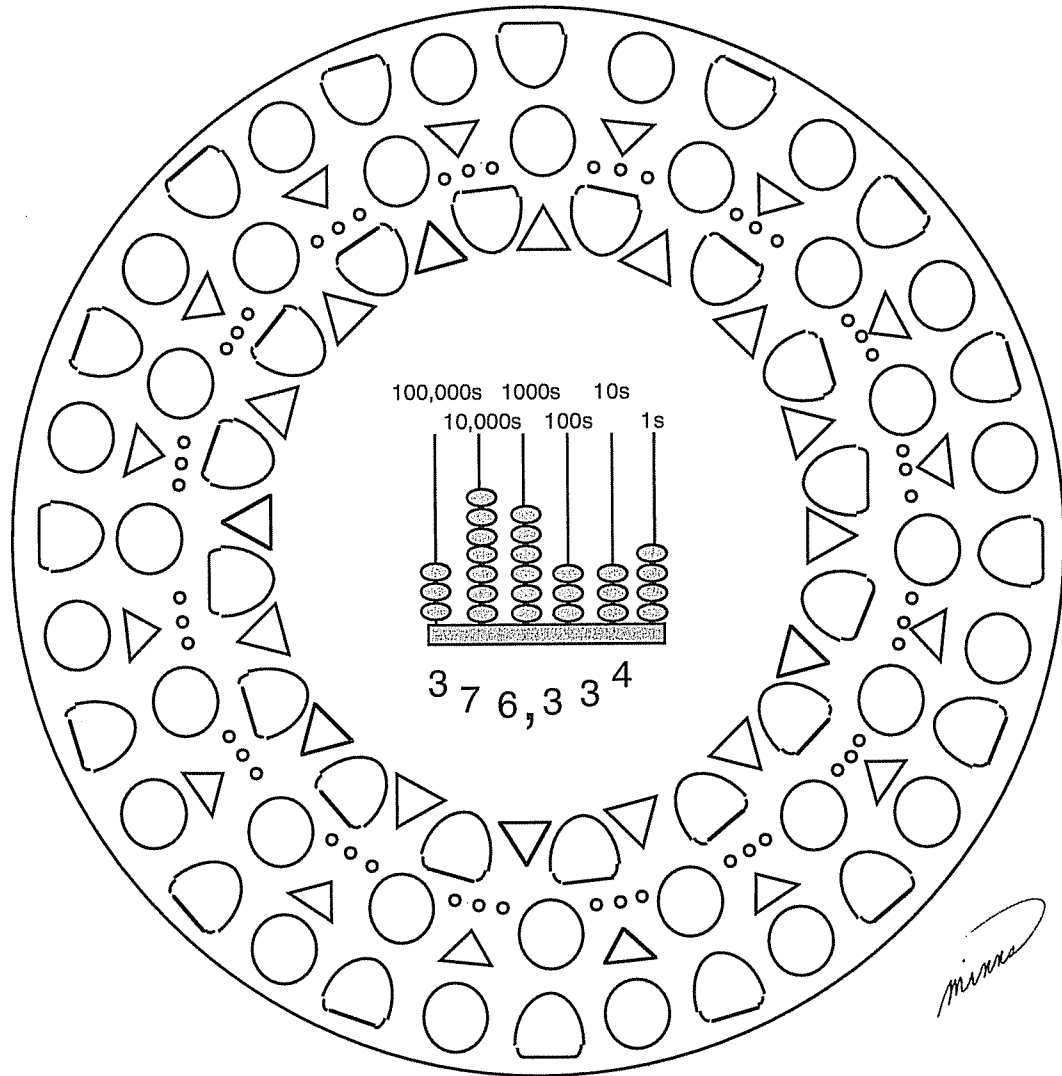


**Patterns in Arithmetic**  
**Place Value - Booklet 2 PDF**  
**Rounding Off and Estimating**  
**Parent/Teacher Guide**



**By Alysia Krafel, Suki Glenn, and Susan Carpenter**

**Illustrations by Karen Minns and Suki Glenn**

Based on methods developed by Prof. Michael Butler at the  
UCI Farm Elementary School  
University of California, Irvine

# Place Value: Booklet 2 PDF - Rounding Off and Estimating

## Contents

Trading Game .....	1	What's My Rule? .....	15
Trading Game Recording .....	3	Rounding Off: Tens .....	17
Place Value: Counting Cuckoos .....	4	Rounding Large Numbers .....	18
Place Value: Manipulative .....	5	<b>Addition Review</b>	
Place Value: Two Digits .....	6	Estimating: Addition (no instructions)	
Place Value: Three Digits .....	7	Speed Test: Addition (no instructions)	
Place Value: Three Digits Recording .....	9	Circle Math: Review (See Addition: Booklet 3 for instructions)	
Place Value to 100 and 1,000 .....	10	Practice (no instructions)	
Trading Game: Number Values .....	13	Patterns in Sums: Column Addition .....	19
Place Value: Subtraction - Base 5 .....	14	Answer Key .....	20
Place Value: Six Digit .....	14		

This booklet is dedicated to the University of California, Irvine. Thank you for giving the Farm School such a wonderful place to have our school.

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The cover mandala and many delightful illustrations are by Karen Marie Christa Minns. Other illustrations are by Suki Glenn and ClickArt by T/Maker.

To all of the mathematicians, from antiquity to the present, who discovered the principles of mathematics goes our heartfelt appreciation for your dedication.

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Parent/Teacher Guide  
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## Trading Game

**Purpose** The purpose is to develop or reinforce concepts of place value and to form a basis for regrouping. Students love to play this game, and math should be fun. During the game students find patterns, look for relationships, make predictions, and solve problems.

**Materials** One die  
Colored blocks (start with four and eventually use ten colors), or any other counters

**Game Plan** Choose four colored blocks. It doesn't matter what color. For the purpose of explanation the colors used here are consistent.



Orange Blue Red Green

Set four different colored blocks in a row. Arrange the blocks so the first unit is on the right, corresponding to place value getting larger when moving to the left. Choose a trading number. Three is a good number to start with.

The green block is the starting color.  
Three green blocks trade for one red block.  
Three red blocks trade for one blue block.  
Three blue blocks trade for one orange block.

**How to Play** The object of the game is for everyone to get at least one orange block. Students take turns rolling one die, getting one of the first color for each dot on the die and then trading when ready. After students get one orange block they can accumulate more while others are getting their first orange block. Play for three orange blocks when students are more experienced.

**Rules**

1. Each player makes his own trades. The other players must remain silent while the player who has rolled the die figures out what to do.
2. When a player finishes his trades he then passes the die to the next player to signify that he is finished. Then the other players may *verbally* correct any errors that were made.
3. Players may not touch each other's blocks.

**Notes**

- 1 The teacher should be present to offer assistance while the students play the first few games. It is best not to change the trading value for the first several games.
2. To shorten the game, vary the number of places by setting the winning block at one blue or one orange. Or set the trading number at two instead of three. 2 greens = 1 red, 2 reds = 1 blue, etc.
3. Vary the trading number. Change the value from trading three to trading four or five so that 4 greens = 1 red and 4 reds = 1 blue, etc.

**Sample Game** Sample player moving through four moves. Block Values:  
3 greens = 1 red, 3 reds = 1 blue, 3 blues = 1 orange, 3 oranges = 1 yellow, 3 yellows = 1 purple.



Purple Yellow Orange Blue Red Green

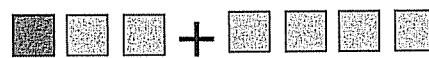
Turn 1. Rolls a five. Picks up five green blocks.



Trades in three greens for one red. Ends with two greens and one red.



Turn 2. Rolls a four. Picks up four greens and adds them to the two greens and one red from the last turn.



Player now has six greens and one red. The six greens trade in for two reds. Player now has three reds. Those three reds trade in for one blue. Ends with one blue.



Turn 3. Rolls a two. Picks up two greens. No trades possible. Ends with two greens and one blue.



Turn 4. Rolls a five. Picks up five greens. Now has seven greens and one blue. The seven greens trade in for two reds leaving one green remaining. Ends with one green, two reds and one blue.



## Extensions

1. Play the Trading Game with pennies, dimes, and dollar bills. Use two dice to make the game move faster. The first one to get one dollar wins. Playing with real money is much more interesting to students than the play stuff. Another variation is to play for a set amount of time, for example, thirty minutes. The person with the most money at the end of that time period wins.

2. Play the Trading Game backwards. Start with the highest value block and trade down to zero. Before playing decide how to end the game. Will the exact amount be needed to reach zero, or will you take away, into the negative values? Play a few games each way. Encourage the students to create different ways to end the game.

3. Use the Base Ten Blocks to trade up to one thousand. Roll one die and pick up ten times the number shown. Roll a five and pick up five ten rods.

4. For students with a lot of experience with the trading game, give several puzzles. These puzzles are quite challenging, since the trades are done mentally. Students can prove the answers with blocks.



**Puzzle 1** "The trading number is three. You have these blocks: two greens, two reds, and one blue. Figure out *in your head* what you would end up with if you rolled a three." "Two green and two blue blocks."

**Puzzle 2** "The trading number is three. You have these blocks: two greens, two reds, and two blues. Figure out *in your head* what you would end up with if you rolled a five." "One green, and one red, and one orange."

**Puzzle 3** "The trading number is now four. You have these blocks: two greens, three reds, and one blue. Figure out what you would end up with if you rolled a four." "Two green and two blue blocks."

**Puzzle 4** "The trading number is four. You have these blocks: three greens, three reds, and two blues. Figure out what you would end up with if you rolled a six." "One green, one red, and three blue blocks."

## Trading Game: Recording

**Prerequisites** Play many trading games with different bases without recording.

**Materials** Trading Game Record Sheet, page 2  
One die  
Colored blocks

**Lesson** **"Record what happens on each turn using the recording sheet."** This example follows the sample game given in the previous lesson.

Turn	Number Rolled	Purple	Yellow	Orange	Blue	Red	Green
1	5					1	2
2	4				1	0	0
3	2				1	0	2
4	5				1	2	1

**"When the trading number is three, what digits appear in your record?"** "Zero, one, two."

**"Change the trading number to four. Notice which numbers appear on the sheet. Predict what numbers will be on the sheet if the trading number is five. What if the trading number is six?"**

**"Explain the pattern you see."**

"Only the numbers zero to three appear on the recording sheet when the trading number is four because whenever you get four of anything you trade up. Four green blocks will show on the record sheet as a one in the red column."

**"What else is like this?"** The answer will be unique.

## Place Value: Counting Cuckoos

### Purpose

The purpose is to introduce a different way of counting so that students understand the relationships of numbers in our counting system. Counting to four is used so that any preconceived notions of our counting system won't interfere with the discoveries. Also, it is less cumbersome to play the game with a smaller amount of blocks. Base Ten is used with the same system later. Counting in different bases is easy for students when presented as a game. Don't let the concept of different bases keep you, the adult, from enjoying and learning more about numbers as you do the activities.

### Materials

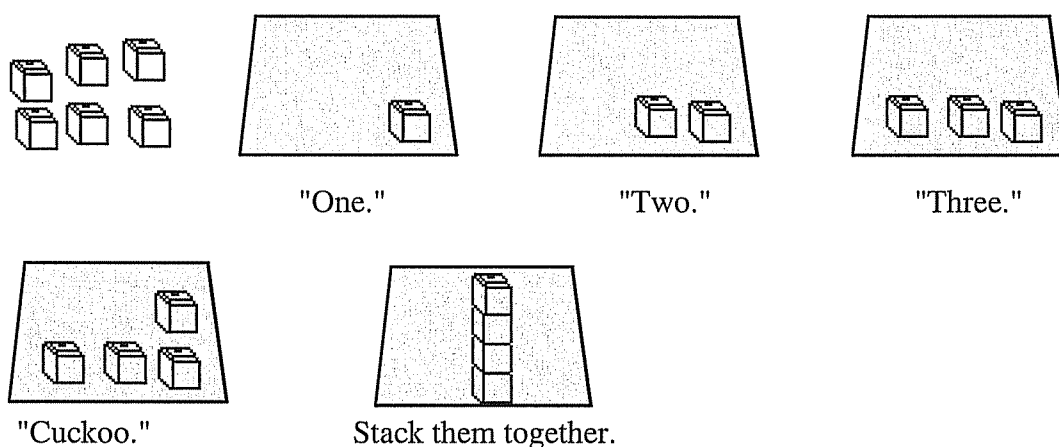
Unifix cubes  
Scratch paper for a workboard

### Lesson

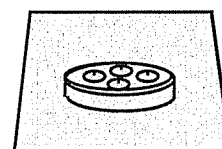
Count up to four. **"Today we are going to count a different way. Instead of saying four, we will say cuckoo. Count with me. One, two, three, cuckoo."** Everyone counts together. **"Again, one, two, three, cuckoo."** Count several times, as many as it takes for everyone to remember to count in cuckoos.

After the students are comfortable counting in cuckoos, start the new game. Count around the circle. The person who says cuckoo sits down. Play until there is only one person standing. Be sure to ask who will be left standing while the game is being played. Play again and start with the person who was the last one standing. Repeat several times and keep asking for predictions. Look for patterns.

Each student has a pile of counters. Count together in cuckoos. Start with all of the blocks off the workboard. Count one block at a time and add it to the workboard.



As soon as you have a cuckoo amount of blocks, stack them together. Count several stacks to make sure everyone understands what counting in cuckoos means. If you are using blocks or beans, group them together in a small cup when there is a cuckoo.

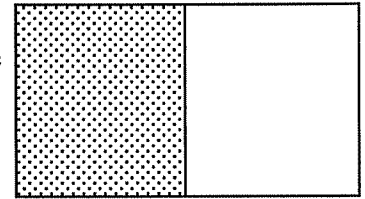


## Place Value: Manipulative

**Purpose** The purpose is to introduce the workboard and counting in base four.

**Materials** Unifix cubes or counters with three small bowls or cups  
Workboard made from two pieces of paper, one white and one any color.

Workboard



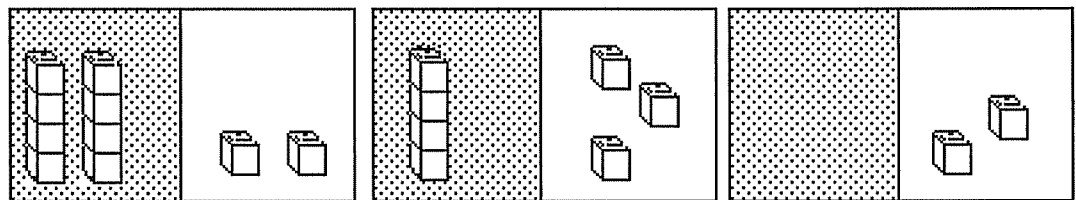
**Warm Up** Review counting by cuckoos (base four).

**Lesson Session 1** Pass out a workboard to each student. Be sure the students start with the white side of the board on their right side. **"White side on the right"** is easy to remember.

**"Clear the place value boards of all blocks. Add one block to the white side of the board each time I say ding."** Students add one block. Continue until there are four loose blocks. **"What will you have now?"** The students should realize they now have a cuckoo. **"The way the rule works is: Once there is a cuckoo, cuckoos always go on the left side of the board."** Continue adding blocks until there are three cuckoos and three blocks. **Stop at three cuckoos and three blocks at this stage of the lessons.** Later, students will figure out how to build with three digits.

**Session 2** Repeat Session 1 but this time, **"Say the amount you have after each ding."** "Zero cuckoos and zero." Ding. "Zero cuckoos and one." Continue adding blocks until there are three cuckoos and three blocks. Count back down from three cuckoos and three blocks to zero cuckoos and zero blocks. Remove one block each time the teacher says ding. When three cuckoos and zero is reached, allow the student to discover one cuckoo has to be taken apart in order for one block to be taken away. The number can be read as "one cuckoo and one" or "one cuckoo and one block."

**Test for Understanding** 1. Place different amounts on the board and have the student read the board. Such as:

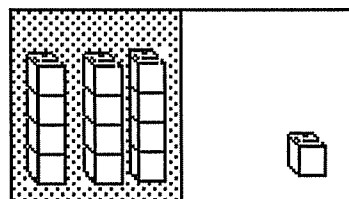


Two cuckoos and two

One cuckoo and three

Zero cuckoos and two

2. Ask the student to build three cuckoos and one.



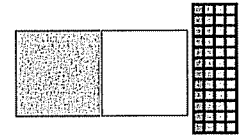
## Place Value: Two Digits

**Purpose** The purpose is to record place value in base four in two places.

**Prerequisites** Place Value: Counting Cuckoos and Place Value: Manipulative. Practice going up to three cuckoos and three ones several times with different manipulatives.

**Materials** Place Value Strips: Four Digits, page 3; make multiple copies - cut into single strips  
Unifix cubes or counters with three containers or cups  
Workboard

**Warm Up** Pass out a workboard, a recording strip, and manipulatives. Be sure the student starts with the white side of the board on the right and the recording strips match the workboard.



Start by having the student count a few cuckoos on the board. This should be easy by now and done with confidence. If it is difficult, practice more before recording. The number can be read as "one cuckoo and one" or "one cuckoo and one block."

**Lesson Session 1** "Clear the place value boards of all blocks. How many cuckoos and blocks on your board?" "Zero cuckoos and zero." Be sure the student says the entire number including each place. "Record that on the top of your recording strip." It should look like this:

		0	0
--	--	---	---

"Add one block to the white side of the board each time I say ding. Read the board, 'Zero cuckoos and one' and record."

		0	0
		0	1

Say ding again. The student adds another block, reads, and records. Continue adding blocks until three cuckoos and three blocks is reached.

The strip will look like this: →

		0	0
		0	1
		0	2
		0	3
		1	0
		1	1
		1	2
		1	3
		2	0
		2	1
		2	2
		2	3
		3	0
		3	1
		3	2
		3	3

Do not count up any more. Stop at three cuckoos and three. Say, "Look for patterns. Circle all of the patterns you find." Discuss them. Save this strip for the next session.

### Session 2

		3	3
		3	2
		3	1
		3	0
		2	3
		2	2
		2	1
		2	0
		1	3
		1	2
		1	1
		1	0
		0	3
		0	2
		0	1
		0	0

Use the strip from the last lesson. Attach a blank strip to the end with tape. Have the student read the last number on the strip. He should be able to read it as "Three cuckoos and three" and build it with blocks. "This time, take off one block each time I say ding. Read and then record."

Check his work as he subtracts.

Repeat counting and recording one strip in *base five*. Make up a new name for a group in five blocks. "One, two, three, four, \_\_\_\_\_."

		0	0
		0	1
		0	2
		0	3
		0	4
		1	0
		1	1

		1	2
		1	3
		1	4
		2	0
		2	1
		2	2
		2	3

		2	4
		3	2
		3	3
		3	4
		4	0

		4	1
		4	2
		4	3
		4	4

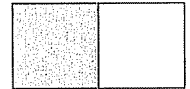


## Place Value: Three Digits

**Purpose** The purpose is to discover how to count up from two digit numbers to three digit numbers in base four (cuckoos). Reminder: In this book a 'cuckoo' is always a group of four blocks.

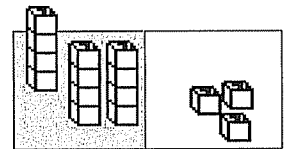
**Prerequisites** Place Value: Counting Cuckoos, Place Value: Manipulative, and Place Value: Recording. Many months of practice with several different bases. Students are ready when they ask what comes after three cuckoos and three.

**Materials** Unifix cubes or counters with three small bowls  
Workboard  
Extra sheet of scratch paper

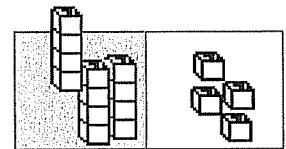


**Warm Up** Pass out workboard and manipulatives. Have the student begin with the white side of the board on the right. Start by having the student count a few cuckoos on the board.

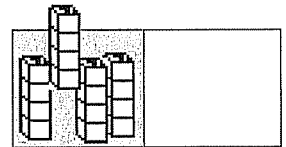
**Lesson** Clear the place value boards of all blocks. Start counting in cuckoos. Count up to three cuckoos and three.



Say ding again; have the student put on one more block. Then wait to see what she does.



Here is a typical scenario: She adds one more block to the ones side. Since she now has a cuckoo, she puts the single blocks together, then puts this stack on the left side of the board, which is the cuckoo side. Now what?



Here comes the leap in thinking. She has to make a generalization that since there are more than three stacks of cuckoos on the left side of the board, these stacks cannot stay in this column. It is the same ground rule as before. Once there is a cuckoo amount of blocks in the ones place, the blocks are grouped together and moved to the left side of the board. The same is true of the cuckoo side of the board (left). Once there is a cuckoo amount of cuckoos, the blocks are grouped together and moved to the left. The key here is the phrase, 'a cuckoo amount of cuckoos.' This is what the student must figure out that she has. Do not tell her this.

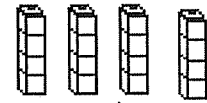
I have had success by having the student count the cuckoos. "One, two, three, four" is the typical response. This is *not* correct. Most students can easily count the single blocks in cuckoos. But when they count the stacks of blocks, they do not generalize and count in cuckoos. If she counts to four, ask her to go back and count the single blocks again.

"One, two, three, cuckoo."  Put them together in a stack.   
One, two, three, cuckoo

"Where does a cuckoo go?" "On the cuckoo side."

"Why?" "They are now cuckoos. And cuckoos go on the other side."

Now have her count the cuckoos (or stacks of blocks).



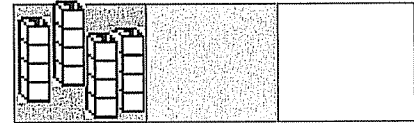
One, two, three, cuckoo

"Yes, one, two, three, *cuckoo*. That is how many you have. Excellent thinking. Where would you put them?"

"Over here?" (Points off the board to the left.)

"That makes sense." At this point bring out another sheet of paper of a different color.

"This is how you can show another column."

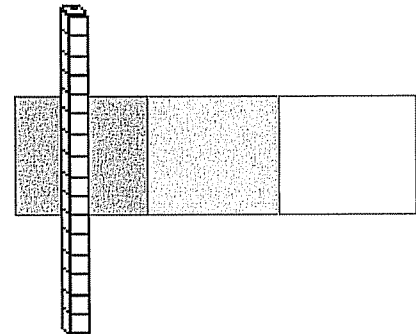


"Now we need a new name." As in the familiar base ten system, the third column's name is "hundred."

"How about giant cuckoo?"

"Now we need to show the stacks are one giant cuckoo."

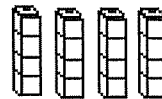
She takes all of the stacks and puts them together in a long stack. This stack is put on the left of the board.



Or all of the stacks can be put into a bowl to indicate one giant group.

The physical model has been figured out, but there is one last thing to confirm. If the stack was made into a giant cuckoo, break it into cuckoos again (stacks of four).

"How many cuckoos are there?"

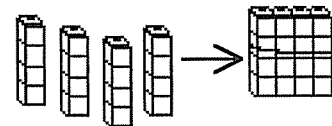


"Cuckoo cuckoos, or a cuckoo amount of cuckoos." (It is the same as saying ten tens if you are counting in base ten.) If the student says "Four," go back to the counting section again at the top of the previous page. Have her rethink this part until the light comes on and the student realizes that it is a cuckoo amount of cuckoos. This is a difficult concept and may take some time.

## Variation

The way cuckoo cuckoos, or giant cuckoos, are displayed can add an important dimension to the understanding of our number system. At first, allow the student to express the giant cuckoo in any way that makes sense. Then try this variation. Use Unifix cubes and build in stacks. Build the numbers until there is a giant cuckoo, then rubber band it together into a square.

Use this square for giant cuckoos.



The student has now built a concrete manipulative of a square number. This serves as a model for the pictures of square numbers and their symbolic form  $4^2$  (read four to the power of two) she will encounter in the future. A model a student can build and verify is a solid foundation for all difficult concepts.

## Place Value: Three Digits - Recording

### Purpose

The purpose is to record three digit numbers in base four (using cuckoos).

### Prerequisites

Place Value: Counting Cuckoos, Place Value: Manipulative, Place Value: Recording, Place Value: Three Digits, and practice in counting with three digits in several different bases over a few weeks to several months

workboard

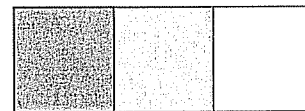
### Materials

A copy of Place Value Strips: Four Digits, page 3

Unifix cubes or other counters

Tape and scissors

Make a workboard with two colored pieces of scratch paper and one white.



### Warm Up

Pass out a workboard and manipulatives. Be sure the student begins with the white side of the board on her right.


### Lesson

Start by having the student count up to three giant cuckoos, three cuckoos, and one on the board. This should be easy for the student by now and done with confidence. This can be done quickly if you count by twos.

0	0	0
0	0	1
0	0	2
0	0	3
0	1	0
0	1	1
0	1	2
0	1	3
0	2	0
0	2	1
0	2	2
0	2	3
0	3	0
0	3	1
0	3	2
0	3	3
1	0	0
1	0	1
1	0	2
1	0	3
1	1	0
1	1	1
1	1	2
1	1	3
1	2	0
1	2	1
1	2	2
1	2	3
1	3	0
1	3	1
1	3	2
1	3	3

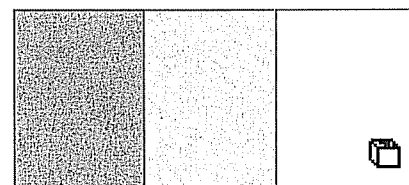
**"Clear the place value boards of all blocks. What amount do you have on your board?"** "Zero giant cuckoos, zero cuckoos, and zero."

Be sure the student says the entire statement.

**"Record that on the top of the recording strip."** 

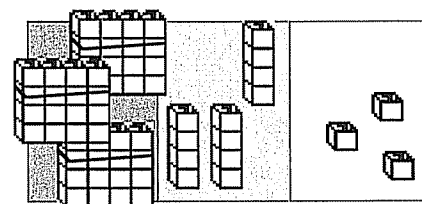
**"Ding."** The student adds one block to the white side of the board. **"Read the board and record."** "Zero giant cuckoos, zero cuckoos, and one."





Continue adding blocks and building the strips longer until you get to three giant cuckoos, three cuckoos, and three.





By now the student may be able to work independently to finish this activity. Some students will want to drop the manipulatives and just record because they know the pattern. This is fine. Just be sure to check the strip to make sure the student isn't making mistakes. Also have the student build a few numbers once in a while to check for understanding and accuracy. Once 333 is reached, let the student take the next step and add another column for four digits.

Repeat counting and recording one strip in base five. Use your new name for a group of five.

## Place Value to One Hundred and One Thousand

**Purpose** The purpose is to review place value in the hundreds place and to extend the understanding of place value to numbers up to ten thousand.

**Prerequisites** Place Value: Counting Cuckoos, Place Value: Manipulative, Place Value: Recording in Two Places, and Place Value: Recording in Three Places. Repeat in base five.

**Activities**

1. How long will a line of one hundred of each of these be: pennies, Unifix cubes, centimeter cubes or colored cubes, pinto or lima beans? Have the student estimate by placing a piece of masking tape or by stretching a length of string. After making the first estimation, make a length of ten objects. Let her modify the estimate. Continue adding objects until the count gets up to fifty. With this information have her estimate one more time. Compare the estimates.

2. Draw a square that ten standing students could fit into. How big would the square be if you wanted to stand one hundred? Have students notice seating capacity signs in theaters and restaurants. Can you seat one hundred students on a school bus? Are there one hundred seats per row in a theater?

3. What in the world weighs one hundred pounds? Make a list of things weighing one hundred pounds.

4. Have the student estimate how high in a jar one hundred beans will go. Or select a range of sizes of food jars. Which one will just hold one hundred beans?

5. How far is one hundred feet? How far is one hundred of your paces set heel to toe?

6. Close your eyes and raise your hand when ten seconds have passed; lower it when one hundred seconds have passed.

7. How long does it take to hop one hundred times? How long does one hundred turns of a jump rope take?

8. Number from zero to one hundred on place value strips.

9. What was going on in the world one hundred years ago?

10. What can you buy for one hundred dollars?

### How much is one thousand?

1. Continue the numbers on the place value strips into four digits and count as far as the student wants to go. This will take several days and can be done by several students. Estimate how long the strip will be when it is finished. Tape it up on the wall or ceiling when it's done. If an error is made in the counting, the student can cut out the wrong part and tape in a corrected version. Place Value Strips: Four Digits, page 3.

2. Using centimeter grid paper, cut out one square, then a row of ten squares, then

a large square of one hundred cm squares. Write a dark one hundred on the one hundred cm square. Have the student estimate how much space will be taken up by a one thousand small cm squares. Then proceed to cut out nine more squares of one hundred. Paste them next to each other on a large piece of paper. Label each one hundred as you go up, two hundred, three hundred, four hundred, etc. When you are finished, draw a dark, heavy line around the entire one thousand. Use this picture of one unit, one ten, one hundred, and one thousand to make a chart. "**How many units are in one thousand? How many tens in one thousand? How many one hundreds? What pattern do you notice?**" "There are one thousand units, one hundred tens, and ten hundreds, and one thousand. They go down by factors of ten."

3. Solve addition problems with place value blocks that go into the thousands, e.g.,  $295 + 458 + 289 = 1042$ .

4. Estimate where, on a one gallon jar, the top of one thousand pinto beans will be. A fast but not as accurate way to fill the jar is to count out one hundred beans and weigh them. Then multiply that weight by ten and weigh out that many beans.

5. Using the jar of one thousand beans as a standard, fill another jar to a level that is less than the level of the one thousand and have everyone in the family or class guess how many beans are in the jar. Later, refill the jar to over one thousand and estimate again.

6. What in the world weighs one thousand pounds? This is a good research project. Have students make a list of animals and objects that might weigh around one thousand pounds. Then look them up in the encyclopedia or on the Internet. Draw pictures of the things that weigh around one thousand pounds and make a display of them.

7. What was going on in the world one thousand years ago? Have the student guess what kinds of machines people had. Were there dinosaurs then? Who lived where you live now? What was the population of the world then; what is it now?

8. There is a book about John F. Kennedy called *One Thousand Days*. How many years is that? Is that a full presidential term? What happened to Mr. Kennedy?

9. What can you buy with one thousand dollars?

10. How far is one thousand feet? Walk off one thousand paces. It is fun to pace it off on the beach if you have one available. How many feet make one mile?

## Note

These activities are important for developing concepts of numbers in the world. We all know that the national debt each year is in the billions of dollars, but how many of us have even an inkling of how much that is in physical terms? (One billion seconds is about thirty-two years!) The physical grasp of number sizes is critical for us to have in order to really understand our mathematical world. The activities are fun for most students and help them to realize that numbers are alive, that they are a part of our everyday world and not just something we do in school. It gives the written numbers on the paper a physical meaning.

**Test for  
Understanding**

1. This is a test of the abstract concept of numbers to one hundred and one thousand. "What does  $99 + 1 = ?$  (100) What does  $1,000 - 1 = ?$  (999) What does  $399 + 1 = ?$  (400)" If these can not be done in the head, it would be safe to assume that the student's abstract understanding of place value is weak.
2. Build a number in the hundreds with the Base Ten Blocks. Have the student read the number.
3. Write a number in the hundreds and have the student build it with Base Ten Blocks.
4. Write a number in the hundreds and have the student draw a picture of the blocks she would use to build a model of the number.

**Testimonial  
by a UCI,  
Farm  
Elementary  
School  
Graduate**

"For the UCI administration, to whom it may concern:

My name is Ross Venook. I am a freshman at Stanford University, a Woodbridge High School graduate, and a graduate of Farm School. Those are in reverse chronological order only. Most of all, I am a student of life. I owe this to Farm School....

...(Circle math and counting in base 4--the way to a freer, better conceptualization of mathematics in kindergarten.) The idea of 'place value' is the most difficult concept for young children to understand, mainly because it conflicts with their only base (no pun intended) in numbers, namely sequential counting. The base 4 counting taught me to regard ten as an arbitrary choice in the same position as other numbers in their own bases. By separating numbers into 10s, 100s, 1000s, etc., as a method to arithmetic, I developed an early understanding of number concept. Beyond that, counting in base 4 didn't seem to have helped me much—until Pre-Calculus, when I began to hear the '1, 2, 3, BING' of my sixth year in my head when my teacher tried to explain to the class of high school juniors and seniors what different bases were. She was failing where my first grade Farm School teacher had succeeded. Why? Because the teachers at Farm School knew that the number 10 is not particularly special as a base, and that until we were taught otherwise (such as through rote methods taught in all public schools anywhere near Farm School), we could get past such limited thinking."

Excerpt from a letter written in the 1990s by Ross Venook in support of the Farm School.

## Trading Game: Number Values

**Purpose** The purpose is to make a connection between language and math by posing a puzzle and having the student write, draw pictures, and write a number sentence of the solution.

**Prerequisites** Play the Trading Game many times in different bases and with different trading amounts. Be sure all students know how to make their own trades.

**Materials** Trading Game: Logic Puzzles, page 5  
Dice  
Colored blocks or other counters, six different colors  
Paper and pencil

**Lesson** Play one game of the trading game using six colors with three as the trading amount. Use two dice to help speed up the game.

The colors are: purple blue green yellow orange red



For a large group, play a mock game with only one player rolling the dice. Ask different students to explain how to make the trades.

The game can be stopped after a few students have traded up to green. Point to the red and ask, "**How much is it worth?**" "One." Record this for all to see. Have each student record independently.

**"If the red is one, how many red blocks is the orange worth?"**

"Three." Again, record this.

**"The yellow is worth...?"** This may take some thinking and time to figure out.

"Nine." Another way of phrasing it is, "**How many reds does it take to make a yellow?**" The students may build a model if they need to.

The number pattern so far is 1, 3, 9.

The rest of the lesson will be done independently or in small cooperative groups.

**"Write the answer to the following questions and explain how you got the answer. Write as if you were going to tell someone else how you figured out the answer. Draw pictures and write a number sentence."**

**"How many red blocks do you need to get a green block? Continue the pattern.**

**What is the next number in the series?"** "Twenty-seven."

1, 3, 9, \_\_\_\_

**Challenge** **"Continue the pattern. "1, 3, 9, 27, 81, 243."**

**"How many reds do you need to make a purple?"** "Two hundred forty-three red."

**"How many reds do you need to make a blue?"** "Eighty-one red."

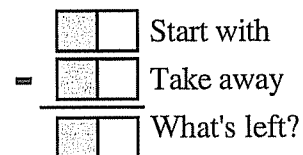
**"How many greens do you need to make a purple?"** "Nine green."

**Worksheet** Trading Game: Logic Puzzles, page 5

## Place Value: Subtraction - Base 5 and Place Value: Six Digit

**Purpose** The purpose is to learn to subtract and regroup in different bases manipulatively. Subtracting in different bases is a step that helps students generalize the process of standard regrouping in base ten.

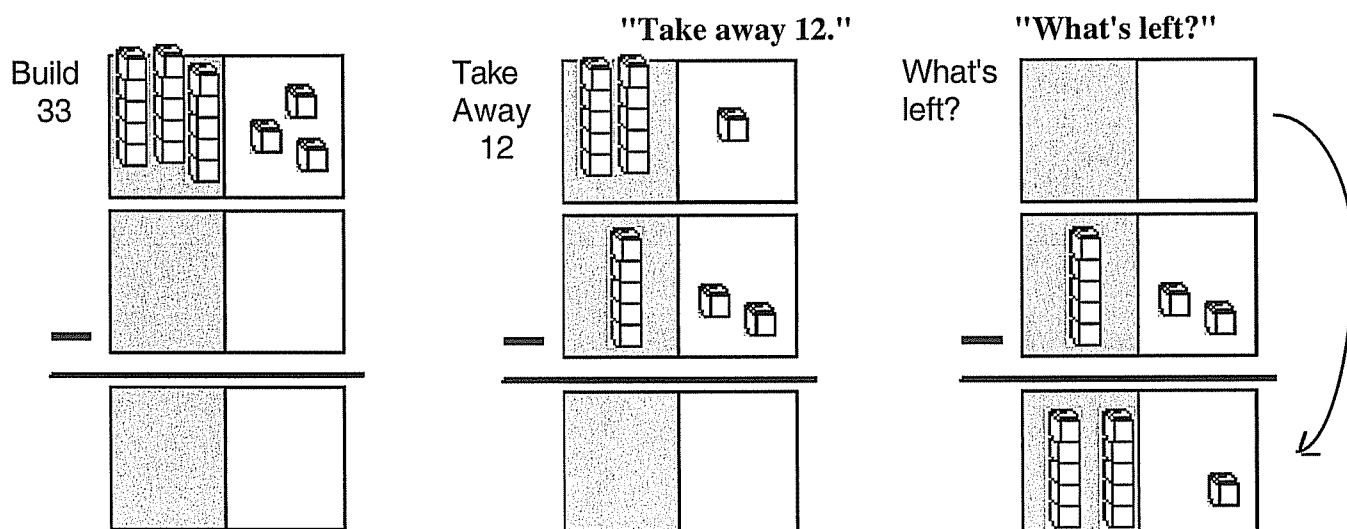
**Prerequisites** Place Value: Counting Cuckoos, Place Value: Manipulative, Place Value: Recording, and fluency with counting in base four (cuckoos), and base five



**Materials** Place Value: Subtraction - Base 5, Worksheet 1, page 6  
Unifix cubes or cups and beans  
Three Place Value Subtraction Boards. Make these with three white and three colored sheets of paper taped together.

**Lesson** Each student starts three Place Value Subtraction Boards with the white squares on the right. Use manipulatives only.

**"Build 33 in base 5 in the top workboard."**



**Worksheets** Solve another problem or two together if it is needed. Do not give any regrouping problems at this time. Then have the student complete Place Value: Subtraction - Base 5, Worksheet 1, page 6 independently.

Place Value: Subtraction - Base 5, Worksheet 2, page 7 If a student has difficulty with row three, which has regrouping problems, have the student build the problem with the manipulative.

Abacus Mystery Numbers, page 8

**Practice Worksheets** Return to the base ten system by doing the first problem together on Place Value: Six Digit - Worksheet 1, page 9. Have the student complete it independently.

Place Value: Six Digit - Worksheets 2 - 5, pages 10 - 13



## What's My Rule?

### Purpose

The purpose is to learn to spot patterns in number series. When you are looking for a pattern that uncovers a hidden operation, you look at what number you started with and what number you ended with and try to figure out what happened to the numbers in between. This is one thing scientists and mathematicians do when they discover new "formulas." A game that exercises this skill is What's My Rule?

### Activity

To play, think of a simple operation such as  $+ 2$ . The student gives you a number and you add two to it and say the new number back. For example, if she says, "one," you say "three." She says, "five" and you say, "seven." The number she gives you is called the independent variable, or the number In. The number you say back is called the dependent variable, or the number Out.

Record the information on a chart like this:

IN	OUT
1	3
5	7
9	<u>   ?</u>

What's My Rule? +2

When a student thinks she knows the rule, let her predict the number out loud. Finally, when everyone can predict successfully, let someone formulate the rule of plus 2. Students love to make these up for each other using easy addition, subtraction, multiplication, and division operations.

Play this game regularly. It's a good rainy day and in-the-car game.

One teacher called this activity Black Box and made a symbolic black box out of a milk carton decorated with gears and levers with a slide inside that flipped a card upside down. A card would be put in the slot in the top of the box and come out the number written on the back of the card came out a bottom slot. The students then guessed the rule. When the box appeared, the students' minds focused to discover the relationship between the In and Out number of the day.

### Worksheet

What's My Rule? - Blank page to copy is on the following page.

Sample games:

IN	OUT
2	4
6	8
9	___
20	___

What's My Rule? \_\_\_\_\_

IN	OUT
7	4
3	0
10	7
8	___
20	___

What's My Rule? \_\_\_\_\_

\*Answers : 9      Rule: Add 2  
 11      22      20      17      Rule: Subtract 3  
 8      5

What's My Rule?

Date \_\_\_\_\_

IN	OUT
—	—
—	—
—	—
—	—
—	—

What's My Rule? \_\_\_\_\_

IN	OUT
—	—
—	—
—	—
—	—
—	—

What's My Rule? \_\_\_\_\_

IN	OUT
—	—
—	—
—	—
—	—
—	—

What's My Rule? \_\_\_\_\_

IN	OUT
—	—
—	—
—	—
—	—
—	—

What's My Rule? \_\_\_\_\_

IN	OUT
—	—
—	—
—	—
—	—
—	—

What's My Rule? \_\_\_\_\_

IN	OUT
—	—
—	—
—	—
—	—
—	—

What's My Rule? \_\_\_\_\_

## Rounding Off: Tens

**Purpose** The purpose is to induce the rules for rounding off numbers to the nearest ten or hundreds place.

**Prerequisites** What's My Rule?

### Lesson

Play What's My Rule? with an operation rounding off to the nearest ten. **"What number would you like to put in? For this game limit the number to two digits."** "Seventy-six."

**"If the In number is seventy-six, the Out number is eighty. What other number would you like to try?"** "Seventy-two."

Record the numbers and the rounded off numbers on a piece of paper or the chalkboard.

**"If I put In eighty-nine, predict what the Out number will be."** "Ninety."

After the students can correctly predict what the Out number will be, ask, **"What's the rule?"**

IN	OUT
76	80
72	70
35	40
17	20
43	40
50	50
86	90

1. If the ones digit is less than five, the tens digit remains the same and the ones digit changes to zero.

2. If the ones digit is five or more, add one to the ten's digit, and change the ones digit to zero.

**"Mathematicians call this 'rounding off' a number to the nearest ten."**

**"When have you done this, seen it, or heard it?"**

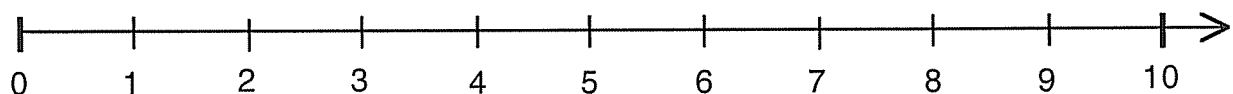
"About three hundred kids were there."

"It costs around twenty dollars."

"I have to get up around seven in the morning."

**"Does this work with a three digit number? Try it."**

**Worksheets** Rounding Off: Tens - page 14 Draw a number line on a piece of paper from 0 to 10.



**"Put your finger on the 3. Is your finger closer to 0 or to 10?"** "The zero."

**"Put your finger on the 8. Is your finger closer to 0 or to 10?"** "The ten."

## Rounding Large Numbers

### Lesson 1

Play What's My Rule? with an operation rounding off to the nearest hundred. **"Let's make the In number over one hundred but less than one thousand."**

"Three hundred seventy-six." **"Four hundred."**

"Two hundred seventy-three." **"Three hundred."**

After the students can correctly predict what the Out number will be, ask, **"What's the rule?"**

1. Find the digit in the hundreds place. If the digit to the right of it is less than five, do not change the hundreds digit but change every digit to the right of it to zero.

2. If the digit is five or greater, add one to the hundreds digit and change all the digits to the right of it to zero.

**"Mathematicians call this operation 'rounding off.' Now that we have rounded off to the nearest ten and the nearest hundred, would anyone like to try rounding off for a thousand or million?"** Encourage further generalizing of the rule.

IN	OUT
376	400
273	300
449	400
617	600
589	600
138	100
161	200

### Worksheet

Rounding Off: Large Numbers - Worksheet 1, page 15

### Lesson 2

#### Materials

Base Ten Blocks

**"Build 386 with Base Ten Blocks."**

**"Take out enough hundred blocks to be lowest closest hundred to 386."**

**"Take out enough hundred blocks to be highest closest hundred to 386."**

**"Complete this statement."** 386 comes between \_\_\_\_ hundred and \_\_\_\_ hundred.  
Answer: 386 comes between 300 and 400.

**"What number is halfway between 300 and 400?"** "350."

**"Is 386 greater than or less than the halfway number?"** "Greater than."

**"So, 386 rounds to \_\_\_\_\_?"** "400."

Repeat this line of questioning with 237.

### Worksheets

Rounding Off: Large Numbers - Worksheets 2 - 5, pages 16 - 19

### Lesson 3

#### Materials

Base Ten Blocks

**"Build 1,432 with Base Ten Blocks."**

**"Take out enough thousand blocks to be lowest closest thousand to 1,432."**

**"Take out enough thousand blocks to be highest closest thousand to 1,432."**

**"Complete this statement":** 1,432 comes between \_\_\_\_ thousand and \_\_\_\_ thousand.

Answer: 1,432 comes between 1 thousand and 2 thousand.

**"What number is halfway between 1,000 and 2,000?"** "1,500."

**"Is 1,432 greater than or less than the halfway number?"** "Less than."

**"So, 1,432 rounds to \_\_\_\_\_?"** "1,000."

Repeat this line of questioning with 2,684.

### Worksheets

Rounding Off: Large Numbers - Worksheets 6 and 7, pages 20 and 21

## Patterns in Sums: Column Addition

### Purpose

The purpose is to develop pattern play and to facilitate mastery of sums. To 'make tens,' counting in place value units, as a strategy for efficient adding.

### Materials

Patterns in Sums: Column Addition - Worksheet 1, page 31

Cuisenaire Rods

Scratch paper

$$\begin{array}{r} 6 \\ 4 \\ 3 \\ + 2 \\ \hline 11 \\ 24 \\ 13 \\ + 25 \end{array}$$

### Lesson

Give a few column addition problems such as:

Easy to solve example:

$$\begin{array}{r} 6 \\ 4 \\ 2 \\ 8 \\ 5 \\ + 5 \\ \hline \end{array}$$

**"With Cuisenaire rods make ten as many ways as possible using only two rods. Prove that each is equal to ten. Record each combination in a number sentence on scratch paper."**

**"With the combinations you just made, write three column addition problems that would be easy to solve."**

Give a column addition problem such as:

$$\begin{array}{r} 6 \\ 1 \\ 3 \\ 4 \\ 9 \\ + 3 \\ \hline \end{array}$$

**"Is there a way to make this addition easier?"**

One student drew a looping line between each pair of numbers that added up to ten and wrote ten in the loops.

Take students' suggestions and try them.

**"Does the answer come out the same?"**

"Yes."

**"Why?"**

"The numbers are the same. They are just being added up in a different order."

$$\begin{array}{r} 6 \\ 1 \\ 3 \\ 4 \\ 9 \\ + 3 \\ \hline \end{array}$$

Diagram showing looping lines between 6 and 4 (forming 10), 1 and 9 (forming 10), and 3 and 3 (forming 6).

Then the student drew looping lines between the pair of numbers that were doubles and wrote their sum. Finally she added the pairs of numbers:  $10 + 10 + 6 = 26$ .

**"Try this looping method on one of your easy to solve problems."**

Give a few column addition problems with double digits before giving Patterns in Sums: Column Addition - Worksheet 1, page 31 to complete independently.

### Worksheets

Patterns in Sums: Column Addition, Worksheets 2 - 3, pages 32 - 33

Gus the Bus Driver, Worksheets 1 and 2, pages 34 and 35

Assessment, page 36

# **Patterns in Arithmetic**

**Place Value: Book 2**

**Rounding Off and Estimating**

## **Answer Key for the Student Workbook**

**By Suki Glenn and Susan Carpenter**

# Answer Key Legend

AWV = answer(s) will vary

BUWV = break up will vary

OWV = order will vary

## Pattern Blocks

r = red trapezoid

g = green triangle

y = yellow hexagon

o = orange square

b = blue parallelogram

t = tan rhombus

## Cuisenaire Rods

1 w = white

2 r = red

3 lg = light green

4 p = purple

5 y = yellow

6 dg = dark green

7 bk = black

8 bn = brown

9 bl = blue

10 o = orange

Note: Some items and pages are left out of the answer key.

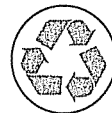
- 1) Some pages in which the answers are open-ended or will vary.
- 2) Make your own problems. Since students create their own problems and solutions, these sections give valuable information about the level of confidence and competence. It can be a useful source of curriculum for other students.
- 3) Practice pages.
- 4) Workboards.
- 5) The answers are in the Parent/Teacher Guide.

Patterns in Arithmetic: Place Value - Booklet 2  
Answer Key for the Student Workbook  
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# Place Value - Booklet 2

## Trading Game Logic Puzzle

Set up the blocks as a model. The trading number is three.  
This is the set up for this trading game: purple red blue yellow green

- 3 greens = 1 yellow
- 3 yellows = 1 blue
- 3 blues = 1 red
- 3 reds = 1 purple

Warm-up: do these without blocks.

- You begin with nothing and roll a five. What do you have now? 1 yellow, 2 greens
- Then you roll a four. Now what do you have? 1 blue
- Then you roll a six two turns in a row. What do you have now? 2 blues, 1 yellow  
Now, take out the blocks and see if you are right.
- You have two green blocks, one yellow block, and one blue block. You roll a four. What do you end up with? 2 blue  
(Remember, you are thinking about it this time. Build to check it after you have guessed).
- You have one green, two yellows, two blues, and one red block. You roll a six. What do you have now? 1 green, 1 yellow, 2 reds
- You have two greens, two yellows, one blue, and two reds. How many greens must be added to end up with zero green, zero yellow, zero blue, zero red, and one purple  
10 greens
- If a green = 1  
then a yellow = 3  
a blue = 9  
a red = 27  
a purple = 81
- If the trading number is four,  
then a green = 1  
a yellow = 4  
a blue = 16  
a red = 64  
a purple = 256

5

## Place Value Subtraction: Base 5 - Worksheet 1

Build 33 Take Away 12 	Build 43 Take Away 12 	Build 44 Take Away 23 
Build 13 Take Away 12 	Build 34 Take Away 3 	Build 40 Take Away 20 
Build 42 Take Away 13 	Build 31 Take Away 12 	Make your own. <u>AWV</u> Build Take Away

6

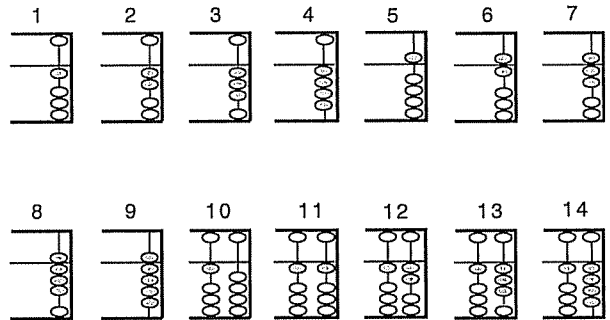
## Place Value Subtraction: Base 5 - Worksheet 2

- $$\begin{array}{r} 44 \\ - 34 \\ \hline 10 \end{array}$$
- $$\begin{array}{r} 34 \\ - 23 \\ \hline 11 \end{array}$$
- $$\begin{array}{r} 41 \\ - 20 \\ \hline 21 \end{array}$$
- $$\begin{array}{r} 42 \\ - 31 \\ \hline 11 \end{array}$$
- $$\begin{array}{r} 14 \\ - 3 \\ \hline 11 \end{array}$$
- $$\begin{array}{r} 43 \\ - 22 \\ \hline 21 \end{array}$$
- $$\begin{array}{r} 34 \\ - 21 \\ \hline 13 \end{array}$$
- $$\begin{array}{r} 42 \\ - 42 \\ \hline 0 \end{array}$$
- $$\begin{array}{r} 42 \\ - 24 \\ \hline 13 \end{array}$$
- $$\begin{array}{r} 43 \\ - 14 \\ \hline 24 \end{array}$$
- $$\begin{array}{r} 30 \\ - 10 \\ \hline 20 \end{array}$$
- $$\begin{array}{r} 43 \\ - 24 \\ \hline 14 \end{array}$$

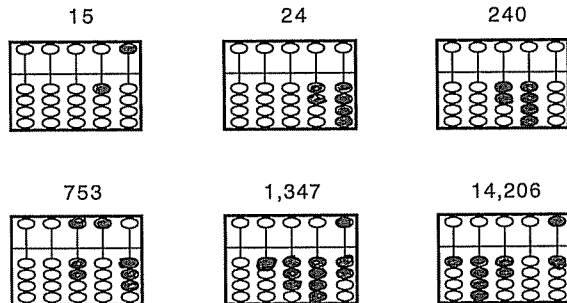
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## Mystery Abacus Numbers

Look at the numbers on these pictures of an abacus. Find the pattern.



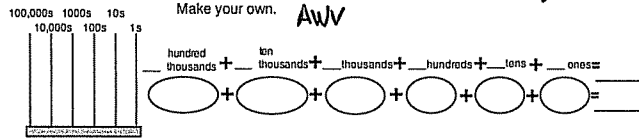
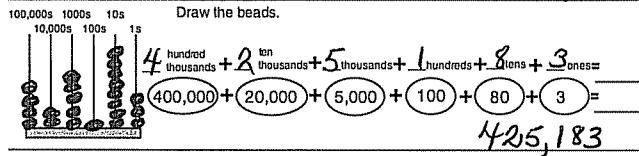
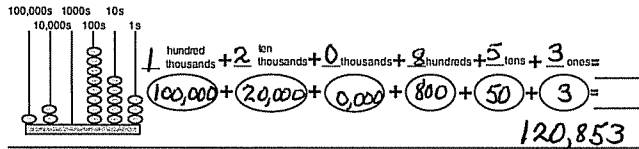
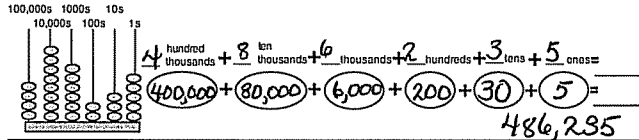
Color the beads that would be moved to build these numbers.



8



### Place Value: Six Digit - Worksheet 1



$$400,000 + 30,000 + 2,000 + 300 + 40 + 2 = 432,342$$

$$500,000 + 80,000 + 3,000 + 200 + 50 + 9 = 583,259$$

$$300,000 + 10,000 + 7,000 + 200 + 80 + 1 = 317,281$$

$$900,000 + 20,000 + 3,000 + 700 + 30 + 8 = 923,738$$

9

### Place Value: Six Digit - Worksheet 3

The first six place value names are on this chart.

Hundred Thousands	Ten Thousands	One Thousands	Hundreds	Tens	Ones
5	2	4	6	1	3

- What digit is in:
  - the ones place? 3                      the one thousands place? 4
  - the tens place? 1                              the ten thousands place? 2
  - the hundreds place? 6                              the hundred thousands place? 5

- In the number 387,962, what is the place value name of the:
  - 8 ten thousands                              6 tens
  - 2 ones    7 one thousands
  - 3 hundred thousands                              9 hundreds

- In the number 254,103, what is the place value name of the:
  - 0 tens    1 hundreds
  - 2 hundred thousands                              5 ten thousands
  - 4 thousands    3 ones

- Continue the patterns. What is happening? \_\_\_\_\_

100, 200, 300, 400, 500, 600, 700, 800, 900, 1,000, 1,100, 1,200

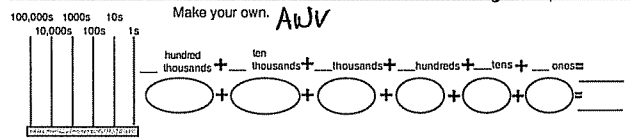
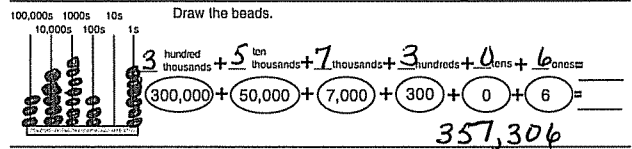
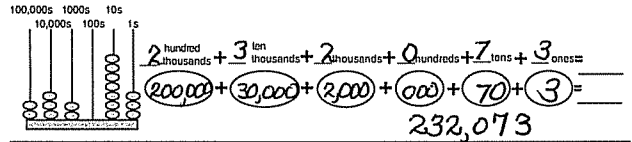
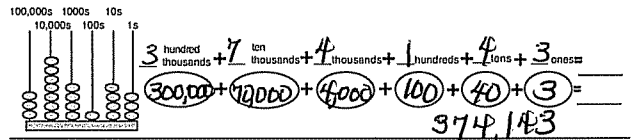
1,000; 2,000; 3,000; 4,000; 5,000; 6,000; 7,000; 8,000; 9,000

100,000; 200,000; 300,000; 400,000; 500,000; 600,000

700,000; 800,000; 900,000; 1,000,000; 1,100,000; 1,200,000

11

### Place Value: Six Digit - Worksheet 2



$$500,000 + 70,000 + 3,000 + 0 + 90 + 1 = 573,091$$

$$800,000 + 20,000 + 4,000 + 0 + 10 + 2 = 824,012$$

$$900,000 + 60,000 + 1,000 + 800 + 30 + 7 = 961,837$$

$$800,000 + 00,000 + 5,000 + 200 + 60 + 7 = 805,267$$

10

### Place Value: Six Digit - Worksheet 4

- Write the place value of each digit in the number 834, 972.

3 ten thousands                              9 hundreds  
 2 ones    7 tens  
 8 hundred thousands                              4 thousands

- Write the place value name of each underlined digit.

329,037 thousands                              437,18 ones  
 139,586 tens                                      496,319 ten thousands  
 236,961 hundred thousand                              342,995 thousands

- What digit is in the hundreds place in 5,289? 2
- What digit is in the ones place in 523,136? 6
- What digit is in the one hundreds place in 321,603? 6
- What digit is in the hundred thousands place in 752,048? 7
- What digit is in the ten thousands place in 461,258? 6
- What digit is in the thousands place in 903,147? 3

- Continue the patterns. What is happening? Each number is greater by 10 times.

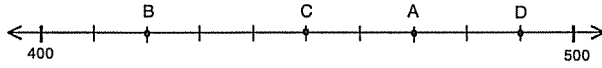
6; 60; 600; 6,000; 60,000; 600,000

4; 40; 400; 4,000; 40,000; 400,000

12



### Rounding Off Large Numbers - Worksheet 3



- Point A = 470.  
Point A is closer to 500.  
Point A rounds off to 500.
- Point C = 450.  
Point C is closer to 500.  
Point C rounds off to 500.
- Point B = 420.  
Point B is closer to 400.  
Point B rounds off to 400.
- Point D = 490.  
Point D is closer to 500.  
Point D rounds off to 500.

Round each number to the nearest

- 421 comes between 400 and 500.  
Halfway number 450.  
421 rounds off to 400.
- 832 comes between 800 and 900.  
Halfway number 850.  
832 rounds off to 800.
- 109 comes between 100 and 200.  
Halfway number 150.  
109 rounds off to 100.
- 550 comes between 500 and 600.  
Halfway number 550.  
550 rounds off to 600.
- 798 comes between 700 and 800.  
Halfway number 750.  
798 rounds off to 800.
- 668 comes between 600 and 700.  
Halfway number 650.  
668 rounds off to 700.
- 249 comes between 200 and 300.  
Halfway number 250.  
249 rounds off to 200.
- 310 comes between 300 and 400.  
Halfway number 350.  
310 rounds off to 300.

Make your own. Have one number round up and the other round down. **AWV**

- \_\_\_\_\_ comes between \_\_\_\_\_ and \_\_\_\_\_.  
Halfway number \_\_\_\_\_.  
\_\_\_\_\_ rounds off to \_\_\_\_\_.
- \_\_\_\_\_ comes between \_\_\_\_\_ and \_\_\_\_\_.  
Halfway number \_\_\_\_\_.  
\_\_\_\_\_ rounds off to \_\_\_\_\_.

17

### Rounding Off Large Numbers - Worksheet 4

These numbers are correctly rounded off to the nearest hundred.

$$376 \rightarrow 400 \quad 561 \rightarrow 600 \quad 450 \rightarrow 500$$

$$4,615 \rightarrow 4,600 \quad 9,342 \rightarrow 9,300 \quad 17,265 \rightarrow 17,300$$

These numbers are incorrectly rounded off to the nearest hundred.  $\nrightarrow$  means does not

$$325 \nrightarrow 400 \quad 410 \nrightarrow 300 \quad 389 \nrightarrow 500$$

$$3,782 \nrightarrow 4,600 \quad 17,225 \nrightarrow 17,100 \quad 36,075 \nrightarrow 36,000$$

Circle the numbers that are correctly rounded off to the nearest hundred. Correct the others.

$$164 \rightarrow 100 \quad 345 \rightarrow 300 \quad 678 \rightarrow 700$$

$$4,362 \rightarrow 4,360 \quad 9,865 \rightarrow 9,900 \quad 728 \rightarrow 800$$

Round off these numbers to the nearest hundred.

$$452 \rightarrow 500 \quad 178 \rightarrow 200 \quad \text{AWV} \rightarrow 600$$

$$4,854 \rightarrow 4,900 \quad 2,670 \rightarrow 2,700 \quad \rightarrow 13,500$$

$$12,853 \rightarrow 12,900 \quad 68,232 \rightarrow 68,200 \quad \rightarrow \quad \rightarrow$$

What is the rule for rounding off to the nearest hundred?

Go to the hundreds place and look to the digit to the right. If that digit is five or greater, round up to the next higher number. If the digit to the right is less than five, change the remaining digits to the right to zeros.

18

### Rounding Off Large Numbers - Worksheet 5

Round off. Solve the rounded off problems.

Ball park estimate

$$\begin{array}{r} 385 \rightarrow 400 \\ + 414 \rightarrow 400 \\ \hline 800 \end{array}$$

Ball park estimate

$$\begin{array}{r} 885 \rightarrow 900 \\ - 414 \rightarrow 400 \\ \hline 500 \end{array}$$

$$\begin{array}{r} 478 \rightarrow 500 \\ + 372 \rightarrow 400 \\ \hline 900 \end{array}$$

$$\begin{array}{r} 265 \rightarrow 300 \\ - 193 \rightarrow 200 \\ \hline 100 \end{array}$$

$$\begin{array}{r} 325 \rightarrow 300 \\ + 363 \rightarrow 400 \\ \hline 700 \end{array}$$

$$\begin{array}{r} 615 \rightarrow 600 \\ - 272 \rightarrow 300 \\ \hline 300 \end{array}$$

$$\begin{array}{r} 287 \rightarrow 300 \\ + 249 \rightarrow 200 \\ \hline 500 \end{array}$$

$$\begin{array}{r} 192 \rightarrow 200 \\ - 129 \rightarrow 100 \\ \hline 100 \end{array}$$

$$\begin{array}{r} 305 \rightarrow 300 \\ + 527 \rightarrow 500 \\ \hline 800 \end{array}$$

$$\begin{array}{r} 805 \rightarrow 800 \\ - 423 \rightarrow 400 \\ \hline 400 \end{array}$$

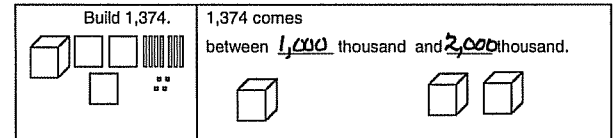
$$\begin{array}{r} 527 \rightarrow 500 \\ + 384 \rightarrow 400 \\ \hline 900 \end{array}$$

$$\begin{array}{r} 527 \rightarrow 500 \\ - 384 \rightarrow 400 \\ \hline 100 \end{array}$$

19

### Rounding Off Large Numbers - Worksheet 6

Base Ten blocks can be used to help round off to the nearest thousand.



What number is halfway between 1,000 and 2,000? 1,500

Is 1,374 greater than or less than the halfway number? less than

1,374 is closer to 1,000 and therefore rounds to 1,000.

2,823 comes between 2,000 and 3,000.

The halfway number is 2,500.

2,823 is (greater than, less than, or equal) to 2,500.

2,823 rounds to 3,000.

3,247 comes between 3,000 and 4,000.

The halfway number is 3,500.

3,247 is (greater than, less than, or equal) to 3,500.

3,247 rounds to 3,000.

Round each number to the nearest thousand.

Number	Comes Between	Halfway number	Rounds
1,286	<u>1,000</u> and <u>2,000</u>	<u>1,500</u>	<u>1,000</u>
3,592	<u>3,000</u> and <u>4,000</u>	<u>3,500</u>	<u>4,000</u>
9,325	<u>9,000</u> and <u>10,000</u>	<u>9,500</u>	<u>9,000</u>
634	<u>600</u> and <u>700</u>	<u>650</u>	<u>600</u>
8,097	<u>8,000</u> and <u>9,000</u>	<u>8,500</u>	<u>8,000</u>
6,612	<u>6,000</u> and <u>7,000</u>	<u>6,500</u>	<u>7,000</u>
15,639	<u>15,600</u> and <u>15,700</u>	<u>15,650</u>	<u>15,700</u>
5,239	<u>5,000</u> and <u>6,000</u>	<u>5,500</u>	<u>5,000</u>
117,328	<u>117,000</u> and <u>118,000</u>	<u>117,500</u>	<u>117,000</u>
1,500	<u>1,000</u> and <u>2,000</u>	<u>1,500</u>	<u>2,000</u>

20

# Rounding Off Large Numbers - Worksheet 7

'About how many' is another way of estimating answers. Rounding off is a way to find out 'about how many'. Here is one way to round off large numbers. For example, 16,723 dogs live in my town. Round off this number to the nearest ten thousand.

Skip count by multiples of the place value number which is being rounded.  
 10,000, 20,000, 30,000, 40,000, 50,000,  
60,000, 70,000, 80,000, 90,000, 100,000.

16,723 comes between 10,000 and 20,000.

What is the half way number between the multiples? 15,000

Is the number being rounded larger or smaller than the halfway number? larger



So about 20,000 dogs live in my town.

When rounding to the nearest thousand, skip count by multiples of 1,000.  
 1,000, 2,000, 3,000, 4,000, 5,000, 6,000,  
7,000, 8,000, 9,000, 10,000, 11,000.

Fill in the chart to round each number to the nearest thousand.

comes between	halfway number	rounds to
6,836 <u>6,000</u> and <u>7,000</u>	<u>6,500</u>	<u>7,000</u>
9,242 <u>9,000</u> and <u>10,000</u>	<u>9,500</u>	<u>9,000</u>
10,436 <u>10,000</u> and <u>11,000</u>	<u>10,500</u>	<u>10,000</u>
14,127 <u>14,000</u> and <u>15,000</u>	<u>14,500</u>	<u>14,000</u>
648,500 <u>648,000</u> and <u>649,000</u>	<u>648,500</u>	<u>649,000</u>

Fill in the chart to round each number to the nearest ten thousand.

comes between	halfway number	rounds to
16,378 <u>10,000</u> and <u>20,000</u>	<u>15,000</u>	<u>20,000</u>
88,674 <u>80,000</u> and <u>90,000</u>	<u>85,000</u>	<u>90,000</u>
77,137 <u>70,000</u> and <u>80,000</u>	<u>75,000</u>	<u>80,000</u>
426,231 <u>400,000</u> and <u>500,000</u>	<u>450,000</u>	<u>400,000</u>
2,486,947 <u>2,480,000</u> and <u>2,490,000</u>	<u>2,485,000</u>	<u>2,490,000</u>

21

## Speed Test: Addition

$$\begin{array}{r} 6 \\ +6 \\ \hline 12 \end{array} \quad \begin{array}{r} 7 \\ +6 \\ \hline 13 \end{array} \quad \begin{array}{r} 9 \\ +9 \\ \hline 18 \end{array} \quad \begin{array}{r} 7 \\ +7 \\ \hline 14 \end{array} \quad \begin{array}{r} 4 \\ +7 \\ \hline 11 \end{array} \quad \begin{array}{r} 8 \\ +9 \\ \hline 17 \end{array}$$

$$\begin{array}{r} 4 \\ +4 \\ \hline 8 \end{array} \quad \begin{array}{r} 3 \\ +5 \\ \hline 8 \end{array} \quad \begin{array}{r} 2 \\ +5 \\ \hline 7 \end{array} \quad \begin{array}{r} 3 \\ +2 \\ \hline 5 \end{array} \quad \begin{array}{r} 4 \\ +1 \\ \hline 5 \end{array} \quad \begin{array}{r} 3 \\ +6 \\ \hline 9 \end{array}$$

$$\begin{array}{r} 4 \\ +2 \\ \hline 6 \end{array} \quad \begin{array}{r} 5 \\ +8 \\ \hline 13 \end{array} \quad \begin{array}{r} 4 \\ +9 \\ \hline 13 \end{array} \quad \begin{array}{r} 8 \\ +6 \\ \hline 14 \end{array} \quad \begin{array}{r} 3 \\ +3 \\ \hline 6 \end{array} \quad \begin{array}{r} 8 \\ +8 \\ \hline 16 \end{array}$$

$$\begin{array}{r} 6 \\ +2 \\ \hline 8 \end{array} \quad \begin{array}{r} 4 \\ +5 \\ \hline 9 \end{array} \quad \begin{array}{r} 2 \\ +2 \\ \hline 4 \end{array} \quad \begin{array}{r} 5 \\ +0 \\ \hline 5 \end{array} \quad \begin{array}{r} 7 \\ +3 \\ \hline 10 \end{array} \quad \begin{array}{r} 3 \\ +4 \\ \hline 7 \end{array}$$

$$\begin{array}{r} 2 \\ +8 \\ \hline 10 \end{array} \quad \begin{array}{r} 6 \\ +4 \\ \hline 10 \end{array} \quad \begin{array}{r} 9 \\ +3 \\ \hline 12 \end{array} \quad \begin{array}{r} 3 \\ +8 \\ \hline 11 \end{array} \quad \begin{array}{r} 8 \\ +4 \\ \hline 12 \end{array} \quad \begin{array}{r} 5 \\ +5 \\ \hline 10 \end{array}$$

$$\begin{array}{r} 6 \\ +5 \\ \hline 11 \end{array} \quad \begin{array}{r} 7 \\ +2 \\ \hline 9 \end{array} \quad \begin{array}{r} 2 \\ +9 \\ \hline 11 \end{array} \quad \begin{array}{r} 8 \\ +8 \\ \hline 16 \end{array} \quad \begin{array}{r} 5 \\ +7 \\ \hline 12 \end{array} \quad \begin{array}{r} 7 \\ +8 \\ \hline 15 \end{array}$$

23

## Estimating: Addition



Start the estimating habit. Round each number to the greatest place and then add. When summing up the actual numbers the answer should be close to the estimate.

$$\begin{array}{r} \text{Round} \\ 132 \rightarrow 100 \\ + 221 \rightarrow 200 \\ \hline 353 \rightarrow 300 \text{ estimate} \end{array}$$

$$\begin{array}{r} \text{Round} \\ 215 \rightarrow 200 \\ + 373 \rightarrow 400 \\ \hline 588 \rightarrow 600 \text{ estimate} \end{array}$$

$$\begin{array}{r} \text{Round} \\ 325 \rightarrow 300 \\ + 264 \rightarrow 300 \\ \hline 589 \rightarrow 600 \text{ estimate} \end{array}$$

$$\begin{array}{r} \text{Round} \\ 461 \rightarrow 500 \\ + 237 \rightarrow 200 \\ \hline 698 \rightarrow 700 \text{ estimate} \end{array}$$

$$\begin{array}{r} \text{Round} \\ 252 \rightarrow 300 \\ + 378 \rightarrow 400 \\ \hline 630 \rightarrow 700 \text{ estimate} \end{array}$$

$$\begin{array}{r} \text{Round} \\ 323 \rightarrow 300 \\ + 409 \rightarrow 400 \\ \hline 732 \rightarrow 700 \text{ estimate} \end{array}$$

$$\begin{array}{r} \text{Round} \\ 372 \rightarrow 400 \\ + 189 \rightarrow 200 \\ \hline 561 \rightarrow 600 \text{ estimate} \end{array}$$

$$\begin{array}{r} \text{Round} \\ 255 \rightarrow 300 \\ + 133 \rightarrow 100 \\ \hline 388 \rightarrow 400 \text{ estimate} \end{array}$$

22

## Circle Math: Review - Worksheet 1

Example:  $234 = \begin{array}{|c|c|c|} \hline \text{shaded} & \text{shaded} & \text{empty} \\ \hline \end{array} = (200) + (30) + (4)$

$+123 = + \begin{array}{|c|c|c|} \hline \text{shaded} & \text{shaded} & \text{empty} \\ \hline \end{array} = + (100) + (20) + (3)$

$357 = \begin{array}{|c|c|c|} \hline \text{shaded} & \text{shaded} & \text{empty} \\ \hline \end{array} = (300) + (50) + (7)$

$136 = \begin{array}{|c|c|c|} \hline \text{shaded} & \text{shaded} & \text{empty} \\ \hline \end{array} = (100) + (30) + (6)$

$+213 = + \begin{array}{|c|c|c|} \hline \text{shaded} & \text{shaded} & \text{empty} \\ \hline \end{array} = + (200) + (10) + (3)$

$349 = \begin{array}{|c|c|c|} \hline \text{shaded} & \text{shaded} & \text{empty} \\ \hline \end{array} = (300) + (40) + (9)$

$232 = \begin{array}{|c|c|c|} \hline \text{shaded} & \text{shaded} & \text{empty} \\ \hline \end{array} = (200) + (30) + (2)$

$+153 = + \begin{array}{|c|c|c|} \hline \text{shaded} & \text{shaded} & \text{empty} \\ \hline \end{array} = + (100) + (50) + (3)$

$385 = \begin{array}{|c|c|c|} \hline \text{shaded} & \text{shaded} & \text{empty} \\ \hline \end{array} = (300) + (80) + (5)$

24

Circle Math: Review - Worksheet 2

Example:  
 $236 = 200 + 30 + 6$   
 $+ 127 = + 100 + 20 + 7$   


---

 $363 = 300 + 60 + 3$

$357 = 300 + 50 + 7$   
 $+ 276 = + 200 + 70 + 6$   


---

 $633 = 600 + 30 + 3$

$243 = 200 + 40 + 3$   
 $+ 257 = + 200 + 50 + 7$   


---

 $500 = 500 + 0 + 0$

Circle Math: Review - Worksheet 3  
 Round and Estimate

Example:  
 $100 \begin{array}{|c|} \hline 126 \\ \hline \end{array} = 100 + 20 + 6$      $600 \begin{array}{|c|} \hline 634 \\ \hline \end{array} = \text{ } + \text{ } + \text{ }$   
 $+ \begin{array}{|c|} \hline 279 \\ \hline \end{array} = 200 + 70 + 9$      $+ \begin{array}{|c|} \hline 178 \\ \hline \end{array} = \text{ } + \text{ } + \text{ }$   


---

 $400 \begin{array}{|c|} \hline 405 \\ \hline \end{array} = 400 + 0 + 5$      $800 \begin{array}{|c|} \hline 812 \\ \hline \end{array} = \text{ } + \text{ } + \text{ }$

$200 \begin{array}{|c|} \hline 189 \\ \hline \end{array} = \text{ } + \text{ } + \text{ }$      $400 \begin{array}{|c|} \hline 354 \\ \hline \end{array} = \text{ } + \text{ } + \text{ }$   
 $+ \begin{array}{|c|} \hline 255 \\ \hline \end{array} = \text{ } + \text{ } + \text{ }$      $+ \begin{array}{|c|} \hline 396 \\ \hline \end{array} = \text{ } + \text{ } + \text{ }$   


---

 $500 \begin{array}{|c|} \hline 444 \\ \hline \end{array} = \text{ } + \text{ } + \text{ }$      $800 \begin{array}{|c|} \hline 750 \\ \hline \end{array} = \text{ } + \text{ } + \text{ }$

$500 \begin{array}{|c|} \hline 483 \\ \hline \end{array} = \text{ } + \text{ } + \text{ }$      $300 \begin{array}{|c|} \hline 289 \\ \hline \end{array} = \text{ } + \text{ } + \text{ }$   
 $+ \begin{array}{|c|} \hline 468 \\ \hline \end{array} = \text{ } + \text{ } + \text{ }$      $+ \begin{array}{|c|} \hline 311 \\ \hline \end{array} = \text{ } + \text{ } + \text{ }$   


---

 $1,000 \begin{array}{|c|} \hline 951 \\ \hline \end{array} = \text{ } + \text{ } + \text{ }$      $600 \begin{array}{|c|} \hline 600 \\ \hline \end{array} = \text{ } + \text{ } + \text{ }$

Circle Math: Review - Worksheet 4



Round and estimate.

$3,175 = 3,000 \text{ round}$   
 $+ 2,587 = + 3,000 \text{ round}$   


---

 $5,762 = 6,000 \text{ est.}$

$1,353 = 1,000$   
 $+ 2,869 = + 3,000$   


---

 $4,222 = 4,000$

$3,175 = 3,000 + 100 + 70 + 5$   
 $+ 2,587 = + 2,000 + 500 + 80 + 7$   


---

 $5,762 = 5,000 + 700 + 60 + 2$

$1,353 = 1,000 + 300 + 50 + 3$   
 $+ 2,869 = + 2,000 + 800 + 60 + 9$   


---

 $4,222 = 4,000 + 200 + 20 + 2$

Circle Math: Review - Worksheet 5  
 Round and Estimate BUWV

$\begin{array}{|c|} \hline 2,346 \\ \hline \end{array} = \text{ } + \text{ } + \text{ } + \text{ }$      $\begin{array}{|c|} \hline 2,547 \\ \hline \end{array} = \text{ } + \text{ } + \text{ } + \text{ }$   
 $+ \begin{array}{|c|} \hline 1,367 \\ \hline \end{array} = \text{ } + \text{ } + \text{ } + \text{ }$      $+ \begin{array}{|c|} \hline 1,482 \\ \hline \end{array} = \text{ } + \text{ } + \text{ } + \text{ }$   


---

 $\begin{array}{|c|} \hline 3,713 \\ \hline \end{array} = \text{ } + \text{ } + \text{ } + \text{ }$      $\begin{array}{|c|} \hline 4,029 \\ \hline \end{array} = \text{ } + \text{ } + \text{ } + \text{ }$   
 3,000 est.    4,000 est.

$\begin{array}{|c|} \hline 4,000 \\ \hline \end{array} = \text{ } + \text{ } + \text{ } + \text{ }$      $\begin{array}{|c|} \hline 5,000 \\ \hline \end{array} = \text{ } + \text{ } + \text{ } + \text{ }$   
 $+ \begin{array}{|c|} \hline 4,386 \\ \hline \end{array} = \text{ } + \text{ } + \text{ } + \text{ }$      $+ \begin{array}{|c|} \hline 5,378 \\ \hline \end{array} = \text{ } + \text{ } + \text{ } + \text{ }$   


---

 $\begin{array}{|c|} \hline 7,964 \\ \hline \end{array} = \text{ } + \text{ } + \text{ } + \text{ }$      $\begin{array}{|c|} \hline 7,662 \\ \hline \end{array} = \text{ } + \text{ } + \text{ } + \text{ }$   
 8,000 est.    7,000 est.  
 Make your own.

$\begin{array}{|c|} \hline 4,753 \\ \hline \end{array} = \text{ } + \text{ } + \text{ } + \text{ }$      $\begin{array}{|c|} \hline \text{ } \\ \hline \end{array} = \text{ } + \text{ } + \text{ } + \text{ }$   
 $+ \begin{array}{|c|} \hline 3,000 \\ \hline \end{array} = \text{ } + \text{ } + \text{ } + \text{ }$      $+ \begin{array}{|c|} \hline \text{ } \\ \hline \end{array} = \text{ } + \text{ } + \text{ } + \text{ }$   


---

 $\begin{array}{|c|} \hline 7,451 \\ \hline \end{array} = \text{ } + \text{ } + \text{ } + \text{ }$      $\begin{array}{|c|} \hline \text{ } \\ \hline \end{array} = \text{ } + \text{ } + \text{ } + \text{ }$   
 8,000 est.



Patterns in sums: Column Addition- Worksheet 3  
Find Doubles and Make Tens

$\begin{array}{r} 425 \\ 575 \\ 464 \\ 138 \\ +546 \\ \hline 2,148 \end{array}$	$\begin{array}{r} 819 \\ 566 \\ 634 \\ 581 \\ +320 \\ \hline 2,920 \end{array}$	$\begin{array}{r} 877 \\ 145 \\ 235 \\ 737 \\ +536 \\ \hline 2,530 \end{array}$	$\begin{array}{r} 690 \\ 806 \\ 354 \\ 496 \\ +358 \\ \hline 2,704 \end{array}$
---	---	---	---

$\begin{array}{r} 178 \\ 363 \\ 387 \\ 468 \\ +484 \\ \hline 1,880 \end{array}$	$\begin{array}{r} 146 \\ 741 \\ 595 \\ 420 \\ +428 \\ \hline 2,330 \end{array}$	$\begin{array}{r} 413 \\ 478 \\ 293 \\ 547 \\ +249 \\ \hline 1,980 \end{array}$	$\begin{array}{r} 226 \\ 855 \\ 910 \\ 376 \\ +345 \\ \hline 2,712 \end{array}$
---	---	---	---

$\begin{array}{r} 526 \\ 484 \\ 350 \\ +653 \\ \hline 2,013 \end{array}$	$\begin{array}{r} 685 \\ 175 \\ 680 \\ +932 \\ \hline 2,472 \end{array}$	$\begin{array}{r} 903 \\ 796 \\ 167 \\ +194 \\ \hline 2,060 \end{array}$	$\begin{array}{r} 264 \\ 630 \\ 856 \\ +275 \\ \hline 2,025 \end{array}$
--	--	--	--

$\begin{array}{r} 285 \\ 571 \\ 175 \\ 835 \\ +534 \\ \hline 2,400 \end{array}$	$\begin{array}{r} 564 \\ 684 \\ 472 \\ 476 \\ +796 \\ \hline 2,992 \end{array}$	$\begin{array}{r} 4,843 \\ 5,981 \\ 1,225 \\ 9,209 \\ +1,467 \\ \hline 22,725 \end{array}$	$\begin{array}{r} 2,434 \\ 5,618 \\ 8,252 \\ 2,290 \\ +3,676 \\ \hline 22,270 \end{array}$
---	---	--	--

33

Gus the Bus Driver - Worksheet 1

In the summer Gus drives a bus the same route every day. First people get on and then people get off.

Gus keeps a log at each stop. Help Gus do his math.



At Avocet Street: The bus was empty, then 28 people got on. Write the number sentence that shows how many people are on the bus now.

$0 + 28 = 28$

At Bluebird Avenue: Nobody got off and 26 more people got on. Write the number sentence that shows how many people are on the bus now.

$28 + 26 = 54$

At Canary Street: 16 people got off then 25 got on. Show your work below or explain how you got the answer.

$54 - 16 = 38 + 25 = 63$

How many people are on the bus now? 63 people



At Duck Lane: 38 people got off, then 26 got on. Show your work below or explain how you got the answer.

How many people are on the bus now 51 people.

34

Gus the Bus Driver - Worksheet 2



At Eagle Court: 28 people got off and no one got on.

Show your work.  $\begin{array}{r} 51 \\ -28 \\ \hline 23 \end{array}$

How many people are on the bus now? 23 people

At Finch Street: 17 people got off and 18 got on.

Show your work.  $23 - 17 = 6 + 18 = 24$

How many people are on the bus now? 24 people



At Hummingbird Lane: 13 people got off and 14 got on.

Show your work.  $24 - 13 = 11 + 14 = 25$

Hummingbird Lane is his last stop. How many people are on the bus? 35

Show your work.  $21 + 14 = 35$

At what street did Gus have the most people on the bus? Canary

At what street did Gus have the fewest people on the bus? Avocet

35

Assessment

1. 2,973 round to greatest place 3,000

2. Write a number and name each place value. AWV

hundred thousands	ten thousands	one thousands	hundreds	tens	units or ones
-------------------	---------------	---------------	----------	------	---------------

3. Write these numbers in words.

41,297 forty-one thousand two hundred ninety seven

504,481 five hundred four thousand four hundred eighty-one

4. Estimate sum, then add.

$\begin{array}{r} 45,000 \\ 800 \\ 2,000 \\ 100 \\ \hline 47,900 \end{array}$	$\begin{array}{r} 45,321 \\ 792 \\ 1,834 \\ 86 \\ \hline 48,033 \end{array}$
---	--

5. Add:  $27 + 3,064 + 483$

$+ 10,746 + 207,020 = 221,340$

36

Patterns in Arithmetic: Place Value - Booklet 2 PDF  
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Rounding Off and Estimating

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