L10 THE TABLE GAME #1

Capsule Lesson Summary

Introduce a truth table for the relation "is a divisor of." Review the greatest common divisor operation ⊓. Introduce the minimum operation ↓ and the maximum operation ↑. Given a list of seven operations, determine which is the operation for a 9-by-9 table.

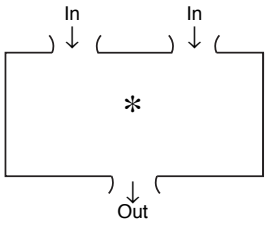
Materials

Teacher	• 9-by-9 operation table transparency • Blackline L10	Student	• Paper • Two 9-by-9 operation tables • Worksheets L10* and **

Advance Preparation: Use Blackline L10 to make both a transparency of a 9-by-9 operation table for display and copies for students. You may prefer to prepare the table on the chalkboard or a grid board.

Description of Lesson

Exercise 1



This exercise uses an operation rule to introduce a truth table for the relation "is a divisor of." As necessary, review how an operation rule works.

T: ***I have a secret rule for *. I'll give you some clues about my rule. Try to guess my rule.***

Write several number sentences on the board as clues.

$2 * 4 = 1$
$4 * 2 = 0$
$3 * 9 = 1$
$3 * 8 = 0$
$6 * 2 = 0$
$2 * 6 = \square$

Then write an open sentence and see if anyone can predict what number goes in the box.

T: ***If you think you know my rule, what number is 2 * 6 (read as "two star six")? Write it on a piece of paper.***

Check many answers before letting someone answer aloud, but do not announce the rule yet.

S: ***2 * 6 = 1.***

Continue with a few more open sentences before asking for a description of the rule.

$2 * 6 = \boxed{1}$
$5 * 5 = \boxed{1}$
$4 * 7 = \boxed{0}$
$4 * 8 = \boxed{1}$

T: ***What is my rule?***

S: ***If the first number is a divisor of the second, the answer is 1. If it is not, the answer is 0.***

Rephrase students' explanations of the rule to emphasize true and false statements, as in the following dialogue. Point to the appropriate number sentences as you explain,

T: ***"2 is a divisor of 4" is true, so 2 * 4 = 1.***
"4 is a divisor of 2" is false, so 4 * 2 = 0.
"3 is a divisor of 9" is true, so 3 * 9 = 1.
⋮ ⋮
"4 is a divisor of 7" is false, so 4 * 7 = 0.
"4 is a divisor of 8" is true, so 4 * 8 = 1.

Display a 9-by-9 operation table, and distribute copies of the table for students.

T: ***We are going to make a table for this operation. Since the operation gives a truth value (a statement is true or false), let's call the operation*** T_D ***meaning truth table for "is a divisor of."***

Instruct students to put T_D in the upper left corner of their tables.

T_D	1	2	3	4	5	6	7	8	9
1				1					
2				1		1			
3								0	1
4		0					0	1	
5					1				
6		0							
7									
8									
9									

Make several entries in the table with the class. For example, here entries are made for the results on the board.

Read another entry, such as "1 is a divisor of 4" is true.

Then direct students to work individually or with partners to complete the table.

After many students have completed the table, discuss patterns in the table.

T: ***Do you notice any patterns in the table?***

S: ***There are 1s along the diagonal (from upper left to lower right).***

Record 1s along that diagonal in the table on display.

S: ***1 is a divisor of every number, so there are all 1s in the first row.***

Record 1s in the first row of the table.

T: ***Are there any 1s in the table below the diagonal of 1s?***

S: ***No, because the first number is greater than the second number in those cases. A number cannot be a divisor of a number less than itself.***

Record 0s in the table below the diagonal of 1s.

T: ***Are there any more 1s in the table?***

S: ***Yes, a few more.***

Quickly complete the table with the class.

T_D	1	2	3	4	5	6	7	8	9
1	1	1	1	1	1	1	1	1	1
2	0	1	0	1	0	1	0	1	0
3	0	0	1	0	0	1	0	0	1
4	0	0	0	1	0	0	0	1	0
5	0	0	0	0	1	0	0	0	0
6	0	0	0	0	0	1	0	0	0
7	0	0	0	0	0	0	1	0	0
8	0	0	0	0	0	0	0	1	0
9	0	0	0	0	0	0	0	0	1

T: ***In this table we put 1 for true (the first number is a divisor of the second), and we put 0 for false (the first number is not a divisor of the second). We call this a truth table for the relation "is a divisor of."***

Exercise 2

Erase the board and then write this expression.

$8 \sqcap 12$

T: ***Do you remember what this symbol ($\sqcap$) means?***

S: ***Greatest common divisor.***

T: ***Let's find the greatest common divisor of 8 and 12.***
What are the positive divisors of 8? (1, 2, 4, and 8)
What are the positive divisors of 12? (1, 2, 3, 4, 6, and 12)

List the divisors of 8 and 12 on the board.

$8 \sqcap 12$	
1	1
2	2
4	3
8	4
	6
	12

T: ***What positive divisors do 8 and 12 have in common?*** (1, 2, and 4)
Which of these common divisors is the greatest? (4)
So the greatest common divisor of 8 and 12 is 4.

Record the result and pose several more problems. (Answers are in boxes.)

$8 \sqcap 12 = 4$ $\qquad$ $15 \sqcap 45 = \boxed{15}$

$14 \sqcap 49 = \boxed{7}$ $\qquad$ $56 \sqcap 64 = \boxed{8}$

Provide students with another copy of a 9-by-9 operation table and display a cleared table. Instruct students to put $\sqcap$ in the upper left corner of this table, and then begin collectively completing this operation table for $\sqcap$. You may want to stop and let students complete the table individually. As before, look for patterns in the table.

$\sqcap$	1	2	3	4	5	6	7	8	9
1	1	1	1	1	1	1	1	1	1
2	1	2	1	2	1	2	1	2	1
3	1	1	3	1	1	3	1	1	3
4	1	2	1	4	1	2	1	4	1
5	1	1	1	1	5	1	1	1	1
6	1	2	3	2	1	6	1	2	3
7	1	1	1	1	1	1	7	1	1
8	1	2	1	4	1	2	1	8	1
9	1	1	3	1	1	3	1	1	9

Exercise 3

Erase the board and clear the table.

$3 * 5 = 5$
$9 * 4 = 9$
$4 * 9 = 9$
$6 * 6 = 6$
$1 * 8 = \square$

T: ***I have another secret rule for *. Here are some hints.***

Note: The rule assigns the greater of the two numbers in a pair.

T: ***If you think you know my rule, what is 1 * 8?***

S: ***8.***

T: ***What is my rule?***

S: ***You always take the greater of the two numbers. If the two numbers are the same, you give that number.***

Draw an arrow pointing upward on the board. ↑

T: ***Let's use an arrow pointing upward to indicate this operation, and call the operation* maximum.**

To reinforce the notation, call on students to complete these number sentences. (Answers are in boxes.)

$2 \uparrow 5 = \boxed{5}$
$3 \uparrow 3 = \boxed{3}$
$0 \uparrow 1 = \boxed{1}$

T: ***What do you think an arrow pointing down means?***

Draw an arrow pointing down on the board. ↓

S: ***Minimum.***

S: ***Take the smaller of the two numbers.***

T: ***And if the numbers are the same?***

S: ***The result is that number.***

Call on students to complete these number sentences. (Answers are in boxes.)

$7 \downarrow 3 = \boxed{3}$
$6 \downarrow 9 = \boxed{6}$
$8 \downarrow 8 = \boxed{8}$

With class input, observe how to complete operation tables for these two operations.

↑	1	2	3	4	5	6	7	8	9
1	1	2	3	4	5	6	7	8	9
2	2	2	3	4	5	6	7	8	9
3	3	3	3	4	5	6	7	8	9
4	4	4	4	4	5	6	7	8	9
5	5	5	5	5	5	6	7	8	9
6	6	6	6	6	6	6	7	8	9
7	7	7	7	7	7	7	7	8	9
8	8	8	8	8	8	8	8	8	9
9	9	9	9	9	9	9	9	9	9

↓	1	2	3	4	5	6	7	8	9
1	1	1	1	1	1	1	1	1	1
2	1	2	2	2	2	2	2	2	2
3	1	2	3	3	3	3	3	3	3
4	1	2	3	4	4	4	4	4	4
5	1	2	3	4	5	5	5	5	5
6	1	2	3	4	5	6	6	6	6
7	1	2	3	4	5	6	7	7	7
8	1	2	3	4	5	6	7	8	8
9	1	2	3	4	5	6	7	8	9

Exercise 4

List these operations on the board and display a cleared 9-by-9 table.

T_D
↑
↓
⊓
+
–
x

*	1	2	3	4	5	6	7	8	9
1									
2									
3									
4									
5									
6									
7									
8									
9									

T: ***We're going to play a kind of Guess My Rule game with this table. I'll choose one of these seven operations*** (point to the list) ***to be *; you will try to figure out which one.***

Note: Choose ↓ as the secret operation, but do not tell the class. Record 1 in the table for 1 * 1.

T: ***Your first clue is that 1 * 1 = 1. Are there any operations that we know * cannot be?***

S: **** cannot be + or –. 1 + 1 = 2 and 1 – $\widehat{1}$ = 0***

Eliminate + and – from the list of possible operations.

As a second clue, record 9 in the table for 9 * 9.

S: **** cannot be x because 9 x 9 = 81.***

S: ***The table cannot be a truth table because it has a number other than 0 and 1 in it.***

Eliminate T_D, and x from the list of operations. At this point, observe that there are still three possibilities for the table: ↑, ↓, or ⊓.

T: ***With these three possibilities for *, are there any entries you know for sure we could make in the table?***

S: ***A diagonal entry, because for all three possibilities, a number starred with itself is still that number.***

Record the entries along the diagonal from the upper left square to the lower right square.

*	1	2	3	4	5	6	7	8	9
1	1								
2		2							
3			3						
4				4					
5					5				
6						6			
7							7		
8								8	
9									9

T: ***Suppose you could ask for any entry in the table to help you discover *. What would you ask for?***

Consider students' comments concerning their choices.

S: ***1 * 5. If 1 * 5 = 5, we know * is ↑. If 1 * 5 = 1, we could eliminate ↑.***

S: ***4 * 6, because 4 ↑ 6 = 6 and 4 ↓ 6 = 4, and 4 ⊓ 6 = 2, three different answers.***

Any entry that differentiates the three possibilities would be a good choice. Make an entry as requested by a student, for example, 4 * 6 = 4. The students should identify the operation as ↓.

Worksheets L10* and ** are available for individual work.

Name_____ L10 ★

With the given information, list which of these operations could be ✱:

T_D ↑ ↓ ⊓ + − ×

Information	Possibilities for ✱
6 ✱ 3 = 3	↓, ⊓, −
8 ✱ 4 = 0	T_D
2 ✱ 2 = 0	−
2 ✱ 2 = 4	+, ×
6 ✱ 6 = 6 and 3 ✱ 2 = 1	⊓
9 ✱ 6 ≠ 3	T_D, ↑, ↓, +, ×
8 ✱ 6 ≠ 8	T_D, ↓, ⊓, +, −, ×
1 ✱ 1 ≠ 1	+, −

Name_____ L10 ★★

Nim appears in at least three places in this table for one of these operations:

T_D ↑ ↓ ⊓ + − ×

Which of these operations has at least this condition in the same? +

✱	3	4	5	6
3				
4				Nim
5			Nim	
6		Nim		

Who is Nim? 10

Nim appears in at least four places in this table for one of the seven operations listed above.

Which of these operations has at least four entries the same? T_D

✱	1	2	3	4
1				
2	Nim		Nim	
3		Nim		
4		Nim		

Who is Nim? 0

Capsule Lesson Summary

Introduce truth tables for the relations "is a multiple of," <, and >. Review the least common multiple operation ⊔. Review addition, subtraction, and multiplication modulo 10 using games with ten number friends. Provided with a list of 14 possible operations, determine the operation for:

- a 2-by-2 table by analyzing its given entries;
- a 9-by-9 table by making trial entries until the operation is evident.

Materials

Teacher
- 9-by-9 operation table transparency
- Blackline L10

Student
- Paper
- 9-by-9 operation tables
- Worksheets L11* and **

Advance Preparation: Use Blackline L10 to make both a transparency of a 9-by-9 operation table for display and copies for students. You may prefer to prepare the table on the chalkboard or a grid board.

Description of Lesson

Exercise 1

Display a 9-by-9 operation table. Remind the class about how to construct a truth table for the relation "is a divisor of" (see Exercise 1 of Lesson L10).

T_D	1	2	3	4	5	6	7	8	9
1	1	1	1	1	1	1	1	1	1
2	*0*	1	*0*	1	*0*	1	*0*	1	*0*
3	*0*	*0*	1	*0*	*0*	1	*0*	*0*	1
4	*0*	*0*	*0*	1	*0*	*0*	*0*	1	*0*
5	*0*	*0*	*0*	*0*	1	*0*	*0*	*0*	*0*
6	*0*	*0*	*0*	*0*	*0*	1	*0*	*0*	*0*
7	*0*	*0*	*0*	*0*	*0*	*0*	1	*0*	*0*
8	*0*	*0*	*0*	*0*	*0*	*0*	*0*	1	*0*
9	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*	1

Write the symbol T_M on the board.

T: ***We can also make a truth table for the relation "is a multiple of." In the table 1 means true, so when the first number is a multiple of the second, assign 1. 0 means false, so assign 0 when the first number is not a multiple of the second.***

Invite students to help complete this truth table, look for patterns, and compare it to the truth table for T_D.

T_M	1	2	3	4	5	6	7	8	9
1	1	*0*	*0*	*0*	*0*	*0*	*0*	*0*	*0*
2	1	1	*0*	*0*	*0*	*0*	*0*	*0*	*0*
3	1	*0*	1	*0*	*0*	*0*	*0*	*0*	*0*
4	1	1	*0*	1	*0*	*0*	*0*	*0*	*0*
5	1	*0*	*0*	*0*	1	*0*	*0*	*0*	*0*
6	1	1	1	*0*	*0*	1	*0*	*0*	*0*
7	1	*0*	*0*	*0*	*0*	*0*	1	*0*	*0*
8	1	1	*0*	1	*0*	*0*	*0*	1	*0*
9	1	*0*	1	*0*	*0*	*0*	*0*	*0*	1

L11

Write the symbols $T_<$ and $T_>$ on the board.

T: ***We can also make truth tables for the relations < and >. In the $T_<$ table, assign 1 if it is true that the first number is less than the second and assign 0 if it is not. For example, 2 * 8 would be 1 and 8 * 2 would be 0.***

Invite students to help complete these truth tables. Look for patterns and compare the tables.

$T_<$	1	2	3	4	5	6	7	8	9
1	0	1	1	1	1	1	1	1	1
2	0	0	1	1	1	1	1	1	1
3	0	0	0	1	1	1	1	1	1
4	0	0	0	0	1	1	1	1	1
5	0	0	0	0	0	1	1	1	1
6	0	0	0	0	0	0	1	1	1
7	0	0	0	0	0	0	0	1	1
8	0	0	0	0	0	0	0	0	1
9	0	0	0	0	0	0	0	0	0

$T_>$	1	2	3	4	5	6	7	8	9
1	0	0	0	0	0	0	0	0	0
2	1	0	0	0	0	0	0	0	0
3	1	1	0	0	0	0	0	0	0
4	1	1	1	0	0	0	0	0	0
5	1	1	1	1	0	0	0	0	0
6	1	1	1	1	1	0	0	0	0
7	1	1	1	1	1	1	0	0	0
8	1	1	1	1	1	1	1	0	0
9	1	1	1	1	1	1	1	1	0

Erase the board and then write this expression.

T: ***What does this symbol*** (point to $\sqcup$) ***mean?*** $9 \sqcup 6$

S: ***Least common multiple.***

T: ***When we ask for the least common multiple of two numbers, it is understood that we want the least common positive multiple of the numbers. What are some positive multiples of 9?***

S: ***9, 18, 27, 36, and so on.***

T: ***What are some positive multiples of 6?***

S: ***6, 12, 18, 24, 30, and so on.***

$9 \sqcup 6$

9	6
18	12
27	18
36	24
45	30
⋮	36
	⋮

List some of the multiples of 9 and of 6 on the board.

T: ***What is the least common multiple of 9 and 6?***

S: ***18.***

Record the answer and pose several more problems. (Answers are in boxes.)

$\sqcup 6 = 18$ $\qquad$ $16 \sqcup 8 = \boxed{16}$

$\sqcup 4 = \boxed{20}$ $\qquad$ $12 \sqcup 15 = \boxed{60}$

Direct students to complete a 9-by-9 operation table for $\sqcup$.

⊓	1	2	3	4	5	6	7	8	9
1	1	2	3	4	5	6	7	8	9
2	2	2	6	4	10	6	14	8	18
3	3	6	3	12	15	6	21	24	9
4	4	4	12	4	20	12	28	8	36
5	5	10	15	20	5	30	35	40	45
6	6	6	6	12	30	6	42	24	18
7	7	14	21	28	35	42	7	56	63
8	8	8	24	8	40	24	56	8	72
9	9	18	9	36	45	18	63	72	9

Exercise 2

If appropriate, recall with the class the storybook *Dancing Friends*.† In the story, the boy invites the ten whole numbers 0 through 9 over to his house to play games.

Write these numerals on the board.

0 1 2 3 4 5 6 7 8 9

T: ***The ten number friends are upset at first because they don't know any games that just the ten of them can play. They can't do multiplication. Do you know why?***

S: ***8 x 0 = 72, and 72 is not one of the ten friends.***

A student may resist and say that 7 and 2 are present and therefore that 72 is present. If so, point out that 7, 2, and 72 are three different numbers.

T: ***Are there other operations they cannot do?***

The class should rule out addition, subtraction, and division. Consider any other operations or relations that your students suggest, and decide with the class whether or not the ten numbers could play them. For example, a student could suggest that the numbers play $\sqcap$ (greatest common divisor) in which the greatest common divisor of any two of these numbers is again one of the ten numbers. Note that any whole number 1 to 9 is a divisor of 0.

T: ***Well, 0 invents several games that the ten friends can play. First 0 shows the ten friends how to do addition with ten friends, or addition modulo 10 ($+_{10}$).***

Write these number sentences on the board.

$2 \times_{10} 4 = 6$
$4 \times_{10} 7 = 1$
$6 \times_{10} 6 = 2$
$5 \times_{10} 3 = 8$
$7 \times_{10} 6 =$

T: ***Do you understand 0's game? What number is $7 +_{10} 6$? Who can explain the game?***

S: ***$7 +_{10} 6 = 3$.***

S: ***Add in the usual way and keep only the ones digit.***

S: ***Add the two numbers. If the sum is greater than 10, subtract 10.***

Pose several problems for students to practice addition modulo 10. (Answers are in boxes.)

†It is not necessary that students have read this storybook prior to this lesson.

$8 +_{10} 4 = \boxed{2}$ $\quad$ $\boxed{7} +_{10} 8 = 5$ $\quad$ $\boxed{4} +_{10} \boxed{4} = 8$

$5 +_{10} 9 = \boxed{4}$ $\quad$ $9 +_{10} \boxed{6} = 5$ $\quad$ or $\quad$ $\boxed{9} +_{10} \boxed{9} = 8$

Write this problem on the board.

$3 \times_{10} 4 =$

T: ***The ten numbers also play a multiplication game. What do you think 3 $\times_{10}$ 4 (read as "three times four modulo 10") is?***

S: ***2, because 3 x 4 = 12 and we get 2 if we keep only the ones digit in 12.***

Pose several more problems for students to practice multiplication modulo 10. (Answers are in boxes.)

$4 \times_{10} 5 = \boxed{0}$ $\quad$ $\boxed{6} \times_{10} 9 = 4$ $\quad$ $\boxed{3} \times_{10} \boxed{3} = 9$

$7 \times_{10} 3 = \boxed{1}$ $\quad$ $8 \times_{10} \boxed{4 \text{ or } 9} = 2$ $\quad$ $\boxed{7} \times_{10} \boxed{7} = 9$

$\boxed{5} \times_{10} \boxed{5} = 5$

Note: Explanations most likely will be in terms of keeping the ones digit. If a student suggests subtracting 10 from the result of the usual multiplication, observe that they may need to subtract 10 more than once to get a number from 0 to 9.

Write this problem on the board.

$7 -_{10} 3 =$

T: ***The ten numbers might also play a subtraction game. What is 7 $-_{10}$ 3?***

S: ***4, because 7 – 3 = 4 and 4 is one of the ten numbers.***

T: ***When would there be a problem playing the subtraction game?***

S: ***When the first number is less than the second number, such as 3 $-_{10}$ 7.***

$3 -_{10} 7 =$

T: ***How would the ten friends find 3 $-_{10}$ 7 ?***

S: ***3 – 7 = $\widehat{4}$, but $\widehat{4}$ is not one of the ten friends so maybe they would use 4.***

S: ***3 – 7 = $\widehat{4}$. Since $\widehat{4}$ is not one of the ten friends maybe they add 10 (rather than subtract 10) to get 6.***

Let students express their ideas on how to define subtraction modulo 10. Eventually agree that they should add 10 when the result of usual subtraction is negative. The reason for this is to make addition and subtraction modulo 10 opposites. That is,

if $3 -_{10} 7 = \boxed{6}$ then $\boxed{6} +_{10} 7 = 3$

just as $3 - 7 = \boxed{\widehat{4}}$ and $\boxed{\widehat{4}} + 7 = 3$

Distribute copies of 9-by-9 operation tables, and direct students to complete tables for $+_{10}$, $-_{10}$, and $\times_{10}$. You may like to organize this work in small groups.

$+_{10}$	1	2	3	4	5	6	7	8	9
1	2	3	4	5	6	7	8	9	0
2	3	4	5	6	7	8	9	0	1
3	4	5	6	7	8	9	0	1	2
4	5	6	7	8	9	0	1	2	3
5	6	7	8	9	0	1	2	3	4
6	7	8	9	0	1	2	3	4	5
7	8	9	0	1	2	3	4	5	6
8	9	0	1	2	3	4	5	6	7
9	0	1	2	3	4	5	6	7	8

$-_{10}$	1	2	3	4	5	6	7	8	9
1	0	9	8	7	6	5	4	3	2
2	1	0	9	8	7	6	5	4	3
3	2	1	0	9	8	7	6	5	4
4	3	2	1	0	9	8	7	6	5
5	4	3	2	1	0	9	8	7	6
6	5	4	3	2	1	0	9	8	7
7	6	5	4	3	2	1	0	9	8
8	7	6	5	4	3	2	1	0	9
9	8	7	6	5	4	3	2	1	0

$\times_{10}$	1	2	3	4	5	6	7	8	9
1	1	2	3	4	5	6	7	8	9
2	2	4	6	8	0	2	4	6	8
3	3	6	9	2	5	8	1	4	7
4	4	8	2	6	0	4	8	2	6
5	5	0	5	0	5	0	5	0	5
6	6	2	8	4	0	6	2	8	4
7	7	4	1	8	5	2	9	6	3
8	8	6	4	2	0	8	6	4	2
9	9	8	7	6	5	4	3	2	1

Exercise 3

Draw this 2-by-2 table on the board and list these operations.

*	3	4
6	1	0
7	0	0

T_D T_M $T_<$ $T_>$

$\downarrow$ $\uparrow$ $\sqcap$ $\sqcup$

$+_{10}$ $-_{10}$ $\times_{10}$

T: ***This table is for one of these operations. Which of these operations cannot be *? Why?***

S: **** cannot be $\sqcap$ because 0 is not a divisor of any number.***

S: ***It might be a truth table because it has only 0s and 1s in it.***

S: **** cannot be $T_<$ or $T_>$. $6 > 3$, $6 > 4$, $7 > 3$, $7 > 4$, so all of the entries in the table would be 1.***

S: **** cannot be $\uparrow$ or $\downarrow$ because if it were there would be no 0 entry.***

S: **** cannot be $\times_{10}$ because $6 \times 3 = 18$, so $6 \times_{10} 3 = 8$.***

Cross out operations that * cannot be. Continue until the class finds that * is T_M.

Exercise 4

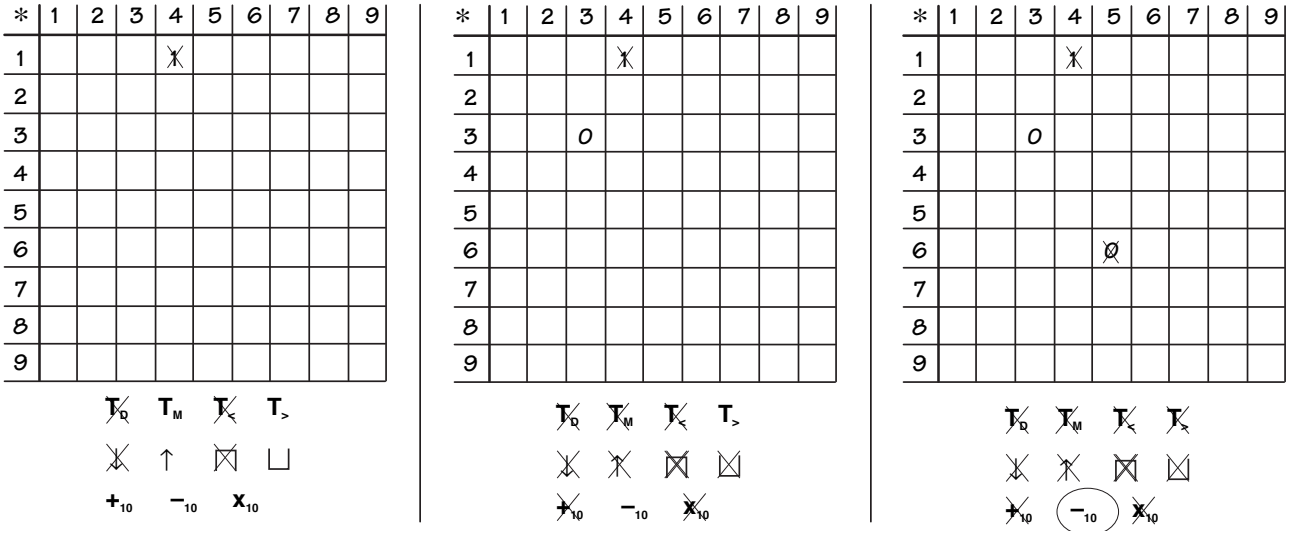
Draw a 9-by-9 table on the board, and next to it list the same operations as in Exercise 3.

T: ***I am thinking of one of these operations*** (point to the list)***. Try to figure out which one. You choose numbers and tell me where to put them in the table. I'll tell you whether or not the entries are correct.***

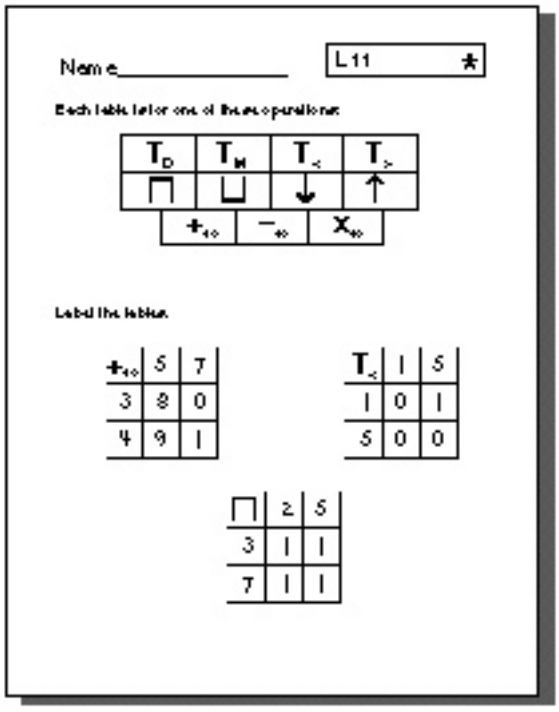
Choose a secret operation, for example $-_{10}$, but do not tell the class.

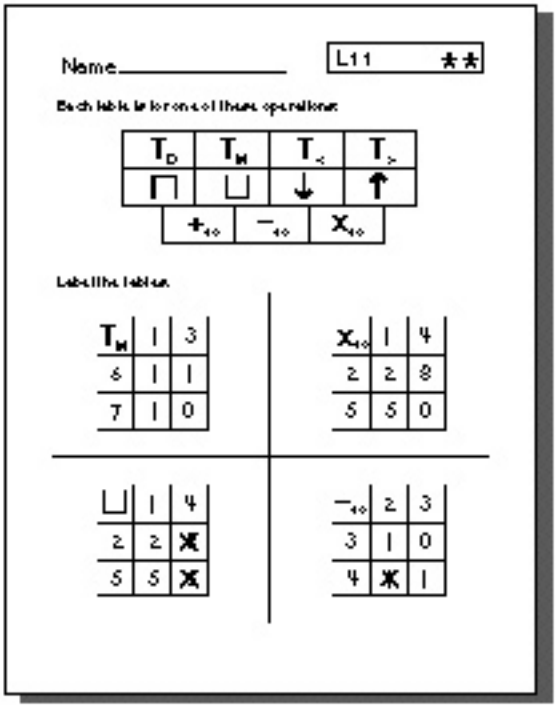
Invite students to suggest numbers and tell you where to put them in the table. Record an entry in the table and announce when it is correct; put $\times$ through an incorrect entry. After each entry discuss which operations can be crossed off the list. Continue until the operation is determined.

The following sequence shows how the operation could be determined after three trial entries.



Worksheets L11* and ** are available for individual work.





Capsule Lesson Summary

Introduce a truth table for the relation "has the same parity." Provide a list of 12 operations, and ask which of those operations have tables with various characteristics. Introduce *The Table Game*.

Materials

Teacher
- 9-by-9 operation table transparency
- Table Game posters
- Table Game scoring sheet
- Tape
- Markers
- Blacklines L14(a) and (b)

Student
- Table Game analysis sheet

Advance Preparation: Use Blackline L10 to make a transparency of a 9-by-9 operation table. You may prefer to prepare the table on the chalkboard or a grid board. Use Blackline L14(a) to make copies of the Table Game analysis sheet for students. Use Blackline L14(b) to make copies of a scoring sheet for use in play of the game (Exercise 2).

Description of Lesson

Exercise 1

Tape a copy of *The Table Game* poster to the board, and display a 9-by-9 operation table nearby.

The Table Game

$+_{10}$	$-_{10}$	x_{10}
$\sqcap$	$\sqcup$	$\uparrow$
T_D	T_M	$\downarrow$
$T_<$	$T_>$	T_P

*	1	2	3	4	5	6	7	8	9
1									
2									
3									
4									
5									
6									
7									
8									
9									

Remind the class that in previous lessons they have constructed tables for all the operations on the Table Game poster except T_P.

T: ***This last symbol (T_P) on the poster is for another truth table. The P means* parity*. Do you know how we use this word with numbers?***

Some students may recognize the word as having to do with even and odd. Let students express their ideas first, and then explain that two numbers have the same parity if they are both even or both odd.

T: ***Let's examine the truth table for the relation "has the same parity." Remember, in a truth table 1 means true and 0 means false. Where will there be 1s in the table? Where will there be 0s?***

Label the table for T_P, and invite students to make some entries. As entries are made reiterate that 1 is for true and 0 is for false.

T: ***"2 has the same parity as 6" is true because 2 and 6 are both even.***
"2 has the same parity as 5" is false because 2 is even and 5 is odd.
"5 has the same parity as 3" is true because 5 and 3 are both odd.

The class should quickly find patterns that make the table easy to complete.

T_P	1	2	3	4	5	6	7	8	9
1	1	0	1	0	1	0	1	0	1
2	0	1	0	1	0	1	0	1	0
3	1	0	1	0	1	0	1	0	1
4	0	1	0	1	0	1	0	1	0
5	1	0	1	0	1	0	1	0	1
6	0	1	0	1	0	1	0	1	0
7	1	0	1	0	1	0	1	0	1
8	0	1	0	1	0	1	0	1	0
9	1	0	1	0	1	0	1	0	1

Clear the display table, and ask the following questions to stimulate students to think about other operations and their tables.† Refer to the table on the board. Each time a question is asked, list the possibilities on the board as students suggest them and the class agrees. The last three questions will require the most analysis. Encourage students to rule out several possibilities at a time or to consider related operations as well.

- Which of these operations have no zero in their tables? ($\downarrow$, $\uparrow$, $\sqcap$, $\sqcup$)
- Do any of these operations have negative numbers in their tables? (No)
- Do any of these operations have numbers greater than 9 in their tables? ($\sqcup$)
- Which of these operations have zeros everywhere along this diagonal (trace the diagonal from the upper left corner to the lower right corner) in their tables? ($-_{10}$, $T_<$, $T_>$)
- Which of these operations have ones everywhere along this diagonal (trace the diagonal from the upper left corner to the lower right corner) in their tables? (T_D, T_M, T_P)
- Which of these operations have all ones in the first row (the 1-row)? ($\sqcap$, $\downarrow$, T_D)
- Which of these operations have all zeros in the first row (the 1-row)? ($T_>$)

Exercise 2: The Table Game

Select one student who will be a reliable scorekeeper††. Divide the rest of the class into four (or two) teams. In the following example, the four teams are referred to as Team A, Team B, Team C, and Team D. Distribute Table Game analysis sheets to students.

Play a game involving a table for an unknown operation *. The object is to determine which of 12 operations listed on the poster is *. Although all of the plays in the game are made in the same way, the scoring rules divide the game into two parts with different but related goals.

The game begins with one or two entries already in the table as starting clues. Such an entry can be correct or incorrect (indicated by an X through it). Players, either independently or with their team members, then use the clues to try to eliminate some of the 12 possibilities for * listed on their analysis sheets. After a few minutes, a player from Team A suggests an entry to the table; for example,

†"Their tables" refers to their completed 9-by-9 tables. Completed tables for all 12 operations in *The Table Game* can be found at the end of Lesson L15.

††The scorekeeper could be an adult who is available during the class time, such as a teacher's aide or a student teacher.

the player might suggest that 2 * 3 = 6. Make the entry in the table. If correct, tell the class; if incorrect, say "no" and put an X through the entry. Allow a few minutes for players to use the information gained from the play to help identify the operation *. Then give players the option to turn in their analysis sheets with one of the operations circled. A team gains ten points each time a member correctly identifies the operation. If team members are consulting among themselves, you may ask the team to turn in just one sheet. The scorekeeper tallies the points for each team but does not reveal the score at this time.

Proceed in the same manner for plays from the other three teams, but each time decrease the number of points that can be gained (9-8-7). With two teams, each team makes two plays. The last time students (or teams) may turn in their analysis sheets is after the fourth play is made.

Now the scoring changes. The remainder of the game allows each player (alternating teams) to suggest an entry in the table in the same manner as before. Only now players earn points for their team based on whether or not their entries are correct. The scoring is as follows.

- A team gains one point if a member suggests a correct entry in a square on the main diagonal (shaded squares).
- A team gains two points if a member suggests a correct entry in a square other than on the main diagonal.

A team is not penalized for an incorrect suggestion; the entry is simply made and crossed out.

*	1	2	3	4	5	6	7	8	9
1									
2									
3									
4									
5									
6									
7									
8									
9									

The game ends after each player has had a turn. Call on a player to identify * while the scorekeeper computes the scores. It is a good idea to give the scorekeeper a tally sheet similar to the one on Blackline L14(b).

The secret operation is _____.

Points	**TEAM A**	**TEAM B**	**TEAM C**	**TEAM D**
First part of game				
For **correctly** identifying *				
• after first play 10 pts.				
• after second play 9 pts.				
• after third play 8 pts.				
• after fourth play 7 pts.				
First part of game				
For **correctly** making an entry				
• on the diagonal 1 pt.				
• other than on the diagonal 2 pts.				

Play the game a couple of times. These are some possible choices for the unknown operation * with appropriate starting clues.

	Operation *	Starting Clue
First game:	x_{10}	$3 * 7 = 1$
Second game:	T_M	$8 * 5 = 0$
Third game:	↑	$5 * 5 \neq 0$

The rest of this lesson description describes a possible game. The operation * is x_{10} and $3 * 7 = 1$ is a starting clue.

T: ***Knowing that 3 * 7 = 1 should help you to eliminate some of the possibilities for the operation. Cross out as many operation symbols as you can on your analysis sheet.***

Allow a few minutes for analysis.

Note: For your information only, four possibilities for * remain: x_{10}, ⌐¬, $T_<$, and T_P.

The first player from Team A suggests an entry.

S: ***1 * 1 = 1.***

T: ***That's correct.***

Allow a few minutes for analysis.

T: ***Does anyone want to turn in their sheet for a possible ten points?***

Nobody turns in an analysis sheet.

*	1	2	3	4	5	6	7	8	9
1	1								
2									
3							1		
4									
5									
6									
7									
8									
9									

The first player from Team B suggests an entry.

S: ***5 * 6 = 1.***

T: ***No; that's not correct.***

Allow a few minutes for analysis.

T: ***Does anyone want to turn in their sheet for a possible nine points?***

*	1	2	3	4	5	6	7	8	9
1	1								
2									
3							1		
4									
5						X			
6									
7									
8									
9									

A couple players (teams) turn in their sheets. Now there are two possibilities for *: x_{10}, or T_P. Those who turned in their sheets may have been taking a chance. They get the nine points only if they circled x_{10}.

The next two players make suggestions, and some more players turn in their sheets for eight points and for seven points.

*	1	2	3	4	5	6	7	8	9
1	1								
2									
3							1		
4				✗					
5						✗			
6					0				
7									
8									
9									

S (Team C)**:** ***4 * 4 = 1.***

T: ***No, that's not correct.***

S (Team D)**:** ***6 * 5 = 0.***

T: ***Yes, that's correct.***

Note: The operation is determined when Team C's entry is made. Because 1 is crossed out, meaning $4 * 4 \neq 1$, * cannot be **TP**.

The scorekeeper tallies the points so far but does not reveal the results to the class.

Now the scoring changes. Students suggest entries and earn points for their team based on whether or not the entries are correct.

*	1	2	3	4	5	6	7	8	9
1	1	✗							
2					0				
3							1		
4				✗					
5		0			5	✗			
6					0				
7									
8									
9									

S *(*Team A*)***: *2 * 5 = 0.***

T: ***Correct—two points for Team A.***

S (Team B)**:** ***1 * 2 = 0.***

T: ***Not correct—no point for Team B.***

S (Team C)***: 5 * 5 = 5.***

T: ***Correct—one point for Team C.***

S (Team D)***: 5 * 2 = 0.***

T: ***Correct—two points for Team D.***

The game continues until every player has had a turn.

T: ***While the scorekeeper is computing the scores, who can tell us which operation * is?***

S: **X10.**

The scores are revealed and the winning team is announced.

Note: You may like to vary the game by letting students turn in their analysis sheets for a possible 15 points after the starting clues alone. The operation in the game sometimes can be determined by only one or two entries. If you choose to play in this way, adjust the scorekeeper's sheet accordingly.

Capsule Lesson Summary

Given a 2-by-2 table with all four of its entries, identify which of 12 operations the table is for. Given three entries in a 9-by-9 table, determine which of 12 operations the table is for. Play *The Table Game*.

Materials

Teacher
- 9-by-9 operation table transparency
- Table Game posters
- Tape
- Markers

Student
- Table Game analysis sheet
- Worksheets L15* and **

Advance Preparation: Use Blackline L10 to make a transparency of a 9-by-9 operation table. You may prefer to prepare the table on the chalkboard or on a grid board.

Description of Lesson

Exercise 1

Display a copy of *The Table Game* poster and draw this 2-by-2 table nearby.

The Table Game

$+_{10}$	$-_{10}$	x_{10}
⊓	⊔	↑
T_D	T_M	↓
$T_<$	$T_>$	T_P

*	1	4
2	0	1
5	1	0

T: ***This table is for one of these operations. Looking at the entries in this table, you probably have some idea about which operation the table is for. Take a few minutes to test some operations that you think could be *.***

The emphasis in this exercise is on using intuition and not systematic consideration of each possibility for *. After two or three minutes, let students suggest operations that might be *. Most likely, students will suggest looking at truth tables first since the table has only 0s and 1s. Each time someone suggests an operation, ask the class if any of the four entries in the table prohibits * from being that operation. Continue until the class identifies the operation as T_P.

Repeat this exercise with a couple more 2-by-2 tables. Use the tables suggested below or others of your choice.

↑	7	8
5	7	8
6	7	8

$-_{10}$	3	1
7	4	6
2	1	1

T_D	1	6
1	1	1
3	0	1

Exercise 2

Erase the 2-by-2 table and display a 9-by-9 table. Make the entries shown below.

The Table Game

$+_{10}$	$-_{10}$	x_{10}
⊓	⊔	↑
T_D	T_M	↓
$T_<$	$T_>$	T_P

*	1	2	3	4	5	6	7	8	9
1									X
2									
3									
4									
5									
6									
7									
8									
9	O								

T: ***This table is for one of these operations. There are two clues. What can we eliminate from the list of possible operations.***

S: **** cannot be ↑, ↓, ⊓, or ⊔ because those operations do not have 0s in the table.***

S: **** cannot be T_P because 1 and 9 are both odd; they are the same parity so 1 * 9 would be 1.***

S: **** cannot be T_M because 9 is a multiple of 1. 9 * 1 would be 1.***
**** cannot be T_D because 1 is a divisor of 9. 1 * 9 would be 1.***

S: **** cannot be $T_<$ because 1 < 9 is true. 1 * 9 would be 1.***
**** cannot be $T_>$ because 9 > 1 is true. 9 * 1 would be 1.***

The class should determine that the table is for $+_{10}$.

Exercise 3

Play *The Table Game* in the usual way. (See Lesson L14 for a description of the game.) A possible game is described below. Indicate only the starting clues in the 9-by-9 table on the board at the beginning of the game.

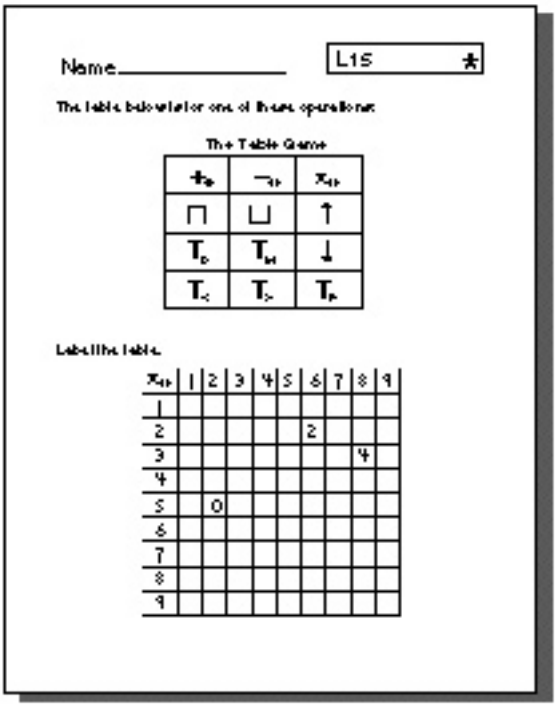
Operation *	Starting Clues
T_M	$1 * 2 \neq 1$
	$3 * 3 \neq 0$

Worksheets L15*, **, and *** are available for individual work.

Note: With these starting clues 6 of the 12 possible operations can be eliminated; namely, $-_{10}$, ⊓, T_D, ↓, $T_<$, and $T_>$.

Worksheets L15*, **, and *** are available for individual work.

For your convenience, the page following the worksheet keys has completed tables for all the operations in *The Table Game*.



Name_____ L1S ★

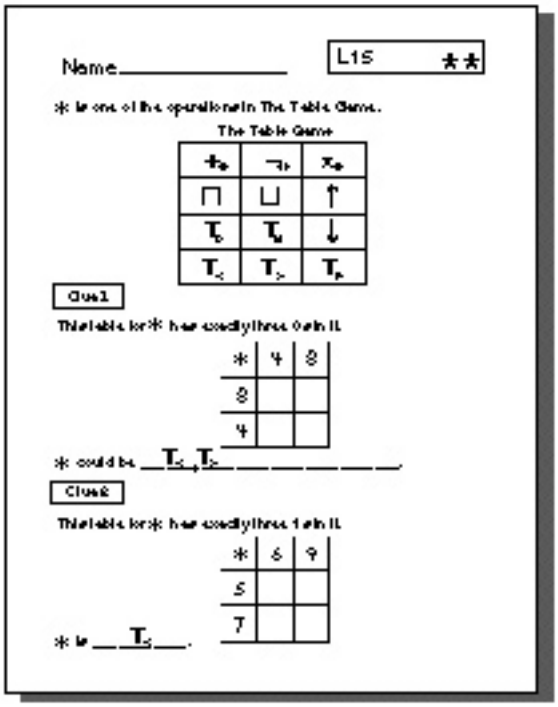
The table below is for one of these operations:

The Table Game

$+_6$	$\neg_6$	x_6
⊓	⊔	↑
T_0	T_M	↓
$T_<$	$T_>$	$T_=$

Label the table.

x_6	1	2	3	4	5	6	7	8	9
1									
2						2			
3								4	
4									
5		0							
6									
7									
8									
9									



Name_____ L1S ★★

$*$ is one of the operations in The Table Game.

The Table Game

$+_6$	$\neg_6$	x_6
⊓	⊔	↑
T_0	T_M	↓
$T_<$	$T_>$	$T_=$

Clue 1

This table for $*$ has exactly three 0s in it.

$*$	4	8
8		
4		

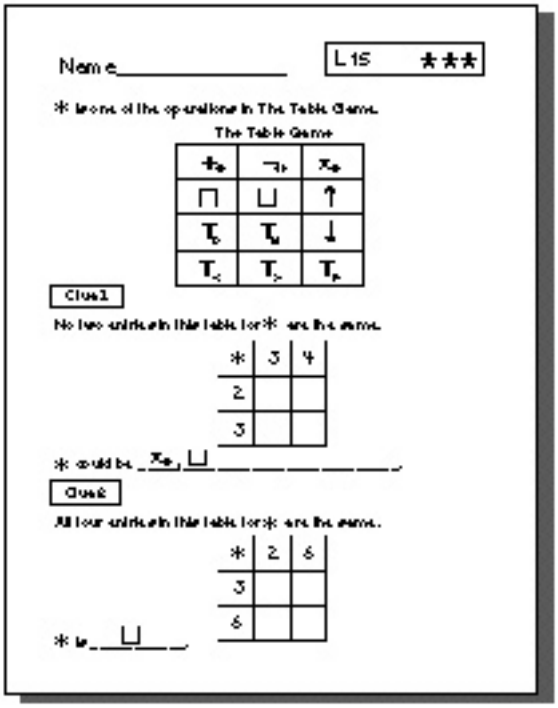
$*$ could be $T_<$, $T_>$ _____.

Clue 2

This table for $*$ has exactly three 1s in it.

$*$	6	9
5		
7		

$*$ is ___$T_<$___.



Name_____ L1S ★★★

$*$ is one of the operations in The Table Game.

The Table Game

$+_6$	$\neg_6$	x_6
⊓	⊔	↑
T_0	T_M	↓
$T_<$	$T_>$	$T_=$

Clue 1

No two entries in this table for $*$ are the same.

$*$	3	4
2		
3		

$*$ could be x_6, ⊔ _____.

Clue 2

All four entries in this table for $*$ are the same.

$*$	2	6
3		
6		

$*$ is ___⊔___.

$+_{10}$	1	2	3	4	5	6	7	8	9
1	2	3	4	5	6	7	8	9	0
2	3	4	5	6	7	8	9	0	1
3	4	5	6	7	8	9	0	1	2
4	5	6	7	8	9	0	1	2	3
5	6	7	8	9	0	1	2	3	4
6	7	8	9	0	1	2	3	4	5
7	8	9	0	1	2	3	4	5	6
8	9	0	1	2	3	4	5	6	7
9	0	1	2	3	4	5	6	7	8

$-_{10}$	1	2	3	4	5	6	7	8	9
1	0	9	8	7	6	5	4	3	2
2	1	0	9	8	7	6	5	4	3
3	2	1	0	9	8	7	6	5	4
4	3	2	1	0	9	8	7	6	5
5	4	3	2	1	0	9	8	7	6
6	5	4	3	2	1	0	9	8	7
7	6	5	4	3	2	1	0	9	8
8	7	6	5	4	3	2	1	0	9
9	8	7	6	5	4	3	2	1	0

x_{10}	1	2	3	4	5	6	7	8	9
1	1	2	3	4	5	6	7	8	9
2	2	4	6	8	0	2	4	6	8
3	3	6	9	2	5	8	1	4	7
4	4	8	2	6	0	4	8	2	6
5	5	0	5	0	5	0	5	0	5
6	6	2	8	4	0	6	2	8	4
7	7	4	1	8	5	2	9	6	3
8	8	6	4	2	0	8	6	4	2
9	9	8	7	6	5	4	3	2	1

⊓	1	2	3	4	5	6	7	8	9
1	1	1	1	1	1	1	1	1	1
2	1	2	1	2	1	2	1	2	1
3	1	1	3	1	1	3	1	1	3
4	1	2	1	4	1	2	1	4	1
5	1	1	1	1	5	1	1	1	1
6	1	2	3	2	1	6	1	2	3
7	1	1	1	1	1	1	7	1	1
8	1	2	1	4	1	2	1	8	1
9	1	1	3	1	1	3	1	1	9

⊔	1	2	3	4	5	6	7	8	9
1	1	2	3	4	5	6	7	8	9
2	2	2	6	4	10	6	14	8	18
3	3	6	3	12	15	6	21	24	9
4	4	4	12	4	20	12	28	8	36
5	5	10	15	20	5	30	35	40	45
6	6	6	6	12	30	6	42	24	18
7	7	14	21	28	35	42	7	56	63
8	8	8	24	8	40	24	56	8	72
9	9	18	9	36	45	18	63	72	9

↑	1	2	3	4	5	6	7	8	9
1	1	2	3	4	5	6	7	8	9
2	2	2	3	4	5	6	7	8	9
3	3	3	3	4	5	6	7	8	9
4	4	4	4	4	5	6	7	8	9
5	5	5	5	5	5	6	7	8	9
6	6	6	6	6	6	6	7	8	9
7	7	7	7	7	7	7	7	8	9
8	8	8	8	8	8	8	8	8	9
9	9	9	9	9	9	9	9	9	9

T_D	1	2	3	4	5	6	7	8	9
1	1	1	1	1	1	1	1	1	1
2	0	1	0	1	0	1	0	1	0
3	0	0	1	0	0	1	0	0	1
4	0	0	0	1	0	0	0	1	0
5	0	0	0	0	1	0	0	0	0
6	0	0	0	0	0	1	0	0	0
7	0	0	0	0	0	0	1	0	0
8	0	0	0	0	0	0	0	1	0
9	0	0	0	0	0	0	0	0	1

T_M	1	2	3	4	5	6	7	8	9
1	1	0	0	0	0	0	0	0	0
2	1	1	0	0	0	0	0	0	0
3	1	0	1	0	0	0	0	0	0
4	1	1	0	1	0	0	0	0	0
5	1	0	0	0	1	0	0	0	0
6	1	1	1	0	0	1	0	0	0
7	1	0	0	0	0	0	1	0	0
8	1	1	0	1	0	0	0	1	0
9	1	0	1	0	0	0	0	0	1

↓	1	2	3	4	5	6	7	8	9
1	1	1	1	1	1	1	1	1	1
2	1	2	2	2	2	2	2	2	2
3	1	2	3	3	3	3	3	3	3
4	1	2	3	4	4	4	4	4	4
5	1	2	3	4	5	5	5	5	5
6	1	2	3	4	5	6	6	6	6
7	1	2	3	4	5	6	7	7	7
8	1	2	3	4	5	6	7	8	8
9	1	2	3	4	5	6	7	8	9

$T_<$	1	2	3	4	5	6	7	8	9
1	0	1	1	1	1	1	1	1	1
2	0	0	1	1	1	1	1	1	1
3	0	0	0	1	1	1	1	1	1
4	0	0	0	0	1	1	1	1	1
5	0	0	0	0	0	1	1	1	1
6	0	0	0	0	0	0	1	1	1
7	0	0	0	0	0	0	0	1	1
8	0	0	0	0	0	0	0	0	1
9	0	0	0	0	0	0	0	0	0

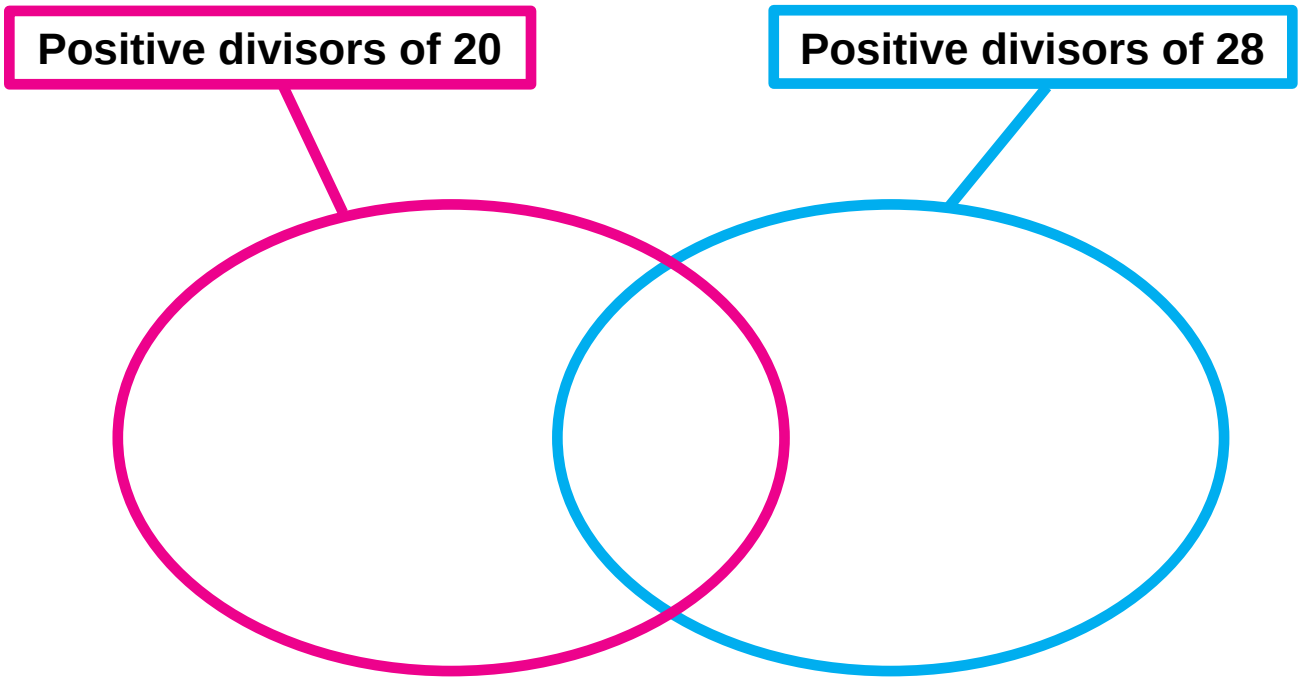
$T_>$	1	2	3	4	5	6	7	8	9
1	0	0	0	0	0	0	0	0	0
2	1	0	0	0	0	0	0	0	0
3	1	1	0	0	0	0	0	0	0
4	1	1	1	0	0	0	0	0	0
5	1	1	1	1	0	0	0	0	0
6	1	1	1	1	1	0	0	0	0
7	1	1	1	1	1	1	0	0	0
8	1	1	1	1	1	1	1	0	0
9	1	1	1	1	1	1	1	1	0

T_P	1	2	3	4	5	6	7	8	9
1	1	0	1	0	1	0	1	0	1
2	0	1	0	1	0	1	0	1	0
3	1	0	1	0	1	0	1	0	1
4	0	1	0	1	0	1	0	1	0
5	1	0	1	0	1	0	1	0	1
6	0	1	0	1	0	1	0	1	0
7	1	0	1	0	1	0	1	0	1
8	0	1	0	1	0	1	0	1	0
9	1	0	1	0	1	0	1	0	1

Name _____

L2 *

Put all of the positive divisors of 20 and of 28 in this string picture.



Complete these number sentences.

20 ⊓ 28 = _____

10 ⊓ 28 = _____

35 ⊓ 28 = _____

Name _____

L2 **

Zim is a secret whole number.

Clue 1

Zim $\square$ 24 = 72

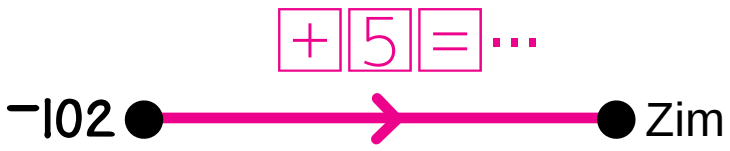
Zim could be _____, _____, _____, or _____.

Clue 2

Zim $\sqrt{\ }$ 30 = 6

Zim could be _____, _____, or _____.

Clue 3



Who is Zim? _____

Name _____

L2 ***

Pom is a secret whole number.

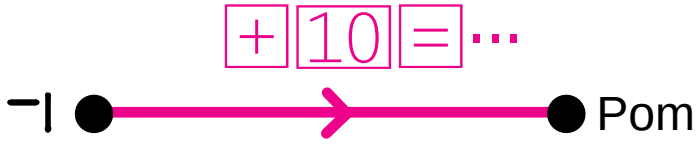
Clue 1

Pom ⌈⌉ 28 = 7

Find a pattern for the numbers that Pom could be.

Pom could be ____, ____, ____, ____, ____, ____, ____, ____, ____, ____, ____, and so on.

Clue 2



Find a pattern for the numbers that Pom could be.

Pom could be ____, ____, ____, ____, ____, ____, and so on.

Clue 3

In this list, Pom is the greatest number less than 1000.

Who is Pom? _____

Name _____

L10 $*$

With the given information, list which of these operations could be $*$:

T_D $\uparrow$ $\downarrow$ $\sqcap$ $+$ $-$ $\times$

Information	Possibilities for $*$
$6 * 3 = 3$	
$8 * 4 = 0$	
$2 * 2 = 0$	
$2 * 2 = 4$	
$6 * 6 = 6$ and $3 * 2 = 1$	
$9 * 6 \neq 3$	
$8 * 6 \neq 8$	
$1 * 1 \neq 1$	

Name _____

L10 **

Nim appears in at least three places in this table for one of these operations:

T_D $\uparrow$ $\downarrow$ $\sqcap$ $+$ $-$ $\times$

Which of these operations has these three entries the same? _____

*	3	4	5	6
3				
4				Nim
5			Nim	
6		Nim		

Who is Nim? _____

Nam appears in at least four places in this table for one of the seven operations listed above.

Which of these operations has these four entries the same? _____

*	1	2	3	4
1				
2	Nam		Nam	
3		Nam		
4		Nam		

Who is Nam? _____

Name _____

L11 *

Each table is for one of these operations:

T_D	T_M	$T_<$	$T_>$
⊓	⊔	↓	↑

$+_{10}$	$-_{10}$	X_{10}

Label the tables.

	5	7
3	8	0
4	9	1

	1	5
1	0	1
5	0	0

	2	5
3	1	1
7	1	1

Name _____

L11 **

Each table is for one of these operations:

T_D	T_M	$T_<$	$T_>$
⊓	⊔	↓	↑

$+_{10}$	$-_{10}$	X_{10}

Label the tables.

	1	3
6	1	1
7	1	0

	1	4
2	2	8
5	5	0

	1	4
2	2	~~8~~
5	5	~~5~~

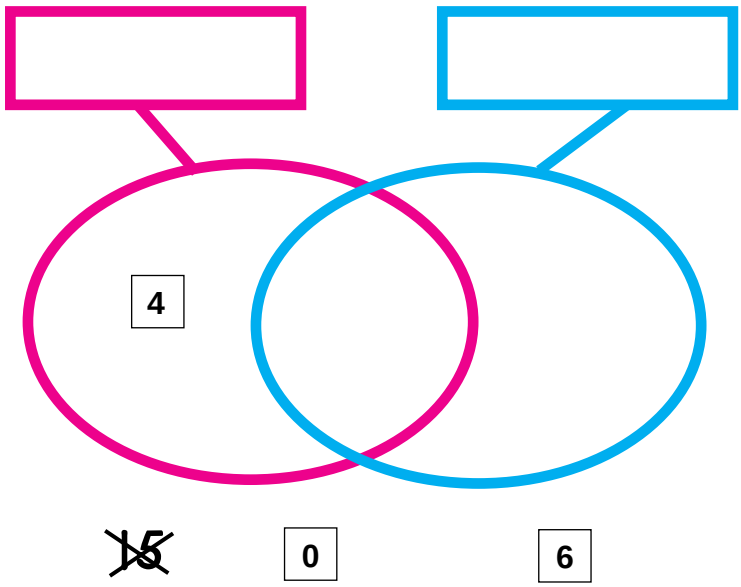
	2	3
3	1	0
4	~~1~~	1

Name _____

L13 *

Use the clues in the picture to cross out labels the strings cannot have. Then label the strings.

RED	BLUE
MULTIPLES OF 2	MULTIPLES OF 2
MULTIPLES OF 3	MULTIPLES OF 3
MULTIPLES OF 4	MULTIPLES OF 4
MULTIPLES OF 5	MULTIPLES OF 5
MULTIPLES OF 10	MULTIPLES OF 10
ODD NUMBERS	ODD NUMBERS
POSITIVE PRIME NUMBERS	POSITIVE PRIME NUMBERS
GREATER THAN 50	GREATER THAN 50
LESS THAN 50	LESS THAN 50
GREATER THAN $\widehat{10}$	GREATER THAN $\widehat{10}$
LESS THAN $\widehat{10}$	LESSTHAN $\widehat{10}$
POSITIVE DIVISORS OF 12	POSITIVE DIVISORS OF 12
POSITIVE DIVISORS OF 18	POSITIVE DIVISORS OF 18
POSITIVE DIVISORS OF 20	POSITIVE DIVISORS OF 20
POSITIVE DIVISORS OF 24	POSITIVE DIVISORS OF 24
POSITIVE DIVISORS OF 27	POSITIVE DIVISORS OF 27

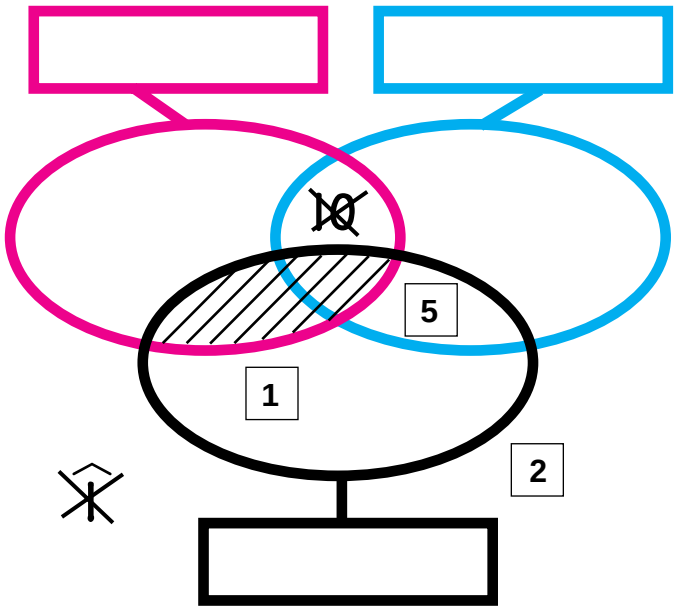


Name _____

L13 **

Use the clues to cross out labels the strings cannot have. Then label the strings.

RED	BLUE	BLACK
MULTIPLES OF 2	MULTIPLES OF 2	MULTIPLES OF 2
MULTIPLES OF 3	MULTIPLES OF 3	MULTIPLES OF 3
MULTIPLES OF 4	MULTIPLES OF 4	MULTIPLES OF 4
MULTIPLES OF 5	MULTIPLES OF 5	MULTIPLES OF 5
MULTIPLES OF 10	MULTIPLES OF 10	MULTIPLES OF 10
ODD NUMBERS	ODD NUMBERS	ODD NUMBERS
POSITIVE PRIME NUMBERS	POSITIVE PRIME NUMBERS	POSITIVE PRIME NUMBERS
GREATER THAN 50	GREATER THAN 50	GREATER THAN 50
LESS THAN 50	LESS THAN 50	LESS THAN 50
GREATER THAN $\widehat{10}$	GREATER THAN $\widehat{10}$	GREATER THAN $\widehat{10}$
LESS THAN $\widehat{10}$	LESSTHAN $\widehat{10}$	LESS THAN $\widehat{10}$
POSITIVE DIVISORS OF 12	POSITIVE DIVISORS OF 12	POSITIVE DIVISORS OF 12
POSITIVE DIVISORS OF 18	POSITIVE DIVISORS OF 18	POSITIVE DIVISORS OF 18
POSITIVE DIVISORS OF 20	POSITIVE DIVISORS OF 20	POSITIVE DIVISORS OF 20
POSITIVE DIVISORS OF 24	POSITIVE DIVISORS OF 24	POSITIVE DIVISORS OF 24
POSITIVE DIVISORS OF 27	POSITIVE DIVISORS OF 27	POSITIVE DIVISORS OF 27



Name _____

L15 *

The table below is for one of these operations:

The Table Game

$+_{10}$	$-_{10}$	x_{10}
⊓	⊔	↑
T_D	T_M	↓
$T_<$	$T_>$	T_P

Label the table.

	1	2	3	4	5	6	7	8	9
1									
2						2			
3								4	
4									
5		0							
6									
7									
8									
9									

Name _____

L15 **

$*$ is one of the operations in The Table Game.

The Table Game

$+_{10}$	$-_{10}$	x_{10}
⊓	⊔	↑
T_D	T_M	↓
$T_<$	$T_>$	T_P

Clue 1

This table for $*$ has exactly three 0s in it.

$*$	4	8
8		
4		

$*$ could be _____.

Clue 2

This table for $*$ has exactly three 1s in it.

$*$	6	9
5		
7		

$*$ is _____.

Name _____

L15 ***

$*$ is one of the operations in The Table Game.

The Table Game

$+_{10}$	$-_{10}$	x_{10}
⊓	⊔	↑
T_D	T_M	↓
$T_<$	$T_>$	T_P

Clue 1

No two entries in this table for $*$ are the same.

$*$	3	4
2		
3		

$*$ could be _____.

Clue 2

All four entries in this table for $*$ are the same.

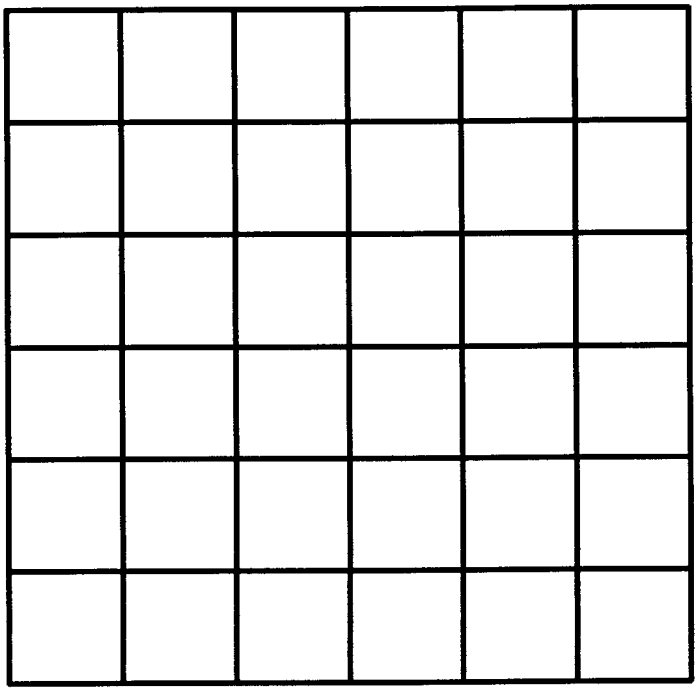
$*$	2	6
3		
6		

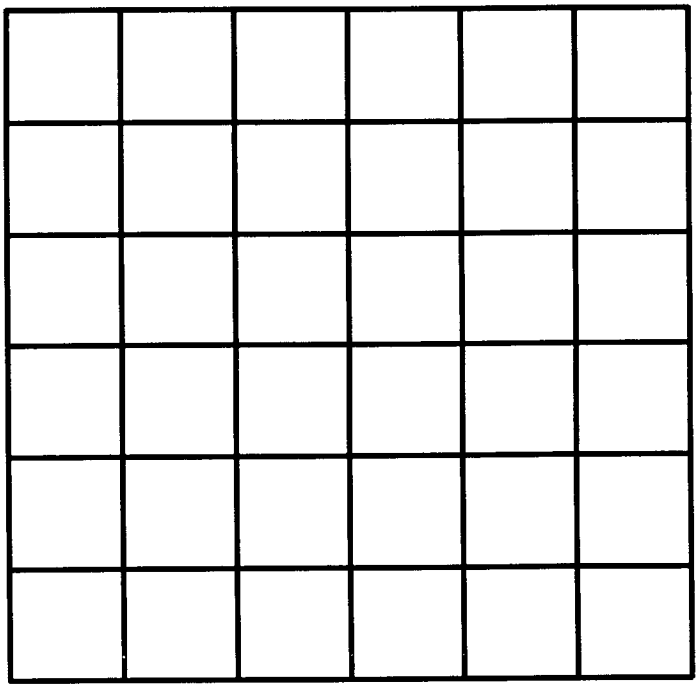
$*$ is _____.

L10

	1	2	3	4	5	6	7	8	9
1									
2									
3									
4									
5									
6									
7									
8									
9									

L12





L14(a)

The Table Game

$+_{10}$	$-_{10}$	x_{10}
$\sqcap$	$\sqcup$	$\uparrow$
T_D	T_M	$\downarrow$
$T_<$	$T_>$	T_P

Name________________

Team________________

The Table Game

$+_{10}$	$-_{10}$	x_{10}
$\sqcap$	$\sqcup$	$\uparrow$
T_D	T_M	$\downarrow$
$T_<$	$T_>$	T_P

Name________________

Team________________

The Table Game

$+_{10}$	$-_{10}$	x_{10}
$\sqcap$	$\sqcup$	$\uparrow$
T_D	T_M	$\downarrow$
$T_<$	$T_>$	T_P

Name________________

Team________________

The Table Game

$+_{10}$	$-_{10}$	x_{10}
$\sqcap$	$\sqcup$	$\uparrow$
T_D	T_M	$\downarrow$
$T_<$	$T_>$	T_P

Name________________

Team________________

Secret Operation: _____ L14(b)

Points

Team A	Team B	Team C	Team D

First part of game

For correctly identifying *

- after first play – 10 points
- after second play – 9 points
- after third play – 8 points
- after fourth play – 7 points

Second part of game

For correctly making an entry

- on the diagonal – 1 point
- other than on the diagonal – 2 points

Secret Operation: _____

Points

Team A	Team B	Team C	Team D

First part of game

For correctly identifying *

- after first play – 10 points
- after second play – 9 points
- after third play – 8 points
- after fourth play – 7 points

Second part of game

For correctly making an entry

- on the diagonal – 1 point
- other than on the diagonal – 2 points

The Table Game

$+_{10}$	$-_{10}$	x_{10}
$\sqcap$	$\sqcup$	$\uparrow$
T_D	T_M	$\downarrow$
$T_<$	$T_>$	T_P

*	1	2	3	4	5	6	7	8	9
1									
2									
3									
4									
5									
6									
7									
8									
9									