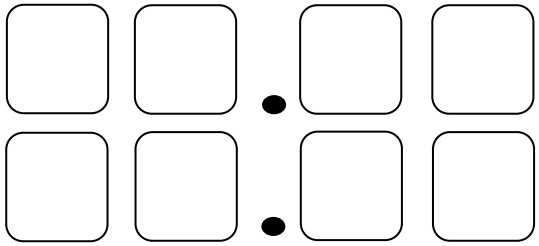
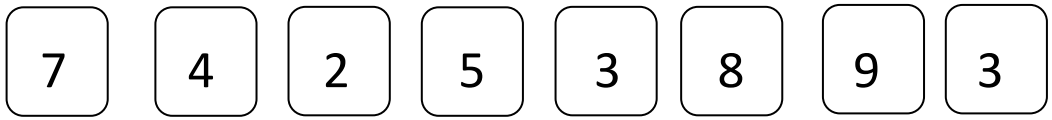
Task: Place Value Game (Addition and Subtraction) **5th Grade**

Raven and Connor are playing a place value game. To play the game, they draw eight number cards then use the numbers to fill in the grid below:



They can then either add or subtract the two numbers they have formed using the number cards. On this particular round, they drew the following number cards:



a) How should Raven and Connor arrange their cards so that the sum of the two numbers is as large as possible? What strategy should they use to arrange their cards? Is there more than one way to do this?

b) How should Raven and Connor arrange their cards so that the sum of the two numbers is as small as possible? What strategy should they use to arrange their cards? Is there more than one way to do this?

c) How should Raven and Connor arrange their cards so that the difference of the two numbers is as large as possible? What strategy should they use to arrange their cards? Is there more than one way to do this?

d) How should Raven and Connor arrange their cards so that the difference of the two numbers is as small as possible but still greater than or equal to 0? What strategy should they use to arrange their cards? Is there more than one way to do this?

Teacher Notes:

Students must understand the place value system in order to be successful in this task. Parts (a), (b), and (c) are fairly standard activities with place value when studying whole numbers. Part (d) is not a standard question and will require more abstract thinking than the other parts.

Teachers may change the choice of cards (a random number generator was used to determine this particular list of cards). For an interactive activity, teachers may use a deck of cards numbered 0-9 and draw eight cards from the deck.

As a variation on the interactive activity, students may be given the grid and an ink pen (to prevent changing answers). Teachers can state the goal (largest sum, smallest sum, largest difference, etc.) and draw the cards one at a time. Students must place each number in the grid AS IT IS DRAWN FROM THE DECK in order to meet the goal. Once the number is placed, students cannot change the placement. This variation requires not only an understanding of place value but also a basic understanding of probability (knowing how many of each digit is left in the deck and the probability that a particular digit will be drawn).

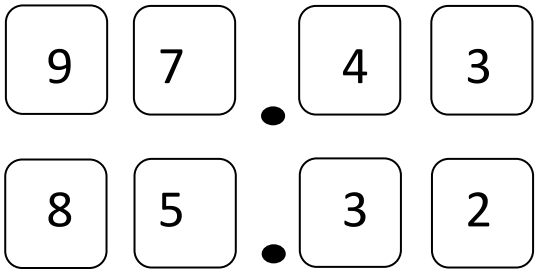
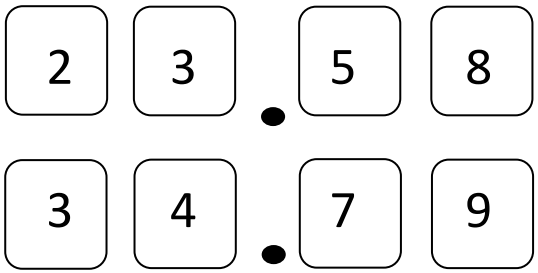
Common Core State Standards for Mathematical Content	Common Core State Standards for Mathematical Practice
5.NBT.A.1. Recognize that in a multi-digit number, a digit in one place represents 10 times as much as it represents in the place to its right and 1/10 of what it represents in the place to its left. 5.NBT.B.7. Add, subtract, multiply, and divide decimals to hundredths, using concrete models or drawings and strategies based on place value, properties of operations, and/or the relationship between addition and subtraction; relate the strategy to a written method and explain the reasoning used.	1. Make sense of problems and persevere in solving them. 2. Reason abstractly and quantitatively. 3. Construct viable arguments and critique the reasoning of others. 4. Model with mathematics. 5. Use appropriate tools strategically. 6. Attend to precision. 7. Look for and make use of structure. 8. Look for and express regularity in repeated reasoning.

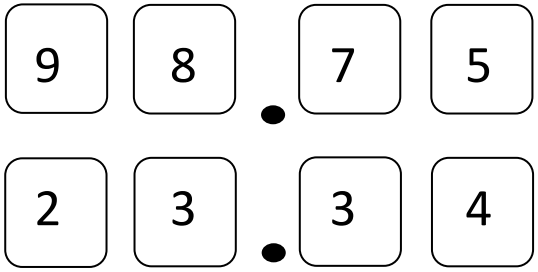
Essential Understandings

- Decimal place value is an extension of whole number place value.
- Whole numbers and decimals can be compared by analyzing corresponding place values.
- The real-world actions for addition and subtraction of whole numbers are the same for operations with fractions and decimals.
- The effects of operations for addition and subtraction with fractions and decimals are the same as those with whole numbers.

Explore Phase

Possible Solution Paths	Assessing and Advancing Questions
Part (a): To make the sum as large as possible, students need to examine the digits given and place the largest digits in the largest place values. One possible solution is:	**Advancing questions:** What does "sum" mean you are doing with your numbers? Suppose you had only four cards and you were working with the grid to the left of the decimal point. How would you decide where to place your cards to make the sum as large as possible?

 The largest possible sum is 182.75. Students may swap cards within the place value (for example, swapping the 9 and 8 cards would result in the same sum). Note: Students may also solve this problem by using a "guess and check" approach by simply placing the cards and determining which arrangement gives them the largest sum. However, to argue that their sum is as large as possible, they will need to appeal to the connection between the place value and the digits they have placed.	**Assessing questions:** Explain your strategy. How do you know that your sum is as large as possible? Can you find more than one placement that will give you the same answer? How many placements can you find that will give the same answer?
Part (b): This is very similar to part (a). To make the sum as small as possible, students need to examine the digits given and place the smallest digits in the largest place values. One possible solution is:  The smallest possible sum is 58.37. Students may swap cards within the place value (for example, swapping the 9 and 8 cards would result in the same sum). Note: Students may also solve this problem by using a "guess and check" approach by simply placing the cards and determining which	**Advancing questions:** What does "sum" mean you are doing with your numbers? Suppose you had only four cards and you were working with the grid to the left of the decimal point. How would you decide where to place your cards to make the sum as small as possible? **Assessing questions:** Explain your strategy. How do you know that your sum is as small as possible? Can you find more than one placement that will give you the same answer? How many placements can you find that will give the same answer?

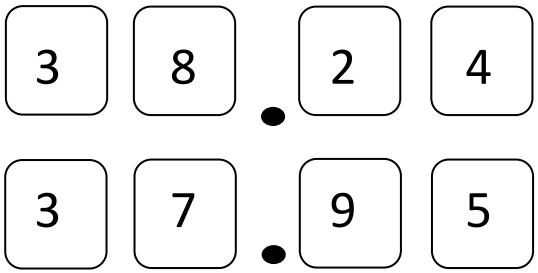
arrangement gives them the smallest sum. However, to argue that their sum is as small as possible, they will need to appeal to the connection between the place value and the digits they have placed.	
Part (c): To make the difference as large as possible, students need to examine the digits given and place the largest digits in the minuend in decreasing order and the smallest digits in the subtrahend in increasing order. The only solution is:  The largest possible difference is 75.41. Note: Students may also solve this problem by using a "guess and check" approach by simply placing the cards and determining which arrangement gives them the largest difference. However, to argue that their difference is as large as possible, they will need to appeal to the connection between the place value and the digits they have placed.	**Advancing questions:** What does "difference" mean you are doing with your numbers? Suppose you had only four cards and you were working with the grid to the left of the decimal point. How would you decide where to place your cards to make the difference as large as possible? **Assessing questions:** Explain your strategy. How do you know that your difference is as large as possible? Can you find more than one placement that will give you the same answer? Why or why not?
Part (d): To make the difference as small as possible, students need examine the digits given and make the minuend and the subtrahend as close to each other as possible, with the minuend being slightly larger than the subtrahend. The strategy for solving the problem will vary slightly with the original list of digits available. We have an advantage here in that one of the digits (3) is repeated—i.e., we have two cards labeled "3". We can therefore place the "3" cards in the tens places in both numbers, making our tens digit 0 when we subtract. (Note: if we do not have repeated digits, we will need to choose our tens digits to be as close to each	**Advancing questions:** What does "difference" mean you are doing with your numbers? Suppose you had only four cards and you were working with the grid to the left of the decimal point. How would you decide where to place your cards to make the difference as small as possible? (Note: You must be careful here—there are smaller differences possible, but these smaller differences are less than 0—a sixth-grade concept.) **Assessing questions:** Explain your strategy. How do you know that your difference is as small

other as possible.)

Next, we want our ones digits to be as close to each other as possible. We have several pairs of unused digits that have a difference of 1: 9 and 8; 8 and 7; and 5 and 4. We may try each pair in the ones place (with the larger of the pair being placed in the minuend). To determine which of these placements we should use, we must complete our choices of digits for the tenths and hundredths places.

Once we have placed the ones digits, we will have four digits left. These four digits must be used to represent the tenths and hundredths places in the minuend and the subtrahend. In the minuend, we want to choose the smallest digit to represent the tenths, and the second smallest to represent the hundredths. In the subtrahend, we will choose the largest digit to represent the tenths and the second largest to represent the hundredths.

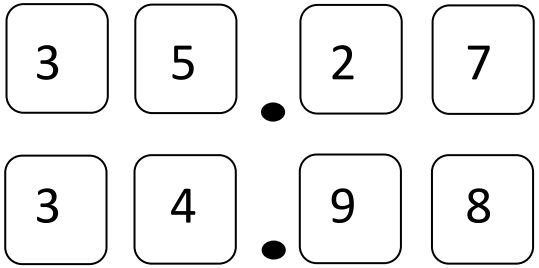
To determine which placement of digits will give us the smallest positive difference, we will need to calculate the three differences we construct. In this particular case, students will need to calculate three differences. Two of these calculations give us the same (smallest) difference:



or

as possible?

Can you find more than one placement that will give you the same answer? How many placements can you find that will give the same answer?



The smallest possible (non-negative) difference is 0.29.

Note: This problem includes the stipulation that the difference must be greater than or equal to 0 because positive and negative numbers are not studied in detail until the 6th grade. Without this stipulation, students would simply swap the minuend and the subtrahend in part (c) to get the smallest (but negative) difference. Including this stipulation increases the difficulty of this problem, primarily because it may not be clear exactly what role place value plays in the strategy.

Possible Student Misconceptions	
For part (a), students may think that "as large as possible" is equivalent to "the largest I can find". A similar misconception can occur with parts (b), (c), and (d).	**Advancing Questions:** Are there other ways you can arrange the number cards? Will any of these arrangements give you a larger (or smaller) answer? **Assessing Question:** How would you convince someone that your answer is correct?
In the subtraction problems, students may elect to subtract the smallest digit from the largest digit for each place, regardless of which digit is in the minuend and which is in the subtrahend.	**Advancing Questions:** How do you subtract one number from another? What happens if the digit in the minuend is smaller than the digit in the subtrahend? Do you need to make any trades?
Entry/Extensions	**Assessing and Advancing Questions**
If students can't get started….	**Advancing question:** Suppose you had only four cards and you were working with the grid to

	the left of the decimal point. How would you decide where to place your cards?
If students finish early….	**Assessing questions:** (Give the students another set of eight number cards.) Do the strategies you have developed for these problems work with this set of number cards? Why or why not? How would your strategy in part (d) change if you had eight DIFFERENT number cards? What properties would your set of number cards need to have in order to get an answer of 0 in part (d)?
Discuss/Analyze	
Whole Group Questions	
Adding and subtracting decimals relies on an understanding of place value just as it does with whole numbers. *Questions:* • Does the placement of the decimal point make a difference in your strategies for these questions? • How did you make sure your sum was the largest in part (a)? The smallest in part (b)? • How did you make sure your difference was the largest in part (c)? The smallest in part (d)? • Which parts have more than one answer? Why? Will these parts ALWAYS have more than one answer, no matter what numbers are chosen? Why or why not?	