with knowledge to systematically solve and check one-step equations later in the module. For example, in this lesson, students transition from

“The inequality is true for any value of x that is greater than or equal to five,” to

“The inequality is true when $x \geq 5$.”

This transition is preparing students to understand why they rewrite complicated-looking equations and inequalities as simpler ones (such as $x = 5$ or $x \geq 5$) to describe solutions. This is an important goal in the solution process.

The \neq symbol has purposefully been omitted in these lessons because it does not satisfy all of the properties listed in Tables 4 and 5 of the Common Core State Standards. However, it is a symbol that is useful and easy to understand. Its absence from the lessons does not mean that you cannot use it in your class, nor should it be forgotten.

Classwork

Opening Exercise (3 minutes)

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State whether each number sentence is true or false. If the number sentence is false, explain why.

a. $4 + 5 > 9$

False. $4 + 5$ is not greater than 9.

b. $3 \cdot 6 = 18$

True.

c. $32 > \frac{64}{4}$

True.

d. $78 - 15 < 68$

True.

e. $22 \geq 11 + 12$

False. 22 is not greater than or equal to 23.

Students share their answers and defend their decisions for each problem.

Example 1 (10 minutes)

The teacher leads the following discussion after students complete the table below. Have students work on the first two columns alone or in groups of two, writing true or false if the number substituted for g results in a true or false number sentence.

Example 1

Write true or false if the number substituted for g results in a true or false number sentence.

Substitute g with	$4g = 32$	$g = 8$	$3g \geq 30$	$g \geq 10$	$\frac{g}{2} > 2$	$g > 4$	$30 \geq 38 - g$	$g \geq 8$
8	<i>True</i>	<i>True</i>	<i>False</i>	<i>False</i>	<i>True</i>	<i>True</i>	<i>True</i>	<i>True</i>
4	<i>False</i>	<i>False</i>	<i>False</i>	<i>False</i>	<i>False</i>	<i>False</i>	<i>False</i>	<i>False</i>
2	<i>False</i>	<i>False</i>	<i>False</i>	<i>False</i>	<i>False</i>	<i>False</i>	<i>False</i>	<i>False</i>
0	<i>False</i>	<i>False</i>	<i>False</i>	<i>False</i>	<i>False</i>	<i>False</i>	<i>False</i>	<i>False</i>
10	<i>False</i>	<i>False</i>	<i>True</i>	<i>True</i>	<i>True</i>	<i>True</i>	<i>True</i>	<i>True</i>

- Let's look at $4g = 32$ and $g = 8$. What do you notice happens when 8 is substituted for g in both of the equations?
 - *8 makes both of the equations result in true number sentences.*
- What do you notice about the substitutions with 4, 2, 0, and 10?
 - *Each of those substituted values makes the equations result in false number sentences.*
- Why do you think that happened?
 - *Because they are both equations, we expect that only one number can be substituted for g to result in a true number sentence. In this case, 8 is the only number that can be substituted to make both equations true.*
- How are $4g = 32$ and $g = 8$ related?
 - *You can get from $4g = 32$ to $g = 8$ by dividing both sides of $4g = 32$ by 4. You can get from $g = 8$ to $4g = 32$ by multiplying both sides of $g = 8$ by 4.*
- In which equation is it easier to observe the value of g that makes the number sentence true?
 - *The second. It is certainly easier to recognize the value in the second equation.*
- Let's look at the next set of inequalities: $3g \geq 30$ and $g \geq 10$. (Let students fill out the table for these two columns.) What do you notice happens when 10 is substituted for g in both of the inequalities?
 - *10 makes both of the inequalities result in true number sentences.*

- Let's substitute some numbers into each inequality to test. For the second inequality, as long as the number is greater than or equal to 10, the inequality will result in a true number sentence. Let's read the inequality aloud together.
 - *Chorally: g is greater than or equal to 10.*
- Let's try 11. 11 is greater than or equal to 10. Substitute 11 for g in $3g \geq 30$. Does this result in a true number sentence?
 - *Yes.*
- How are $3g \geq 30$ and $g \geq 10$ related?
 - *You can get from $3g \geq 30$ to $g \geq 10$ by dividing both sides of $3g \geq 30$ by 3. You can get from $g \geq 10$ to $3g \geq 30$ by multiplying both sides of $g \geq 10$ by 3.*
- In which inequality is it easier to observe the value of g that makes the number sentence true?
 - *The second, which is similar to the first example.*

Continue testing the substitutions, and continue the discussion for the remaining sets of inequalities (but do not ask how the last two inequalities are related). The goal is to have students discover that for each set of equations and inequalities, the second in the set represents a *much clearer* way to represent the solutions. Point out to students that the second equation or inequality will play an important role in the next few lessons. Please note that it is not necessary that students fully understand a process for solving equations and inequalities from these examples.

Example 2 (10 minutes)

Guide students in how to use mental math to answer the questions. Students do not know how to solve one-step equations using a formal method; therefore, they will need guidance in solving these problems. Please note that the second problem includes the use of subtraction to get a negative value. While operations with integers is a Grade 7 topic, this example should be accessible using a visual model.

Example 2

State when the following equations/inequalities will be true and when they will be false.

a. $r + 15 = 25$

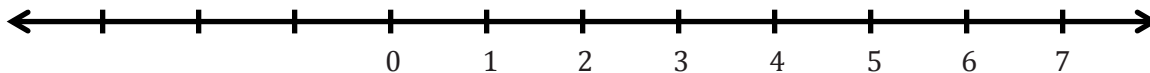
- Can you think of a number that will make this equation true?
 - *Yes, substituting 10 for r will make a true number sentence.*
- Is 10 the only number that results in a true number sentence? Why or why not?
 - *Yes, there is only one value that, if substituted, will result in a true number sentence. There is only one number that can be added to 15 to get exactly 25.*
- What will make the number sentence false?
 - *Any number that is not 10 will result in a false number sentence.*
- If we look back to the original questions, how can we state when the equation will be true? False?
 - *The equation is true when the value substituted for r is 10 and false when the value of r is any other number.*

b. $6 - d > 0$

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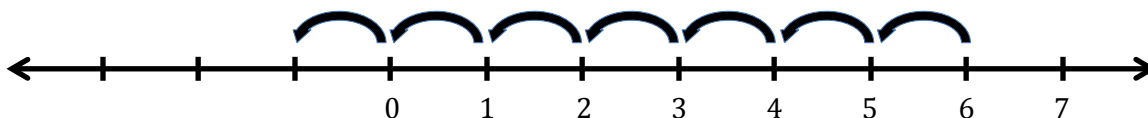
- If we wanted $6 - d$ to equal 0, what would the value of d have to be? Why?
 - *The value of d would have to be 6 because $6 - 6 = 0$.*
- Will substituting 6 for d result in a true number sentence? Why or why not?
 - *If d has a value of 6, then the resulting number sentence would not be true because the left side has to be greater than 0, not equal to 0.*
- How about substituting 5 for d ? 4? 3? 2?
 - *Yes, substituting any of these numbers for d into the inequality results in true number sentences.*
- What values can substitute for d in order for the resulting number sentence to be true?
 - *The inequality is true for any value of d that is less than 6.*
- What values for d would make the resulting number sentence false?
 - *The inequality is false for any value of d that is greater than or equal to 6.*
- Let's take a look at a number line and see why these statements make sense.

Display a number line on the board. Label the number line as shown below.



- Let's begin at 6. If I were to subtract 1 from 6, where would that place be on the number line?
 - 5.
- So, if we substitute 1 for d , then $6 - 1 = 5$, and the resulting number sentence is true. How about if I subtracted 2 from 6? Would our number sentence be true for the value 2?
 - Yes.
- What if I subtracted 6 from the 6 on the number line? Where would that be on the number line?
 - 0.
- So, if we substitute 6 for d , will the resulting number sentence be true or false?
 - False.
- Let's try one more. We have already determined that any number greater than or equal to 6 will result in a false number sentence. Let's try a number greater than 6. Let's try the number 7.
- Start with the 6 on the number line. If we were to subtract 7, in which direction on the number line would we move?
 - To the left
- And how many times will we move to the left?
 - 7

Model beginning at 6 on the number line and move your finger, or draw the unit skips, as you continually move to the left on the number line 7 times.



- So, it seems we have ended up at a place to the left of 0. What number is represented by this position?
 - -1

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Label the number line with -1 .

- Using our knowledge of ordering rational numbers, is -1 greater than or less than 0 ?
 - *Less than.*
- So, we have shown that the inequality is true for any value of d that is less than 6 ($d < 6$) and is false when the value of d is greater than or equal to 6 ($d \geq 6$).

Continue to discuss how to answer each question below with students. As students gain more confidence, have them try to solve the problems individually; discuss the answers when students are finished.

c. $\frac{1}{2}f = 15$

The equation is true when the value substituted for f is 30 ($f = 30$) and false when the value of f is any other number ($f \neq 30$).

d. $\frac{y}{3} < 10$

The inequality is true for any value of y that is less than 30 ($y < 30$) and false when the value of y is greater than or equal to 30 ($y \geq 30$).

e. $7g \geq 42$

The inequality is true for any value of g that is greater than or equal to 6 ($g \geq 6$) and false when the value of g is less than 6 ($g < 6$).

f. $a - 8 \leq 15$

The inequality is true for any value of a that is less than or equal to 23 ($a \leq 23$) and false when the value of a is greater than 23 ($a > 23$).

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Exercises (10 minutes)

Students complete the following problems in pairs.

Exercises

Complete the following problems in pairs. State when the following equations and inequalities will be true and when they will be false.

1. $15c > 45$

The inequality is true for any value of c that is greater than 3 ($c > 3$) and false when the value of c is less than or equal to 3 ($c \leq 3$).

2. $25 = d - 10$

The equation is true when the value of d is 35 ($d = 35$) and false when the value of d is any other number ($d \neq 35$).

3. $56 \geq 2e$

The inequality is true for any value of e that is less than or equal to 28 ($e \leq 28$) and false when the value of e is greater than 28 ($e > 28$).

4. $\frac{h}{5} \geq 12$

The inequality is true for any value of h that is greater than or equal to 60 ($h \geq 60$) and false when the value of h is less than 60 ($h < 60$).

5. $45 > h + 29$

The inequality is true for any value of h that is less than 16 ($h < 16$) and false when the value of h is greater than or equal to 16 ($h \geq 16$).

6. $4a \leq 16$

The inequality is true for any value of a that is less than or equal to 4 ($a \leq 4$) and false when the value of a is greater than 4 ($a > 4$).

7. $3x = 24$

The equation is true when the value of x is 8 ($x = 8$) and false when the value of x is any other number ($x \neq 8$).

Identify all equality and inequality signs that can be placed into the blank to make a true number sentence.

8. $15 + 9 \underline{\hspace{1cm}} 24$
= or \geq or \leq

9. $8 \cdot 7 \underline{\hspace{1cm}} 50$
 $>$ or \geq

10. $\frac{15}{2} \underline{\hspace{1cm}} 10$
 $<$ or \leq

11. $34 \underline{\hspace{1cm}} 17 \cdot 2$
= or \geq or \leq

12. $18 \underline{\hspace{1cm}} 24.5 - 6$
 $<$ or \leq

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Closing (7 minutes)

- For the past two lessons, we have been using sentences to describe when values substituted for variables in equations and inequalities result in true number sentences or false number sentences.
- Let's take a look at an example from each of the past two lessons.

Display the following equation on the board: $5 + x = 8$.

- Substituting 3 for x in the equation results in a true number sentence: $5 + 3 = 8$. Let's evaluate to be sure.
- What is the sum of $5 + 3$?
 - 8

- Does $8 = 8$?
 - Yes.
- So, when we substitute 3 for x , the equation results in a true number sentence. Let's try to substitute 3 for x in $x = 3$.

Display $x = 3$ on the board.

- If we substituted 3 for x , what would our number sentence look like?
 - $3 = 3$
- Is this a true number sentence?
 - Yes.
- Previously, we described the values of x that would make the equation $5 + x = 8$ true in a sentence.

Display on the board: The equation is true when the value of x is 3.

- This is the same sentence we would write for the equation $x = 3$. Therefore, we can shorten this sentence and, instead, say: The equation is true *when* $x = 3$.

Display on the board: The equation is true when $x = 3$.

- Let's look at an inequality from today:

Display $4a \leq 16$ on the board.

- What numbers did we determine would make this inequality result in a true number sentence?
 - *We determined that any number less than or equal to 4 would result in a true number sentence.*

Write this statement on the board: The inequality is true for any value of a that is less than or equal to 4.

- Is there any way we can abbreviate or shorten this statement using symbols instead of words?

Display $a \leq 4$ on the board.

- Let's read this aloud. a is less than or equal to four. We can use this inequality to rewrite the sentence.

Display on the board: The inequality is true when $a \leq 4$.

- Either sentence is a correct way to state the values that make $4a \leq 16$ true.

Exit Ticket (5 minutes)

Name _____

Date _____

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Exit Ticket

State when the following equations and inequalities will be true and when they will be false.

1. $5g > 45$

2. $14 = 5 + k$

3. $26 - w < 12$

4. $32 \leq a + 8$

5. $2 \cdot h \leq 16$

Exit Ticket Sample Solutions

State when the following equations and inequalities will be true and when they will be false.

1. $5g > 45$

The inequality is true for any value of g that is greater than 9 and false when the value of g is less than or equal to 9.

OR

The inequality is true when $g > 9$ and false when $g \leq 9$.

2. $14 = 5 + k$

The equation is true when the value of k is 9 and false when the value of k is any other number.

OR

The equation is true when $k = 9$ and false when $k \neq 9$.

3. $26 - w < 12$

The inequality is true for any value of w that is greater than 14 and false when the value of w is less than or equal to 14.

OR

The inequality is true when $w > 14$ and false when $w \leq 14$.

4. $32 \leq a + 8$

The inequality is true for any value of a that is greater than or equal to 24 and false when the value of a is less than 24.

OR

The inequality is true when $a \geq 24$ and false when $a < 24$.

5. $2 \cdot h \leq 16$

The inequality is true for any value of h that is less than or equal to 8 and false when the value of h is greater than 8.

OR

The inequality is true when $h \leq 8$ and false when $h > 8$.

Problem Set Sample Solutions

State when the following equations and inequalities will be true and when they will be false.

1. $36 = 9k$

The equation is true when the value of k is 4 and false when the value of k is any number other than 4.

OR

The equation is true when $k = 4$ and false when $k \neq 4$.

2. $67 > f - 15$

The inequality is true for any value of f that is less than 82 and false when the value of f is greater than or equal to 82.

OR

The inequality is true when $f < 82$ and false when $f \geq 82$.

3. $\frac{v}{9} = 3$

The equation is true when the value of v is 27 and false when the value of v is any number other than 27.

OR

The equation is true when $v = 27$ and false when $v \neq 27$.

4. $10 + b > 42$

The inequality is true for any value of b that is greater than 32 and false when the value of b is less than or equal to 32.

OR

The inequality is true when $b > 32$ and false when $b \leq 32$.

5. $d - 8 \geq 35$

The inequality is true for any value of d that is greater than or equal to 43 and false when the value of d is less than 43.

OR

The inequality is true when $d \geq 43$ and false when $d < 43$.

6. $32f < 64$

The inequality is true for any value of f that is less than 2 and false when the value of f is greater than or equal to 2.

OR

The inequality is true when $f < 2$ and false when $f \geq 2$.

7. $10 - h \leq 7$

The inequality is true for any value of h that is greater than or equal to 3 and false when the value of h is less than 3.

OR

The inequality is true when $h \geq 3$ and false when $h < 3$.

8. $42 + 8 \geq g$

The inequality is true for any value of g that is less than or equal to 50 and false when the value of g is greater than 50.

OR

The inequality is true when $g \leq 50$ and false when $g > 50$.

9. $\frac{m}{3} = 14$

The equation is true when the value of m is 42 and false when the value of m is any number other than 42.

OR

The equation is true when $m = 42$ and false when $m \neq 42$.