**LESSON PLAN OUTLINE- (2-Day Lesson)**

**Day 1-Understanding Inequalities**

1. TITLE OF LESSON: Understanding Inequalities
2. CONTEXT OF LESSON: Earlier in the school year, students learned the inequality symbols and used them to compare fractions, decimals, percents, integers, etc. They have just finished a unit on equations. The next natural step is to link these two ideas together and have them work with one-step inequalities, learning to solve them and graph their solutions. This is the first of 2 lessons that will address these topics.
3. LEARNING OBJECTIVES and ASSESSMENT:

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| --- | --- | --- |
| Learning Objective | Bloom | Assessment (Formative/Summative) |
| Students will be able to identify and correctly label each of the following inequality symbols: <, >, ≤, ≥ | Knowledge | Observation as students work with table group; list of students struggling with identifications for possible remediation; various table groups to be called upon for identifications. (This topic should be prior knowledge as it was covered earlier in the school year.) |
| Students will be able to create an example of a real-world situation that can be modeled by an inequality. | Synthesis | Students will share their example with their table group, write all 4 on a piece of computer paper, and will bring paper to the document camera to receive feedback from the rest of the class and the teacher on their work. These papers will be collected from each table group so teacher can informally check for student understanding. Teacher will check that students have created situations which have a *range* of possible answers, rather than just one solution. |
| Students will be able to graph an inequality on a number line, and interpret the number line to visually identify examples and non-examples of solutions to the inequality. | Comprehension | Students will practice with "whiteboards", so teacher can collect data by observation, and record information about struggling students in a checklist. Students will also complete a few problems of this nature in an exit slip, for which they will receive a grade. |

1. RELATED 2009 VIRGINIA STANDARDS OF LEARNING:

SOL 7.15: The student will

a) Solve one-step inequalities in one variable; and

b) graph solutions to inequalities on the number line.

1. MATERIALS NEEDED:

Student warm-up folder(stored on classroom tables)

Warm-up PowerPoint slide

Answer key for previous night's homework

4-5 Notes worksheet for each student(2-sided)

Answer key for 4-5 Notes worksheet

6 sheets of blank computer paper(1 per table group)

A sheet protector for each student, with a -10 through 10 number line printed on one side of the paper inserted inside.

A Dry erase marker & eraser for each student

Exit slip for each student

\*Classroom teacher will be responsible for securing all of above materials.

1. PROCEDURE:

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| --- | --- | --- |
| Time | Mathematical Tasks to be Used,  Teacher Thoughts/Actions/Questions | Anticipated Student Comments, Questions, Actions, and Strategies |
|  | WARM-UP/CHECK HOMEWORK: Have students take out their homework from the previous night, and their warm-up folder. Display the warm-up PowerPoint slide and have students begin as you circulate around the room to determine students who did not complete the homework assignment. Tell them to set the warm-up aside for now, that you will come back to it in a few minutes.  Students will then check their homework assignment from last class with their table group. Tell them to check each answer with their table group. When they get to problems which they have different answers, they should look at each other's work and have a discussion to try to find where a mistake was made. Tell them to ask their group members to "prove" to them that their answer is correct. Tell them that after this process, when we come back together as a class, we can answer any remaining questions, or talk about problems that you still disagree about.  Give them time to work together on this task, and then follow procedures outlined above, only going over problems they are still unsure of. If they have no disagreements or questions, highlight one or two higher-level problems , asking students to explain how they approached those problems, and asking the class if anyone used different methods. After a discussion about these problems, have students file their work in the homework section of their binder for future reference. | Students will take out their homework assignment, and begin on their warm-up in their warm-up folder. Then they will begin to compare homework answers with their table group. Students may try to get teacher input for questions they disagree about, but the teacher should prompt them to work only with their group for now, and if they cannot come to an agreement, we will discuss their questions when we come back together as a class. Students will circle any questions they wish to have further explained.  After working with table group, students will listen to teacher/classmates as challenging problems are explained. They will also ask questions they still have. Then, they will file their homework away into their binder for future reference. |
|  | INTRODUCTION: Introduce inequalities by asking students, "How many of you have ever been to King's Dominion or Busch Gardens?", "Do any of you like to ride the roller coasters when you go?" Elicit responses from the students. Depending on their responses, next questions could be, "Have you always been able to go on the rollercoasters? Why or why not?" and "What is a requirement of the park to be able to ride a rollercoaster?" Your response could be to point out that amusement parks have a range of acceptable heights that must be met in order to ride. Explain that rather than listing all of the possible heights you could be to ride, it is helpful to think of your height having to be greater than or equal to a certain number to be able to ride. Situations like this in which there are a range of possible numbers that will work can be expressed as an inequality, and inequalities will be our focus over the next few days.  BODY: Tell students that before we get to the new material, we need to recall a few things about equations. Then we will learn about inequalities in the real-world and how to graph inequalities, and determine solutions. Ask them to get out their warm-up, while you hand out the 4-5 Notes worksheet to them. Explain that the first few questions from the warm-up are also at the top of their notes sheet and they will need to fill them in after we agree on the answers. Display a blank copy of the 4-5 Notes under the document camera. Call on them for their ideas for the fill in the blank portion, filling them in and discussing as you go. For the open-ended question, be sure to call on a few students since student explanations may differ. After going over this, students may put their warm-up folders away. Explain that inequalities are similar to equations in some ways, in particular the way that you solve them, but different in other ways: mainly the number of solutions.  Next, tell students they will work with their table group to recall/identify the 4 inequality symbols on their paper (under Part I). Give students time for this groupwork. As they work, circulate around the room so you are able to identify students having trouble recalling the information. Come back together as a class, and call on students from a variety of table groups to give their answers.  Move on to Part II of the notes. Stress to students again that unlike equations, inequalities have many solutions, and there are many real-world situations which can be represented by a range of numbers. Tell them to think back to our rollercoaster example at the beginning of the lesson. Read with them the example on the paper and ask students how they could represent this as an inequality. Then they should list 3 solutions to this inequality. Call on various students to give possible heights that would work.  Next, students will write their own real-world situation, translate it to an inequality, and write out 3 solutions. They should work individually on this. Then, they should receive feedback from their table group, and make any changes they would like. Each table group will be given a blank piece of computer paper. They should fold the paper into fourths. In each fourth, each person in their group writes out their example, including their inequality and solutions. Teacher will call on at least 2 table groups(depending on time constraints) to share their examples. Other students in class will be asked to provide feedback on their examples. Teacher will collect this sheet from each table group for further review.  Graphing Solutions(Part III) will be the next focus. Complete Part III of the notes with students, having them fill in their notes as you complete the work together on the document camera. For each example, teacher should stress the meaning of the symbol and the need for students to think through what it actually means in order to help with the graphing. For example, when explaining example 1, the teacher should ask a student to read the inequality( h is greater than or equal to 48). Then ask the student, "Could h be 49? Could it be 50? Could it be 49.5? etc... Could it be 48?" This leads to an explanation of how we can show on the graph to include or exclude a number(open or closed circles). Continue through the 4 examples, questioning students as you go. Then have them complete the summary box at the end of the section asking them to summarize when to use a closed circle and when to use an open circle when graphing. Have a class discussion about this to make sure students have been able to generalize this information.  Now, have students use their inequality from their real-world situation they wrote earlier in the lesson and graph this on the number line provided. This helps them link together the different topics of today's lesson. As students work, walk around the room to observe their graphs.  Next, students will practice graphing, and determining solutions with a "whiteboard". The length of this portion of the lesson may be modified as needed. Distribute sheet protectors, dry-erase markers, and erasers to each student. (The sheet protectors will have a piece of paper with a number line printed on one side already inserted.) Teacher will read a series of 10 questions(or more if time allows) allowing students to practice skills learned today. The first question will ask students to graph a given inequality. After students have sketched the graph, they will hold up their whiteboard for the teacher to check their work, telling them if it is correct or not. For the 2nd question, they will be asked to use the graph they just drew to visually determine if a particular number is a solution to that inequality. They will answer by writing yes or no on their whiteboard. Practice will continue in this manner until 10 questions have been given or time runs out. Materials will be collected. | Most students in our school typically answer yes, that they have been to either King's Dominion or Busch Gardens. Several will usually answer yes, that they enjoy riding the rollercoasters. Students should be able to reason through the next set of questioning, stating that they couldn't when they were younger because they were too short. Amusement parks have height requirements to be able to ride on certain rides.  Students typically get very excited when talking about rollercoasters, and all want to share their favorites. It may help with classroom management to take a minute to do a quick survey of their favorites.  Students get out their warm-up and receive 4-5 Notes worksheet. Students listen, and offer answers as warm-up questions are reviewed. They also record correct answers on their 4-5 Notes worksheet.  Students may have trouble remembering the word "inverse" for the 2nd fill-in-the-blank. Often they think of the word "opposite" instead. Usually after prompting them to use the more mathematical word for opposite, they will be able to remember "inverse". If students have trouble answering that an equation has *one* solution, they can be provided with a basic example such as x + 2 = 5, and prompted, "How many numbers could you substitute for x to make this equation true?" This will help them make this connection.  Students will work with their table group to identify inequality symbols. Most students will identify the inequality symbols in the typical ways("less than", "greater than", "less than or equal to", "greater than or equal to"). Challenge them to come up with other wordings for each symbol (i.e. "at least")  Students follow along as teacher leads them into Part II of the notes. Before students are able to write the inequality, you may have to prompt them by asking them, i.e. "If you were 51" tall, would you be able to ride?", "If you were 48" tall would you be able to ride?", etc. Help them to take this information and write it as an inequality with a variable. Make sure to point out reasonableness of answers as well. Students may respond that someone could be i.e.90" tall and still ride the roller coaster. This is not a reasonable height. You could also tie in to the discussion at this point that there are rides that also have height limits, in addition to minimums.  Students write their own real-world example, translate it to an inequality and write out 3 solutions. Teacher should be on the lookout for examples which do not provide for a range of solutions, but may be best represented by an equation. Students may need help thinking of situations with a range of possibilities. Teacher could provide a topic, and student could take this topic, expand upon it and write it out as a problem.  Students will listen to other groups real-world situations and provide feedback.  Students should fill in Part III of their notes, guided by the teacher. Students may ask about the number lines. They sometimes have the idea that a number line must always be from -10 to 10 or some other range of numbers that includes zero. Explain to them this is not always the case, and we will set up our number lines in the way that will best display the inequality.  Students may have questions about example 4 because the variable does not come first. It should be explained to students that this type of inequality may be re-written with the variable appearing first. They need to understand that in switching the order this will also switch the inequality symbol. Provide them with an explanation as to why. Students also may have a hard time with example 3. It is often harder for them to determine "greater than" or "less than" a negative number. It may be necessary to review with them that larger numbers always appear to the right on a number line, regardless of whether you are comparing negative or positive numbers.  Student listens for each of the problems read off by the teacher and answers each of the questions on their whiteboard. |
|  | CLOSURE: Have a class discussion about the topics learned today. Highlight again that inequalities have many solutions, and can be used to represent many situations in the real-world. Also reiterate that a number line helps us to visually display all of those possible solutions, including not just whole numbers, but also all of the fractions/decimals in between. Tell them that next time they will build upon what they learned today by looking at one-step inequalities where they will need to solve first to determine solutions before graphing.  Lastly, have students complete an exit slip with 3 questions. Collect these from students as they leave class. | Students participate in the class discussion.  Students complete an exit slip and hand it to the teacher on their way out of class. |

1. MEETING THE NEEDS OF ALL STUDENTS: Students who are above grade-level could be challenged at various times throughout the lesson. When groups are asked to recall names of inequality symbols, they could be challenged to come up with *as many ways as possible* to write them. Also, when looking at the example of the inequality for the King's Dominion rollercoaster, you could challenge them to write a compound inequality showing the possible heights provided that there is a height maximum for the ride as well. They could also be challenged to look for any "tricks" or "shortcuts" that might help them when graphing inequalities.

Students who are below grade-level may need extra support throughout the lesson, including additional prompting from the teacher when coming up with real-world examples. Students who are below grade-level or have special needs can also be purposefully grouped with helpful peers.

1. WHAT COULD GO WRONG WITH THIS LESSON AND WHAT WILL YOU DO ABOUT IT? Students could need additional practice with last night's homework before continuing with new material. Whiteboards can be used as an additional opportunity for practice if this is needed before beginning the new lesson. If the computer isn't working to display the PowerPoint slide for the warm-up, have a copy of it ready to display under the document camera. If students struggle with warm-up questions, you can tell them to look back into their notes. If students lack motivation to participate with their group when checking their homework, make this into a competition between table groups and give a reward to the group with the best effort/discussions. If students are off-task (doodling, etc.) with the whiteboards, they can be given paper instead and have their work collected for a grade.
2. CONNECTION TO CTA: This lesson includes strategies presented by Pat Lintner and John Strebe at the CTA. I used Pat Lintner's ideas of including open-ended assessments more frequently, by incorporating an open-ended question into the warm-up. I also used John Strebe's idea of group-work as a way to get reluctant students more active in class participation. His method for checking homework was also incorporated. This makes learning more student-centered as students question and help each other.



* Solving an equation means…
* To solve an equation, we use operations. (For example, we use addition to “undo” subtraction.)
* An equation has how many solutions?

**4-5 Notes: Inequalities**

**Let’s recall what we have learned about equations: SOL 7.15**

**Part I: Inequality Symbols**

Let’s recall our earlier work with inequalities. Work together with your table group to write out the meaning for each symbol shown.

**< ≤**

**> ≥**

**Part II: Solutions to inequalities**

Unlike equations, inequalities have ***MANY*** solutions.

**Example:** In order to ride the Anaconda roller coaster at King’s Dominion, you must be at least 48” tall.

Write this as an inequality:

What are some solutions for this inequality?

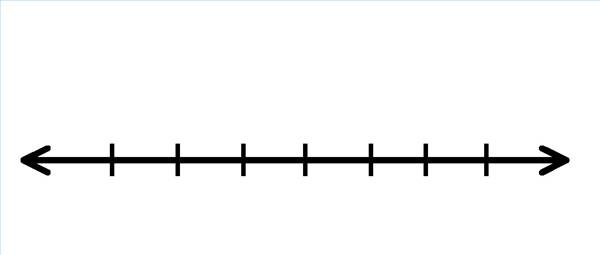
Now, use the boxes below to write your own example of a real-world situation that can be represented by an inequality. Then, write it as an inequality and list 3 solutions.

**Real-world situation:**

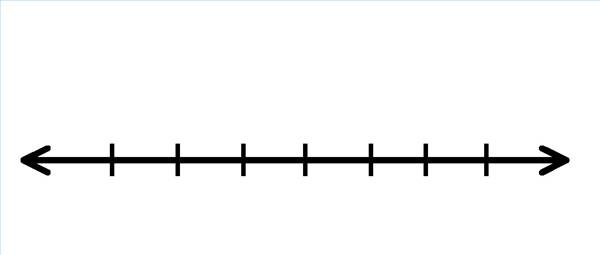
**Inequality & Solutions**

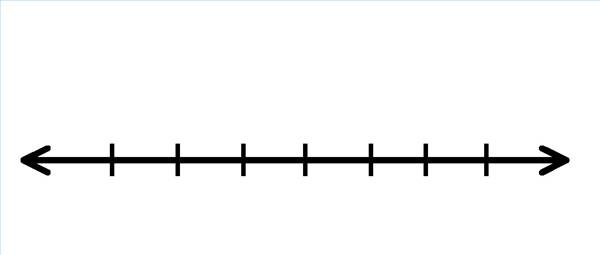
**Part III: Graphing Solutions**

Because there are many solutions to an inequality, we often graph these solutions on a number line to show all of the possibilities.

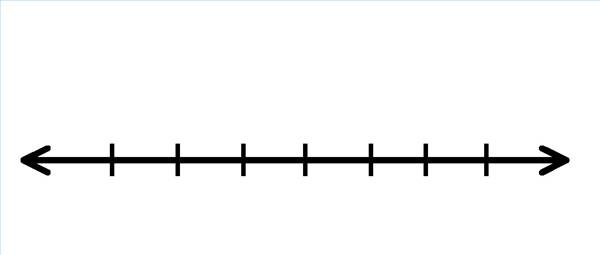


**Example 1:** h ≥ 48 **Graph:**

** Example 2:** a ≤ 3 **Graph:**

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**Example 3:** p < -2 **Graph:**

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**In summary:**

* **For which two symbols would you use a closed circle when graphing? Why?**

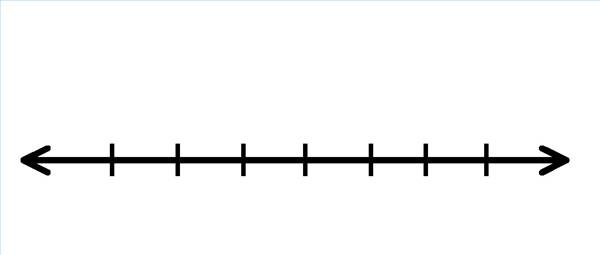
* **For which two symbols would you use an open circle when graphing? Why?**

**Example 4:** 4 < m **Graph:**

Graph your inequality from Part II in the space below.

**MCj04119740000%5b1%5d**

My inequality:

 Graph:

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**Warmup: Let’s recall what we have learned about equations**

* Solving an equation means…
* To solve an equation, we use operations. (For example, we use addition to “undo” subtraction.)
* An equation has how many solutions?
* Jason solved the equation below. Examine his work and explain the error he made in solving the equation.

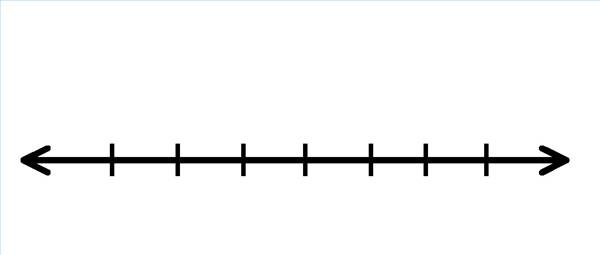
y - (-4) = 6

+ 4 + 4

y = 10

**Exit Slip**

1. Graph the inequality and list 3 solutions: m > 7. Is 7 a solution? Why or why not?



2. When graphing the inequality k ≥ 5, would you use an open circle or closed circle? How do you know?