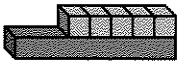
LESSON 2.4

The Distributive Law

LINEAR ADDITION AND SUBTRACTION

In the case of x, y, and constant blocks — in other words quantities of degree 1 or 0 — you can think of adding as putting together blocks end-to-end *in a line.* For example, $2x + 5$ is shown by connecting the two x-blocks and the 5-block on their 1-by-1 faces.

Similarly, subtraction of quantities of degree 0 and 1 can be shown linearly, by making sure that the uncovered area models a single line segment. The figure shows $y - 5$.



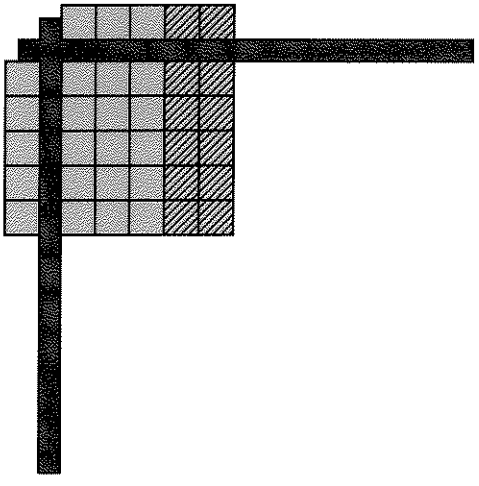
This representation is based on a *length* model of addition and subtraction.

1. Sketch these sums, showing length.
a. $y + 2$ b. $3x + 1$

2. Sketch these differences, showing length.
a. $y - 2$ b. $3x - 1$

THE UNCOVERED RECTANGLE

It is possible to use the corner piece for multiplication when minus signs are involved. For example, this figure shows the multiplication $5(5 - 2)$.



Remember that the shaded blocks are upstairs Look at the part of the downstairs blocks that are not covered by upstairs blocks. The answe to the multiplication is represented by the **uncovered rectangle** with dimensions 5 and $5 - 2$. Of course, the product is 5 times 3, or 15, which is the answer you get when you sim plify upstairs and downstairs blocks.

THE DISTRIBUTIVE LAW

Find these products, using the Lab Gear. Remember to use upstairs for minus.

3. $x(5 + y)$ **4.** $(5 - x)y$

5. $5(x + y)$ **6.** $(y - 5)x$

7. $y(5 + x)$ **8.** $(y - x)5$

9. **Summary** Explain how you can correctly remove parentheses from an algebraic expression when they are preceded or followed by a multiplication, and when there is more than one term in the parentheses.

10. Remove the parentheses.
a. $a(b + c)$ b. $(a - b)c$

The rule you have discovered in this section is called *the distributive law of multiplication over addition and subtraction.*

Use the distributive law to multiply. You may use the Lab Gear to check your work.

11. a. $2x(x + 1)$ b. $2x(x - 1)$

12. a. $2x(x + y + 5)$
b. $2x(x + y - 5)$
c. $2x(-x + y + 5)$
d. $2x(x - y + 5)$

For problems 13-18:

a. Show the quantity with the Lab Gear, using upstairs to show minus.

b. Arrange the blocks so the uncovered part is a rectangle.

c. Write a multiplication of the type, *length times width = area* for the uncovered rectangle.

13. $xy - 2y$ **14.** $xy - 2x$

15. $xy - x^2$ **16.** $xy + x - x^2$

17. $y^2 + xy - 5y$ **18.** $y^2 - xy - y$

19. Explain how someone might have done problem 18 without the Lab Gear.

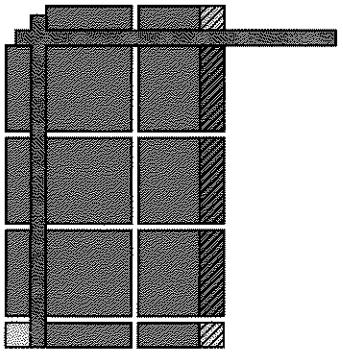
20. Write $x^2 - xy - x$ as a multiplication of the type, *length times width = area,* for the uncovered rectangle.

RELATED PRODUCTS

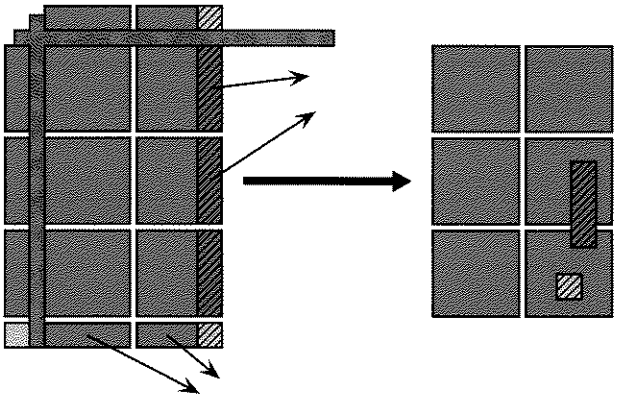
21. Use the corner piece to show

$$(3x + 1)(2x - 1).$$

This figure shows the product $(3x + 1)(2x - 1)$.



Notice that, inside the corner piece, the uncovered rectangle has dimensions $3x + 1$ and $2x - 1$. These are the original factors. This tells you that we did the multiplication correctly. But the product can be simplified, as shown below.



22. a. Explain what was done to the blocks in problem 21 after using the corner piece. Which blocks were removed, and why?

b. Write the final answer, combining like terms.

23. Use the Lab Gear to find the product: $(3x - 1)(2x + 1)$. Sketch the process as was done for problem 21.

24. a. Show the multiplication $(3x + 2)(2x + 5)$ with the Lab Gear. Write the product.

b. Write two more multiplications, both involving minus, that use the same blocks as $(3x + 2)(2x + 5)$. In each case write the product.

25. **Summary** You can use the same blocks to show all three of these products with the Lab Gear. Explain why the products are different, even though the same blocks are used. Include sketches as part of your explanation.

a. $(2x + 3)(3x + 5)$

b. $(2x + 3)(3x - 5)$

c. $(2x - 3)(3x + 5)$

26. You will learn how to model

$$(2x - 3)(3x - 5)$$

with the Lab Gear in a later chapter. Try to find a way to do this without looking ahead in the book.

REVIEW ***UNLIKE TERMS***

27. Al *still* doesn't like terms. For each problem, give the correct answer, if possible, and explain what Al did wrong. Use Lab Gear sketches or substitute numbers.

a. $x^2 - x = x$

b. $3x - x = 3$

c. $9x - 4y = 5(x - y)$