1.5 Dimensions

You will need:

the Lab Gear 

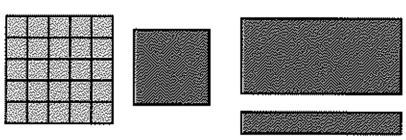
DIMENSIONS AND THE LAB GEAR

Of course, all the Lab Gear blocks are three-dimensional, (as are all objects in the real world). However, we sometimes use the x-block, or the 5-block as a **model** of a one-dimensional object. That is, as a model of a line segment of length x, or 5. Similarly, we can use the x^2- or xy-blocks as models of two-dimensional, flat objects.

1. Some blocks, such as the x^3, cannot be used as models of one- or two-dimensional objects. Make a list of these blocks, which we will call the 3-D blocks.

When making sketches of the Lab Gear, if 3-D blocks or three-dimensional arrangements are not involved, it is much more convenient to work with two-dimensional sketches of the blocks **as seen from above.**

2. Which blocks do these figures represent?



3. Make a 2-D sketch of each of the ten "flat" blocks as seen from above.

4. On your sketch, write *1* on the blocks that model one-dimensional line segments, and *2* on the blocks that model two-dimensional figures.

5. Which block can be thought of as a model of a zero-dimensional point?

6. Sketch the following:
   a. four x-blocks arranged to model a one-dimensional line segment;
   b. four x-blocks arranged to model a two-dimensional rectangle;
   c. four x-blocks arranged to model a three-dimensional box.

7. Sketch the following:
   a. three x^2-blocks arranged to represent a two-dimensional rectangle;
   b. three x^2-blocks arranged to represent a three-dimensional box.

FACES OF THE LAB GEAR

The x^2-block, **as seen from the side**, looks just like the x-block seen from the side, since in either case you see an x-by-1 rectangle.

8. a. Make an x-by-1 rectangle by tracing an x-block.
   b. Place the x^2-block on the rectangle you traced. For it to fit, you will have to stand it on edge.
   c. Which other two blocks can be placed on the rectangle?

9. a. Using a block, trace another rectangle (or square).
   b. Find all the blocks that fit on it.

10. Repeat problem 9, until you have found five more groups of blocks. List each group. Some blocks will appear on more than one list.

In the next sections, when putting blocks next to each other, join them along matching faces.

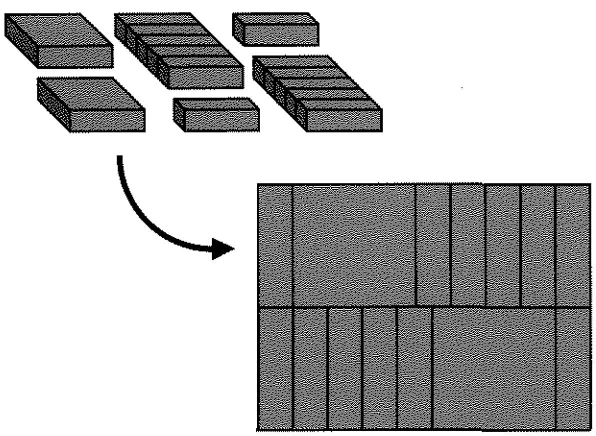
MAKE A RECTANGLE

11. **Exploration** Build each shape and sketch it, showing which blocks you used.
   a. Use only blue blocks; make a rectangle that is not a square.
   b. Use both yellow and blue blocks; make a rectangle that is not a square.
   c. Use both yellow and blue blocks; make a square.
   d. Use only blue blocks; make a square.

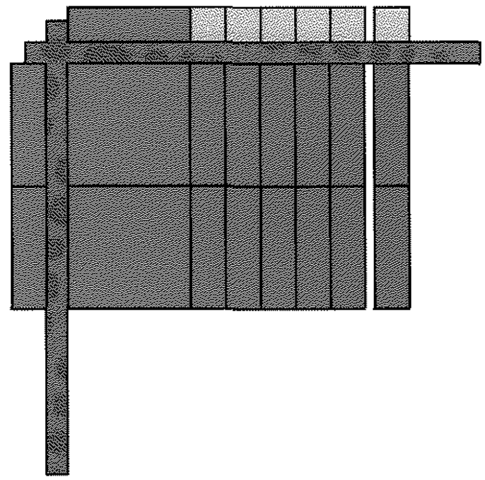
12. Use 1-blocks to make as many different rectangles as you can, having area:
   a. 12   b. 13   c. 14
   d. 30   e. 31   f. 32

13. Make and sketch as many Lab Gear rectangles as you can having area:
   a. $8x$ b. $6xy$

You can rearrange the blocks $2x^2 + 12x$ into a rectangle like this.



The length and width of this rectangle are $x + 6$ and $2x$, which can be seen better if you organize the blocks logically and use the corner piece, as shown. (Notice that you could also turn the rectangle so that the length and width are exchanged. This is considered to be the same rectangle.) The area of the rectangle $2x^2 + 12x$ can be found by just counting the blocks.

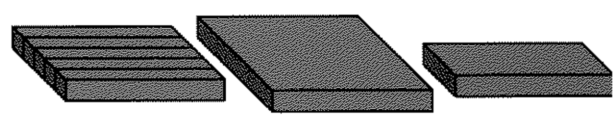


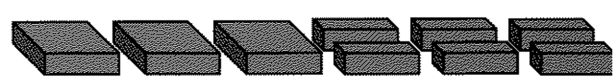
14. There is another rectangular arrangement of the same blocks which has different dimensions. Find it.

For each problem:
   a. Arrange the given blocks into a rectangle in the corner piece.
   b. Sketch it (as seen from above).
   c. Write the length, width, and area.

Find two different solutions for problem 17.

15. 

16. 

17. 

By now you should be able to find the length, width, and area of any Lab Gear rectangle. This will be a useful skill throughout this course.

For each problem, the area of a rectangle is given.

a. Get the blocks that are named.
b. Make the rectangle.
c. Write the length and width.

One problem is impossible. Explain why.

18. $3x^2 + 9x$ **19.** $3xy + 2x + x^2$

20. $4x^2 + 9y$ **21.** $x^2 + 5x$

MAKE A SQUARE

For each problem, the area of a square is given.

a. Get the blocks.
b. Make the square.
c. Write the side length.

One problem is impossible. Explain why.

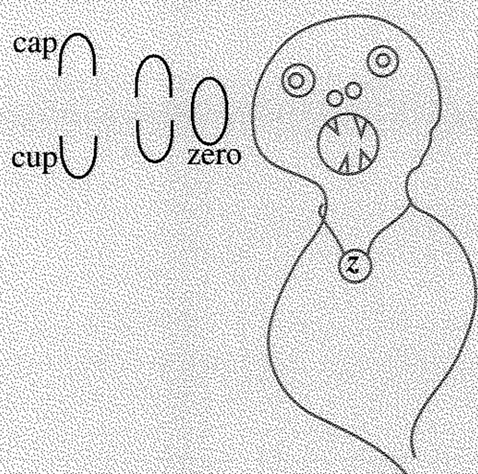
22. 36 **23.** 49

24. 40 **25.** $4x^2$

26. $9x^2$ **27.** $x^2 + 2x + 1$

PREVIEW *THE ZERO MONSTER*

The Zero Monster eats zeroes. However, all I have to feed it are cups ($\cup$), and caps ($\cap$). It will not eat cups or caps, but it can put one $\cup$ together with one $\cap$ to create a zero, which it eats.



For example, if there are three cups and five caps, it will make and eat three zeroes, leaving two caps. This can be written like this:

$$\cup\cup\cup + \cap\cap\cap\cap\cap = \cap\cap$$

or like this:

$$3\cup + 5\cap = 2\cap$$

28. Find out how many zeroes the Zero Monster ate. What was left after it finished eating? Fill in the blanks.

a. $9\cup + 6\cap =$ ___
b. $9\cup + 6\cup =$ ___
c. $9\cap + 6\cap =$ ___
d. $9\cap + 6\cup =$ ___

29. Fill in the blanks.

a. $4\cup +$ ___ $= 8\cap$
b. $4\cup +$ ___ $= 8\cup$
c. $4\cap +$ ___ $= 8\cap$
d. $4\cap +$ ___ $= 8\cup$

30. Fill in the blanks.

a. $7\cup +$ ___ $= 1\cap$
b. $7\cup +$ ___ $= 1\cup$
c. $7\cap +$ ___ $= 1\cap$
d. $7\cap +$ ___ $= 1\cup$

$2\cap$ and $2\cup$ are examples of *opposites,* because when you add them, you get zero. The concept of opposite is important in algebra, and we will return to it in Chapter 2.