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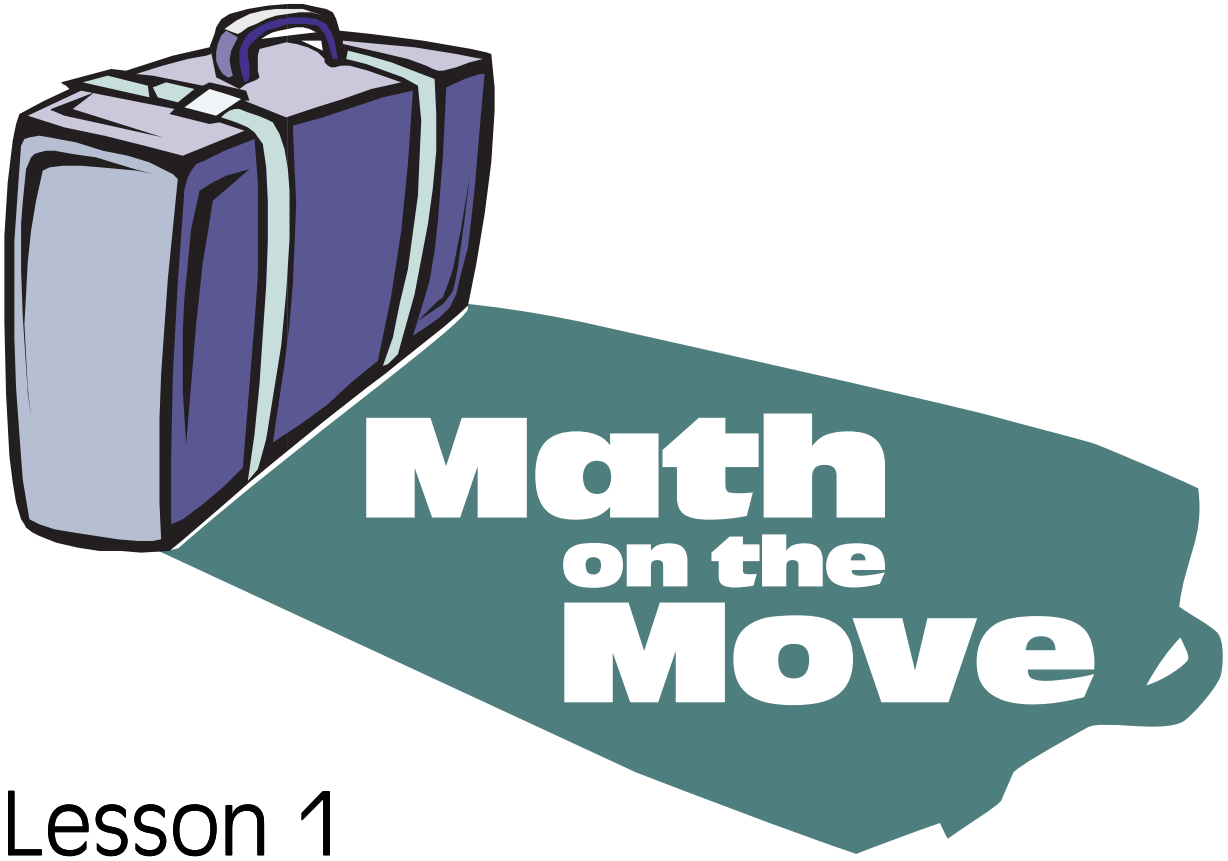

Lesson 1

Arithmetic Operations

Objectives

- Perform the operations of addition, subtraction, multiplication, and division with whole numbers

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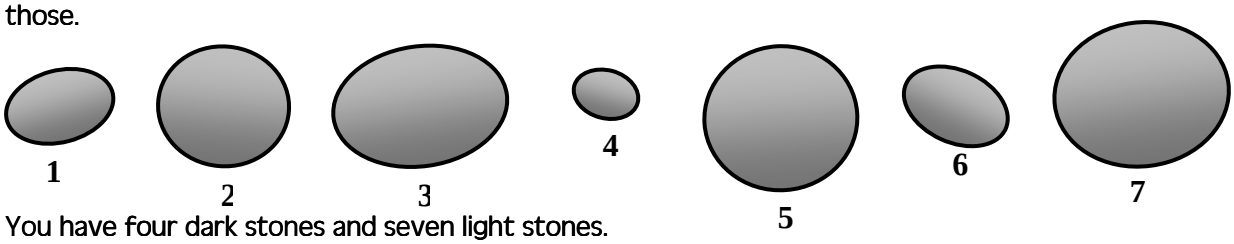
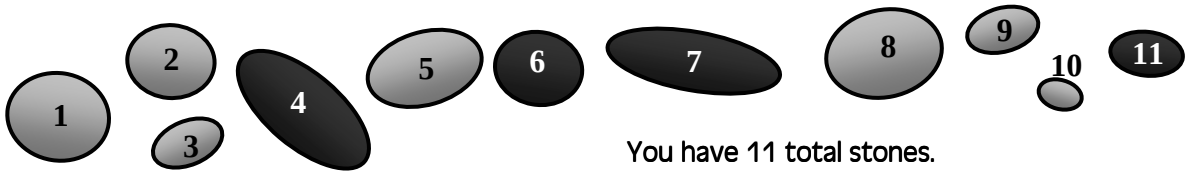
Imagine you are walking on a beach, picking up stones. You pick up some dark stones and count them.

There are four dark stones. You then see how many light colored stones you can find and count those.



You have four dark stones and seven light stones.

You wonder how many stones you have altogether, so you lay them all down and count.



You have 11 total stones.

You used **addition** to find the **sum** of the number of dark stones and light stones. To add 4 and 7, you started at 4, counted 7 more, and ended with 11. You could have also started with 7 and counted 4 more; the answer would have been the same.

- **Addition** is the operation used to count the number of objects in two or more groups. The symbol used for addition is "+".
- The **sum** is the number you get when you add two numbers together.

For example, 2 + 3 = 5. 9 plus 7 is 16. The sum of 6 and 0 is 6.

We could have shown the total number of stones using math notation. Four dark and seven light stones can be shown in a couple ways.

$$4 + 7 = 11, \qquad \text{just as} \qquad \begin{array}{r} 4 \\ +\ 7 \\ \hline 11 \end{array}$$

Even though both ways are correct, the second way of writing an addition problem is helpful when we add larger numbers. Here is another example.

Example

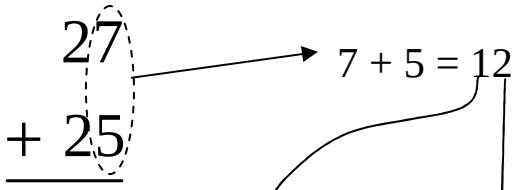
Jahmel threw a ball 27 feet. He then threw the ball another 25 feet. What is the sum of the distances that Jahmel threw the ball?

Solution

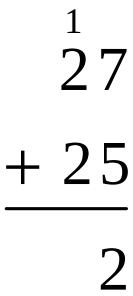
We need to use addition to solve this problem.

Step 1: line the numbers up on top of each other as shown below.

Step 2: Add the digits farthest to the right



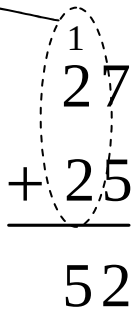
Step 3: Put the 2 below, and carry the 1 to the next place, as follows



Step 4: Now add each digit in the next column.

1 + 2 + 2 = 5

Step 5: Write this sum next to the 2.



So Jahmel threw the ball a total of 52 feet.

Algorithm

To add two or more numbers:

5. Write the numbers so that the digits to the far right of each number are directly on top of one another.
6. Add all the digits to the far right.
    a. If the sum is ten or more, write the number in the tens place on top of the next column on the left, and write the digit in the ones place so that it is directly under the digits you added.
7. Add the digits in the column to the left of the ones you just added.
    a. If the sum is ten or more, repeat step 2 a.
8. Repeat this process until every column of digits has been added.

Here is one more example, and then you will try some on your own.

Example

Tony filled up his gas tank for $35. Later that day, his car broke down, which cost him $129 to repair. How much money did Tony spend on his car that day?

Solution

To solve this problem, we must add 35 and 129. When we line up our numbers, we must make sure the digits farthest to the right are lined up.

Correct

$$\begin{array}{r} 129 \\ +\ 35 \\ \hline \end{array}$$

$$\begin{array}{r} 129 \\ +\ 35 \\ \hline \end{array}$$

Incorrect

Now we follow the steps from before, working from right to left. The final sum looks like this.

$$\begin{array}{r} {\scriptstyle 1} \\ 129 \\ +\ 35 \\ \hline 164 \end{array}$$

Note that this same method works for adding more than two numbers.

1. Find the sums

a) $1 + 2 =$ b) $7 + 2 =$ c) $11 + 4 =$

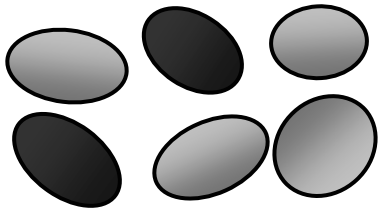
d) $4 + 6 =$ e) $7 + 6 =$ f) $7 + 8 =$

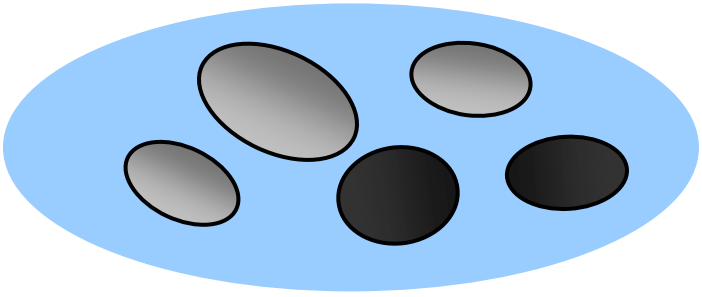
g) $14 + 7 =$ h) $30 + 40 =$ i) $179 + 5 =$

2. Pedro picked 1,247 peaches on Monday, and 989 on Tuesday. How many peaches did he pick all together?

3. Find the sum. 124 + 65 + 4

You keep walking on the beach. You decide to throw five of the stones into the water, one at a time. After you throw the first stone, you count down one from the initial ten stones, leaving nine stones. Then you throw one more stone, leaving eight stones. Then seven, and finally six stones are left in your hand.





This process of taking away is called **subtraction**.

- **Subtraction** is the operation used when things are taken away from a group. The symbol we use for subtraction is a dash, "—"
- The answer to a subtraction problem is called the **difference**.

For example, 5 – 3 = 2. 14 minus 2 is 12. The difference between 21 and 7 is 14.

Example

What is the difference between 8 and 5?

Solution

First we must understand that this question is asking us to find the difference. That means we will use subtraction. To find 8 – 5, we will start from 8, and count backwards 5.

8	7	6	5	4	3
	1	2	3	4	5

So 8 – 5 = 3

There is another, simpler method to find the difference of two numbers that uses addition.

Example

Adrian bought groceries costing $23, and he hands the cashier $30. How much change should Adrian receive?

Solution

To find how much change Adrian will receive, we must find the difference of 30 and 23. One way to find this is to ask ourselves the question, "23 plus what will give me 30?" In other words,

$$23 + \_\_\_ = 30$$

Now we just count up from 23, and keep track of how many that is.

24 25 26 27 28 29 30

That's seven more, so $23 + \underline{7} = 30$, and Adrian will receive $7 change.

This method is very helpful for finding differences in your head. This is also why you often see people using their fingers when they subtract. What about subtracting numbers that are too large to keep track of in your head?

Example

Pedro has a bag with 150 candies in it. For Halloween, he gives away 72 pieces of candy. How many pieces of candy does he have left?

Solution

Whenever we see phrases such as "give away" or "less" or "take away" or "minus," it tells us we will be using subtraction. In this case, the problem tells us Pedro gives away 72 pieces from his 150. This tells us we will be subtracting

150 – 72

These are two large numbers, so we will use the same method we did before with addition, writing the numbers on top of one another.

$$\begin{array}{r} 150 \\ -\ 72 \\ \hline \end{array}$$

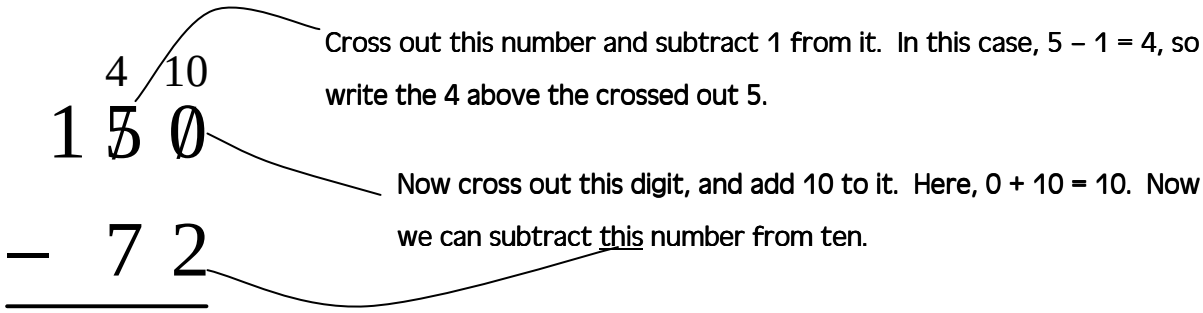
Step 1: Write the numbers on top of one another, with the digits on the right perfectly lined up.

Step 2: Starting with the digits on the right, subtract the bottom one from the top one.

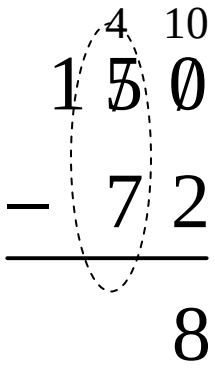
$$\begin{array}{r} 150 \\ -\ 72 \\ \hline \end{array}$$

How can we find 0 – 2 if two is larger than zero?

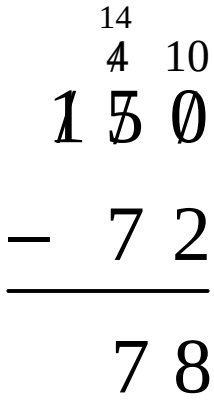
We must use the *borrowing method*. In the number 150, notice the second digit, the 5. That digit is in the tens place. We can borrow one of the tens from the five tens to perform this subtraction. One ten is worth ten ones, just as a ten-dollar bill can be exchanged for ten one-dollar bills. We will use the 1 ten, and exchange it for ten ones.



Now we look at the four and the seven in the middle column. Since 7 is larger than 4, we must borrow again, but this time from the hundreds place. We will exchange one hundred for 10 tens.



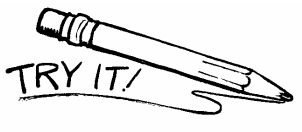
Once finished, the problem will look like this. We now know that Pedro had 78 pieces of candy left.



Algorithm

To subtract two numbers:

1. Write the numbers so that the digits to the far right of each number are directly on top of one another.
2. Starting with the digits farthest to the right, subtract the bottom from the top.
    a. If the bottom digit is larger than the top digit, borrow one unit from the tens place on the top number. Subtract one from it, and add ten to the ones place of the top number. Now subtract the ones.
3. Subtract the digits in the tens places.
    a. Borrow from the hundreds place, if the bottom digit is larger than the top in the tens place.
4. Repeat this process until every column of digits has been subtracted from.



4. Find the differences

a) $3 - 2 =$ b) $7 - 4 =$ c) $9 - 3 =$

d) $6 - 5 =$ e) $8 - 1 =$ f) $11 - 3 =$

g) $15 - 7 =$ h) $13 - 11 =$ i) $6 - 6 =$

5. Solve the next subtraction problems by rewriting them as addition problems (*Ex:* 7 – 4 = should be rewritten as 4 + __ = 7)

a) $17 - 13 =$ b) $12 - 9 =$ c) $56 - 52 =$

d) $27 - 22 =$ e) $13 - 12 =$ f) $54 - 24 =$

6. Tami is saving money for a trip to Hawaii over spring break. The package tour she is interested in costs $1745. From her part-time job she has saved $1290 so far. How much more money must she save?

You decide that throwing stones is a lot of fun. You gather as many stones as you can, and separate them into groups of five. Pretty soon, you have made many groups. "Let's see," you think to yourself, "there are 1, 2, 3, …, 9 groups of five. I wonder how many stones I will be able to throw." To find this out, we could add five to itself nine times.

$$5 + 5 + 5 + 5 + 5 + 5 + 5 + 5 + 5 = 45$$

- **Multiplication** is the same as adding a number many times, or repeated addition. 9×5 is the same as adding 5 to itself nine times. There are 9 groups of 5. The symbol we use for multiplication is "$\times$"
- The answer to a multiplication problem is called the **product**

For example, $3 \times 2 = 6$. 4 times 3 is 12. the product of 7 and 5 is 35.

Just as we can add in any order and still get the same answer (3 + 2 = 5, and 2 + 3 = 5), we may multiply in any order. $9 \times 4 = 36$, and $4 \times 9 = 36$. Nine groups of four is the same as four groups of nine. There is also a step-by-step process to multiply larger numbers.

Example

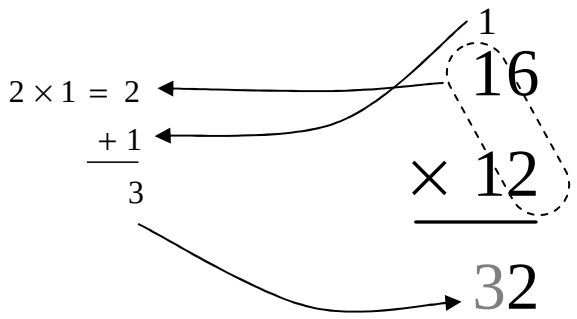
Esmaralda is making cookies at the bakery she works for. She mixes enough dough to fill 16 cookie trays with 12 cookies each. How many cookies will Esmaralda bake altogether?

Solution

Since we are filling 12 trays each with 16 cookies, this means we will have 12 groups of 16. In other words, we must find the product of 12 and 16: that is, 12×16. We will start by arranging the numbers vertically, as we did before with addition and subtraction.

$$\begin{array}{r} {\scriptstyle 1} \\ 16 \\ \times\ 12 \\ \hline 2 \end{array}$$

Step 1: Multiply the two and the six. $6 \times 2 = 12$, so we put the two from the 12 below the digits column, and carry the one to the tens place.



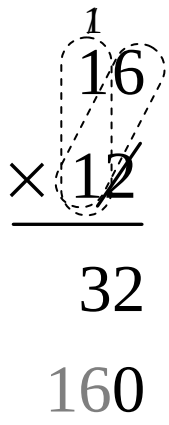
Step 2: Multiply the two and the one. $2 \times 1 = 2$. Add this to the 1 that you carried from the first step. $2 + 1 = 3$. Write the three below.

Step 3: Cross out the 2, and the 1 that you carried. Put a zero beneath the 32 that lines up with the 2.

$$\begin{array}{r} {\scriptstyle 1} \\ 16 \\ \times\ 1\cancel{2} \\ \hline 32 \\ 0 \end{array}$$

Step 4: Multiply the 1 and 6. $1 \times 6 = 6$. Write the 6 under the 3.

Step 5: Multiply the 1 and the other 1. $1 \times 1 = 1$. Don't do anything with the remainder you crossed out. Write the 1 next to the 6.



Step 6: Finally, add the two products.

$32 + 160 = 192$

$$\begin{array}{r} {\scriptstyle 1} \\ 16 \\ \times\ 12 \\ \hline 32 \\ +160 \\ \hline 192 \end{array}$$

Esmaralda made 192 cookies.

Example

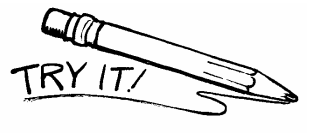
Find the product. 15×13

Solution

Here we will illustrate each step in a more condensed way. Study each step from left to right, and notice the changes.

$$\begin{array}{r} 15 \\ \times 13 \\ \hline \end{array} \qquad \begin{array}{r} {\scriptstyle 1}\,15 \\ \times 13 \\ \hline 45 \end{array} \qquad \begin{array}{r} {\scriptstyle 1}\,15 \\ \times 13 \\ \hline 45 \\ 0 \end{array} \qquad \begin{array}{r} {\scriptstyle 1}\,15 \\ \times 13 \\ \hline 45 \\ 150 \end{array} \qquad \begin{array}{r} {\scriptstyle 1}\,15 \\ \times 13 \\ \hline 45 \\ +150 \\ \hline 195 \end{array}$$

Your work will only look like the very last one on the right.



7. Find the products.

a) $3 \times 2 =$ b) $9 \times 7 =$ c) $5 \times 3 =$

d) $7 \times 4 =$ e) $3 \times 9 =$ f) $5 \times 11 =$

g) $2 \times 4 =$ h) $12 \times 5 =$ i) $8 \times 8 =$

8. Find the products.

a) $\begin{array}{r} 27 \\ \times\ 23 \\ \hline \end{array}$ b) $\begin{array}{r} 13 \\ \times\ 13 \\ \hline \end{array}$

9. Isabel is seeing how much gas she buys in a year. Her car holds 12 gallons of gas. If she fills up her car 24 times all year, how many gallons of gas has she bought that year?

After you throw all those stones in the lake, your friend Alejandro finds you. "I saw you were skipping stones in the water, so I found you some more." You count the stones Alejandro found, and there are 30 of them. You explain that you were throwing them in groups of five because it is more fun that way. Alejandro wonders aloud, "I wonder how many groups of five stones we can make with 30."

To answer Alejandro's question, we must use **division**. We must find the **quotient** of $30 \div 5$.

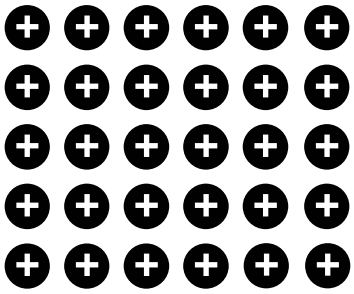
- **Division** is the process of separating something into smaller, equally sized groups.
- The **quotient** is the answer to a division problem.
- The **dividend** is the number you are separating into groups. (30, above)
- The **divisor** (5, above), can be thought of in two ways:

1) The size of each group (how many groups of 5 are in 30?)
2) The number of groups we are dividing a number into (The size of each group when we make 30 into 5 equal groups)

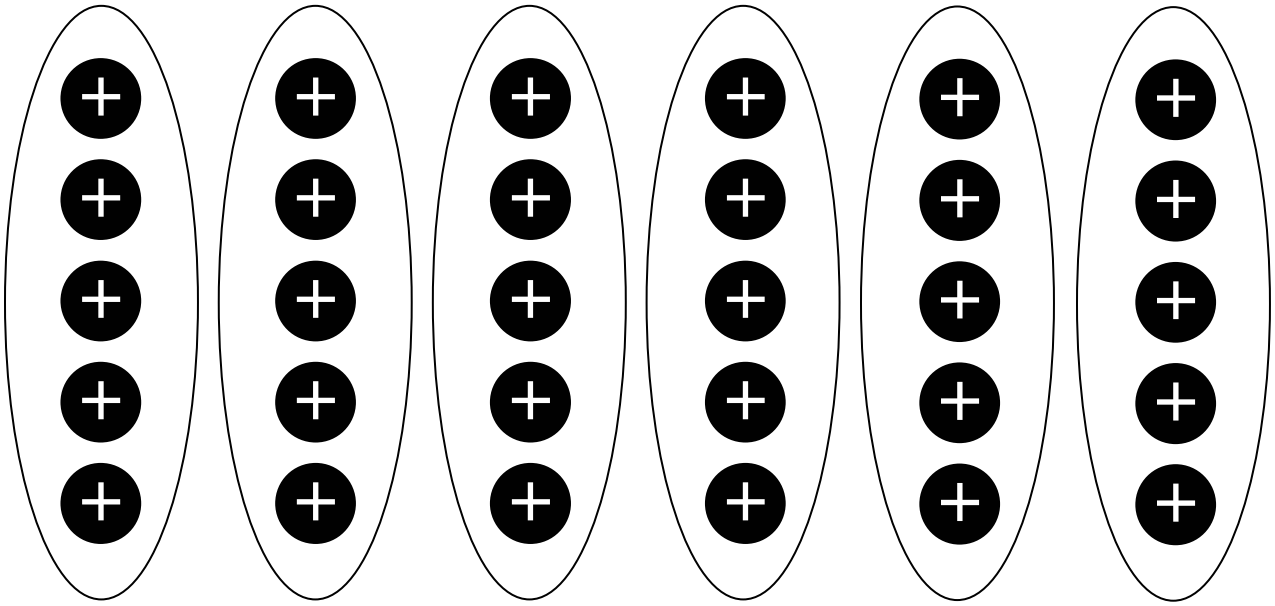
For example, $6 \div 2 = 3$ means there are three groups of two in 6. It also means that when 6 objects are split into two groups, there will be three objects in each group. In both cases, 6 is the dividend, 2 is the divisor, and 3 is the quotient.

To answer Alejandro's question ($30 \div 5$), we must figure out how many groups of five 30 can be made into. Let's use integer chips to represent stones.

If we let one positive integer chip represent one stone, we can show the thirty stones Alejandro brought like this:



We need to find how many groups of five we have. We see that



we can make six groups of five. Six groups of five stones is thirty stones. Doesn't this remind you of multiplication? Specifically, $6 \times 5 = 30$.

We could have answered this division question by turning it into a multiplication problem.

$30 \div 5 = \_\_\_\_$ is the same as asking $5 \times \_\_\_\_ = 30$

Example

Find the quotient of 28 and 4.

Solution

We must first understand that quotient means to divide. Therefore, we must find $28 \div 4$.

With what we just discovered, we may change this into multiplication, and ask ourselves,

$$4 \times \_\_\_\_ = 28$$

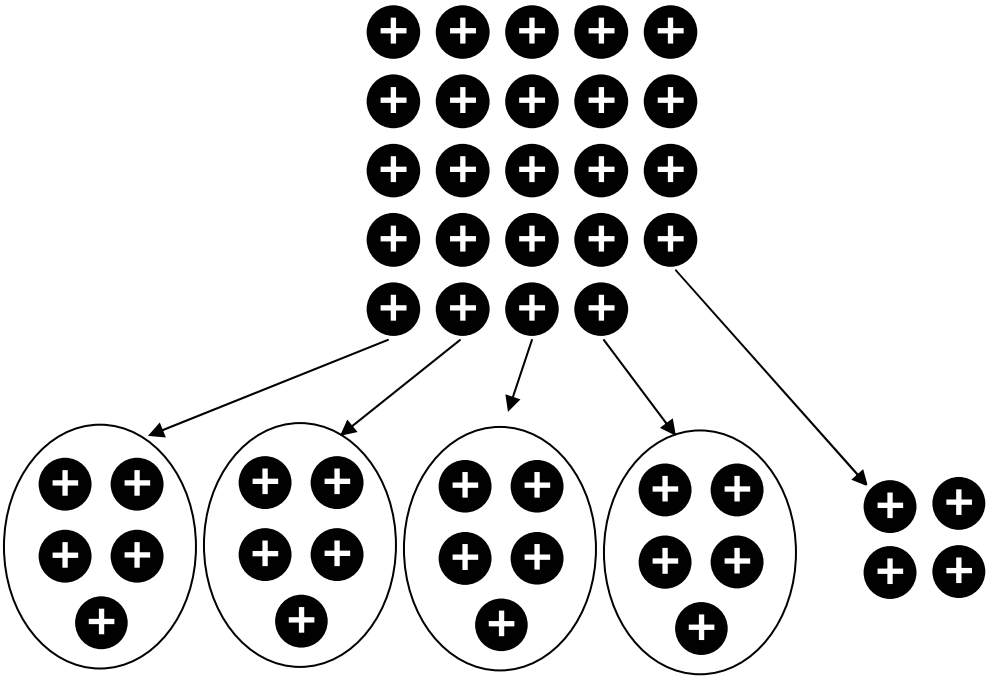
Now the question is easier to answer.

If you do not know this multiplication fact in your head, you can write out something like this:

$$4 \times 1 = 4$$
$$4 \times 2 = 8$$
$$4 \times 3 = 12$$
$$4 \times 4 = 16$$
$$4 \times 5 = 20$$
$$4 \times 6 = 24$$
$$4 \times 7 = 28$$

We see that $4 \times 7 = 28$, so this tells us our answer is 7.

After you throw 30 stones, Alejandro brings you some more. "I could only find 24 stones this time" he says. "I don't think this will work very well." You think about dividing 24 and 5. With the integer chips, $24 \div 5$ will look like this:



There are four perfect groups of 5 stones, then four left over.

In math, this leftover four is called a **remainder**.

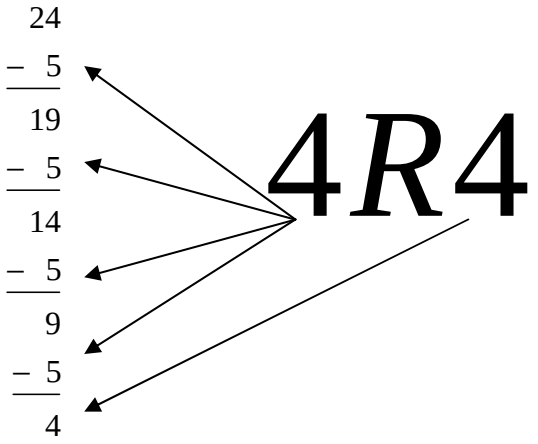
- A **remainder** is the amount left over after dividing a number into equal groups. To show a remainder, put an upper case "*R*" next to the number of even divisions.

  For example, $5 \div 2 = 2\ R1$

The remainder will always be smaller than the divisor. If the remainder were larger than the divisor, we could keep separating the dividend into groups until the remainder is less than the divisor.

Just as multiplication is really repeated addition, or adding many times, division can be shown as repeated subtraction. If we go back to our school problem, we can also think about $24 \div 5$ like this: "How many times can I subtract 5 from 24 without making it negative?" Thinking this way, we see that

We can subtract 5 from 24 four times, and then have 4 left over. This means our answer is $4\ R\,4$.



Thinking of division as repeated subtraction helps us make a rule for dividing larger numbers.

Example

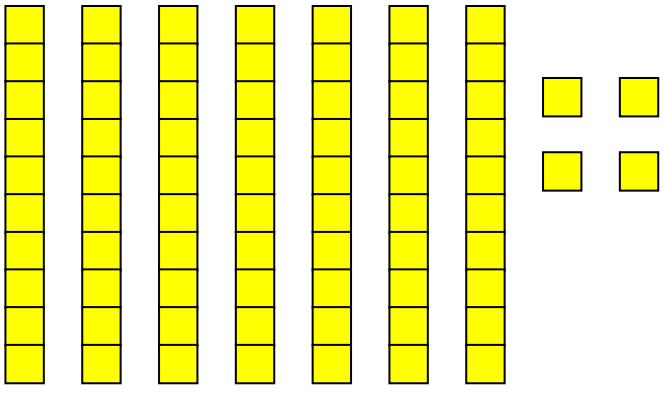
Find $74 \div 3$

Solution

In the number 74, we see that 7 is in the tens place, and 4 is in the ones place.

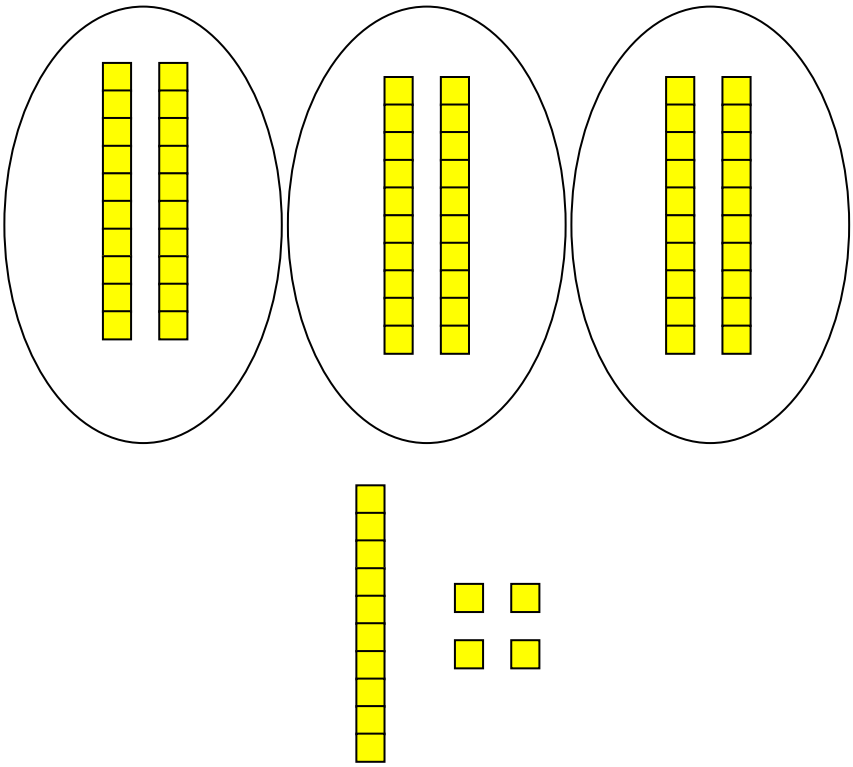
We can also say that there are 7 tens, and 4 ones. Visually, this looks like this:

We need to divide 74

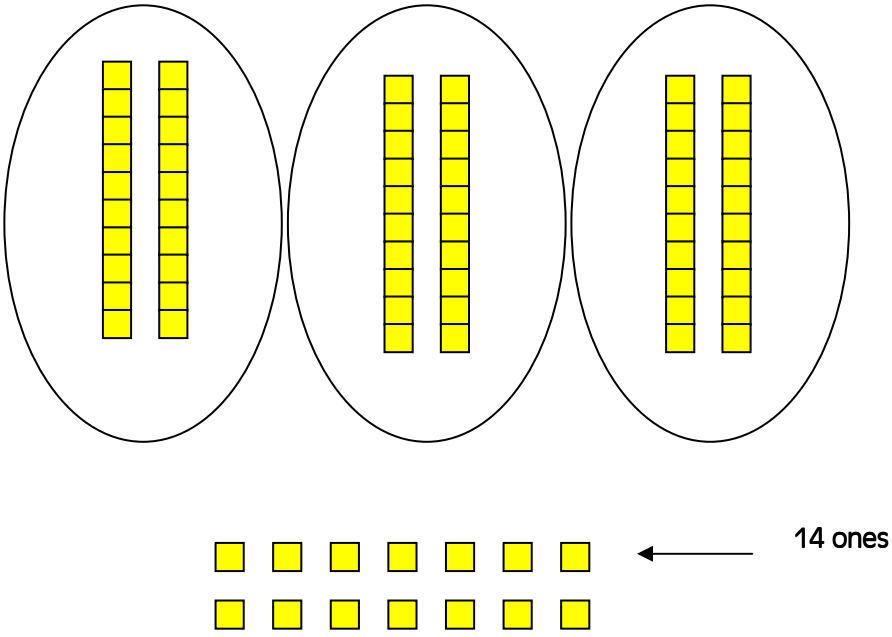


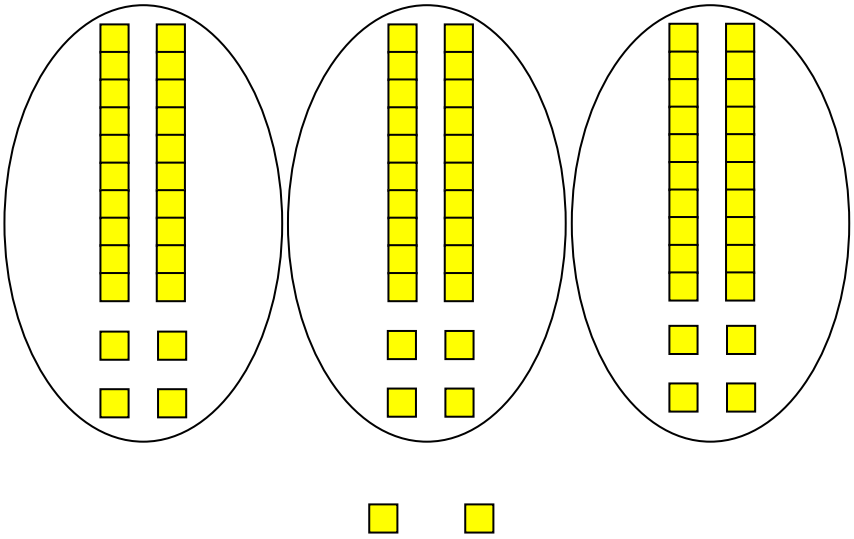
Into three groups

First, let's divide the tens.



Each group evenly fits 2 tens. We are left with 1 ten and 4 ones. Since we cannot evenly divide one ten into three groups, we must break this into ten ones, leaving us with 14 ones to divide into three groups.





Finally, we see that each group contains 2 tens and 4 ones. There are 2 ones remaining. The 2 ones can not be divided into three groups evenly, so our answer is,

$$24\,R\,2$$

We can show this exact method with numbers too!

Instead of writing $74 \div 3$, we will write

$$3\overline{)74}$$

It means the exact same thing. Then, just as we did with the blocks, we divide the tens place by three.

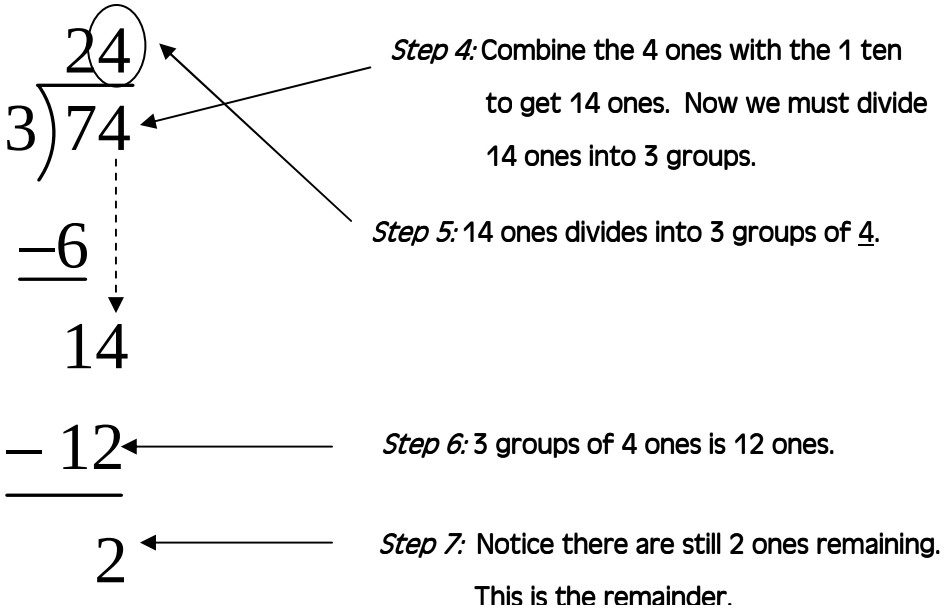
$$\begin{array}{r} 2 \\ 3\overline{)74} \\ \underline{-6} \\ 1 \end{array}$$

Step 1: 7 tens divide into 3 groups of 2 tens

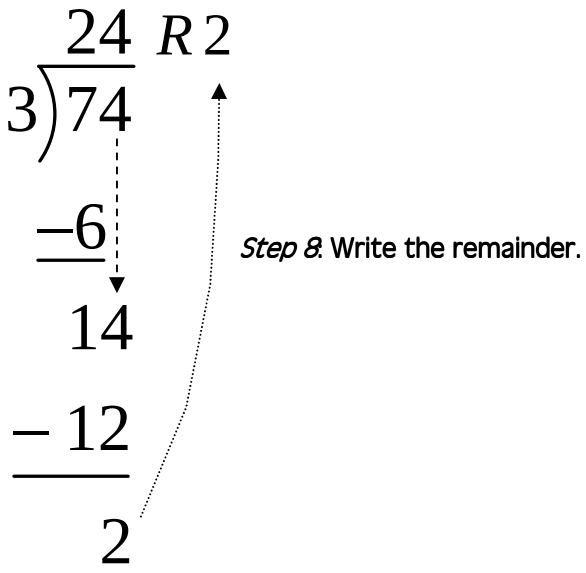
Step 2: 3 groups of 2 tens is 6 tens

Step 3: There is still one ten left to divide, which does not divide evenly into three groups.

At this point in our visual model, we broke the group of ten into 10 ones, and combined it with our 4 ones. We will show this as follows,



The final solution, with all the work, will look like this,



10. Find the quotients by rewriting the division problems as multiplication problems. (For example, to find $10 \div 2 = \_\_\_$, you would write $2 \times \_\_\_ = 10$, then fill in $2 \times \underline{5} = 10$.)

a) $12 \div 2 = \_\_\_$ b) $16 \div 4 = \_\_\_$ c) $50 \div 25 = \_\_\_$

d) $24 \div 8 = \_\_\_$ e) $35 \div 7 = \_\_\_$ f) $18 \div 2 = \_\_\_$

g) $100 \div 4 = \_\_\_$ h) $20 \div 5 = \_\_\_$ i) $36 \div 12 = \_\_\_$

Use the step by step method to find the differences. There may be remainders.

11. $2\overline{)28}$ 12. $2\overline{)428}$ 13. $4\overline{)27}$

14. $3\overline{)32}$ 15. $5\overline{)223}$ 16. $6\overline{)1000}$

17. A school is divided into grades nine, ten, eleven, and twelve. Each grade has the same number of students. If there are 1,424 students in the school, how many students are in grade ten?

☑ Review

1. Highlight the following terms and their definitions where they appear in this lesson.
    a. addition
    b. sum
    c. subtraction
    d. difference
    e. multiplication
    f. product
    g. division
    h. quotient
    i. dividend
    j. divisor
    k. remainder

2. Write one question you would like to ask your mentor, or write one thing you learned in this lesson.

Practice Problems

Math On the Move Lesson 1

Directions: Write your answers in your math journal. Label this exercise Math On the Move – Lesson 1, Set A and B.

Set A

1. Write which operation should be used to solve the word problem (addition +, subtraction – , multiplication $\times$, or division $\div$). Do not solve.
   a) Pedro spends $13 on groceries and $25 on gas. How much money did Pedro spend?
   b) Find the difference between 14 and 8.
   c) What is the product of 9 and 11?
   d) Sandy buys four cartons of eggs. Each carton has 12 eggs. How many eggs did Sandy buy?
   e) What is the quotient of 400 and 2?
   f) Manuel is sending gift bags full of chocolate to his family for Christmas. He has 6 people to send gift bags to and 78 pieces of chocolate. If Manuel wants to give each person the same amount, how many pieces of chocolate should he send to each person?
   g) Marta has a bunch of 7 bananas. After three days, there are 4 left. How many bananas were eaten?

2. Find the sum, difference, product, or quotient

a) $19 + 4$	b) 3×9	c) 4×2	d) $12 \div 3$
e) $19 - 11$	f) $4 + 13$	g) $8 \div 2$	h) 3×8
i) $14 \div 7$	j) 11×3	k) $3 + 4$	l) $51 - 5$

Set B

1. Teresa rents three movies. One movie is 120 minutes long, one is 90 minutes, and the third is 147 minutes long. If she watches all three back to back, how many minutes will it take?

2. Celio earns $8 per hour. If he works for 40 hours one week, how much will he be paid before taxes?
3. Rosa makes a New Year's resolution to lose 15 pounds. She weighs herself in January at 150 pounds. In February, she weighs herself at 139 pounds. Did she achieve her goal? If not, how much more weight does she have to lose?
4. If one American dollar is worth 121 Japanese yen, how many dollars is 1331 yen worth?

1. a) 3 b) 9 c) 15 d) 10 e) 13 f) 15
   g) 21 h) 70 i) 184
2. 2,236 peaches
3. 193
4. a) 1 b) 3 c) 6 d) 1 e) 7 f) 8
   g) 8 h) 2 i) 0
5. a) $13 + \underline{4} = 17$ b) $9 + \underline{3} = 12$ c) $52 + \underline{4} = 56$
   d) $22 + \underline{5} = 27$ e) $12 + \underline{1} = 13$ f) $24 + \underline{30} = 54$
6. $455
7. a) 6 b) 63 c) 15 d) 28 e) 27 f) 55
   g) 8 h) 60 i) 64
8. a) 621 b) 169
9. 288
10. a) $2 \times \underline{6} = 12$ b) $4 \times \underline{4} = 16$ c) $25 \times \underline{2} = 50$ d) $8 \times \underline{3} = 24$
    e) $7 \times \underline{5} = 35$ f) $2 \times \underline{9} = 18$ g) $4 \times \underline{25} = 100$ h) $5 \times \underline{4} = 20$
    i) $12 \times \underline{3} = 36$
11) 14 12) 214 13) 6 *R*3 14) 10 *R*2
15) 44 *R*3 16) 166 *R*4 17) 356

End of Lesson 1