Manipulative Mathematics **Name**_____

Game of Twenty-four

The Game of Twenty-four is a great way to think mathematically.
Given four numbers, you add, subtract, multiply and/or divide them so that the result is 24. You must use each number once--but only once.

Start with the numbers 1, 1, 4, and 8.

1) How can you use these numbers to create 24? Don't worry yet about 1, 1, 4, and 8. Think of pairs of any two numbers that multiply to 24. List some of the pairs here:

2) First, let's think of 24 as the product of $3 \cdot 8$.
We want to combine **1, 1, 4, 8** to get 3 and 8.

   (a) One way is to use 4 minus 1 to get 3, then 3 times 8 is 24. But we need to use the number 1. How can we use the 1 and still have 24? 24 times 1 is still 24.

   Putting this all these steps together using good algebra notation gives $(4-1)(8)(1)$.
   Verify that this expression simplifies to 24.

   $$(4-1)(8)(1)$$

   (b) Here is another way to use the same four numbers, 1, 1, 4, 8, to get the product $3 \cdot 8$:
   4 times 1 is 4, and then 4 minus 1 gives 3. Finally multiply that 3 by 8 to get 24.
   Show that this expression simplifies to 24:

   $$(4 \bullet 1-1)(8)$$

3) This time, we'll use the fact that 24 is the product of $6 \bullet 4$.

   (a) Can we combine 1, 1, 4, 8 to make 6 times 4?
   Well, 1 plus 1 is 2, 8 minus 2 gives 6, and then 6 times 4 is 24.
   Show that this expression simplifies to 24:

   $$[8-(1+1)] \bullet 4$$

   (b) Can you think of another combination? Using good algebra notation, write a different expression and show that it simplifies to 24.

4) Another number fact that might help make 24 is $12 \bullet 2 = 24$.

(a) How can you combine 1, 1, 4, 8 to create 12 and 2?
4 plus 8 is 12, and 1 plus 1 is 2. Then twelve times two is 24!
Write this as one expression using good algebra notation, then show that it simplifies to 24.

(b) Can you think of another combination? Using good algebra notation, write a different expression and show that it simplifies to 24.

Now use the numbers 5, 3, 5, 4 to make 24.

5) Verify that each expression simplifies to 24.

(a) $5 \bullet 5 + 3 - 4$ (b) $(3 \bullet 5) + (5 + 4)$

6) Using good algebra notation, write a different expression that simplifies to 24.

Next try 3, 6, 6, 9.

7) Verify that each expression simplifies to 24.

(a) $3 + 6 + 6 + 9$ (b) $(6 \bullet 9) \div 3 + 6$

8) Using good algebra notation, write a different expression that simplifies to 24.