Squares and Square Roots   Name: _____

Key Terms:

    a. Square of a number - Multiplying a number by itself. Ex: 3 X 3 = 9
    b. Factors - Numbers that multiply together to make a product. Ex: 3 and 4 are factors of 12 as we know that 3 X 4 = 12.

**Part A: <u>Factors</u>**

Let's take the number 36. There are a number of ways we can make 36 as a product of two factors.

1 X 36 = 36   2 X 18 = 36   3 X 12 = 36   4 X 9 = 36   6 X 6 = 26

We would say that the factors of 36 are 1,2,3,4,6,9,12,18 and 36. If a number is multiplied by itself such as 6 X 6 in this case, it is still only included once on the set of factors.

We can use area models to determine the number of factors a number has. Let's pick the number 12. How many ways can we make rectangles that have an area of 12 units?
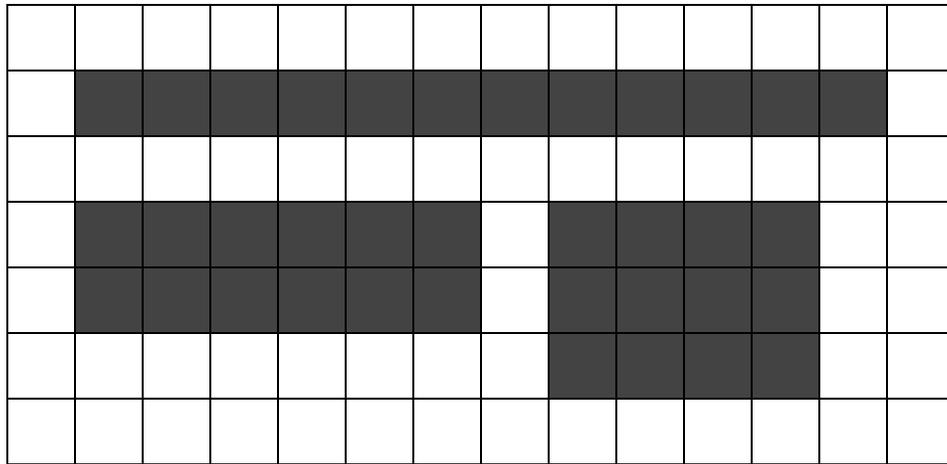

- The three rectangles above can be expressed as 1 X 12, 2 X 6 or 3 X 4.
- We could also show this as 12 X 1, 2 X 6, 4 X 3.
- Multiplication is commutative, meaning you can 'commute' or move numbers around and still arrive at the same answer. Thus 3 X 4 and 4 X 3 will both give you 12. They will also form congruent rectangles when mapped out.
- The factors of 12 would be: 1, 2, 3, 4, 6, 12

Check Your Understanding

Using the grid below, determine the factors of the following numbers.

   a. 6
   b. 9
   c. 16
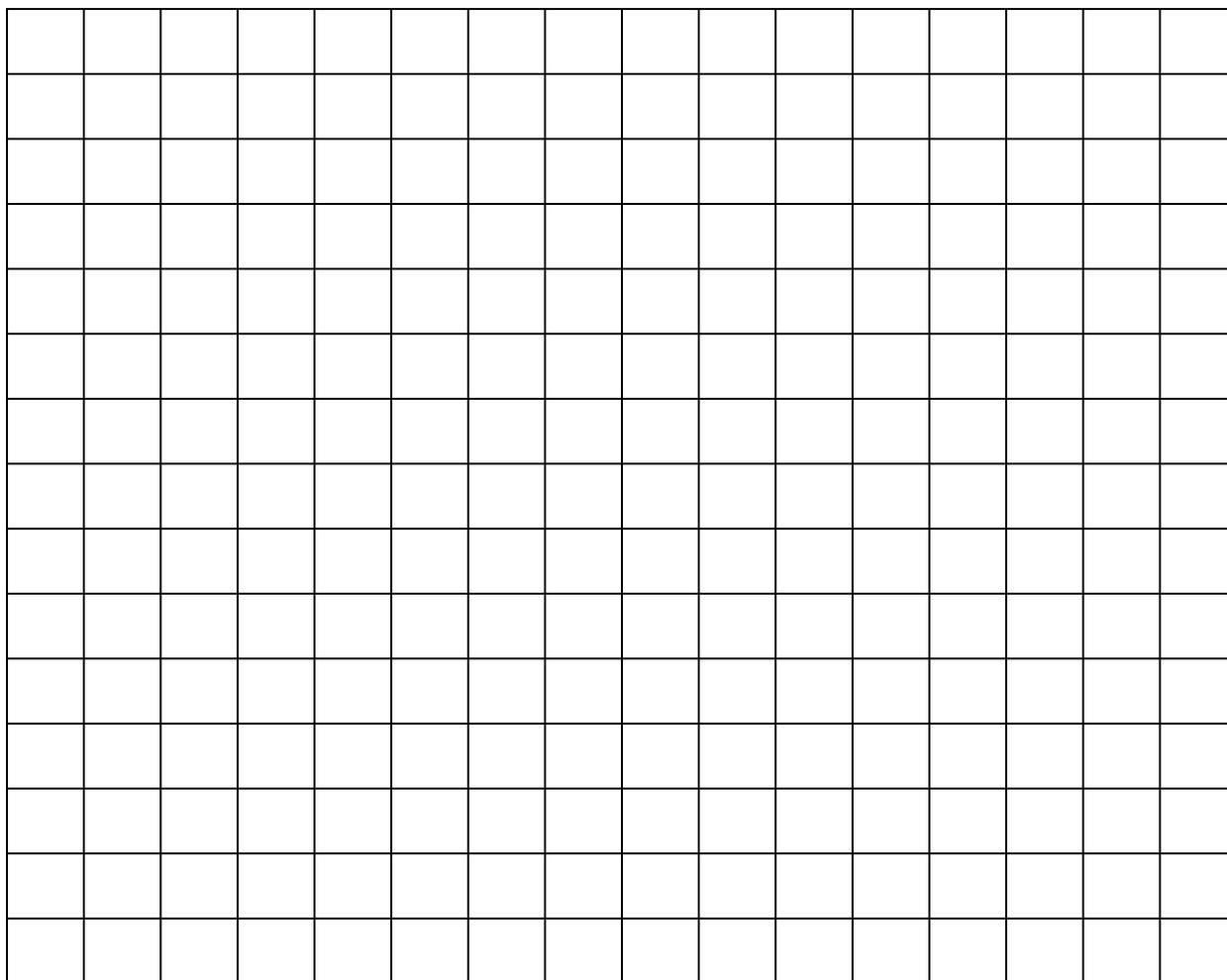
Factors of:

6 _____

9 _____

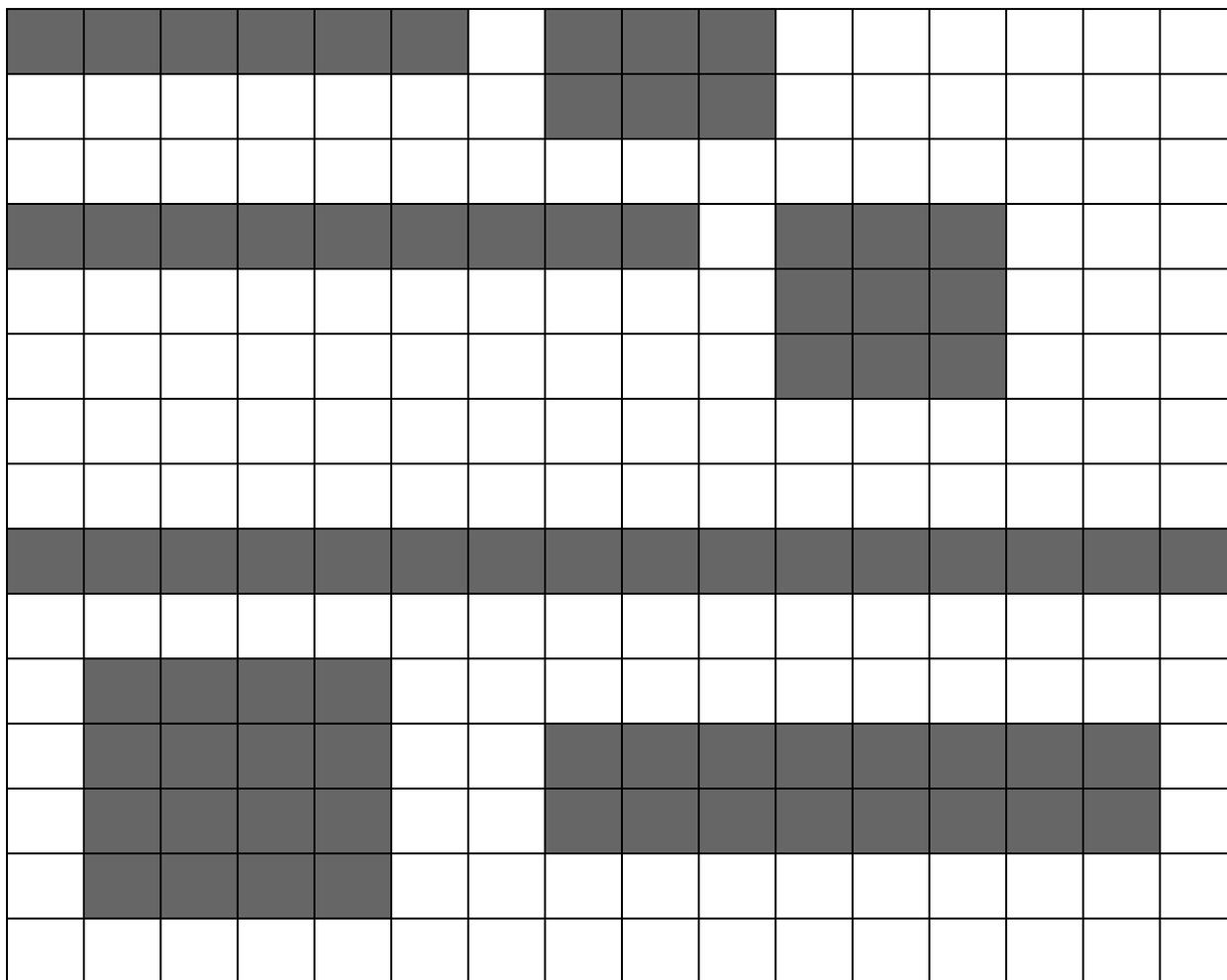16 _____

Check Your Understanding

Using the grid below, determine the factors of the following numbers.

   d. 6
   e. 9
   f. 16

Factors of:

6   1, 2, 3, 6

9   1, 3, 9

16   1, 2, 4, 8, 16

Part B: Square Roots

Recall: When a number is multiplied by itself we say that we have squared the number.

Example: 7 X 7 = 49

A square root is the inverse of this operation. When finding the square root of a number, we are looking for a factor that is multiplied by itself.

Example, the square root of 49 is 7. This is shown as follows: $\sqrt{49}$ = 7.

A root can also be called a factor. Thus, you are looking for the factors of a number that will make it a perfect square when mapped out.

Let's use 16 as an example. When mapped out, 16 looks like this.
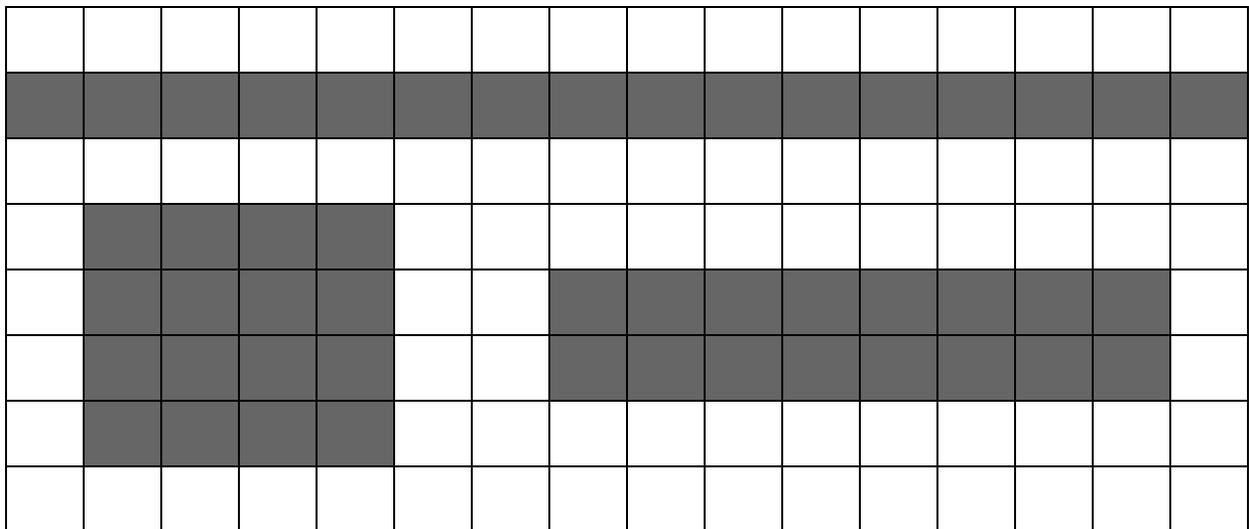
Only one of the shapes above is a square. The length of the square is 4 units. Thus, 4 is the number that when multiplied by itself has a product of 16. We say the square root of 16 is 4.

$$4 \text{ X } 4 = 16 \qquad \text{AND} \qquad \sqrt{16} = 4$$

Note: Not all numbers will be perfect squares. A perfect square is a number that has a square root that is not a decimal or a fraction.

16 is considered a perfect square. It can be made the following ways. 1 X 16, 2 X 8, 4 X 4

4 X 4 shows us that there is a number that when multiplied by itself will give us a product of 16.

The factors of 16 are 1, 2, 4, 8, 16. Notice there is an odd number of factors. Will this be the same for all perfect squares? Why is this?

When identifying factors we generally identify pairs of numbers. Pairs will always result in an even number. When a number is a perfect square there will be one set of factors that is represented by only number. Meaning we don't write the same number down twice. Because all the other factors match up, this will give us an odd number for all perfect squares.
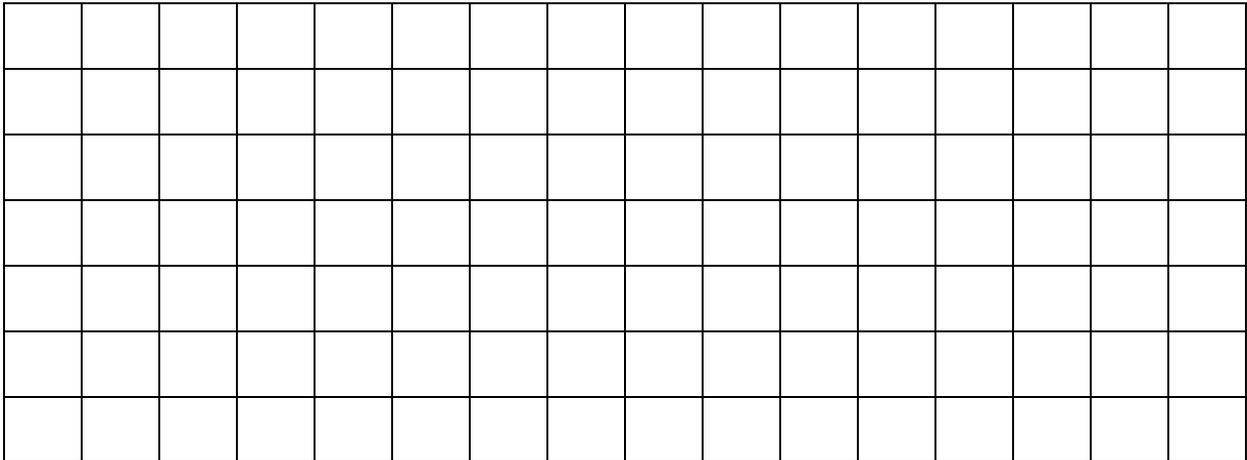
Test Your Knowledge:

1. Which numbers between 1 - 100 would be considered perfect squares? Why?

2. Which of the following are perfect squares? How do you know?

a. 12
b. 25
c. 30
d. 49

3. Use the grid below to demonstrate why 9 is considered a perfect square while 6 is not.

4. Identify the square roots of the following numbers.

a. 121
b. 169
c. 225

Test Your Knowledge:

1. Which numbers between 1 - 100 would be considered perfect squares? Why?

   1, 4, 9,16, 25, 36, 49, 64, 81, 100 all these numbers can be made by multiplying a number by itself. This is demonstrated below.

1 X 1 = 1	**2 X 2 = 4**	**3 X 3 = 9**	**4 X 4 = 16**
5 X 5 = 25	**6 X 6 = 36**	**7 X 7 = 49**	**8 X 8 = 64**
9 X 9 = 81	**10 X 10 = 100**		

2. Which of the following are perfect squares? How do you know?

   a. 12 Square root contains a decimal. Not a perfect square.
   b. 25 5 X 5 = 25 Perfect square
   c. 30   Square root contains a decimal. Not a perfect square.
   d. 49 7 X 7 = 49 Perfect square

3. Use the grid below to demonstrate why 9 is considered a perfect square while 6 is not.
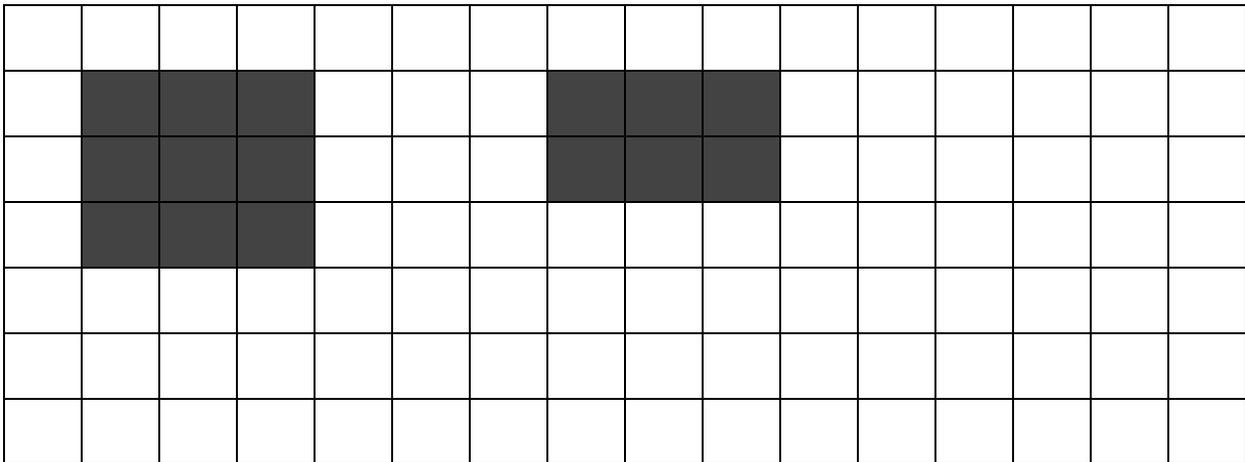
9 tiles can be arranged to make a square that is 3 units by 3 units.
6 tiles can not be arranged to make a square.

4. Identify the square roots of the following numbers.

   a. $\sqrt{121}$ = **11**
   b. $\sqrt{169}$ = **13**
   c. $\sqrt{225}$ = **15**

Assignment

1. Three numbers have been listed below,along with all their factors. Determine which numbers are perfect squares. How do you know?

   a. 400: 1, 2, 4, 5, 8, 10, 16, 20, 25, 40, 50, 80, 100, 200, 400
   b. 200: 1, 2, 4, 5, 8, 10, 20, 25, 40, 50, 100, 200
   c. 1000: 1, 2, 4, 5, 8, 10, 20, 25, 40, 50, 100, 125, 200, 250, 500, 1000

2. List the factors of the following numbers in order from least to greatest (ascending). Which numbers are perfect squares?

   a. 20: _____

   b. 36: _____

   c. 125: _____

3. Find the number that has a square root of 12. How did you arrive at your answer?

4. Calculate the following:

   a. $\sqrt{64}$ = _____   b. $\sqrt{400}$ = _____   c. $\sqrt{225}$ = _____

5. Put in order from least to greatest.

   a. 4 , $\sqrt{36}$, 5, $\sqrt{4}$ _____

   b. $\sqrt{64}$, 49, 64, $\sqrt{49}$ _____

Assignment

1. Three numbers have been listed below,along with all their factors. Determine which numbers are perfect squares. How do you know?

   a. **400: 1, 2, 4, 5, 8, 10, 16, 20, 25, 40, 50, 80, 100, 200, 400**
   b. 200: 1, 2, 4, 5, 8, 10, 20, 25, 40, 50, 100, 200
   c. 1000: 1, 2, 4, 5, 8, 10, 20, 25, 40, 50, 100, 125, 200, 250, 500, 1000

Only 400 is a perfect square. It is the only number that has a factor that is multiplied by itself. It is the only number that has an ODD number of factors.

2. List the factors of the following numbers in order from least to greatest (ascending). Which numbers are perfect squares?

   a. **20: 1, 2, 4, 5, 10, 20   - Not a perfect square.**

   b. **36: 1, 2, 3, 4, 6, 9, 12, 18, 36 - Is a perfect square.**

   c. **125: 1, 5, 25, 125 - Not a perfect square.**

3. Find the number that has a square root of 12. How did you arrive at your answer?

12 X 12 = 144

A square root is the factor that is multiplied by itself to obtain a product. In this case we are given the factor and must multiply it by itself. The square root of 144 is 12.

4. Calculate the following:

   a. $\sqrt{64}$ = **8**   b. $\sqrt{400}$ = **20**   c. $\sqrt{225}$ = **15**

5. Put in order from least to greatest.

   a. 4 , $\sqrt{36}$, 5, $\sqrt{4}$ $\sqrt{4}$, 4, 5, $\sqrt{36}$

   b. $\sqrt{64}$, 49, 64, $\sqrt{49}$ $\sqrt{49}$, $\sqrt{64}$, 49, 64