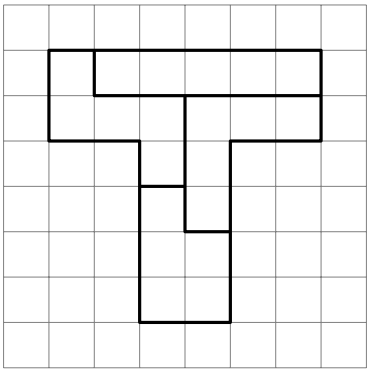
Pentomino Problems

The first puzzles we'll look at are *doubling pentomino* puzzles. For example, it is possible to use the I, P, V, and Z pentominoes to make a double-sized T pentomino, as shown below.

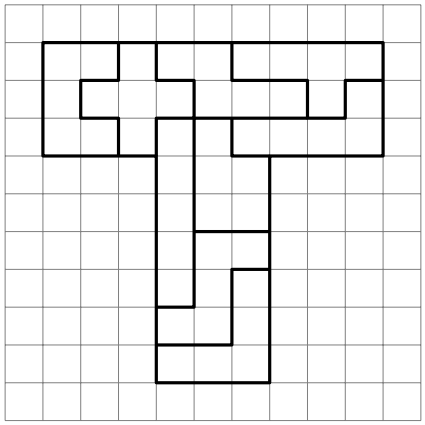


1. With the L, N, P, and V pentominoes, double the Z pentomino.
2. With the L, N, P, and V pentominoes, double the U pentomino.
3. With the L, N, P, and V pentominoes, double the L pentomino in two *different* ways.
4. With the L, N, P, and Y pentominoes, double the N pentomino.
5. With the I, L, N, and P pentominoes, double the L pentomino.
6. Now try some on your own. But be careful! Not every pentomino can be doubled. For example, the V and X pentominoes cannot be doubled – although the rest can. Can you find solutions for doubling the remaining pentominoes?

Next, we'll look at some rectangle puzzles. At first, you'll be given the pieces to use. After that, you'll have to figure it out on your own!

1. Using the F, I, P, U, and Y pentominoes, make a 5×5 square.
2. Using the I, P, T, V, and W pentominoes, make a 5×5 square.
3. Using the L, T, V, W, and Y pentominoes, make a 5×5 square.
4. Using the N, P, T, V, W, and Y pentominoes, make a 6×5 rectangle.
5. Using the I, L, T, W, Y, and Z pentominoes, make a 6×5 rectangle. Then, with the six pentominoes left over, make *another* 6×5 rectangle.
6. Using all the pentominoes, make either a 3×20, 4×15, 5×12, or 6×10 rectangle.
7. Make a rectangle of any size you can using whatever pentominoes you need!

The next puzzles we'll look at are *tripling pentomino* puzzles. For example, it is possible to use all the pentominoes *except* the F, T, and W pentominoes to make a triple-sized T pentomino, as shown below.



1. Using all the pentominoes except the U, X, and Y pentominoes, triple the L pentomino.
2. Using all the pentominoes except the T, W, and Z pentominoes, triple the W pentomino.
3. Using all the pentominoes except the L, W, and Y pentominoes, triple the Z pentomino.
4. Using all the pentominoes except the F, I, and X pentominoes, triple the X pentomino.
5. As it happens, *all* the pentominoes can be tripled. Can you find solutions for the rest of them?

Finally, we'll briefly discuss the 8×8 square puzzle. Of course, since $8 \times 8 = 64$, you can't use all the pentominoes to make an 8×8 square. However, you *can* if you *also* use a 2×2 square. The set of pentominoes you were given to take home with you gives an example of this.

It turns out that no matter where you put the 2×2 square within the 8×8 square, you can *always* fit the twelve pentominoes in the remaining area. Can you figure out how to do this in all the possible cases? One example is shown below. For any one position of the 2×2 square, there are many possible solutions.