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- Linear Equations
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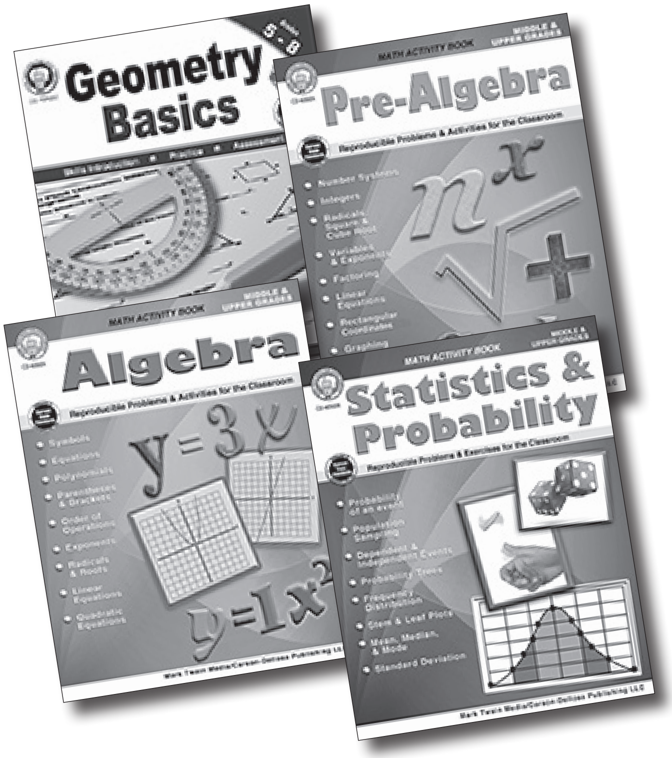

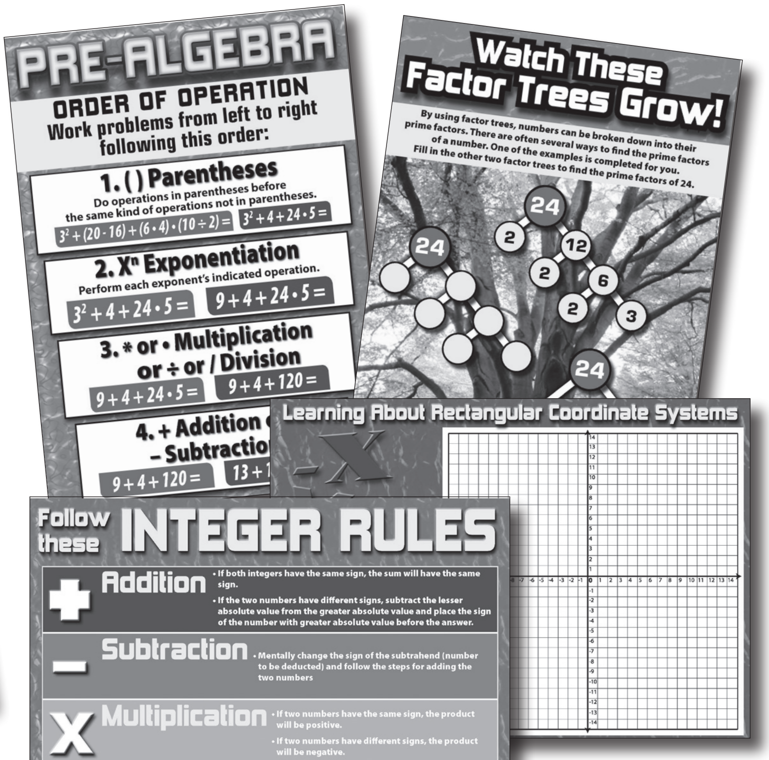

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PRE-ALGEBRA

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Introduction

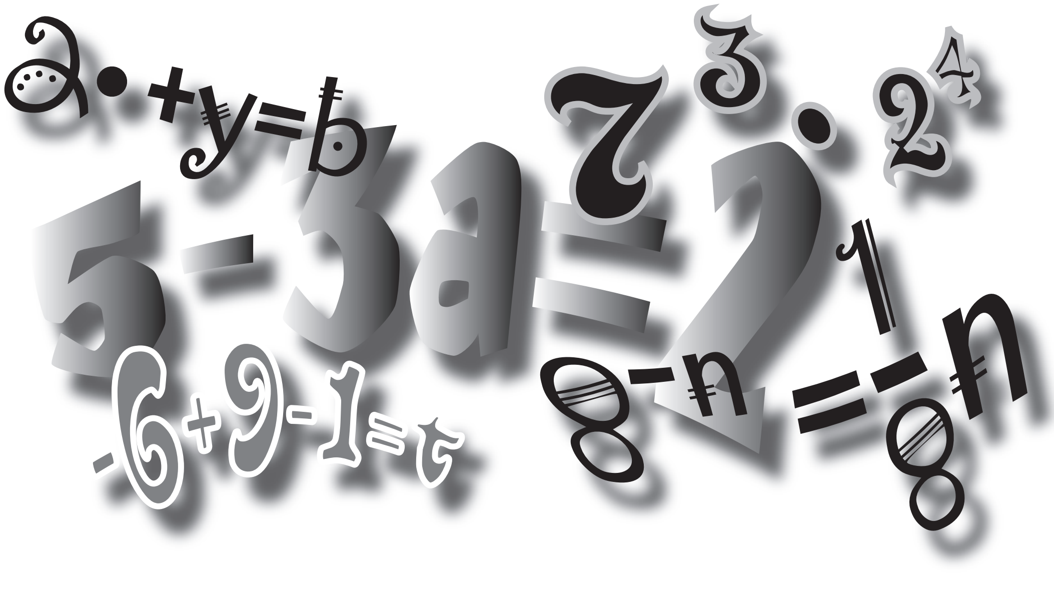
A challenge facing U.S. educators is that of increasing the number of high school students completing mathematics course work to the algebra level and beyond. This has become a critical issue since many of today's high school graduates do not possess the mathematics skills necessary for the modern workplace.

Many students find the concepts presented in algebra to be abstract, and they become discouraged. In far too many cases, students have not had sufficient opportunity to practice those algebra concepts, which appear more abstract than they really are.

This book is designed to help students become familiar with some of the basic concepts necessary for success in algebra. The concepts chosen are those that must be understood to succeed in problem-solving activities, which are a vital part of high school mathematics.

Teachers are encouraged to make copies and transparencies of this book to use in guided and independent practice. The pages can also be scanned to make digital files, and the e-book version is already in a digital format that can be used with the teacher providing guidance as the activities are completed on a classroom Whiteboard, a computer projection device, or on individual computers. Guided practice to assure understanding is the key to successfully completing independent practice and developing a positive attitude toward algebra.

—THE AUTHOR



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Number Systems

The number systems you are most familiar with are the counting numbers and the whole numbers. The **counting numbers** begin with the number 1, while the whole numbers begin with 0. So **whole numbers**, which you have used often, include the counting numbers plus 0.

In your study of algebra, you will need to get to know another number system to solve problems. These new numbers are called the integer numbers. The **integer numbers** include the whole numbers and a new set of numbers known as negative numbers. The integers are called signed numbers since they include both positive and negative numbers.

Let's review the number systems we have talked about.

1, 2, 3, 4, 5, 6, 7, 8, 9 . . . Counting Numbers

0, 1, 2, 3, 4, 5, 6, 7, 8, 9 . . . Whole Numbers

. . . -9, -8, -7, -6, -5, -4, -3, -2, -1, 0, +1, +2, +3, +4, +5, +6, +7, +8, +9 . . . Integer Numbers

The integers include numbers to the right and left of 0. The numbers on the right are **positive** and are noted with the small plus (+) sign. Positive numbers may also be written without the plus sign. The numbers on the left side of 0 are the **negative numbers**, and they are noted with the small minus (-) sign. Remember, the integers are known as signed numbers.

. . . -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 . . .

←―――――――― ――――――――→

You can see on the above number line that the integers to the right and left of 0 are exactly the same *except* for the sign. Any given number on the right has an opposite number on the left. The +5 integer has an opposite on the left, and it is -5. All numbers except 0 also have an opposite.

Directions: Fill in the following blanks with words from the reading that complete each sentence.

Counting numbers begin with the number **1.** ____________. Whole numbers begin with **2.** ____________. Whole numbers include the counting numbers plus **3.** ____________. The integer number system includes positive and **4.** ____________________ numbers. Those integers to the left of 0 have a **5.** ______________________ sign, while those to the right have a **6.** ______________________ sign.

Integer numbers have opposites. The opposite of +4 is **7.** ____________. The opposite of -7 is **8.** ____________. The opposite of +60 is **9.** ____________.

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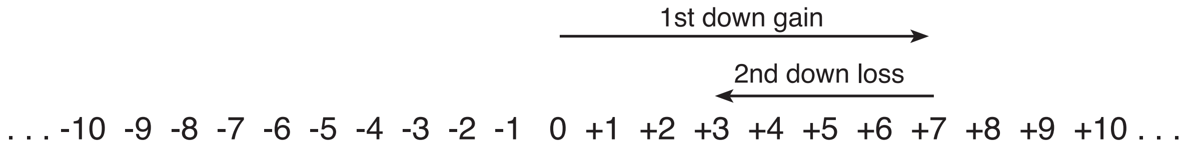
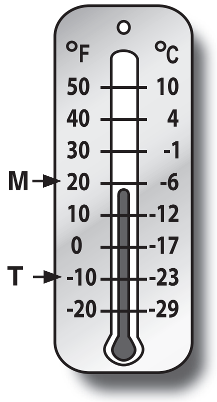
The Integer Number System

A number line can be helpful in understanding the **integer number system**—a number system that you use quite frequently in your daily life.

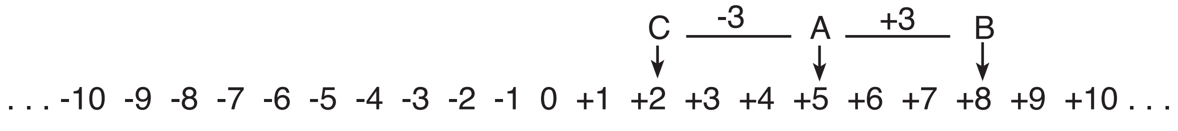
Let's use the number line below to keep track of the yards lost and gained in a football game. The distance between each number represents 1 yard. Let's say your team has a first down and gains 7 yards. This is a gain, so it is represented on the number line by +7. Now on the second down, your team loses 4 yards. A four-yard loss is a -4, so this is represented by showing a -4-yard move to the left from +7. So for the two downs, your team has a net gain of +3 yards.





A thermometer, which is much like a number line, can be used to understand positive and negative numbers. Let's say you live where the winters are very cold. Monday you leave for school and the temperature is 20°F. Since the 20 is a positive number, it is 20° above 0, which has been marked with the letter "M" for Monday. Now on Tuesday, you leave for school and note the mercury in the thermometer is at point "T" for Tuesday. Since the "T" is by the 10 below 0, it has a negative sign, and you say it is 10° below zero.

Let's practice with the number line below so that you become comfortable with using positive and negative numbers. Point A is at +5 on the number line. If you were told to move +3 places, you would move 3 places to the right of "A" and be at Point "B" or at +8. If you were told to move -3 places from Point A, you would be at Point C, which is located at +2.



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The Integer Number System *(continued)*

Directions: Use the number line below to locate the following.

1. +3 places from +10 is at ________

2. -4 places from +6 is at ________

3. +8 places from -9 is at ________

4. -7 places from +3 is at ________

5. +10 places from -4 is at ________

6. -4 places from -2 is at ________

7. -6 places from -6 is at ________

. . . -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 +10 +11 +12 +13 . . .

Directions: Use the number line above to answer the questions that follow.

8. To get from +4 to +9 you must move ______ spaces in the positive direction.

9. To get from -3 to -9 you must move ______ spaces in the ____________ direction.

10. To get from +3 to -4 you must move ______ spaces in the ____________ direction.

11. To get from -2 to +6 you must move ______ spaces in the ____________ direction.

Review: Integers on a number line

Those integers on a number line to the left of zero are called **12.** ____________ numbers. The integers to the right of zero are called **13.** ____________ numbers. Integers have opposites. The opposite of -7 is +7. What is the opposite of each of the following?

14. +2 is opposite ________

15. -40 is opposite ________

16. +800 is opposite ________

17. +6 is opposite ________

18. -249 is opposite ________

19. +2,101 is opposite ________

20. -5,732 is opposite ________

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Number Properties

In algebra, you will study number properties. These properties are known as **commutative**, **associative**, and **distributive**.

The *commutative property of addition* says that the order in which you add whole numbers will not change the sum. For example, 5 + 3 = 8 and 3 + 5 = 8, so 5 + 3 = 3 + 5.

In your study of algebra, you will often see letters used to stand in for numbers. These letters are called **unknowns**. You will see the commutative property for addition stated as $a + b = b + a$ where a and b are unknown and can be any whole numbers.

Directions: Complete the following.

Solve so that
$a + b = b + a$

1. 7 + 3 = ________ so ________ + 7 = 10

2. 25 + ________ = 35 so 10 + ________ = 35

3. 210 + 150 = ________ so 150 + ________ = 360

4. 84 + ________ = 104 so ________ + 84 = 104

5. 25 + ________ = 90 so 65 + ________ = 90

Directions: Complete the following using $a + b = b + a$ when you fill in the blank for each problem.

$$a + b = b + a$$

6. 5 + 7 = 7 + 5 $a = 5$ $b = 7$

7. ________ + ________ = ________ + ________ $a = 35$ $b = 64$

8. ________ + ________ = ________ + ________ $a = 111$ $b = 742$

9. ________ + ________ = ________ + ________ $a = 37$ $b = 94$

10. ________ + ________ = ________ + ________ $a = 2{,}101$ $b = 642$

11. ________ + ________ = ________ + ________ $a = 10$ $b = 18$

12. ________ + ________ = ________ + ________ $a = 12$ $b = 23$

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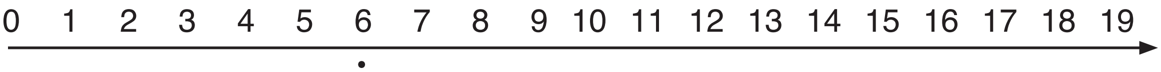
Whole Numbers

Using the number line below, place a dot to represent the answer for each problem. The number line represents part of the whole number system.

Example: 3 + 1 + 2 = 6, so a dot is placed below 6 on the number line.



Directions: Solve the following. Then place a dot on the number line beneath the correct answer for each problem.

1. 7 + 3 + 1 = __________

2. 1 + 7 + 3 = __________

3. 5 + 4 + 2 = __________

4. 2 + 4 + 5 = __________

5. 3 + 6 + 4 = __________

6. 4 + 3 + 6 = __________

7. 8 + 2 + 1 = __________

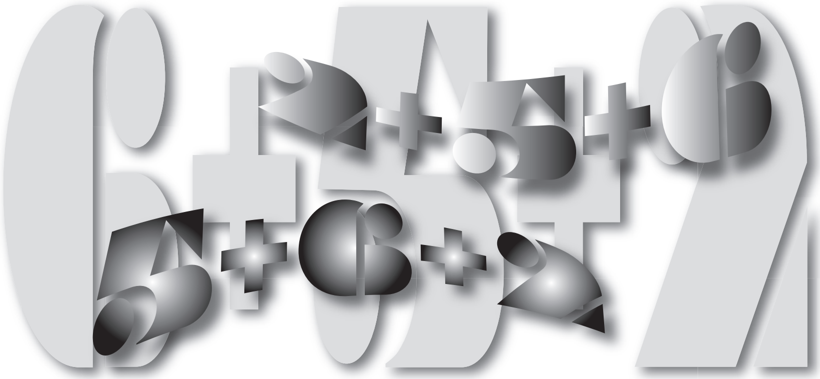
8. 2 + 1 + 8 = __________

9. 2 + 4 + 3 + 5 = __________

10. 3 + 5 + 2 + 4 = __________

11. The order in which whole numbers are added does not change the __________.

Another important thing to remember is that when whole numbers are added, the sum is *always* another whole number. A special term is applied to this fact. The special term is ***closure***. It means that the whole number system is closed for addition; therefore, when whole numbers are added, the sum is another whole number.



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Commutative Property for Multiplication

The *commutative property for multiplication* states that the order in which whole numbers are multiplied does not change the product. For example, $3 \cdot 7 = 7 \cdot 3$. In algebra you will see this stated as $a \cdot b = b \cdot a$ when any whole numbers can replace the unknowns a and b.

Directions: Solve the following.

1. $4 \cdot 3 =$ ______ **2.** $3 \cdot 4 =$ ______ **3.** $2 \cdot 5 =$ ______ **4.** $5 \cdot 2 =$ ______

5. $3 \cdot 7 =$ ______ **6.** $7 \cdot 3 =$ ______ **7.** $10 \cdot 2 =$ ______ **8.** $2 \cdot 10 =$ ______

Notice in the above problems that the order of multiplying the numbers does not change the product. Also, you will see that all of the products are whole numbers. When whole numbers are multiplied, the product is another whole number. So multiplication is closed for the multiplication of whole numbers. Remember, the special term applied for this fact is ***closure***.

Directions: Complete the following using the numbers given for a and b for each problem.

Example: $2 \cdot 7 = 7 \cdot 2$ $a = 2$ $b = 7$

9. ________ • ________ = ________ • ________ $a = 5$ $b = 4$

10. ________ • ________ = ________ • ________ $a = 12$ $b = 6$

11. ________ • ________ = ________ • ________ $a = 111$ $b = 246$

12. ________ • ________ = ________ • ________ $a = 1{,}074$ $b = 917$

13. ________ • ________ = ________ • ________ $a = 47$ $b = 86$

The fact that you can change the order of whole numbers when multiplying can be helpful. Solve the following.

14. $\begin{array}{r} 40 \\ \times\ 86 \\ \hline \end{array}$ **15.** $\begin{array}{r} 86 \\ \times\ 40 \\ \hline \end{array}$ **16.** $\begin{array}{r} 800 \\ \times\ 770 \\ \hline \end{array}$ **17.** $\begin{array}{r} 770 \\ \times\ 800 \\ \hline \end{array}$

Did you get the same answer for problems 14 and 15 and the same answer for problems 16 and 17?

18. Which problem was easier to solve, 14 or 15? ____________________

19. Which problem was easier to solve, 16 or 17? ____________________

20. Can you explain why it was easier to solve two of the problems? ____________________

____

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Associative Property for Addition

Directions: In the following problems, add the numbers in the parentheses first, and then add the number outside the parentheses.

Example: $6 + (3 \overset{\substack{\text{add first}\\ \downarrow}}{+} 4) = 6 + 7 = 13$

1. 8 + (5 + 2) = _____ + _____ = _____

2. (8 + 5) + 2 = _____ + _____ = _____

3. (8 + 2) + 5 = _____ + _____ = _____

4. 9 + (6 + 1) = _____ + _____ = _____

5. (9 + 6) + 1 = _____ + _____ = _____

6. (9 + 1) + 6 = _____ + _____ = _____

7. (12 + 3) + 5 = _____ + _____ = _____

8. 12 + (3 + 5) = _____ + _____ = _____

9. (12 + 5) + 3 = _____ + _____ = _____

10. 10 + (6 + 7) = _____ + _____ = _____

11. (10 + 6) + 7 = _____ + _____ = _____

12. (7 + 10) + 6 = _____ + _____ = _____

From the work above, you can see that the order in which you add the numbers in a problem does not change the answer. This property of addition is called the *associative property for addition.* You can use this property to help make it easier to solve addition problems.

Directions: Solve the following (rearrange the numbers to make the problems as easy as you can).

13. 9 + 8 + 4 + 1 = (______ + ______) + (______ + ______) = ______

14. 1 + 12 + 8 + 4 = (______ + ______) + (______ + ______) = ______

15. 14 + 3 + 6 + 9 = (______ + ______) + (______ + ______) = ______

16. 18 + 7 + 10 + 7 = (______ + ______) + (______ + ______) = ______

17. 25 + 16 + 5 + 4 = (______ + ______) + (______ + ______) = ______

18. 29 + 4 + 16 + 10 = (______ + ______) + (______ + ______) = ______

19. 61 + 14 + 6 + 9 = (______ + ______) + (______ + ______) = ______

20. 13 + 6 + 7 + 11 = (______ + ______) + (______ + ______) = ______

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Associative Property for Multiplication

Directions: In the problems below, multiply the numbers between the parentheses first. Then multiply that answer by the number outside the parentheses.

multiply first

Example: (7 • 5) • 3 = 35 • 3 = 105

1. (6 • 3) • 4 = _____ • _____ = _____

2. 6 • (3 • 4) = _____ • _____ = _____

3. 3 • (6 • 4) = _____ • _____ = _____

4. (9 • 4) • 5 = _____ • _____ = _____

5. 9 • (4 • 5) = _____ • _____ = _____

6. (9 • 5) • 4 = _____ • _____ = _____

7. (12 • 2) • 6 = _____ • _____ = _____

8. 12 • (2 • 6) = _____ • _____ = _____

9. (6 • 12) • 2 = _____ • _____ = _____

10. (15 • 3) • 5 = _____ • _____ = _____

11. 15 • (3 • 5) = _____ • _____ = _____

12. 3 • (15 • 5) = _____ • _____ = _____

In multiplying the above problems, the order in which the numbers are multiplied does not change the product. This is known as the *associative property for multiplication.* You will find that this property allows you to rearrange numbers and can make problems easier to solve.

Directions: Solve the following (rearrange the numbers to make the problems as easy as possible).

Example: 6 • 3 • 5 • 2 = (6 • 5) • (3 • 2) = 30 • 6 = 180

13. 15 • 3 • 6 • 5 = (_____ • _____) • (_____ • _____) = (_____) • (_____) = _____

14. 5 • 12 • 2 • 8 = (_____ • _____) • (_____ • _____) = (_____) • (_____) = _____

15. 8 • 3 • 5 • 2 = (_____ • _____) • (_____ • _____) = (_____) • (_____) = _____

16. 14 • 8 • 5 • 4 = (_____ • _____) • (_____ • _____) = (_____) • (_____) = _____

17. 17 • 2 • 8 • 5 = (_____ • _____) • (_____ • _____) = (_____) • (_____) = _____

18. 3 • 5 • 24 • 2 = (_____ • _____) • (_____ • _____) = (_____) • (_____) = _____

19. 25 • 5 • 2 • 4 = (_____ • _____) • (_____ • _____) = (_____) • (_____) = _____

20. 3 • 10 • 6 • 11 = (_____ • _____) • (_____ • _____) = (_____) • (_____) = _____

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Distributive Property of Multiplication Over Addition

Another very important number property that can be used with whole numbers is the *distributive property of multiplication over addition*. This property lets you take a problem like 5 • 46 and rewrite it as follows. First, write it as 5 • (40 + 6). Then you can go a step farther to simplify the problem and rewrite it again as (5 • 40) + (5 • 6). This rewriting often makes it easier to solve the problem.

Directions: Solve the following.

Example: 8 • 46 = 8 • (40 + 6) = (8 • 40) + (8 • 6) = 320 + 48 = 368

1. 5 • 36 = 5 • (______ + ______) = (5 • 30) + (5 • ______) = ______ + ______ = ______
2. 9 • 42 = 9 • (______ + ______) = (9 • ______) + (9 • ______) = ______ + ______ = ______
3. 12 • 88 = 12 • (______ + ______) = (12 • ______) + (12 • ______) = ______ + ______ = ______
4. 7 • 35 = 7 • (______ + ______) = (7 • ______) + (7 • ______) = ______ + ______ = ______
5. 6 • 78 = 6 • (______ + ______) = (6 • ______) + (6 • ______) = ______ + ______ = ______
6. 8 • 48 = 8 • (______ + ______) = (8 • ______) + (8 • ______) = ______ + ______ = ______
7. 14 • 268 = 14 • (______ + ______) = (14 • ______) + (14 • ______) = ______ + ______ = ______
8. 18 • 160 = 18 • (______ + ______) = (18 • ______) + (18 • ______) = ______ + ______ = ______
9. 3 • 38 = 3 • (______ + ______) = (3 • ______) + (3 • ______) = ______ + ______ = ______
10. 11 • 79 = 11 • (______ + ______) = (11 • ______) + (11 • ______) = ______ + ______ = ______

4 • 25

4 • (20+5)

(4•20) + (4•5)

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Properties of Subtraction and Division

Do the same number properties work with subtraction and division? The commutative properties for multiplication and addition let you multiply or add whole numbers in any order and get the correct product or sum. Will the commutative property work for subtraction? Does $a - b = b - a$? If $a = 4$ and $b = 2$, does $4 - 2 = 2 - 4$? No, because $4 - 2 = 2$, while $2 - 4 = -2$. So $a - b$ does **not** equal $b - a$. You will note that -2 is not a whole number; it is a negative number and part of the integer number system.

What about the commutative property and division? Does $a \div b = b \div a$? If $a = 4$ and $b = 2$, does $4 \div 2 = 2 \div 4$? No, because $4 \div 2 = 2$, while $2 \div 4 = \frac{1}{2}$. So $a \div b$ does not equal $b \div a$.

The commutative property does not work for subtraction or division problems.

Will the associative property work for subtraction? Will $(a - b) - c = a - (b - c)$? If $a = 8$, $b = 4$, and $c = 2$, then $(8 - 4) - 2 = 2$, but $8 - (4 - 2) = 6$. $(a - b) - c$ does not equal $a - (b - c)$.

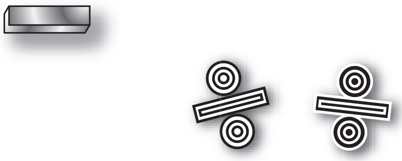
Does the associative property work for division? Does $(a \div b) \div c = a \div (b \div c)$? If $a = 8$, $b = 4$, and $c = 2$, then $(8 \div 4) \div 2 = 1$, but $8 \div (4 \div 2) = 4$. So $(a \div b) \div c$ does not equal $a \div (b \div c)$.

The associative property does not work for subtraction or division.

Directions: For the next exercise you will use two symbols. The symbols are (=) for equals and (≠) for does not equal. Insert the correct symbol (= or ≠) in the blank in each of the following problems.

Example: $a \cdot b = b \cdot a$
($a \cdot b$ equals $b \cdot a$, so the symbol = goes in the blank)

Remember to check each problem to determine if = or ≠ is correct. Substitute $a = 8$, $b = 4$, and $c = 2$, and work each problem.



1. $a + b$ ______ $b + a$
2. $a \cdot (b \cdot c)$ ______ $(a \cdot b) \cdot c$
3. $a + (b + c)$ ______ $(a + b) + c$
4. $a - b$ ______ $b - a$
5. $a \div b$ ______ $b \div a$
6. $a - (b - c)$ ______ $(a - b) - c$
7. $a \div (b \div c)$ ______ $(a \div b) \div c$

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Properties of Zero/Identity Elements

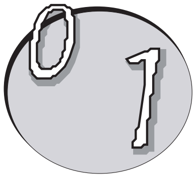
Zero is a special number in our numeration system. Zero never has a positive or negative sign associated with it. So when zero is added to any number, the answer is always the number to which zero is added. This is known as the *identity element for addition.*

$5 + 0 = 5$ $12 + 0 = 12$ $180 + 0 = 180$
$0 + 5 = 5$ $0 + 12 = 12$ $0 + 180 = 180$

In algebra you will see the identity element for addition stated as $a + 0 = a$ and $0 + a = a$.

Zero has another property called the *multiplication property of zero*. This property states that if zero is multiplied by any number, the result is always zero.

$5 \cdot 0 = 0$ $0 \cdot 114 = 0$ $28 \cdot 0 = 0$
$0 \cdot 9 = 0$ $12 \cdot 0 = 0$ $0 \cdot 13 = 0$



In algebra this property is often stated as $a \cdot 0 = 0$ and $0 \cdot a = 0$.

The *identity element for multiplication* says that when any number is multiplied by 1, the answer will always be the number being multiplied by one. In algebra books you will often see the identity element for multiplication stated as $a \cdot 1 = a$ and $1 \cdot a = a$.

Answer the following.

1. When zero is added to any number, the answer is always the ________________ to which zero has been added.

2. When zero is multiplied by any number, the answer is always ________________.

3. The identity element for multiplication says that when any number is multiplied by _____, the answer will always be the number being multiplied by 1.

Directions: Place the letter that matches the definition of the property demonstrated in each problem in the space before it. The first one is done for you.

A. Identity element for addition B. Identity element for multiplication
C. Multiplication property of zero

4. __A__ $8 + 0 = 8$
5. ______ $9 \cdot 1 = 9$
6. ______ $4 \cdot 0 = 0$
7. ______ $0 + 48 = 48$
8. ______ $1 \cdot 17 = 17$
9. ______ $17 \cdot 1 = 17$
10. ______ $96 \cdot 1 = 96$
11. ______ $1 \cdot 124 = 124$
12. ______ $47 \cdot 0 = 0$

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Order of Operations

In many problems you will find that you must perform more than one operation. There is an order in which you should perform the operations to get the correct answer. The order is to multiply or divide first from left to right, and then subtract or add from left to right.

Example: In the problem 8 • 7 + 5 • 4, the multiplication will be performed first and then the addition. So 8 • 7 + 5 • 4 becomes 56 + 20 = 76

Directions: Solve the following (multiply first).

1. 5 • 4 + 3 • 2 = _____ + _____ = _____

3. 4 • 8 + 7 • 2 = _____ + _____ = _____

2. 6 • 9 + 3 • 8 = _____ + _____ = _____

4. 2 • 9 + 4 • 3 = _____ + _____ = _____

Directions: Solve the following (multiply first).

5. 5 • 4 – 3 • 2 = _____ – _____ = _____

7. 4 • 8 – 7 • 2 = _____ – _____ = _____

6. 6 • 9 – 3 • 8 = _____ – _____ = _____

8. 2 • 9 – 4 • 3 = _____ – _____ = _____

When a problem includes multiplication, division, addition, and subtraction, perform the multiplication or division first from left to right and then the addition or subtraction from left to right.

Example: $\overbrace{4 \cdot 7} - \underbrace{3 \cdot 4} \div 2 = 28 - \overbrace{12 \div 2} = 28 - 6 = 22$

Directions: Solve the following (follow the order of operations).

9. 3 • 8 + 8 ÷ 2 = _____ + 8 ÷ 2 = _____ + _____ = _____

10. 14 ÷ 7 + 4 • 8 – 6 = _____ + 4 • 8 – 6 = _____ + _____ – 6 = _____ – 6 = _____

11. 7 + 3 • 8 – 8 ÷ 2 = 7 + _____ – 8 ÷ 2 = 7 + _____ – _____ = _____ – _____ = _____

12. 6 • 5 – 16 ÷ 8 + 4 = _____ – 16 ÷ 8 + 4 = _____ – _____ + 4 = _____ + 4 = _____

13. 5 • 4 + 28 ÷ 7 – 4 = _____ + 28 ÷ 7 – 4 = _____ + _____ – 4 = _____ – 4 = _____

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Addition of Integers

A number line can be helpful when learning to add integers.

. . . -14 -13 -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 +10 +11 +12 +13 +14 . . .

Follow the directions and solve this problem. On the number line above, draw a dot over the -7. Since you are adding a +9, now draw an arrow beginning at -7 and move +9 places to the right. If you move +9 places right from -7, the tip of the arrow will be over +2. So if you add -7 + +9 you get +2.

Add $\begin{array}{r} -7 \\ + \ \ +9 \\ \hline \end{array}$

Directions: Solve these addition problems. Use the number line if you need to. Remember to start at zero.

I I I I I I I I I I I I 0 I I I I I I I I I I I I

1. $\begin{array}{r} +5 \\ + \ \ +6 \\ \hline \end{array}$ **2.** $\begin{array}{r} -5 \\ + \ \ -3 \\ \hline \end{array}$ **3.** $\begin{array}{r} -10 \\ + \ \ +6 \\ \hline \end{array}$ **4.** $\begin{array}{r} +9 \\ + \ \ -6 \\ \hline \end{array}$

5. $\begin{array}{r} -8 \\ + \ \ +2 \\ \hline \end{array}$ **6.** $\begin{array}{r} -3 \\ + \ \ -7 \\ \hline \end{array}$ **7.** $\begin{array}{r} +6 \\ + \ \ +2 \\ \hline \end{array}$ **8.** $\begin{array}{r} +7 \\ + \ \ 0 \\ \hline \end{array}$

Let's make some rules for adding positive and negative integers:

Rule 1: When adding two integers with the same sign, add the numbers and place the sign of the numbers before the answer.

Example:

Add $\begin{array}{r} +5 \\ + \ \ +6 \\ \hline +11 \end{array}$

When adding (+5) + (+6) = +11, both 5 and 6 have a positive sign, so the answer also has a positive sign.

Rule 2: *When adding two numbers with unlike signs, first find the difference between the two numbers. Then place the sign of the larger number before the answer.*

Example A:

Add $\begin{array}{r} +8 \\ + \ \ -2 \\ \hline +6 \end{array}$

Think 8 – 2 = 6. The larger number is +8, so the sign before the answer is positive.

Example B:

Add $\begin{array}{r} -12 \\ + \ \ +4 \\ \hline -8 \end{array}$

Think 12 – 4 = 8. The sign before the larger number is minus, so the sign before the answer is minus.

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Addition of Integers: Exercises

Directions: Write the rules for adding two integers in the space below.

Rule 1: ____

____

____

Rule 2: ____

____

____

Directions: Add (refer to your rules if needed).

1. +6 + +4

2. -4 + -3

3. +10 + -4

4. -8 + +3

5. +12 + -9

6. -372 + +111

7. +84 + -16

8. +406 + -305

9. -67 + +52

10. -44 + -21

11. -16 + +14

12. +31 + -14

13. +146 + -32

14. +342 + -247

15. -76 + +38

16. -702 + +644

17. +164 + -84

18. -226 + +103

19. -372 + -104

20. - 92 + +21

21. +122 + -87

22. +349 + -52

23. -472 + -304

24. +88 + +64

25. -72 + -31

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Subtraction of Integers

In learning to subtract integers, it is important to review the subtraction process. When you subtract two numbers, you are <u>finding the difference</u>. The numbers subtracted have special names. The first number in the subtraction problem is called the **minuend**, and the second number in the subtraction problem is called the **subtrahend**. The answer is called the **difference**. If you subtract 8 – 5, the <u>minuend</u> is 8 and the <u>subtrahend</u> is 5 with a <u>difference</u> of 3.

$$\begin{array}{rl} 8 & \text{minuend} \\ -\ 5 & \text{subtrahend} \\ \hline 3 & \text{difference} \end{array}$$

In learning to subtract integers, it is important to review the method for checking subtraction. When checking subtraction, think: the subtrahend + what number = the minuend. In the above example, think: 5 + 3 = 8. Be sure to check your work as you learn to subtract integers.

Let's look at the two examples below.

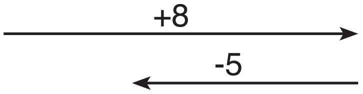
Subtract $\begin{array}{r} +8 \\ -\ \ +6 \\ \hline 2 \end{array}$ You must first think, what number added to +6 will yield 8?
$6 + \underline{\ 2\ } = 8$

Subtract $\begin{array}{r} -12 \\ -\ \ -4 \\ \hline -8 \end{array}$ Think, what number added to -4 will yield -12?
$-4 + \underline{-8} = -12$

The number line can help us understand subtraction of integers. When using the number line, it is important to check the subtraction.

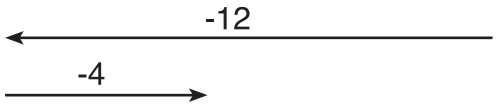
When using the number line, always begin at 0. Subtracting 8 – 5, you first begin at 0, and since 8 is positive, move 8 places to the right. Then, to subtract 5, move 5 places to the left from +8 to +3 on the number line.

Step 1: move 8 places to the right of 0.
Step 2: move 5 places to the left of +8.



. . . -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 +10 +11 +12 . . .

Subtract -4 from -12 or $\begin{array}{r} -12 \\ -\ \ -4 \\ \hline \end{array}$. First begin at 0 and move -12 places to the left. Think, -4 + -8 = -12. This tells us that the correct answer is -8, so the arrow moves back from -12 a total of -4 places to -8.



Step 1: move 12 places to the left of 0.

Step 2: move 4 places to the right of -12.

. . . -12 -11 -10 -9 -8 -7 -6 -5 -4 -3 -2 -1 0 +1 +2 +3 +4 +5 +6 +7 +8 +9 +10 +11 +12 . . .

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Subtraction of Integers: Rule/Exercises

The number line can help you understand the subtraction of positive and negative integers. However, there is a rule for subtracting positive and negative integers that can be used in solving problems.

Rule: When subtracting integers, mentally change the sign of the subtrahend and add the result to the minuend.

Example:
-6 minuend
– -4 subtrahend
-2

Mentally change the sign of the subtrahend from -4 to +4 and add to the minuend -6.

Directions: Subtract.

1.
-8 minuend → -8
– +2 subtrahend → + -2
(mentally change sign of subtrahend and add)
Check: 2 + ______ = -8

2.
-7 minuend → -7
– -4 subtrahend → + +4
(mentally change sign and add)
Check: -4 + ______ = -7

3.
-10 → -10
– -5 → + +5
Check: -5 + ______ = -10

4.
+8 → +8
– +3 → + -3
Check: 3 + ______ = +8

5.
-4 → -4
– -8 → + +8
Check: -8 + ______ = -4

6.
+10 → +10
– -10 → + +10
Check: -10 + ______ = +10

7.
-5 → -5
– -4 → + +4
Check: -4 + ______ = -5

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Addition and Subtraction of Integers: Exercises

Directions: Solve these problems (watch the sign that tells you to add or subtract).

1. +3
\+ +5

2. +10
\+ +4

3. -8
\+ -3

4. -10
– +9

5. -21
– -18

6. +11
\+ -4

7. -7
– -3

8. +12
– +7

9. -62
\+ -14

10. -36
– +11

11. +12
\+ +11

12. -18
\+ -12

13. +6
\+ -3

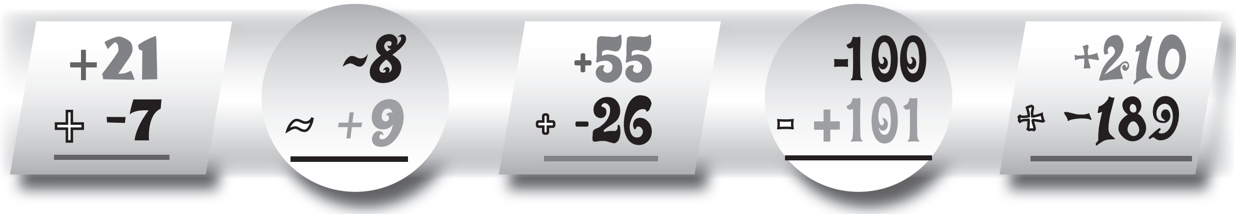
14. -6
\+ -2

15. -8
\+ +9

16. -26
\+ +22

17. -14
– -5

18. -110
\+ -214



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Multiplication of Integers

When you multiply two numbers, the answer is called the **product**. In the rules that follow, the "product" means the answer.

There are two rules you must know to multiply integers.

Rule 1: When multiplying two numbers with the same sign, the product is positive.

Rule 2: When multiplying two numbers with different signs, the product is negative.

Directions: Use the above rules to answer the following questions.

1. +3 • +6 = +18 Which rule applies? ____________

2. -3 • -6 = +18 Which rule applies? ____________

3. -3 • +6 = -18 Which rule applies? ____________

4. +3 • -6 = -18 Which rule applies? ____________

Directions: Solve the following (multiply).

5. -2 • -4 = _____

6. +3 • -7 = _____

7. +6 • +5 = _____

8. +8 • +6 = _____

9. -9 • -8 = _____

10. +9 • +8 = _____

11. -10 • +4 = _____

12. -12 • -3 = _____

13. -11 • -8 = _____

14. -7 • +7 = _____

15. +5 • -5 = _____

16. +14 • -3 = _____

Directions: Multiply.

17.
+24
x -6

18.
-12
x -3

19.
-26
x +11

20.
+15
x +12

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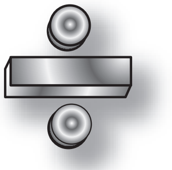
Division of Integers

When you divide one number by another, the first number is the **dividend** and the second number is the **divisor**. The answer or number obtained when dividing one number by another is called the **quotient**.

If 28 is divided by 4, the answer is 7, so



$$\frac{28}{4}\begin{matrix}\text{dividend}\\ \text{divisor}\end{matrix} = 7 \text{ quotient} \quad \text{or} \quad \begin{array}{r} 7 \leftarrow \text{quotient}\\ 4\overline{)28} \leftarrow \text{dividend}\\ \uparrow \quad\quad\quad\\ \text{divisor} \quad\quad\end{array}$$

Like multiplication, the rules for dividing integers are easily applied. There are two rules to use when dividing integers.

Rule 1: When dividing two numbers with the same signs, the quotient is positive.

$$\frac{+28}{+7} = +4 \text{ or } -28 \div -7 = +4$$

Rule 2: When dividing two numbers with different signs, the quotient is negative.

$$\frac{+28}{-7} = -4 \text{ or } -28 \div +7 = -4$$

Directions: Solve the following.

1. $+36 \div +9 =$ ________
2. $-25 \div -5 =$ ________
3. $+36 \div -9 =$ ________
4. $+48 \div +6 =$ ________
5. $+42 \div -7 =$ ________
6. $\frac{+64}{-4} =$ ________
7. $-32 \div +8 =$ ________
8. $\frac{+16}{+4} =$ ________
9. $\frac{-12}{+3} =$ ________
10. $+75 \div -5 =$ ________
11. $-35 \div +7 =$ ________
12. $\frac{+45}{+5} =$ ________
13. $\frac{+20}{+5} =$ ________
14. $-12 \div -3 =$ ________
15. $\frac{-21}{-3} =$ ________

Directions: Divide.

16. $4\overline{)24}$
17. $-6\overline{)-42}$
18. $3\overline{)-81}$
19. $-9\overline{)63}$
20. $-7\overline{)-77}$

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Variables

In mathematics, symbols are often used to represent ideas. For example, the symbol (=) means "is equal to," the symbol (>) means "is greater than," and the symbol (<) means "is less than." The symbols ÷, +, –, and • are the operation symbols that you have used many times.

Sometimes letters are used to represent numbers, and these letters are referred to as **variables**. For example, in $3 + x = 5$, x is the letter that represents the numeral 2.

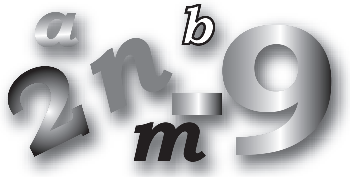
However, in $3 + x =$ ___, the x is a variable that could represent many different numerals depending on the number placed in the blank.

For example:

$3 + x = 7$ The variable, or literal number, that x stands for is 4.
$3 + x = 9$ The variable, or literal number, that x stands for is 6.
$3 + x = 50$ The variable, or literal number, that x stands for is 47.

Each of the above are **equations**. In each equation the variable is x, and the number 3 is called a **constant** because 3 represents the same value in each equation. The answer following the equal (=) sign depends on the number assigned to the variable (x). *Remember*, any letter of the alphabet can be used instead of x. Let's use the letter m for a variable.

For example, in the equation $3 + m =$ ___
$3 + m = 7$ The variable m stands for 4.
$3 + m = 9$ The variable m stands for 6.
$3 + m = 50$ The variable m stands for 47.



Directions: Solve the following addition problems. Choose a number for the variable.

1. $5 + x =$ ________ $x =$ ________ the variable is ________; the constant is ________

2. $6 + y =$ ________ $y =$ ________ the variable is ________; the constant is ________

3. $9 + m =$ ________ $m =$ ________ the variable is ________; the constant is ________

4. $17 + t =$ ________ $t =$ ________ the variable is ________; the constant is ________

5. $25 + p =$ ________ $p =$ ________ the variable is ________; the constant is ________

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Variables and Multiplication

Variables can be used when multiplying numbers. In multiplication problems, the symbol (•) is used to indicate multiplication. When variables are used, the sign for multiplication is often left out. For example, “3” multiplied by the variable *a* will usually be shown as 3*a* rather than 3 • *a*. In the problem 3*a*, the number “3” is the constant, and the letter *a* is the variable. The letter *a* is a variable that could stand for any number. Let’s work a multiplication problem with a variable.

$5a = 25$ Think: 5 multiplied by what number equals 25? 5 times 5 = 25.
The variable *a* equals 5.

Directions: Solve the following multiplication problems that contain a variable.

1. $3a = 6$ $a =$ ________ the constant is ________; the variable is ________

2. $4a = 28$ $a =$ ________ the constant is ________; the variable is ________

3. $9n = 45$ $n =$ ________ the constant is ________; the variable is ________

4. $7b = 56$ $b =$ ________ the constant is ________; the variable is ________

5. $12p = 48$ $p =$ ________ the constant is ________; the variable is ________

6. $10x = 120$ $x =$ ________ the constant is ________; the variable is ________

7. $15x = 90$ $x =$ ________ the constant is ________; the variable is ________

8. $20y = 100$ $y =$ ________ the constant is ________; the variable is ________

9. $14t = 42$ $t =$ ________ the constant is ________; the variable is ________

10. $8w = 72$ $w =$ ________ the constant is ________; the variable is ________

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Variables and Division/Variable Exercises

Variables often appear in division problems. When variables are used in division, you will see the problem “8 divided by *m*” as $8 \div m$ or $\frac{8}{m}$. In division problems with variables, the division process can be completed once you know what number to use for the variable. In the example, $8 \div m$ or $\frac{8}{m}$, let the variable stand for the number 2. Then $8 \div m$ or $\frac{8}{m}$ becomes $8 \div 2$ or $\frac{8}{2}$. Divide as you usually would. So $8 \div m$ (where $m = 2$) becomes $\frac{8}{2} = 4$.

Directions: Solve the following division problems with variables.

1. $14 \div b = 2$ $b =$ ________ the constant is ________; the variable is ________

2. $20 \div t = 5$ $t =$ ________ the constant is ________; the variable is ________

3. $18 \div s = 6$ $s =$ ________ the constant is ________; the variable is ________

4. $24 \div y = 4$ $y =$ ________ the constant is ________; the variable is ________

5. $36 \div y = 4$ $y =$ ________ the constant is ________; the variable is ________

6. $72 \div m = 24$ $m =$ ________ the constant is ________; the variable is ________

7. $88 \div m = 8$ $m =$ ________ the constant is ________; the variable is ________

8. $49 \div x = 7$ $x =$ ________ the constant is ________; the variable is ________

Directions: Solve the following addition, subtraction, multiplication, and division problems containing variables.

9. $7 + x = 21$ $x =$ ______

10. $9 - y = 6$ $y =$ ______

11. $8y = 32$ $y =$ ______

12. $21 + t = 43$ $t =$ ______

13. $\frac{48}{z} = 12$ $z =$ ______

14. $16x = 64$ $x =$ ______

15. $28 - b = 7$ $b =$ ______

16. $\frac{21}{b} = 3$ $b =$ ______

17. $32 + m = 50$ $m =$ ______

18. $14t = 112$ $t =$ ______

19. $9a = 81$ $a =$ ______

20. $122 + c = 182$ $c =$ ______

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Exponents

You will often work with exponents in mathematics. It is important to understand exponents and how to use them. When you see a figure like 3^2, the ^{2} is an exponent and the 3 is called the base. The **exponent** tells you the number of times the base is to be multiplied.

For example, in 3^2 the ^{2} tells you to multiply the 3 two times. $3^2 = 3 \cdot 3 = 9$

Directions: Answer the following.

1. 2^3 2 is the ______________ 3 is the ______________

2. 5^4 5 is the ______________ 4 is the ______________

3. 10^3 3 is the ______________ 10 is the ______________

4. 8^3 8 is the ______________ 3 is the ______________

5. 6^4 4 is the ______________ 6 is the ______________

6. The exponent tells you the number of times the base is to be ________________.

Directions: Fill in the blanks and solve the following problems.

7. $2^2 = 2 \cdot 2 =$ ________

8. $3^2 =$ ________ • ________ = ________

9. $2^3 =$ ________ • ________ • ________ = ________

10. $4^3 =$ ________ • ________ • ________ = ________

11. $5^2 =$ ________ • ________ = ________

12. $10^3 =$ ________ • ________ • ________ = ________

13. $8^3 =$ ________ • ________ • ________ = ________

14. $12^2 =$ ________ • ________ = ________

15. $5^4 =$ ________ • ________ • ________ • ________ = ________

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Exponents: Maximum Power, Minimum Space

In mathematics, when a base number has an exponent, the base number is said to be raised to the indicated power, so 2^3 is read as “2 to the third power.”

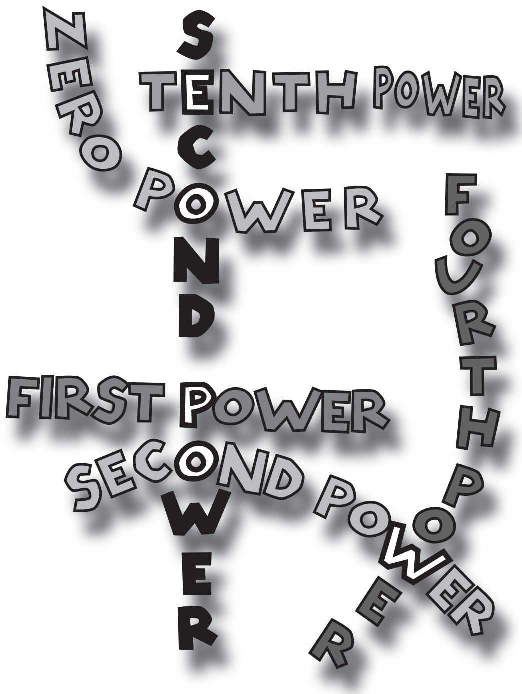
5^2 = 5 to the second power
3^3 = 3 to the third power
9^4 = 9 to the fourth power
4^3 = 4 to the third power

When a number (base) is raised to a power, the number (base) is multiplied the number of times indicated by the exponent (power).

5^2 = 5 to the second power = $5 \cdot 5 = 25$
3^3 = 3 to the third power = $3 \cdot 3 \cdot 3 = 27$
9^4 = 9 to the fourth power = $9 \cdot 9 \cdot 9 \cdot 9 = 6{,}561$
4^3 = 4 to the third power = $4 \cdot 4 \cdot 4 = 64$

Directions: Fill in the blanks.

1. $5^{\underline{\quad}}$ Five to the second power.
2. $3^{\underline{\quad}}$ Three to the third power.
3. $9^{\underline{\quad}}$ Nine to the second power.
4. $8^{\underline{\quad}}$ Eight to the fourth power.
5. $\underline{\quad}^{5}$ Nine to the fifth power.
6. $\underline{\quad}^{3}$ Seven to the third power.
7. $\underline{\quad}^{7}$ Two to the seventh power.
8. $\underline{\qquad}$ Five to the zero power.
9. $\underline{\qquad}$ Two to the first power.
10. $\underline{\qquad}$ Seven to the zero power.



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Exponents: Rules to Remember

When a base is raised to the zero power or first power, remember the following:

1. *Any base raised to the zero power equals one.* $3^0 = 1$, $5^0 = 1$, $10^0 = 1$
2. *Any base raised to the first power equals the base.* $3^1 = 3$, $5^1 = 5$, $10^1 = 10$

Directions: Solve the following.

1. $7^1 =$ ________
2. $3^0 =$ ________
3. $10^1 =$ ________
4. $4^1 =$ ________
5. 8____ = 1
6. 6____ = 1
7. 9____ = 1
8. 9____ = 9

Both negative and positive numbers can be raised to a power. For example, in 2^2, the exponent tells you to raise the positive number 2 to the second power, and in -2^2, the exponent tells you to raise the negative number -2 to the second power.

It is important to learn the following rules:

- *A positive number raised to a power will always have a positive number for an answer.*
- *A negative number raised to an even power will always have a positive number for an answer.*

For example:
-2^2 -2 raised to the second power = 4
-2^4 -2 raised to the fourth power = 16
-2^6 -2 raised to the sixth power = 64
Remember, the even numbers are 2, 4, 6, 8, 10, 12, . . .
In the examples above, the exponents 2, 4, and 6 are all even, so the answers are positive.

- *A negative number raised to an odd power will always have a negative number for an answer.*

For example:
-2^3 -2 raised to the third power = -8
-2^5 -2 raised to the fifth power = -32
-2^7 -2 raised to the seventh power = -128
Remember, the odd numbers are 1, 3, 5, 7, 9, 11, . . .
In the examples above, the exponents 3, 5, and 7 are odd, so the answers will be negative.

Directions: Solve the following.

9. $2^2 =$ ________
10. $3^3 =$ ________
11. $-2^2 =$ ________
12. $-5^2 =$ ________
13. $-2^3 =$ ________
14. $-4^2 =$ ________
15. $7^3 =$ ________
16. $-4^3 =$ ________
17. $-5^3 =$ ________
18. $10^2 =$ ________
19. $-10^3 =$ ________
20. $-4^5 =$ ________

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Adding and Subtracting Exponents

- *If the bases are the same, exponents can be added.*

For example: $2^2 \cdot 2^2 = 4 \cdot 4 = 16$ or $2^2 \cdot 2^2 = 2^{2+2} = 2^4 = 2 \cdot 2 \cdot 2 \cdot 2 = 16$

- *If the bases are different, the exponents cannot be added.*

Directions: Solve the following.

1. $3^2 \cdot 3^3 = 3^{2+3} = 3^5 = 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 = 243$

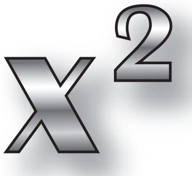
2. $2^2 \cdot 2^3 = 2^{\_\_\_\_\_\_} = \_\_\_\_\_\_ = \_\_\_\_\_\_ \cdot \_\_\_\_\_\_ \cdot \_\_\_\_\_\_ \cdot \_\_\_\_\_\_ \cdot \_\_\_\_\_\_ = \_\_\_\_\_\_$

3. $5^2 \cdot 5^4 = \_\_\_\_\_\_ = \_\_\_\_\_\_ = \_\_\_\_\_\_ \cdot \_\_\_\_\_\_ \cdot \_\_\_\_\_\_ \cdot \_\_\_\_\_\_ \cdot \_\_\_\_\_\_ \cdot \_\_\_\_\_\_ = \_\_\_\_\_\_$

4. $6^1 \cdot 6^2 = \_\_\_\_\_\_ = \_\_\_\_\_\_ = \_\_\_\_\_\_ \cdot \_\_\_\_\_\_ \cdot \_\_\_\_\_\_ = \_\_\_\_\_\_$

5. $2^1 \cdot 2^1 = \_\_\_\_\_\_ = \_\_\_\_\_\_ = \_\_\_\_\_\_ \cdot \_\_\_\_\_\_ = \_\_\_\_\_\_$

6. $10^1 \cdot 10^1 = \_\_\_\_\_\_ = \_\_\_\_\_\_ = \_\_\_\_\_\_ \cdot \_\_\_\_\_\_ = \_\_\_\_\_\_$



7. $7^2 \cdot 7^1 = \_\_\_\_\_\_ = \_\_\_\_\_\_ = \_\_\_\_\_\_ \cdot \_\_\_\_\_\_ \cdot \_\_\_\_\_\_ = \_\_\_\_\_\_$

8. $4^2 \cdot 4^0 = \_\_\_\_\_\_ = \_\_\_\_\_\_ = \_\_\_\_\_\_ \cdot \_\_\_\_\_\_ = \_\_\_\_\_\_$

9. $5^0 \cdot 5^1 = \_\_\_\_\_\_ = \_\_\_\_\_\_ = \_\_\_\_\_\_$

When dividing like bases with exponents, the quotient is obtained by subtracting the exponents and showing the base with the exponent after subtraction.

In dividing to find the quotient, the exponent may be positive or negative.

Example: $4^4 \div 4^2 = \frac{4^4}{4^2} = 4^{4-2} = 4^2$

The dividend 4^4 has the larger exponent, so the exponent in the quotient is positive, 4^2.

Example: $5^3 \div 5^5 = \frac{5^3}{5^5} = 5^{3-5} = 5^{-2}$

The dividend 5^3 has the smaller exponent, so after 5 is subtracted from 3, the exponent in the quotient is negative, 5^{-2}.

Directions: Simplify the following.

10. $3^4 \div 3^2 = \frac{3^4}{3^2} = 3^{4-2} = 3^2$

11. $4^5 \div 4^7 = \frac{4^5}{4^7} = 4^{5-7} = \_\_\_\_\_\_$

12. $2^5 \div 2^4 = \_\_\_\_\_\_ = \_\_\_\_\_\_ = \_\_\_\_\_\_$

13. $7^4 \div 7^6 = \_\_\_\_\_\_ = \_\_\_\_\_\_ = \_\_\_\_\_\_$

14. $6^5 \div 6^9 = \_\_\_\_\_\_ = \_\_\_\_\_\_ = \_\_\_\_\_\_$

15. $9^3 \div 9^1 = \_\_\_\_\_\_ = \_\_\_\_\_\_ = \_\_\_\_\_\_$

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Multiplying Exponents

In algebra you will often see terms like the following: $(3^3)^2$ and $(2)^2(2)^3$.

Let's look at the term $(3^3)^2$.

First, think: what does the base inside the parentheses with the exponent 3 say? Three to the third power.

Second, think: what does the exponent 2 outside the parentheses say? It tells you to raise the terms inside the parentheses to the second power.

So $(3^3)^2$ is three raised to the third power raised to the second power.

(3^3) is $3 \cdot 3 \cdot 3 = 27$ $3^3 = 27$ so $(3^3)^2$ becomes $(27)^2$

Now you have 27 raised to the second power, which is $(27)^2 = 27 \cdot 27 = 729$.

There is a shorter way to solve problems like this. When you have terms like $(3^3)^2$, you can multiply the exponents. So $(3^3)^2$ becomes $3^{3 \cdot 2} = 3^6 = 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 \cdot 3 = 729$, which is the same answer as above.

Directions: Solve the following (you may use your calculator for the final answer).

1. $(2^2)^2 = 2^{2 \cdot 2} = 2^4 = 16$

2. $(2^3)^2 = 2^{\_\_\_\_ \cdot \_\_\_\_} = 2^{\_\_\_\_}$ = ______

3. $(3^2)^2 = 3^{\_\_\_\_ \cdot \_\_\_\_}$ = ______ = ______

4. $(5^2)^2$ = __________ = ______ = ______

5. $(4^2)^2$ = __________ = ______ = ______

6. $(3^1)^2$ = __________ = ______ = ______

7. $(6^0)^2$ = __________ = ______ = ______

8. $(2^3)^3$ = __________ = ______ = ______

9. $(3^3)^2$ = __________ = ______ = ______

10. $(2^2)^3$ = __________ = ______ = ______

11. $(4^1)^2$ = __________ = ______ = ______

12. $(10^2)^2$ = __________ = ______ = ______

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Zero and Negative Integer Exponents

The exponents discussed so far have been with positive integers. What happens when 0, -1, -2, -3, -4, . . . are used as exponents? For example: 10^0 2^{-3} 4^{-2} $(-4)^{-2}$

x^0 When the exponent for any base number is zero, the answer is one (1). Therefore, any number used to replace the base number (x) will equal one (1) if the exponent is zero.

Example: $10^0 = 1$

x^{-n} When the exponent for any base number is negative (x^{-n}), rewrite as a fraction $\frac{1}{x^n}$ with the numerator 1. Change the negative sign of the exponent to positive.

Example: $(-4)^{-2} = \frac{1}{-4^2} = \frac{1}{16}$

Remember, a negative number (-4) raised to an even power (^{2}) results in a positive number.

Directions: Solve the following.

1. $2^0 =$ ______

2. $5^{-2} = \frac{1}{\_\_\_\_\_\_} = \frac{1}{\_\_\_\_\_\_}$

3. $3^{-3} =$ ______ = ______

4. $10^0 =$ ______

5. $10^{-2} =$ ______

6. $-10^{-2} =$ ______

7. $20^0 =$ ______

8. $-2^2 =$ ______

9. $-7^{-2} =$ ______

Review:

10. $10^2 =$ ______

11. $4^2 =$ ______

12. $5^0 =$ ______

13. $-8^2 =$ ______

14. $10^3 =$ ______

15. $8^0 =$ ______

16. $2^{-3} =$ ______

17. $5^{-2} =$ ______

18. $(-4)^{-2} =$ ______

19. $(-3)^{-2} =$ ______

20. $6^1 =$ ______

21. $5^3 =$ ______

Directions: Complete the following.

22. $2^2 + 3^3 + 4^2 =$ ______

23. $3^0 + 5^2 + 3^2 =$ ______

24. $(-3^2) + (-4^2) - 2^3 =$ _____

25. $5^0 + 6^0 + 7^0 =$ ______

26. $6^2 \div 3^2 + 2^1 =$ ______

27. $(2^2)^3 + (3^2)^2 =$ ______

28. $2^{-2} + 3^1 + 2^{-1} =$ ____

29. $3^{-2} + 2^{-2} + 2^{-3} =$ ____

30. $-2^3 \cdot -3^2 =$ ______

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Scientific Notation

Exponents are very useful when working with large numbers that have been rounded off. Such large numbers are used in many of the science courses you will be studying later. Writing extremely large numbers in simple form is known as **scientific notation**.

Let's look at how scientific notation works. Let's use the following numbers:

1 10 100 1,000 10,000 100,000

Looking closely, you can see how the above numbers are related. From left to right each number is ten times larger than the one before. For example, 10 is ten times larger than 1; 100 is ten times larger than 10; 1,000 is ten times larger than 100, and so forth.

Let's look at the above numbers written with exponents.

$1 = 10^0$ $1{,}000 = 10^3$

$10 = 10^1$ $10{,}000 = 10^4$

$100 = 10^2$ $100{,}000 = 10^5$

A science book might tell you that the planet Mars is 36,000,000 miles from Earth. It could be said that "Mars is 36 • 1,000,000 miles from Earth." Using scientific notation, the 1,000,000 can be written as 10^6 and it can then be stated as "Mars is 36 • 10^6 miles from Earth."

Let's write a number like 88,000 using scientific notation.

$88{,}000 = 88 \cdot 1{,}000 = 88 \cdot 10^3$

What about 3,000?

$3{,}000 = 3 \cdot 1{,}000 = 3 \cdot 10^3$

Directions: Solve these using scientific notation.

1. $90{,}000{,}000 = 90 \cdot 1{,}000{,}000 = 90 \cdot 10^6$
2. 20,000,000 = ______ • __________________ = ______ • ______
3. 48,000,000 = ______ • __________________ = ______ • ______
4. 72,000,000 = ______ • __________________ = ______ • ______
5. 97,000,000 = ______ • __________________ = ______ • ______
6. 26,000 = ______ • __________ = ______ • ______
7. 58,000 = ______ • __________ = ______ • ______
8. 2,000 = ______ • __________ = ______ • ______
9. 300 = ______ • __________ = ______ • ______
10. 20,000 = ______ • __________ = ______ • ______

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Simplifying Large Numbers With Scientific Notation

You will often see decimal numbers expressed in scientific notation. For example, 36,000,000 can be written in scientific notation as $36 \cdot 10^6$ or with a decimal as $3.6 \cdot 10^7$. The exponent indicates how many digits the decimal point is moved.

$$36 \cdot 10^6 = \quad 36 \cdot 1{,}000{,}000 = 36{,}000{,}000$$
$$3.6 \cdot 10^7 = \quad 3.6 \cdot 10{,}000{,}000 = 36{,}000{,}000$$

Here is another example:

$$88 \cdot 10^3 = \quad 88 \cdot 1{,}000 = 88{,}000$$
$$8.8 \cdot 10^4 = \quad 8.8 \cdot 10{,}000 = 88{,}000$$

Directions: Complete the following using scientific notation with decimals.

1. 72,000,000 = 7.2 • ______ = 7.2 • ____________________
2. 48,000,000 = ______ • ______ = ______ • ____________________
3. 26,000,000 = ______ • ______ = ______ • ____________________
4. 3,600 = 3.6 • ______ = ______ • _______________
5. 36,000 = ______ • ______ = ______ • _______________
6. 5,500 = 5.5 • ______ = ______ • _______________
7. 55,000 = ______ • ______ = ______ • _______________
8. 55,000,000 = ______ • ______ = ______ • ____________________
9. 2,780,000,000 = 2.78 • ______ = ______ • __________________________
10. 609,000,000,000,000 = ______ • ______ = ______ • ____________________________

$$954{,}500{,}000{,}000{,}000 = 9.545 \cdot 10^{14}$$

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Learning About Factoring

The numbers multiplied together to get a product are called **factors**. For example, all the possible numbers that can be multiplied together (factors) to get the product 18 are shown below.

18 • 1 = 18	1 • 18 = 18
9 • 2 = 18	2 • 9 = 18
6 • 3 = 18	3 • 6 = 18

1, 2, 3, 6, 9, and 18 are factors of 18.

What are the factors of 12?

The factors of 12 are 1, 2, 3, 4, 6, and 12.

1 • 12 = 12	12 • 1 = 12
2 • 6 = 12	6 • 2 = 12
3 • 4 = 12	4 • 3 = 12

Let's look at ways to find out how many factors a number has. One way to find the factors of a number is by division. To find factors, find those numbers that will divide into a number and leave a remainder of zero.

Let's factor 18 using the division method. We will begin with 18 ÷ 1, 18 ÷ 2, 18 ÷ 3, 18 ÷ 4, 18 ÷ 5, 18 ÷ 6, 18 ÷ 7, 18 ÷ 8, 18 ÷ 9.

18	9	6	4	3	3	2	2	2
1)18	2)18	3)18	4)18	5)18	6)18	7)18	8)18	9)18
18	18	18	16	15	18	14	16	18
0R	0R	0R	2R	3R	0R	4R	2R	0R

The only factors of 18 are those divisions with a remainder of zero. Those factors are 1, 2, 3, 6, 9, and 18. All of those numbers divide into 18 with a remainder of zero.

Directions: Find the factors of the following numbers by using division.

1. 8   1)8   2)8   3)8   4)8   5)8   6)8   7)8   8)8

List the factors ______ ______ ______ ______

2. 9   1)9   2)9   3)9   4)9   5)9   6)9   7)9   8)9   9)9

List the factors ______ ______ ______

3. 16   1)16   2)16   3)16   4)16   6)16   7)16   8)16   16)16

List the factors: ______ ______ ______ ______ ______

4. 15   1)15   2)15   3)15   4)15   5)15   6)15   7)15   15)15

List the factors: ______ ______ ______ ______

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Learning About Prime Factors

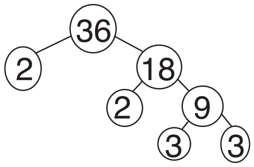
A whole number greater than 1 is **prime** if no number other than 1 and the number itself can divide the number. Another way to describe a prime number is to say that a **prime number** has exactly two factors: 1 and the number. For example, the number 5 is a prime number. The only numbers that will divide into 5 and have a zero remainder are 5 and 1.

Two methods for finding prime factors are the division method and the factor tree method.

What are the prime factors for 36?

Dividing: ② |36
② |18
③ |9
③

Factor Tree:



2, 2, 3, 3, are the prime factors for 36

Directions: Find the prime factors using the division method.

1. 12 2 |12 Prime factors:

2. 24 2 |24 Prime factors:

3. 32 2 |32 Prime factors:

4. 48 2 |48 Prime factors:

5. 96 2 |96 Prime factors:

6. 88 2 |88 Prime factors:

7. 236 2 |236 Prime factors:

8. 512 2 |512 Prime factors:

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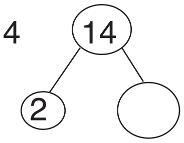
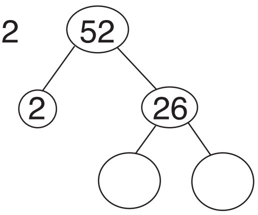
Finding Prime Factors

Directions: Find the prime factors using the factor trees (show your work).

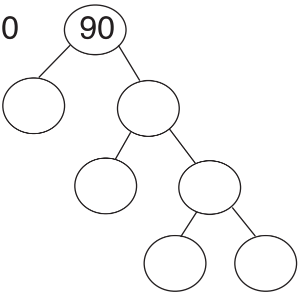
1. 14



2. 52



3. 90

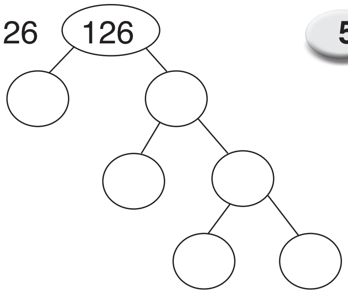


Prime factors: ____________

Prime factors: ____________

Prime factors: ____________

4. 126



5. 342

6. 428

Prime factors: ____________

Prime factors: ____________

Prime factors: ____________

Directions: Write each of the following numbers as a product of prime factors. Use the factor trees above.

7. 14 ______ • ______ = 14

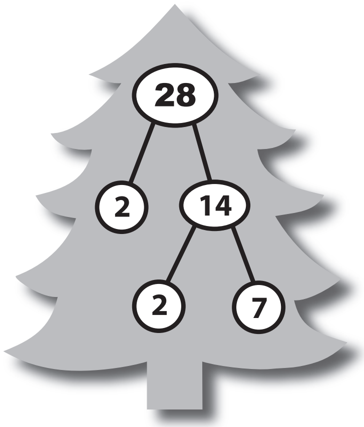
8. 52 ______ • ______ • ______ = ______

9. 90 ______ • ______ • ______ • ______ = 90

10. 126 ______ • ______ • ______ • ______ = ______

11. 342 ______ • ______ • ______ • ______ = ______

12. 428 ______ • ______ • ______ = ______



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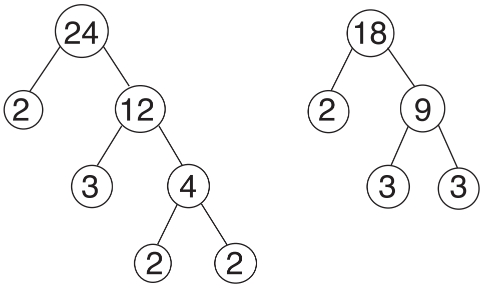
Learning About the Greatest Common Factor

Let's work with two numbers and see how they can be compared. We will be trying to find the greatest common factor for these two numbers.

The **greatest common factor (GCF)** for two numbers is the largest number that is a factor of both numbers.

Find the GCF for the numbers 24 and 18. To find the GCF, it is necessary to find the prime factors of both numbers.

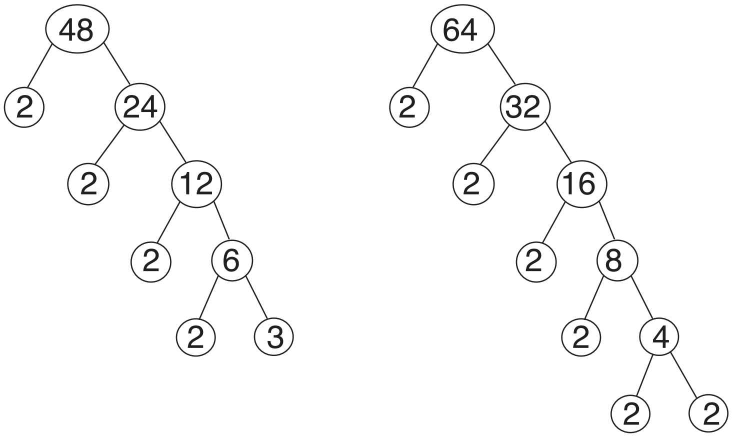


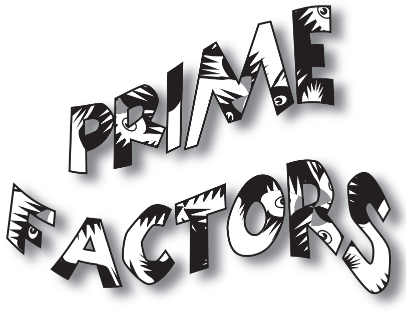
Prime factors for 24:	2	3	2	2
Prime factors for 18:	2	3	3	

Circle the prime factors common to both numbers and multiply: 2 • 3 = 6

Arrange the prime factors for each number so the prime factors found in both numbers can be identified. In the box above, the prime factors 2 and 3 are found in both numbers. Multiply these two prime numbers and the answer is six. Six is the greatest common factor found in both 24 and 18.

Find the GCF for the numbers 48 and 64. First, find the prime factors for each number.





Prime factors for 48	2	2	2	2	3	
Prime factors for 64	2	2	2	2	2	2

Multiply the prime factors common to both numbers: 2 • 2 • 2 • 2 = 16
16 is the GCF for 48 and 64

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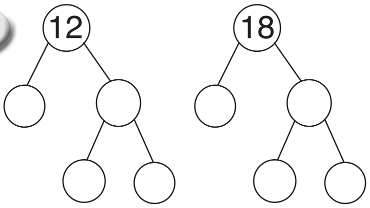
Finding the Greatest Common Factor

Directions: Find the greatest common factor for the following pairs of numbers.

1.

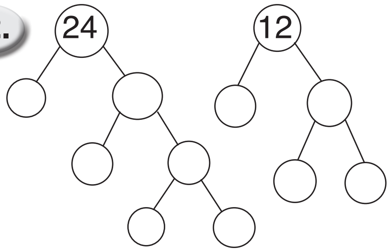


Prime for 12: ____________________

Prime for 18: ____________________

GCF: ____________________

2.



Prime for 24: ____________________

Prime for 12: ____________________

GCF: ____________________

3. 36 54

Prime for 36: ____________________

Prime for 54: ____________________

GCF: ____________________

4. 18 30

Prime for 18: ____________________

Prime for 30: ____________________

GCF: ____________________

5. 18 27

Prime for 18: ____________________

Prime for 27: ____________________

GCF: ____________________

6. 56 16

Prime for 56: ____________________

Prime for 16: ____________________

GCF: ____________________

7. 93 69

Prime for 93: ____________________

Prime for 69: ____________________

GCF: ____________________

8. 72 216

Prime for 72: ____________________

Prime for 216: ____________________

GCF: ____________________

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Learning About the Least Common Multiple

In finding the **least common multiple (LCM)**, you are trying to find the smallest non-zero number that is the multiple of two numbers. The least common multiple of two numbers is found by listing the multiples of the two numbers and then comparing to find the smallest number that is a multiple of both numbers.

Example: Find the LCM for 18 and 24.

The multiples for 18 are: 1 • 18 = 18; 2 • 18 = 36; 3 • 18 = 54; 4 • 18 = 72; 5 • 18 = 90 . . .

The multiples for 24 are: 1 • 24 = 24; 2 • 24 = 48; 3 • 24 = 72; 4 • 24 = 96; 5 • 24 = 120 . . .

Multiples for 18:	18, 36, 54, 72, 90
Multiples for 24:	24, 48, 72, 96, 120

72 is the LCM for the numbers 18 and 24.

Directions: Find the LCM for the following pairs of numbers.

1. 5: 5, ___, ___, ___, ___, ___, ___

7: 7, ___, ___, ___, ___, ___, ___

LCM = __________

2. 6: 6, ___, ___, ___, ___, ___

10: 10, ___, ___, ___, ___, ___

LCM = __________

3. 4: ______________________________

10: ______________________________

LCM = __________

4. 14: ______________________________

21: ______________________________

LCM = __________

5. 30: ______________________________

45: ______________________________

LCM = __________

6. 15: ______________________________

25: ______________________________

LCM = __________

7. 18: ______________________________

20: ______________________________

LCM = __________

8. 6: ______________________________

14: ______________________________

LCM = __________

9. 8: ______________________________

34: ______________________________

LCM = __________

10. 12: ______________________________

22: ______________________________

LCM = __________

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Radicals and Roots

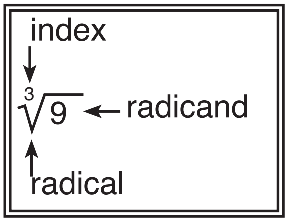
In algebra you will see problems with radicals. The ($\sqrt{}$) is the radical sign. When you are told to find "the square root of 4," it will often be written as $\sqrt[2]{4}$ or $\sqrt{4}$. You are asked to find the numbers (roots) that, when squared, equal 4. There are two numbers (roots) that, when squared, give you 4. The numbers (roots) are 2 and -2.

2 • 2 = 4	Two positive numbers multiplied equal +4.
-2 • -2 = 4	Two negative numbers multiplied equal +4.

When you see $\sqrt{}$, it is the **radical sign**. The number under the radical is the **radicand**.

The $\sqrt{}$ radical sign tells you to find the square root of the radicand under the radical. $\sqrt{9}$ means "find the square root of 9."

Many times you will need to find cube roots, fourth roots, and so on. The number above the radical will tell you the root to find. The number above the radical is the **index**.



$\sqrt[2]{}$ or $\sqrt{}$ means find the square root	$\sqrt[3]{}$ means find the cube root
$\sqrt[4]{}$ means find the fourth root	$\sqrt[8]{}$ means find the eighth root

Directions: Complete the following.

1. Write the symbol for the radical. ________________
2. The number under the radical sign is called the ________________.
3. $\sqrt{4}$ or $\sqrt[2]{4}$ tells you to find the s _ _ _ _ _ r _ _ _ of f _ _ _.
4. $\sqrt[3]{8}$ tells you to find the c _ _ _ r _ _ _ of e _ _ _ _.
5. $\sqrt[4]{16}$ tells you to find the f _ _ _ _ _ r _ _ _ of s _ _ _ _ _ _.

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Finding Square Roots

The radical $\sqrt[2]{4}$ or $\sqrt{4}$ asks you to find the two numbers (roots) that multiplied equal 4. The radical $\sqrt{9}$ or $\sqrt[2]{9}$ asks you to find the two numbers (roots) that multiplied equal 9.

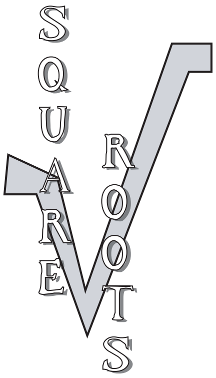
$\sqrt[2]{4}$ or $\sqrt{4}$ $2 \bullet 2 = 4$ or $-2 \bullet -2 = 4$

2 and -2 are the numbers or roots that when multiplied equal 4.

$\sqrt[2]{9}$ or $\sqrt{9}$ $3 \bullet 3 = 9$ or $-3 \bullet -3 = 9$

3 and -3 are the numbers or roots that when multiplied equal 9.

Unless otherwise noted, find only the positive roots.



Directions: Solve the following.

1. $\sqrt{4}$ = ______________
2. $\sqrt{9}$ = ______________
3. $\sqrt{16}$ = ______________
4. $\sqrt{36}$ = ______________
5. $\sqrt{49}$ = ______________
6. $\sqrt{64}$ = ______________
7. $\sqrt{100}$ = ______________
8. $\sqrt{25}$ = ______________
9. $\sqrt{81}$ = ______________
10. $\sqrt{144}$ = ______________

Directions: Answer the following.

11. The square root of 4 is ___________.
12. The square root of 36 is ___________.
13. The square root of 100 is ___________.
14. The square root of 49 is ___________.

Directions: Use the <u>radical sign</u> and write the problem that would tell you to find the following.

15. The square root of 9 $\sqrt{9}$
16. The square root of 64 $\sqrt{\ }$
17. The square root of 81 ______________
18. The square root of 25 ______________
19. The square root of 144 ______________
20. The square root of 16 ______________

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Adding Radicals

Radicals can be added. When adding radicals, the radicals must have the <u>same</u> index and the <u>same</u> radicand.

$$\overset{\downarrow}{2}\sqrt{\overset{\text{index}}{\underset{\uparrow}{3}}} + \overset{\downarrow}{3}\sqrt{\underset{\uparrow\ \text{radicand}}{3}}$$

$2\sqrt{3} + 3\sqrt{3}$ can be added because the radicands are the same (3), and the index in both is square root (2).

$2\sqrt{3} + 2\sqrt[3]{5}$ cannot be added because the radicands are different (3 and 5), and the indexes (2 and 3) are different.

coefficients: $\downarrow$ $\downarrow$

Add: $2\sqrt{3} + 3\sqrt{3}$

Step 1: Add the coefficients 2 and 3. $2 + 3 = 5$

Step 2: Rewrite the answer as $5\sqrt{3}$

$2\sqrt{3} + 3\sqrt{3} = (2 + 3)\sqrt{3} = 5\sqrt{3}$

Directions: Add the following.

1. $7\sqrt{2} + 3\sqrt{2} = (7 + 3)\sqrt{2} = \underline{\qquad}\sqrt{2}$
2. $4\sqrt{5} + 3\sqrt{5} = (\underline{\qquad} + \underline{\qquad})\sqrt{5} = \underline{\qquad}\sqrt{5}$
3. $2\sqrt{7} + 4\sqrt{7} + 3\sqrt{7} = (\underline{\qquad} + \underline{\qquad} + \underline{\qquad})\sqrt{7} = \underline{\qquad}\sqrt{7}$
4. $10\sqrt{3} + 8\sqrt{3} + 2\sqrt{3} = (\underline{\qquad} + \underline{\qquad} + \underline{\qquad})\sqrt{\underline{\quad}} = \underline{\qquad}\sqrt{\underline{\quad}}$
5. $9\sqrt{5} + 5\sqrt{5} = (\underline{\qquad} + \underline{\qquad})\sqrt{\underline{\quad}} = \underline{\qquad}\sqrt{\underline{\quad}}$
6. $7\sqrt{29} + 14\sqrt{29} + 2\sqrt{29} = \underline{\qquad\qquad\qquad}$
7. $14\sqrt{31} + 6\sqrt{31} + 5\sqrt{31} = \underline{\qquad\qquad\qquad}$

When the radical appears without a coefficient before it, the coefficient is the number 1.

$\sqrt{3} = 1\sqrt{3}$

Add: $\overset{\downarrow\ \text{coefficient } 3}{3}\sqrt{2} + \underset{\uparrow\text{coefficient } 1}{\sqrt{2}} = (3 + 1)\sqrt{2} = 4\sqrt{2}$

8. $\sqrt{5} + 2\sqrt{5} = (\underline{\qquad} + \underline{\qquad})\sqrt{5} = \underline{\qquad}\sqrt{5}$
9. $3\sqrt{22} + 19\sqrt{22} + \sqrt{22} = (\underline{\qquad} + \underline{\qquad} + \underline{\qquad})\sqrt{22} = \underline{\qquad}\sqrt{22}$
10. $8\sqrt{7} + \sqrt{7} + 4\sqrt{7} = \underline{\qquad\qquad\qquad}$

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Subtracting Radicals

When subtracting radicals, the radicals subtracted must have the <u>same</u> radicands and the <u>same</u> indexes.

↓ index ↓
$2\sqrt{3} + 3\sqrt{3}$
↑ radicand ↑

$5\sqrt{3} - 3\sqrt{3}$ can be subtracted because the radicands are the same (3) and the indexes are the same (2).

$5\sqrt{3} - 3\sqrt[3]{3}$ cannot be subtracted because the indexes are different (2 and 3).

Subtract: $5\sqrt{3} - 3\sqrt{3}$
Step 1: Subtract the coefficients. $5 - 3 = 2$
Step 2: Rewrite the answer as $2\sqrt{3}$
$5\sqrt{3} - 3\sqrt{3} = (5 - 3)\sqrt{3} = 2\sqrt{3}$

Directions: Subtract the following.

1. $8\sqrt{5} - 3\sqrt{5} = (8 - \_\_\_\_)\sqrt{5} = \_\_\_\_\sqrt{5}$

2. $14\sqrt{11} - 7\sqrt{11} = (\_\_\_\_ - \_\_\_\_)\sqrt{\_\_\_\_} = \_\_\_\_\sqrt{\_\_\_\_}$

3. $32\sqrt{7} - 15\sqrt{7} = (\_\_\_\_ - \_\_\_\_)\sqrt{\_\_\_\_} = \_\_\_\_\sqrt{\_\_\_\_}$

4. $5\sqrt{31} - 2\sqrt{31} - \sqrt{31} = (\_\_\_\_ - \_\_\_\_ - \_\_\_\_)\sqrt{\_\_\_\_} = \_\_\_\_\sqrt{\_\_\_\_}$

5. $8\sqrt{15} - 10\sqrt{15} = (\_\_\_\_ - \_\_\_\_)\sqrt{\_\_\_\_} = -2\sqrt{\_\_\_\_}$

6. $7\sqrt{3} - 11\sqrt{3} = (\_\_\_\_ - \_\_\_\_)\sqrt{\_\_\_\_} = -\_\_\_\_\sqrt{\_\_\_\_}$

7. $26\sqrt{8} - 5\sqrt{8} - 23\sqrt{8} = (\_\_\_\_ - \_\_\_\_ - \_\_\_\_)\sqrt{\_\_\_\_} = -\_\_\_\_\sqrt{\_\_\_\_}$

8. $4\sqrt{6} - 3\sqrt{6} =$ ____________________

9. $27\sqrt{41} - 22\sqrt{41} =$ ____________________

Directions: Solve the following. Watch the signs!

10. $10\sqrt{3} + 8\sqrt{3} - 5\sqrt{3} = (\_\_\_\_ + \_\_\_\_ - \_\_\_\_)\sqrt{\_\_\_\_} = \_\_\_\_\sqrt{\_\_\_\_}$

11. $27\sqrt{5} - 13\sqrt{5} + 2\sqrt{5} - 8\sqrt{5} = (\_\_\_\_ - \_\_\_\_ + \_\_\_\_ - \_\_\_\_)\sqrt{\_\_\_\_} = \_\_\_\_\sqrt{\_\_\_\_}$

12. $14\sqrt{11} - 18\sqrt{11} + 2\sqrt{11} = (\_\_\_\_ - \_\_\_\_ + \_\_\_\_)\sqrt{\_\_\_\_} = -\_\_\_\_\sqrt{\_\_\_\_}$

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Multiplying and Dividing Radicals

Multiply radicals as you would whole numbers. When multiplying radicals, the indexes must be the same; however, the radicands can be different.

$\sqrt{3} \cdot \sqrt{3}$ think $3 \cdot 3 = 9$ so $\sqrt{3} \cdot \sqrt{3} = \sqrt{9} = 3$

$\sqrt{2} \cdot \sqrt{8}$ think $2 \cdot 8 = 16$ so $\sqrt{2} \cdot \sqrt{8} = \sqrt{16} = 4$

Directions: Solve the following.

1. $\sqrt{3} \cdot \sqrt{3} = \sqrt{\_\_\_} =$ ______

2. $\sqrt[4]{2} \cdot \sqrt[4]{8} = \sqrt[4]{\_\_\_} =$ ______

3. $\sqrt{4} \cdot \sqrt{4} = \sqrt{\_\_\_} =$ ______

4. $\sqrt{2} \cdot \sqrt{2} = \sqrt{\_\_\_} =$ ______

5. $\sqrt{7} \cdot \sqrt{7} = \sqrt{\_\_\_} =$ ______

6. $\sqrt{4} \cdot \sqrt{16} = \sqrt{\_\_\_} =$ ______

7. $\sqrt[3]{9} \cdot \sqrt[3]{3} = \sqrt[3]{\_\_\_} =$ ______

8. $\sqrt{4} \cdot \sqrt{9} = \sqrt{\_\_\_} =$ ______

9. $\sqrt{5} \cdot \sqrt{5} = \sqrt{\_\_\_} =$ ______

10. $\sqrt{10} \cdot \sqrt{10} = \sqrt{\_\_\_} =$ ______

Divide radicals as you would divide whole numbers. When dividing radicals, the indexes must be the same; however, the radicands can be different.

$\dfrac{\sqrt{12}}{\sqrt{3}}$ think $\dfrac{12}{3} = 4$ so $\dfrac{\sqrt{12}}{\sqrt{3}} = \sqrt{4} = 2$

Directions: Solve the following.

11. $\dfrac{\sqrt{36}}{\sqrt{9}} = \sqrt{4} =$ ______

12. $\dfrac{\sqrt[3]{64}}{\sqrt[3]{8}} = \sqrt[3]{8} =$ ______

13. $\dfrac{\sqrt{27}}{\sqrt{3}} = \sqrt{\_\_\_} =$ ______

14. $\dfrac{\sqrt{75}}{\sqrt{3}} = \sqrt{\_\_\_} =$ ______

15. $\dfrac{\sqrt[5]{96}}{\sqrt[5]{3}} = \sqrt[5]{\_\_\_} =$ ______

16. $\dfrac{\sqrt{50}}{\sqrt{2}} = \sqrt{\_\_\_} =$ ______

17. $\dfrac{\sqrt[3]{81}}{\sqrt[3]{3}} = \sqrt[3]{\_\_\_} =$ ______

18. $\dfrac{\sqrt{64}}{\sqrt{16}} = \sqrt{\_\_\_} =$ ______

19. $\dfrac{\sqrt[4]{3{,}125}}{\sqrt[4]{5}} = \sqrt[4]{\_\_\_} =$ ______

20. $\dfrac{\sqrt{24}}{\sqrt{6}} = \sqrt{\_\_\_} =$ ______

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Simplifying Radicals

Many radicals can be changed to an equivalent form that is easier to use in solving problems. Changing a radical to this new form is called <u>simplifying</u>.

Step 1: To simplify $\sqrt{18}$, think $\sqrt{18} = \sqrt{2 \cdot 9}$

Step 2: $\sqrt{2 \cdot 9}$ can be written as $\sqrt{2} \cdot \sqrt{9}$

Step 3: Find the $\sqrt{9} = 3$ and rewrite as $3 \cdot \sqrt{2}$ or $3\sqrt{2}$

So $\sqrt{18} = \sqrt{9 \cdot 2} = \sqrt{9} \cdot \sqrt{2} = 3 \cdot \sqrt{2} = 3\sqrt{2}$

Directions: Simplify the following.

1. $\sqrt{12} = \sqrt{4 \cdot \_\_\_} = \sqrt{4} \cdot \sqrt{\_\_} = 2 \cdot \sqrt{\_\_} = 2\sqrt{\_\_}$

2. $\sqrt{18} = \sqrt{9 \cdot \_\_\_} = \sqrt{9} \cdot \sqrt{\_\_} = 3 \cdot \sqrt{\_\_} = \_\_\_\sqrt{\_\_}$

3. $\sqrt{20} = \sqrt{\_\_\_ \cdot \_\_\_} = \sqrt{\_\_} \cdot \sqrt{\_\_} = \_\_\_ \cdot \sqrt{\_\_} = \_\_\_\sqrt{\_\_}$

4. $\sqrt{27} = \sqrt{\_\_\_ \cdot \_\_\_} = \sqrt{\_\_} \cdot \sqrt{\_\_} = \_\_\_ \cdot \sqrt{\_\_} = \_\_\_\sqrt{\_\_}$

5. $\sqrt{8} = \sqrt{\_\_\_ \cdot \_\_\_} = \sqrt{\_\_} \cdot \sqrt{\_\_} = \_\_\_ \cdot \sqrt{\_\_} = \_\_\_\sqrt{\_\_}$

6. $\sqrt{24} = \sqrt{4 \cdot \_\_\_} = \sqrt{\_\_} \cdot \sqrt{\_\_} = \_\_\_ \cdot \sqrt{\_\_} = \_\_\_\sqrt{\_\_}$

7. $\sqrt{32} = \sqrt{4 \cdot \_\_\_} = \_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_$

8. $\sqrt{50} = \sqrt{\_\_\_ \cdot 2} = \_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_$

9. $\sqrt{48} = \sqrt{\_\_\_ \cdot 3} = \_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_$

10. $\sqrt{45} = \sqrt{9 \cdot \_\_\_} = \_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_ = \_\_\_\_\_\_\_\_$

Review: Write the square root of each of the following.

11. 16 = ______

12. 49 = ______

13. 36 = ______

14. 25 = ______

15. 9 = ______

16. 100 = ______

17. 144 = ______

18. 64 = ______

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Multiplying and Simplifying Radicals

Directions: Multiply the radicals in the following exercise. After multiplying the radicals, simplify.

Example: Multiply and simplify $\sqrt{12} \cdot \sqrt{2}$

Step 1: multiply $\sqrt{12} \cdot \sqrt{2} = \sqrt{24}$

Step 2: simplify $\sqrt{24} = \sqrt{4} \cdot \sqrt{6} = 2 \cdot \sqrt{6} = 2\sqrt{6}$

1. $\sqrt{3} \cdot \sqrt{15} = \sqrt{\_\_\_\_} = \sqrt{\_\_} \cdot \sqrt{5} = \_\_\_\_ \cdot \sqrt{\_\_} = \_\_\_\_ \sqrt{\_\_}$
2. $\sqrt{2} \cdot \sqrt{6} = \sqrt{\_\_\_\_} = \sqrt{\_\_} \cdot \sqrt{3} = \_\_\_\_ \cdot \sqrt{\_\_} = \_\_\_\_ \sqrt{\_\_}$
3. $\sqrt{3} \cdot \sqrt{6} = \sqrt{\_\_\_\_} = \sqrt{\_\_} \cdot \sqrt{\_\_} = \_\_\_\_ \cdot \sqrt{\_\_} = \_\_\_\_ \sqrt{\_\_}$
4. $\sqrt{3} \cdot \sqrt{8} = \sqrt{\_\_\_\_} = \sqrt{\_\_} \cdot \sqrt{\_\_} = \_\_\_\_ \cdot \sqrt{\_\_} = \_\_\_\_ \sqrt{\_\_}$
5. $\sqrt{2} \cdot \sqrt{14} = \sqrt{\_\_\_\_} = \sqrt{\_\_} \cdot \sqrt{\_\_} = \_\_\_\_ \cdot \sqrt{\_\_} = \_\_\_\_ \sqrt{\_\_}$

Dividing and Simplifying Radicals

Directions: Divide the radicals in the following exercises. After dividing the radicals, simplify.

Example: Divide and simplify $\sqrt{24} \div \sqrt{3}$

Step 1: Divide $\sqrt{24} \div \sqrt{3} = \dfrac{\sqrt{24}}{\sqrt{3}} = \sqrt{8}$

Step 2: Simplify $\sqrt{8} = \sqrt{4} \cdot \sqrt{2} = 2 \cdot \sqrt{2} = 2\sqrt{2}$

1. $\dfrac{\sqrt{32}}{\sqrt{4}} = \sqrt{\_\_} = \sqrt{\_\_} \cdot \sqrt{\_\_} = \_\_\_\_ \cdot \sqrt{\_\_} = \_\_\_\_ \sqrt{\_\_}$
2. $\dfrac{\sqrt{48}}{\sqrt{4}} = \sqrt{\_\_\_\_} = \sqrt{\_\_} \cdot \sqrt{\_\_} = \_\_\_\_ \cdot \sqrt{\_\_} = \_\_\_\_ \sqrt{\_\_}$
3. $\dfrac{\sqrt{64}}{\sqrt{2}} = \sqrt{\_\_\_\_} = \sqrt{\_\_} \cdot \sqrt{\_\_} = \_\_\_\_ \cdot \sqrt{\_\_} = \_\_\_\_ \sqrt{\_\_}$
4. $\dfrac{\sqrt{56}}{\sqrt{2}} = \sqrt{\_\_\_\_} = \sqrt{\_\_} \cdot \sqrt{\_\_} = \_\_\_\_ \cdot \sqrt{\_\_} = \_\_\_\_ \sqrt{\_\_}$

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Learning About Simple Equations

Many of the math problems you will solve involve equations. **Equations** are mathematical statements that two expressions are equal.

$5 + y = 7$ is an equation.
$5 + y$ is one **member** of the equation.
7 is one member of the equation.
The equal (=) sign tells you the expressions are equal.

In solving equations, you will be solving for the unknown. The **unknown** in the above equation is *y.* Replace *y* with the number that, added to 5, equals 7.

$5 + y = 7$ Find a number for *y.*
$5 + 2 = 7$ Substitute the number 2 for *y.* Add.
$7 = 7$

The number 2 is the correct number for *y* since $7 = 7$ is correct. The number 2 is the **solution** to the above question.

In equations like $5 + y = 7$ or $7 – x = 4$, the letters *y* and *x* are unknowns. Letters such as *y* and *x* are used in equations to represent the unknown. These letters are called **variables**.

In solving equations like $5 + y = 7$, you can subtract the same number from each *member* of the equation, and the resulting equation will still be equal. This is very important in helping you solve such problems. The subtraction process undoes the addition. *Subtraction is the opposite of addition*. Subtraction and addition are inverse operations because they are opposites.

$5 + y = 7$ Subtract 5 from each member of the equation.
$5 + y – 5 = 7 – 5$
$0 + y = 2$ Subtracting 5 from both members of the equation
$y = 2$ helps you find the number *y* equals.

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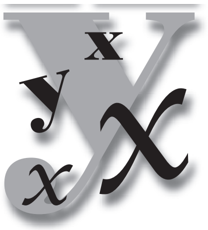
Finding the Value of the Unknown—I

Directions: Solve each problem as directed.

Find the unknown.



1. $y + 4 = 9$ Solve by subtracting 4 from each member of the equation.

$y + 4 - 4 = 9 - 4$ $y + 0 = 5$ $y = 5$

Check by substituting the solution for *y*. $5 + 4 = 9$

2. $x + 10 = 21$ Solve by subtracting 10 from each member of the equation.

$x + 10 - \underline{\qquad} = 21 - \underline{\qquad}$ $x + \underline{\qquad} = \underline{\qquad}$ $x = \underline{\qquad}$

Check by substituting the solution for *x*. $\underline{\qquad} + 10 = 21$

3. $v + 17 = 28$ Solve by subtracting 17 from each member of the equation.

$v + 17 - \underline{\qquad} = 28 - \underline{\qquad}$ $v + \underline{\qquad} = \underline{\qquad}$ $v = \underline{\qquad}$

Check by substituting the solution for *v*. $\underline{\qquad} + 17 = 28$

Find the unknown. Check your solution.

4. $t + 8 = 16$

5. $w + 19 = 25$

6. $b + 34 = 51$

7. $n + 72 = 101$

8. $y + 16 = 29$

9. $x + 3 = 27$

10. $y + 8 = 32$

11. $z + 12 = 30$

12. $x + 41 = 90$

Write the equation.

13. If you add 12 to a number, the sum is 26. Think: what is the unknown? If the unknown is added to 12, the sum is 26. Choose a letter for the unknown and write the equation.

$\underline{\qquad} + \underline{\qquad} = 26$

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Finding the Value of the Unknown—II

Many times you will be asked to find the unknown in an equation where a number is subtracted from the unknown.

For example: $x - 7 = 10$

In equations like $x - 7 = 10$, you can add the same number to each member of the equation, and the resulting equation will still be equal.

$x - 7 = 10$	Add +7 to each member of the equation.
$x - 7 + 7 = 10 + 7$	
$x + 0 = 17$	Adding +7 to each member of the equation
$x = 17$	helps you find the number x equals.

The addition of +7 is the opposite of the -7. Adding +7 undoes the subtraction of -7. *Addition is the inverse operation of subtraction because it has an opposite effect*.

Directions: Solve each problem as directed.

Find the unknown.

1. $y - 3 = 18$ Solve by adding +3 to each member of the equation.

$y - 3 +$ ____ $= 18 +$ ____ y + ____ = ____ y = ____

Check by substituting the solution for y. ____ $- 3 = 18$

2. $x - 5 = 20$ Solve by adding +5 to each member of the equation.

$x - 5 +$ ____ $= 20 +$ ____ $x +$ ____ $=$ ____ $x =$ ____

Check by substituting the solution for x. ____ $- 5 = 20$

Find the unknown. Check the solution.

3. $b - 12 = 7$

4. $t - 4 = 8$

5. $w - 11 = 3$

6. $v - 7 = -3$

7. $y - 4 = -1$

8. $x - 10 = 3$

9. $x - 5 = 4$

10. $t - 8 = -12$

11. $y - 7 = 11$

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Reviewing Simple Equations

Directions: Complete the following.

1. Equations are ______________ statements with _______ expressions that are equal.

2. In the equation $x + 4 = 9$, the two members of the equation are _________ and _________.

3. In solving equations, you can add or ______________ the same number from each member of the equation without changing the result.

> The fact that you can add the same number to each side of an equation without changing the results of the equation has a special name. It is known as the *addition principle of equations.*
>
> The fact that you can subtract the same number from each member of the equation without changing the result has a special name. It is known as the *subtraction principle of equations.*

Directions: Write equations for these problems and solve for the unknown.

4. Aaron bought an apple for 38 cents and had 26 cents left over. How much money did he have before buying the apple?
   - **a.** Think: The unknown is the amount of money Aaron had before he bought the apple. Choose a letter to be the unknown. What letter did you choose? _______
   - **b.** Think: What number must be subtracted from the unknown? _______
   - **c.** Complete the equation. ____ – ____ = 26
   - **d.** How much money did Aaron have before he bought the apple? _______
   - **e.** Check your answer on your own paper. Show your work.

5. Evan made 12 free throws, helping his team win the game. If he had made 6 more free throws, he would have made as many as the total team. How many free throws did Evan's team make? Write the equation and solve the problem.

____

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Solving Equations With Multiplication

Many equations involve multiplication. An equation with multiplication would be $2n = 6$ ($2n$ is another way to write $2 \cdot n$). $2n = 6$ asks "2 times what number (unknown) = 6?"

In solving equations with multiplication, you want to undo the multiplication. *Division is the opposite, or inverse, operation of multiplication* and can be used to solve this problem.

$2n = 6$ To find *n,* each member of the equation can be divided by the same number without changing the result.

$\frac{2n}{2} = \frac{6}{2}$ Divide each member of the equation by 2.

$\frac{2n}{2} = n$ $\frac{6}{2} = 3$ (Remember, $\frac{2}{2} = 1$, but you usually do not place the 1 before the unknown.)

$n = 3$ Rewrite the equation.

Now check your work by substituting 3 for *n* in the original equation.
$2n = 6$ becomes $2 \cdot 3 = 6$ $6 = 6$

Even though you write $2n$ without the multiplication sign (•), when two numbers are written together, use (•) between them to indicate multiplication.

Directions: Find the unknown (check each problem).

1. $8x = 16$ Divide each member by 8.

$\frac{8x}{8} = \frac{16}{8}$ _____ = _____

Substitute the number *x* equals to check.

8 • _____ = 16

2. $14x = 28$

$\frac{14x}{\ } = \frac{28}{\ }$ _____ = _____

14 • _____ = 28

3. $8x = 24$

$\frac{8x}{\ } = \frac{24}{\ }$ _____ = _____

8 • _____ = 24

4. $12x = 60$ $x =$ _____

5. $12y = 36$ $y =$ _____

6. $4t = 32$ $t =$ _____

7. $24w = 48$ $w =$ _____

8. $18p = 36$ $p =$ _____

9. $4t = 16$ $t =$ _____

10. $5t = 55$ $t =$ _____

11. $12y = 144$ $y =$ _____

12. $2e = 16$ $e =$ _____

13. $8r = 32$ $r =$ _____

14. $3x = 42$ $x =$ _____

15. $6y = 60$ $y =$ _____

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Solving Equations With Division

Many equations involve division. Equations like $\frac{x}{12} = 4$ tell you that the unknown x divided by 12 equals 4. When solving equations with division, you must first undo the division. *Multiplication is the inverse, or opposite, operation of division*. To undo the division in $\frac{x}{12} = 4$, each member of the equation can be multiplied by the same number without changing the results.

$\frac{x}{12} = 4$	Multiplication will undo division, so find a number that can be multiplied by both members of the equation.
$\frac{x}{12} \cdot 12 = 4 \cdot 12$	Multiply both members of the equation by 12.
$\frac{x}{\cancel{12}} \cdot \cancel{12} = 48$ $x = 48$	The two 12s in the left member cancel each other, and you must multiply 4 • 12 in the right member.
$\frac{48}{12} = 4$ $4 = 4$	Check by substituting the solution (48) for x in the equation and complete the division.

Directions: Find the unknown (check each problem).

1. $\frac{y}{4} = 6$ Undo the division by multiplying each member of the equation by 4.

$\frac{y}{4} \cdot$ _____ $= 6 \cdot$ _____ _____ = _____

$\frac{\quad}{4} = 6$ Substitute the number y equals in the equation and check.

_____ = 6

2. $\frac{x}{2} = 7$ Undo the division by multiplying each member of the equation by 2.

$\frac{x}{2} \cdot$ _____ $= 7 \cdot$ _____ _____ = _____

$\frac{\quad}{2} = 7$ Substitute the number x equals in the equation and check.

_____ = 7

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Solving Equations With Division *(continued)*

3. $\frac{t}{5} = 6$ $\frac{t}{5} \cdot \_\_\_\_ = 6 \cdot \_\_\_\_$ $\_\_\_\_ = \_\_\_\_$ Check: $\frac{\quad}{5} = 6$ $\_\_\_\_ = 6$

4. $\frac{w}{8} = 4$ $\frac{w}{8} \cdot \_\_\_\_ = 4 \cdot \_\_\_\_$ $\_\_\_\_ = \_\_\_\_$ Check: $\frac{\quad}{8} = 4$ $\_\_\_\_ = \_\_\_\_$

5. $\frac{p}{9} = 8$ $\frac{p}{9} \cdot \_\_\_\_ = 8 \cdot \_\_\_\_$ $\_\_\_\_ = \_\_\_\_$ Check: $\frac{\quad}{9} = 8$ $\_\_\_\_ = \_\_\_\_$

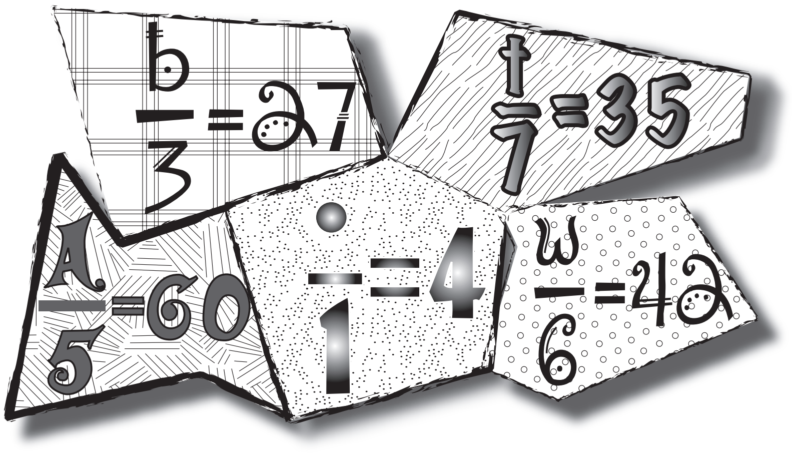
6. $\frac{x}{3} = 12$ $\frac{x}{3} \cdot \_\_\_\_ = 12 \cdot \_\_\_\_$ $\_\_\_\_ = \_\_\_\_$ Check: $\frac{\quad}{3} = 12$ $\_\_\_\_ = \_\_\_\_$

7. $\frac{y}{12} = 12$ $\frac{y}{12} \cdot \_\_\_\_ = 12 \cdot \_\_\_\_$ $\_\_\_\_ = \_\_\_\_$ Check: $\frac{\quad}{12} = 12$ $\_\_\_\_ = \_\_\_\_$

8. $\frac{c}{16} = 4$ $\frac{c}{16} \cdot \_\_\_\_ = 4 \cdot \_\_\_\_$ $\_\_\_\_ = \_\_\_\_$ Check: $\frac{\quad}{16} = 4$ $\_\_\_\_ = \_\_\_\_$

9. $\frac{x}{2} = 32$ $\frac{x}{2} \cdot \_\_\_\_ = 32 \cdot \_\_\_\_$ $\_\_\_\_ = \_\_\_\_$ Check: $\frac{\quad}{2} = 32$ $\_\_\_\_ = \_\_\_\_$

10. $\frac{y}{3} = 7$ $\frac{y}{3} \cdot \_\_\_\_ = 7 \cdot \_\_\_\_$ $\_\_\_\_ = \_\_\_\_$ Check: $\frac{\quad}{3} = 7$ $\_\_\_\_ = \_\_\_\_$



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Ratios

Ratios may be written many ways. One way of writing a ratio is as a fraction. Examples of ratios written as fractions are $\frac{2}{5}$ and $\frac{10}{25}$ and $\frac{6}{30}$. To read the fraction $\frac{2}{5}$ as a ratio, you would read it as "two to five." This is the comparison form. The 2 is compared to 5. The ratio 2 to 5 can also be written as 2:5. We call this the colon form. You read it the same way you read the comparison form.

Directions: Write ratios for each of the following.

1. Write the ratio $\frac{3}{7}$ as a comparison. ______ to ______

2. Write the ratio $\frac{2}{9}$ as a comparison. ______ to ______

3. Write the ratio $\frac{5}{6}$ as a comparison. ______ to ______

4. Write the ratio $\frac{4}{7}$ as a comparison. ______ to ______

5. Write the ratio $\frac{8}{11}$ as a comparison. ______ to ______

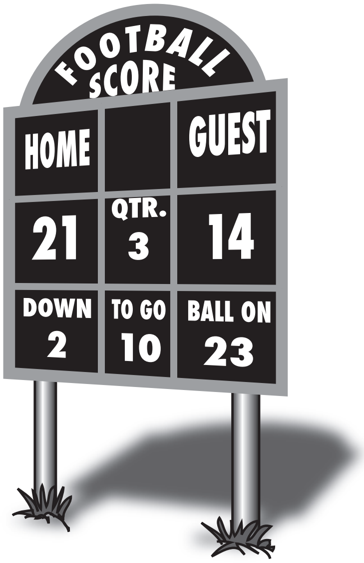
6. Write the ratio $\frac{2}{3}$ in the colon form. ______ : ______

7. Write the ratio $\frac{2}{10}$ in the colon form. ______ : ______

8. Write the ratio $\frac{1}{5}$ in the colon form. ______ : ______

9. Write the ratio $\frac{12}{17}$ in the colon form. ______ : ______

10. Write the ratio $\frac{9}{13}$ in the colon form. ______ : ______



Write the ratio for each of the following.	**Fraction**	**Comparison**	**Colon**
11. The Wolves won 5 games and lost 12.	_____	_____ to _____	_____ : _____
12. The soccer team won 7 games and lost 12.	_____	_____ to _____	_____ : _____
13. The softball team won 10 games and lost 5.	_____	_____ to _____	_____ : _____
14. The football team won 6 games and lost 4.	_____	_____ to _____	_____ : _____
15. The baseball team won 9 games and lost 11.	_____	_____ to _____	_____ : _____

Name: ______________________________ Date: ______________________

Proportions

A proportion compares two equal ratios. Proportions may be written in fraction form. An example of a proportion is $\frac{3}{5} = \frac{6}{10}$. The comparison form is "3 is to 5 as 6 is to 10." The proportion is read "three is to five as six is to ten." Proportions may be written in the colon form as 3:5::6:10. It is read the same way.

The ratios in a proportion must be equal. In our example, $\frac{3}{5}$ and $\frac{6}{10}$ are equal. One way to check to see if your ratios are proportional is to check their cross products. The cross products must be equal.

$\frac{3}{5} \times \frac{6}{10}$ 3 • 10 = 30 3 and 10 are cross products
5 • 6 = 30 5 and 6 are cross products

Directions: Write each pair of ratios as a proportion and a cross product. The first one is done for you.

1. 2 is to 5 4 is to 10 proportion: __2__ : __5__ : : __4__ : __10__
cross products: __2__ • __10__ as __5__ • __4__

2. 5 is to 3 10 is to 6 proportion: ______ : ______ : : ______ : ______
cross products: ______ • ______ as ______ • ______

3. 1 is to 3 3 is to 9 proportion: ______ : ______ : : ______ : ______
cross products: ______ • ______ as ______ • ______

4. 3 is to 5 9 is to 15 proportion: ______ : ______ : : ______ : ______
cross products: ______ • ______ as ______ • ______

5. 2 is to 3 4 is to 6 proportion: ______ : ______ : : ______ : ______
cross products: ______ • ______ as ______ • ______

6. 5 is to 7 10 is to 14 proportion: ______ : ______ : : ______ : ______
cross products: ______ • ______ as ______ • ______

7. 3 is to 8 6 is to 16 proportion: ______ : ______ : : ______ : ______
cross products: ______ • ______ as ______ • ______

8. 9 is to 1 27 is to 3 proportion: ______ : ______ : : ______ : ______
cross products: ______ • ______ as ______ • ______

Name: ______________________________ Date: ____________________

Cross Product Exercises

Directions: Solve the proportions for the unknown. The first one is done for you.

1. $\frac{2}{5} :: \frac{x}{10}$ $2 \cdot 10 = 20$ $20 = 5x$ $\frac{20}{5} = \frac{5x}{5}$ $x = 4$

$5 \cdot x = 5x$

2. $\frac{2}{3} :: \frac{x}{6}$ _____ • _____ = _____ _____ = _____ x _____ = _____ x $x =$ _____

_____ • x = _____ x

3. $\frac{1}{4} :: \frac{x}{8}$ _____ • _____ = _____ _____ = _____ x _____ = _____ x $x =$ _____

_____ • x = _____ x

4. $\frac{1}{3} :: \frac{x}{9}$ _____ • _____ = _____ _____ = _____ x _____ = _____ x $x =$ _____

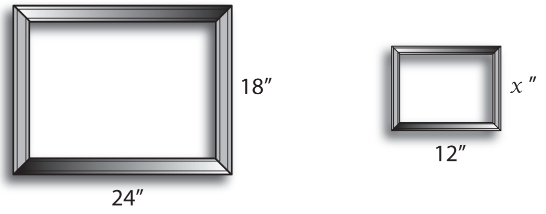
_____ • x = _____ x

5. $\frac{5}{6} :: \frac{x}{12}$ _____ • _____ = _____ _____ = _____ x _____ = _____ x $x =$ _____

_____ • x = _____ x

6. $\frac{1}{9} :: \frac{x}{27}$ _____ • _____ = _____ _____ = _____ x _____ = _____ x $x =$ _____

_____ • x = _____ x



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Finding the Mean

The mean, median, and mode are terms that measure the central tendency for a group of numbers. We use mean, median, and mode to help better understand the information a group of numbers is presenting. Each of the terms tells us something different for a group of numbers. Let's start with the mean.

Mean: The mean is the average of a group of numbers. It is found by first finding the sum of a group of numbers. Then divide the sum by the total number of numbers.

Example: 2 + 3 + 5 + 6 + 9 = 25 — 25 is the sum of five numbers. To find the average of the five numbers, divide 25 by 5.

25 ÷ 5 = 5 — The average of the five numbers is 5.

Directions: Find the mean for the following group of numbers.

14 12 16 20 16 14 18 40

Step 1: Arrange the numbers in order from smallest to largest.

Step 2: Find the sum:

_____ + _____ + _____ + _____ + _____ + _____ + _____ + _____ = _____

Step 3: Divide the sum by the number of numbers:

_____ ÷ _____ = ________

Step 4: Mean = ________

Directions: Find the mean for the following. Round to the nearest tenth if necessary.

1. 3, 2, 5, 3, 1, 3 sum = _____ mean = ________
2. 5, 8, 6, 2, 7, 9, 12 sum = _____ mean = ________
3. 11, 18, 12, 20, 12, 16, 17, 15 sum = _____ mean = ________
4. 77, 56, 34, 77, 45, 70 sum = _____ mean = ________
5. 31, 30, 31, 33, 36, 37, 31, 32 sum = _____ mean = ________
6. 108, 200, 253, 125, 200, 187 sum = _____ mean = ________

Name: ______________________ Date: ______________

Finding the Mode

Mode: The mode is the number in a group that occurs most often.

Example: 2, **3**, **3**, 5, 6, 9

In the group of numbers 2, 3, 3, 5, 6, and 9, the mode is the number 3.

Mode is useful because it can identify the most common event in a group. Let's say the scores on a test were 36, 68, 87, 87, 87, and 100. The mean for this set, 77.5, is below the scores of two-thirds of the test results. The mode, 87, can give us a better idea of how most of the class did on the test.

Directions: Find the mode for the following numbers.

14 12 16 20 16 14 18 40 16

Step 1: Arrange the numbers in order from smallest to largest.

______, ______, ______, ______, ______, ______, ______, ______, ______

Step 2: The mode is the number that occurs most often.

Mode = ______

mode = most often

Directions: Find the mode for the following test scores.

1. 5, 8, 6, 2, 7, 9, 8 mode = ______

2. 11, 18, 12, 20, 12, 16, 17, 15 mode = ______

3. 77, 56, 34, 77, 45, 70 mode = ______

4. 31, 30, 31, 33, 36, 37, 31, 32 mode = ______

5. 108, 200, 253, 125, 200, 187 mode = ______

6. 11, 18, 12, 11, 18, 11, 20, 12, 18, 16, 17, 15, 11 mode = ______

Name: ______________________ Date: ______________

Finding the Median

Median: The median is the number that is in the exact middle of a group of numbers.

Example: 2, 3, **5**, 6, 9 — In the group of numbers 2, 3, 5, 6, and 9, the median is the number 5.

If a group of numbers has an even number of numbers, there will be two numbers in the middle. Find the average of those two numbers, and that is the median.

Example: 4, 5, 7, **8**, **9**, 12, 14, 16 — 8 and 9 are in the middle.
Add 8 + 9 = 17 Divide 17 ÷ 2 = 8.5
8.5 is the median.

Knowing the median can help you understand what a group of numbers represents. In the test scores 48, 63, 85, 86, and 99, the median is 85. The median also tells us that two students scored below 85, and two students scored above 85.

median = middle

Directions: Find the median for the following numbers.

30 20 38 42 24 27 35 45 40

Step 1: Arrange the numbers in order from smallest to largest.

______, ______, ______, ______, ______, ______, ______, ______, ______

Step 2: Count from left and right until you get the number exactly in the middle of the group.

Step 3: The middle score is the median score. Median = ______

Directions: Find the median for the following test scores.

1. 5, 8, 6, 2, 7, 9, 12 median = ______

2. 77, 56, 34, 77, 45, 70, 57 median = ______

3. 31, 30, 31, 33, 36, 37, 31, 32, 33 median = ______

4. 108, 200, 253, 125, 200, 187, 156 median = ______

5. 7, 12, 5, 2, 3, 14, 4, 9 median = ______

6. 13, 8, 11, 26, 9, 5, 3, 6, 2, 10 median = ______

7. 25, 15, 23, 21, 32, 8, 7, 20, 18, 12, 4, 19 median = ______

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Probability

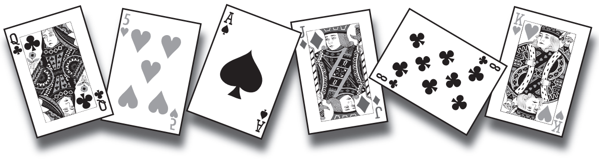
You use probability every day. **Probability** tells us how likely, or unlikely, it is an event will occur. Probability is often written as a proper fraction. The numerator is the number of times an event occurs. The denominator is the number of possible events. When probability is written as a fraction, it is a ratio.

An **event** is one of the outcomes from the total number of events possible. A card is drawn from a deck of 52 cards. What is the probability that the card will be the king of hearts? The drawing of one card is an event. There are 52 different possible cards to draw for one event, and only one of them is the king of hearts. The probability of drawing the king of hearts is 1 event of 52 possibilities. The fractional ratio used to express this probability mathematically is $\frac{1}{52}$.

Similarly, the probability of drawing a card that is not the king of hearts can be expressed as $\frac{51}{52}$ because there are 51 cards you might draw that are not the king of hearts. Which one is more likely? The closer the numerator and denominator are, the more likely the event is to occur. Therefore, $\frac{51}{52}$ is more likely to occur than $\frac{1}{52}$. It's less likely you will draw the king of hearts than another card.

Directions: Decide which part of the fraction is the number of times an event occurs and which part is the total number of possible times an event could occur.

1. $\frac{1}{2}$ The number of events is ______. The number of possible events is ______.
2. $\frac{1}{5}$ The number of events is ______. The number of possible events is ______.
3. $\frac{1}{4}$ The number of events is ______. The number of possible events is ______.
4. $\frac{3}{10}$ The number of events is ______. The number of possible events is ______.
5. $\frac{2}{50}$ The number of events is ______. The number of possible events is ______.
6. $\frac{1}{100}$ The number of events is ______. The number of possible events is ______.



Name: ______________________ Date: ______________

Probability Exercises

An outcome is one of the possibilities that may occur in an experiment. A bag contains 3 marbles. One marble is white. The drawing of one marble is an event. There are three possible outcomes, or events. What is the possibility that a marble drawn from the bag will be white?

1. The number of possible outcomes when a marble is drawn is ______.
2. The number of events in the single drawing is ______.
3. The ratio from the single drawing is **a)** $\frac{1}{2}$. **b)** $\frac{1}{3}$. **c)** $\frac{1}{5}$.
4. The probability that the drawn marble will be white is

   a) one of two. **b)** one of four. **c)** one of three. **d)** one of five.

5. The probability that the drawn marble will not be white is

   a) two of four. **b)** two of three. **c)** two of two. **d)** two of five.

Directions: Circle the correct answer for each of the following.

6. A coin is tossed one time. What is the probability that the coin will be heads?

   a) $\frac{1}{2}$ **b)** $\frac{1}{3}$ **c)** $\frac{1}{5}$ **d)** $\frac{1}{4}$

7. A card is drawn from a deck of 52 cards. What is the probability the card will be a king?

   a) $\frac{1}{52}$ **b)** $\frac{2}{52}$ **c)** $\frac{3}{52}$ **d)** $\frac{4}{52}$

8. A card is drawn from a deck of 52 cards. What is the probability the card will be a king or a queen?

   a) $\frac{2}{52}$ **b)** $\frac{8}{52}$ **c)** $\frac{10}{52}$ **d)** $\frac{12}{52}$

9. A coin is tossed ten times. What is the number of possible events?

   a) 4 **b)** 6 **c)** 8 **d)** 10

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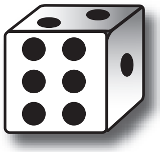
Probability Prediction

The probability of an event will be represented as a number between 0 and 1. A probability of 0 means the event will never occur. A probability of 1 means the event will always occur. Any fraction between 0 and 1 tells you how likely the event is to occur. The closer to 0, the less likely an event is. The closer to 1, the more likely an event is.

A die can be used to show the probability of an event between 0 and 1. The numbers on a die are 1, 2, 3, 4, 5, and 6. If the die is tossed, one of the numbers will always appear. That means the probability of a number not appearing is 0.



Directions: Circle the correct answer for each of the following.

1. When the die is tossed, the number of possible outcomes is

a) 3. **b)** 4. **c)** 5. **d)** 6.

2. The ratio that shows the probability that the number rolled will be the number 1 is

a) $\frac{1}{6}$. **b)** $\frac{2}{6}$. **c)** $\frac{3}{6}$. **d)** $\frac{4}{6}$.

3. The ratio that shows the probability that the number rolled will be the number 5 is

a) $\frac{1}{6}$. **b)** $\frac{2}{6}$. **c)** $\frac{3}{6}$. **d)** $\frac{4}{6}$.

4. The ratio that shows the probability that the number rolled will be any of the 6 numbers is

a) $\frac{1}{6}$. **b)** $\frac{3}{6}$. **c)** $\frac{5}{6}$. **d)** $\frac{6}{6}$.

A bag contains a black token, a white token, a green token, a red token, and a blue token.

5. The total number of possible events or outcomes for drawing a token from the bag is

a) 4. **b)** 5. **c)** 6. **d)** 7.

6. The probability that you will draw any one of the colored tokens on the first draw is

a) $\frac{2}{5}$. **b)** $\frac{3}{5}$. **c)** $\frac{4}{5}$. **d)** $\frac{5}{5}$

7. The probability that you will draw a green or blue token on the first draw is

a) $\frac{1}{5}$. **b)** $\frac{2}{5}$. **c)** $\frac{3}{5}$. **d)** $\frac{4}{5}$.

8. The probability that you will draw a green, white, or red token on the first draw is

a) $\frac{1}{5}$. **b)** $\frac{2}{5}$. **c)** $\frac{3}{5}$. **d)** $\frac{4}{5}$.

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Learning About the Rectangular Coordinate System

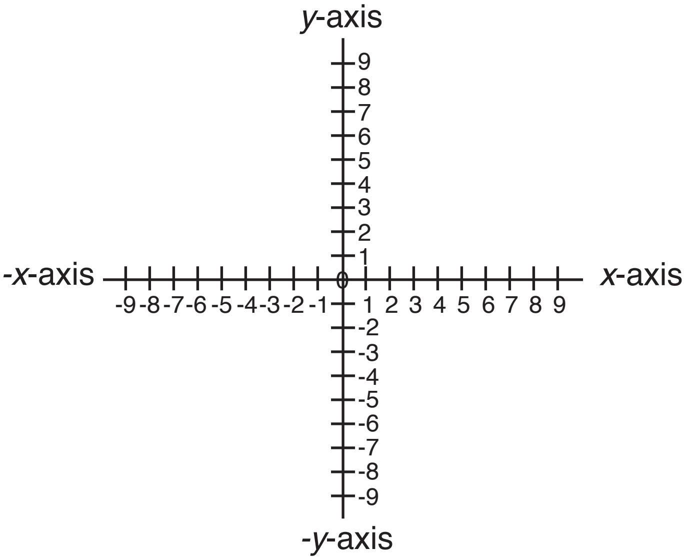
Many people have become famous for their work in mathematics. René Descartes, a French mathematician of the seventeenth century, made an important contribution to mathematics. It was Descartes who developed the rectangular coordinate system.

A **rectangular coordinate system** is developed by drawing two perpendicular lines that are then numbered like a double number line from the point of origin.

The two perpendicular lines at right can be used to develop a rectangular system. The vertical line is called the ***y*-axis**, and the horizontal line is called the ***x*-axis**. The **origin**, or reference point, is zero.

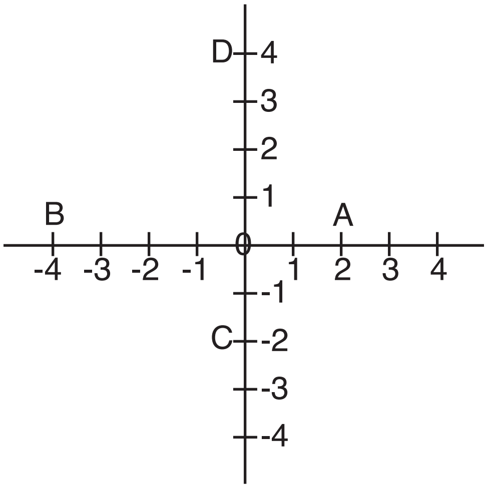
The rectangular coordinate system can be used to locate points in a plane. Note that the *x*- and *y*-axes are numbered in equal units from the origin, or zero.

Rectangular Coordinate System A



Directions: On Rectangular Coordinate System B below, complete the following.

Rectangular Coordinate System B



1. What number is located below the letter A? ______
Which axis is the number on? ______________
Is the number positive or negative? ____________

2. What number is located below the letter B? ______
Which axis is the number on? ______________
Is the number positive or negative? ____________

3. What number is located beside the letter C? ______
Which axis is the number on? ______________
Is the number positive or negative? ____________

4. What number is located beside the letter D? ______
Which axis is the number on? ______________
Is the number positive or negative? ____________

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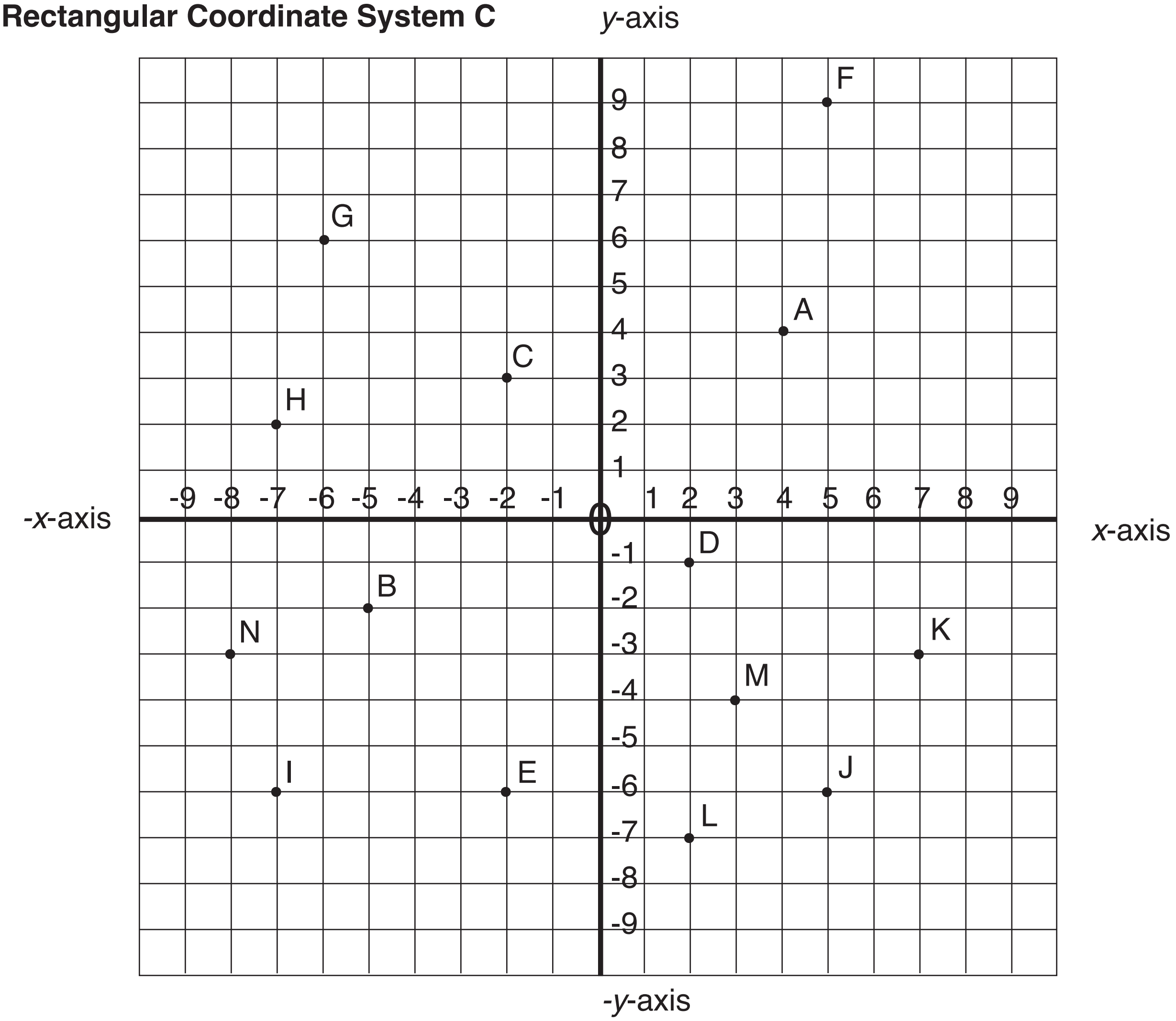
Learning About Coordinates

Rectangular Coordinate System C



Rectangular Coordinate System C will help you understand how to locate coordinate points. A coordinate point is located by its distance from the origin on the *x*- and *y*-axes. Each point has two numbers locating it. The numbers are called the **coordinates**.

Let's locate point A.

Step 1: From the origin, count right on the *x*-axis to the number on the *x*-axis that is directly under the letter "A." The number is 4.

Step 2: From the origin, count up on the *y*-axis to the number that is on the same line as the letter "A." This number is also 4.

Step 3: These two numbers (4, 4) are called the coordinates for locating point A.

The coordinate (number) for the *x*-axis is always written first. Thus, (4, 4) means +4 on the *x*-axis and +4 on the *y*-axis.

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Learning About Coordinates *(continued)*

Let's locate point B using Rectangular Coordinate System C on page 61.

Step 1: From the origin, count left on the *x*-axis to the number on the *x*-axis that is directly above the letter "B." The number is -5.

Step 2: From the origin, count down on the *y*-axis to the number that is on the same line as the letter "B." The number is -2.

Step 3: Write these two coordinates (numbers) with the coordinate on the *x*-axis first. The coordinates are -5, -2.

Directions: Use Rectangular Coordinate System C on page 61 to locate the coordinates for each of the following points. Write the correct coordinates in the spaces provided.

1. C _____, _____

2. D _____, _____

3. E _____, _____

4. F _____, _____

5. G _____, _____

6. H _____, _____

7. I _____, _____

8. J _____, _____

9. K _____, _____

10. L _____, _____

11. M _____, _____

12. N _____, _____

Directions: Answer the following about the coordinates above.

13. For B, which number is the *x*-coordinate? ____________

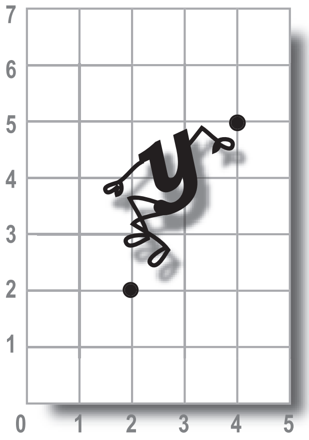
14. For C, which number is the *y*-coordinate? ____________

15. For D, which number is the *y*-coordinate? ____________

16. For E, which number is the *x*-coordinate? ____________

17. For F, which number is the *y*-coordinate? ____________

18. For G, which number is the *x*-coordinate? ____________



Directions: Circle the coordinate indicated in each of the following. The first one is done for you.

19. [✓ 3], 4 (the *x*-coordinate)

20. -2, 5 (the *y*-coordinate)

21. -7, -6 (the *y*-coordinate)

22. 8, -3 (the *y*-coordinate)

23. -3, 4 (the *x*-coordinate)

24. -9, -3 (the *x*-coordinate)

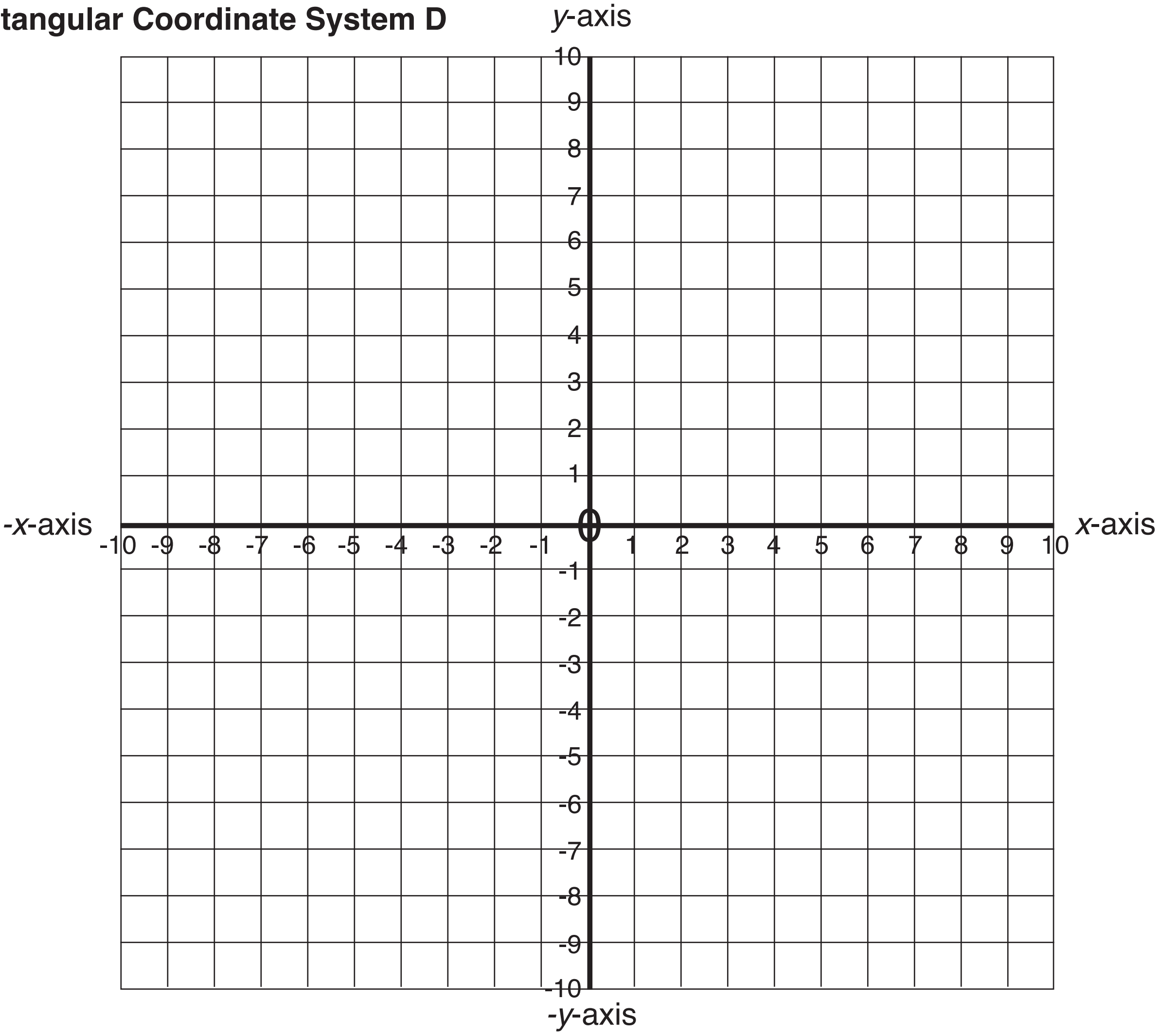
Name: ______________________ Date: ______________

Plotting the Point

For each set of coordinates there is exactly one point located on the rectangular coordinate system. Locating a point on the rectangular coordinate system is called **plotting the point**.

Directions: Use Rectangular Coordinate System D to plot the points below. Place a dot (•) on the graph to locate each point. Then place the letter representing that point next to each dot.

Rectangular Coordinate System D



Plot the point for each set of coordinates.

A.	3, 3	**E.**	1, 8	**I.**	6, -5	**M.**	0, -5
B.	-4, -5	**F.**	8, 1	**J.**	4, -3	**N.**	-5, 0
C.	-4, -2	**G.**	-1, -4	**K.**	-5, 5	**O.**	0, 0
D.	5, 7	**H.**	-5, 3	**L.**	1, 1	**P.**	7, -7

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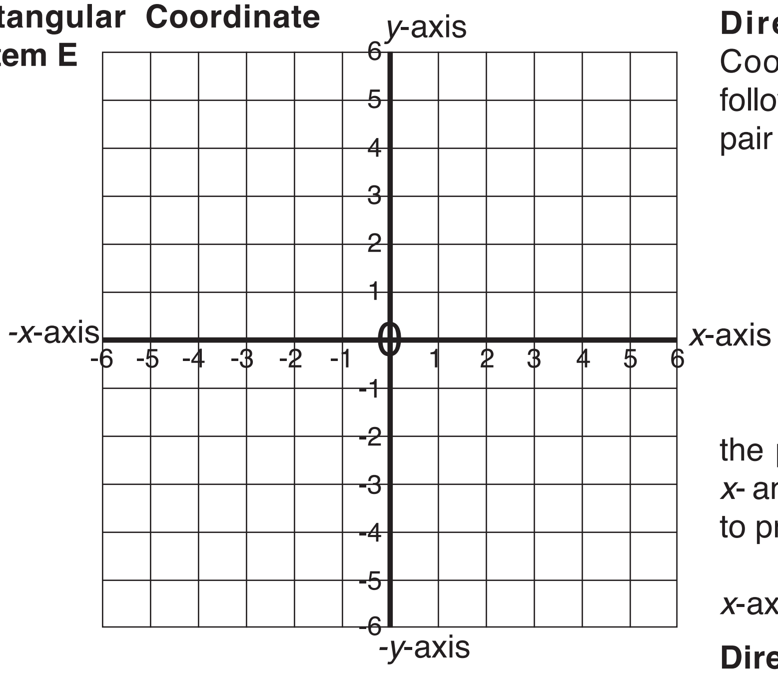
The Rectangular Coordinate System and Equations

The rectangular coordinate system is used to graph equations. When an equation is graphed, the results are visual. Graphing an equation is useful in finding the solutions (answers) to equations.

Learning to Graph Equations

In using the rectangular coordinate system to graph equations, the exact location of coordinates and accurately drawing lines to connect the coordinate points are important. The following exercises will develop the skills of locating coordinates and connecting the located points.

Rectangular Coordinate System E



Directions: Using Rectangular Coordinate System E, locate the following coordinates and connect each pair of coordinates with a straight line.

1. 2, 4; -3, -4

2. 4, 3; -1, -3

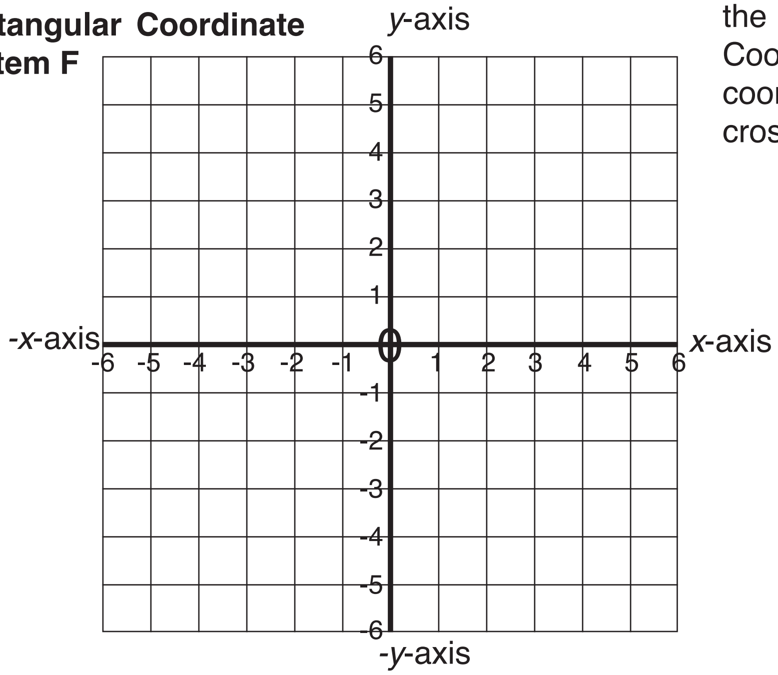
3. -3, 5; 4, -2

4. 3, 5; -4, -2

In graphing equations, locating the points where the line crosses the *x*- and *y*-axes is key in finding solutions to problems.

In **4.** above, the line crosses the *x*-axis at -2, 0 and the *y*-axis at 0, 2.

Rectangular Coordinate System F



Directions: Draw lines connecting the following points on Rectangular Coordinate System F, and write the coordinates locating where the lines cross the *x*- and *y*-axes.

1. 3, 4; -4, -3

Crosses the *x*-axis at ____, ____

Crosses the *y*-axis at ____, ____

2. -1, 6; 6, -1

Crosses the *x*-axis at ____, ____

Crosses the *y*-axis at ____, ____

3. 6, 3; 2, -3

Crosses the *x*-axis at ____, ____

Crosses the *y*-axis at ____, ____

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Linear Equations With Two Variables

You have learned that variables are the letters used in equations to represent numbers. The equation $x = y + 3$ can be used to demonstrate how variables are used in equations.

$x = y + 3$

If $x = 7$, then y must equal 4.
If $x = 10$, then y must equal 7.
If $x = 40$, then y must equal 37.
If $x = -4$, then y must equal -7.

In $x = y + 3$, the value of y depends on the value assigned to x. The variable is y, since it may have different values.

The equation $x = y + 3$ is a linear equation. **A linear equation will be a straight line when graphed on a rectangular coordinate system.**

Many linear equations will be in a form like $2x + y = 16$.

$2x + y = 16$

If $x = 4$, then y equals 8.
If $x = 3$, then y equals 10.
If $x = 7$, then y equals 2.

Directions: Solve the following (use the values for the variables indicated to solve each equation).

1. $x + y = 12$ What does y equal if $x =$ 3? _____ 4? _____ 9? _____

2. $2x + y = 20$ What does y equal if $x =$ 7? _____ 5? _____ 8? _____

3. $7 + x = y$ What does y equal if $x =$ 12? _____ 10? _____ 1? _____

4. $5x + y = 30$ What does y equal if $x =$ 10? _____ 8? _____ 7? _____

5. $3x + 2y = 12$ What does y equal if $x =$ 2? _____ 1? _____ 0? _____

6. $7 + 2y = x$ What does y equal if $x =$ 9? _____ 11? _____ 23? _____

7. $6x – 2 = y$ What does y equal if $x =$ 1? _____ 3? _____ -2? _____

8. $4x – 3 = y$ What does y equal if $x =$ -1? _____ -2? _____ -3? _____

Name: ______________________________ Date: ____________________

Plotting Points for Linear Equations

When plotting points for a linear equation on a rectangular coordinate system, a table of values should be developed. In making a table of values, you are finding the values that *x* and *y* might represent. A table of values for $x = y + 2$ is at the right.

	x	*y*	$x = y + 2$
1.	5	3	→ $5 = 3 + 2$
2.	4	2	→ $4 = 2 + 2$
3.	3	1	→ $3 = 1 + 2$
4.	-5	-7	→ $-5 = -7 + 2$
5.	2	0	→ $2 = 0 + 2$
6.	-1	-3	→ $-1 = -3 + 2$

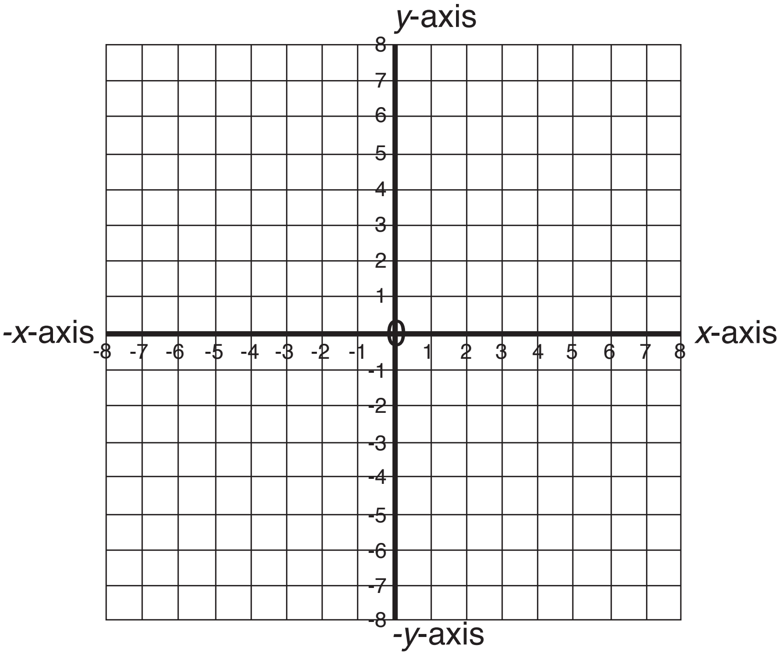
Directions: The *x* and *y* values become the coordinates for plotting the points on the rectangular coordinate system. Use the table above and write the coordinates for each point.

1. _____, _____ **2.** _____, _____ **3.** _____, _____

4. _____, _____ **5.** _____, _____ **6.** _____, _____

Directions: Plot the coordinates for the six points above on Rectangular Coordinate System G.

Rectangular Coordinate System G



Directions: Complete the following.

7. Draw a line connecting the points plotted on Rectangular Coordinate System G.

8. Write the coordinates locating where the line crosses the *x*-axis. _____, _____

9. Write the coordinates locating where the line crosses the *y*-axis. _____, _____

10. The line drawn on Rectangular Coordinate System G represents the linear equation

x = _____ + _____.

Name: ______________________ Date: ______________

Plotting Points for Linear Equations *(continued)*

Directions: Make a table of values for the following linear equations. Plot the coordinate points on Rectangular Coordinate System H. Then draw a line connecting the plotted points for each equation.

11. $y = 2x$

____ = 2 ____
____ = 2 ____
____ = 2 ____
____ = 2 ____

x	y

12. $2x + y = 8$

2 ____ + ____ = 8
2 ____ + ____ = 8
2 ____ + ____ = 8
2 ____ + ____ = 8

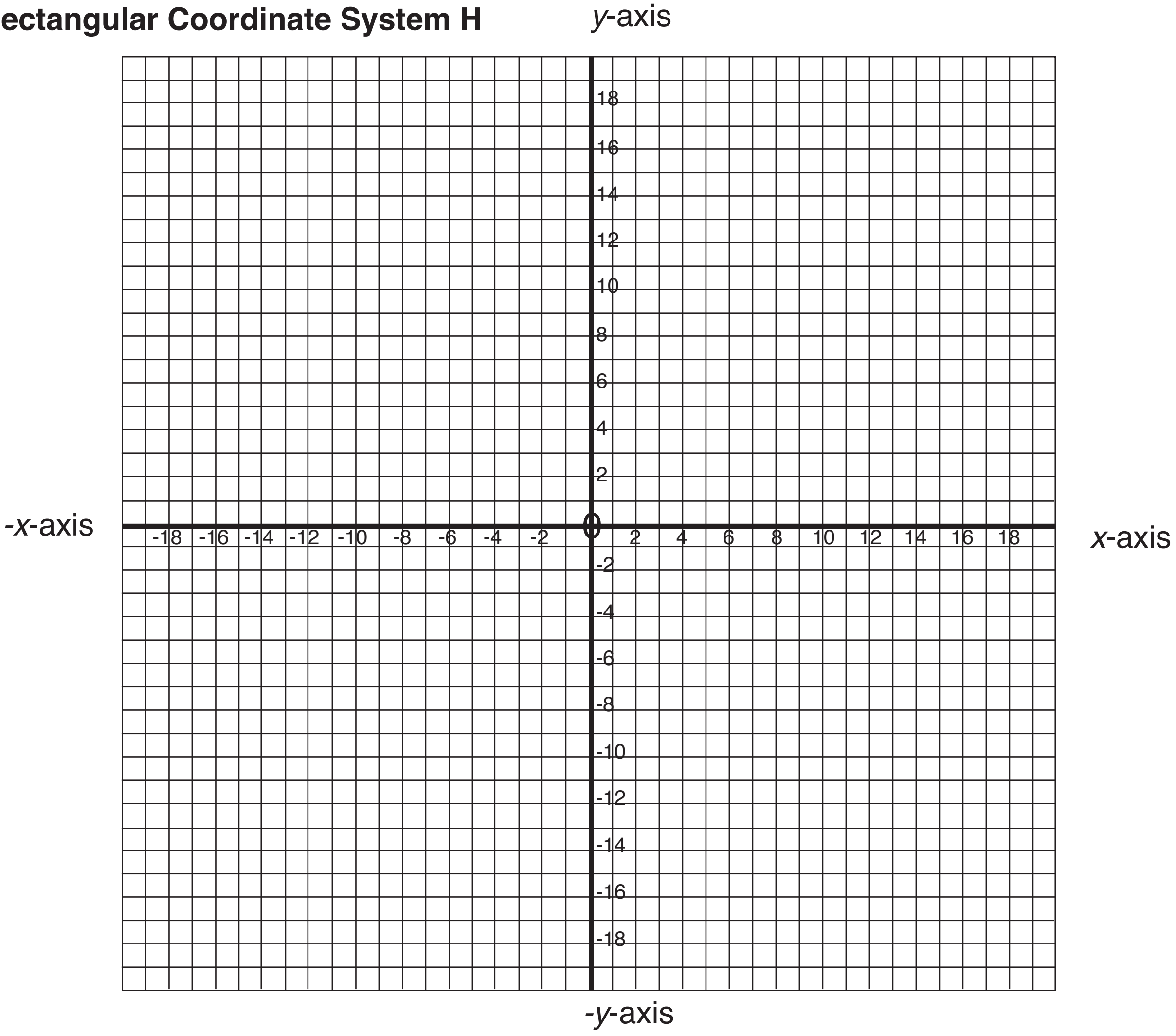
x	y

13. $3x + 1 = y$

3 ____ + 1 = ____
3 ____ + 1 = ____
3 ____ + 1 = ____
3 ____ + 1 = ____

x	y

Rectangular Coordinate System H



Name: ______________________________ Date: ____________________

Finding the Slope and y-Intercept of a Straight Line

Finding the slope of a linear equation and where the line **intercepts** (crosses) the y-axis are important in the study of algebra.

To find the slope and y-intercept of a linear equation, the equation must be written in the form $y = mx + b$.

The equation $2x - y = 8$ is not in the slope-intercept form. A linear equation is in the **slope-intercept form** when the equation is rewritten with y as one member of the equation.

$2x - y = 8$	Rewrite $2x - y = 8$ with y as one member of the equation.
$2x - y + y = 8 + y$	Add $+y$ to each member of the equation.
$2x = 8 + y$	
$2x - 8 = 8 - 8 + y$	Subtract 8 from each member of the equation.
$2x - 8 = y$	Rewrite the equation with y as the left member.
$y = 2x - 8$	The equation is now in the form $y = mx + b$.

Graph $y = 2x - 8$ on Rectangular Coordinate System I. The equation tells you that the slope, or m, is 2. The y-intercept, or b, is -8.

Step 1: Locate the (x, y) coordinates for $x = 0$.
$y = 2x - 8$ becomes $y = (2 \cdot 0) - 8$
The (x, y) coordinates are (0, -8).

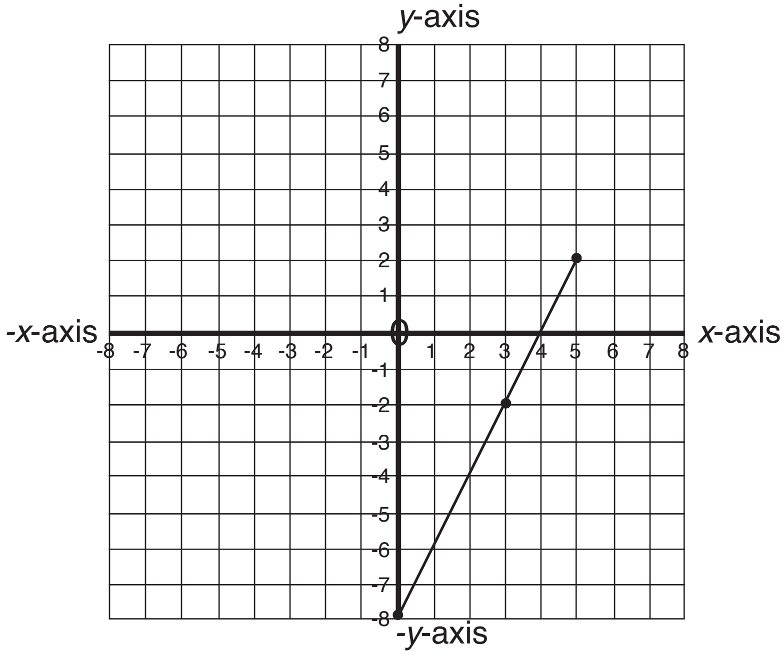
Step 2: Use a number for x other than 0, and find y.
Using 3 for x, $y = (2 \cdot 3) - 8$. $y = -2$
The (x, y) coordinates are (3, -2).

x	y		$y = 2x - 8$
0	-8	→	$-8 = (2 \cdot 0) - 8$
3	-2	→	$-2 = (2 \cdot 3) - 8$

Step 3: Plot the points on the graph, and draw a straight line from (0,-8) to (3, -2).

A number other than $x = 3$ could have been used in Step 2 to find the second (x, y) coordinates. For example, using $x = 5$, $y = (2 \cdot 5) - 8$. Then the (x, y) coordinates are (5, 2). A straight line could then be drawn from (0, -8) to (5, 2).

Rectangular Coordinate System I



Name: ______________________________ Date: ____________________

Finding the Slope and *y*-Intercept of a Straight Line *(continued)*

Determining the Slope and *y*-Intercept of $y = 2x - 8$.

The equation $y = 2x - 8$ is in the slope-intercept form $y = mx + b$.

Directions: Answer the following.

1. In the equation $y = mx + b$, the letter m is the coefficient of x. In the equation $y = 2x - 8$, the coefficient of x is the number ____________.
2. In the equation $y = mx + b$, the letter b locates the point where the graph crosses the y-axis. In the equation $y = 2x - 8$, the number ____________ replaces the letter b in the equation $y = mx + b$.
3. The line drawn to represent the linear equation $y = 2x - 8$ crosses the y-axis at the point ____________.

Remember, the slope and *y*-intercept of a line are found using the following steps.

Step 1. Rewrite the equation so y is a member by itself on one side of the equation.
Step 2. The coefficient for x is the slope of the line.
Step 3. The constant term b must be located using the coordinates $(0, b)$ on the y-axis. This is the point where the line intercepts (crosses) the y-axis.
Step 4. Use a number for x other than 0 in the equation to find a second set of (x, y) coordinates.
Step 5. Plot the points on the graph, and draw a straight line from $(0, b)$ to the second set of (x, y) coordinates.

Directions: Rewrite the following equations in the slope-intercept form $y = mx + b$.

4. $2y = 4x + 8$ Divide each side of the equation by 2, leaving y on one side.
$y =$ _____$x +$ _____
5. $4y = 8x + 4$ Divide each side of the equation by 4, leaving y on one side.
$y =$ _____$x +$ _____
6. $2y = x - 6$ Divide each side of the equation by 2, leaving y on one side.
$y =$ _____$x -$ _____

Directions: Find the *y*-intercept (the 0, *b* coordinate) for $y = mx + b$ in each of the following equations. Write as (x, y) coordinates.

7. $y = 2x + 4$ ________ 8. $y = 2x + 1$ ________ 9. $y = \frac{1}{2}x - 3$ ________

Answer Key

Number Systems (p. 1)
1. 1 2. 0 3. 0 4. negative
5. negative or minus 6. positive or plus
7. -4 8. +7 9. -60

The Integer Number System (p. 3)
1. +13 2. +2 3. -1 4. -4
5. +6 6. -6 7. -12
8. 5 9. 6, negative 10. 7, negative
11. 8, positive 12. negative 13. positive
14. -2 15. +40 16. -800 17. -6
18. +249 19. -2,101 20. +5,732

Number Properties (p. 4)
1. 10, 3 2. 10, 25 3. 360, 210
4. 20, 20 5. 65, 25
7. 35 + 64 = 64 + 35
8. 111 + 742 = 742 + 111
9. 37 + 94 = 94 + 37
10. 2,101 + 642 = 642 + 2,101
11. 10 + 18 = 18 + 10
12. 12 + 23 = 23 + 12

Whole Numbers (p. 5)
Teacher check number line.
1. 11 2. 11 3. 11 4. 11
5. 13 6. 13 7. 11 8. 11
9. 14 10. 14 11. sum

Commutative Property for Multiplication (p. 6)
1. 12 2. 12 3. 10 4. 10
5. 21 6. 21 7. 20 8. 20
9. 5 • 4 = 4 • 5
10. 12 • 6 = 6 • 12
11. 111 • 246 = 246 • 111
12. 1,074 • 917 = 917 • 1,074
13. 47 • 86 = 86 • 47
14. 3,440 15. 3,440 16. 616,000
17. 616,000 18. and 19. Answers will vary.
20. The answer to the second question is the same as the answer to the first. The order of the numbers multiplied does not change the product, so by rearranging the order, you can just write down the zeroes and continue with the rest of the problem.

Associative Property for Addition (p. 7)
1. 8 + 7 = 15 2. 13 + 2 = 15
3. 10 + 5 = 15 4. 9 + 7 = 16
5. 15 + 1 = 16 6. 10 + 6 = 16
7. 15 + 5 = 20 8. 12 + 8 = 20
9. 17 + 3 = 20 10. 10 + 13 = 23
11. 16 + 7 = 23 12. 17 + 6 = 23
The order of the numbers may vary. Possible order includes:
13. (9 + 1) + (8 + 4) = 22
14. (12 + 8) + (4 + 1) = 25
15. (14 + 6) + (3 + 9) = 32
16. (18 + 7) + (10 + 7) = 42
17. (25 + 5) + (16 + 4) = 50
18. (29 + 10) + (16 + 4) = 59
19. (61 + 9) + (14 + 6) = 90
20. (13 + 7) + (6 + 11) = 37

Associative Property for Multiplication (p. 8)
1. 18 • 4 = 72 2. 6 • 12 = 72
3. 3 • 24 = 72 4. 36 • 5 = 180
5. 9 • 20 = 180 6. 45 • 4 = 180
7. 24 • 6 = 144 8. 12 • 12 = 144
9. 72 • 2 = 144 10. 45 • 5 = 225
11. 15 • 15 = 225 12. 3 • 75 = 225
The order of the numbers may vary. Possible order includes:
13. (15 • 3) • (6 • 5) = 45 • 30 = 1,350
14. (5 • 2) • (12 • 8) = 10 • 96 = 960
15. (8 • 3) • (5 • 2) = 24 • 10 = 240
16. (14 • 8) • (5 • 4) = 112 • 20 = 2,240
17. (17 • 2) • (8 • 5) = 34 • 40 = 1,360
18. (3 • 24) • (5 • 2) = 72 • 10 = 720
19. (25 • 4) • (5 • 2) = 100 • 10 = 1,000
20. (3 • 6) • (10 • 11) = 18 • 110 = 1,980

Distributive Property of Multiplication Over Addition (p. 9)
1. 30 + 6, 6, 150 + 30 = 180
2. 40 + 2, 40, 2, 360 + 18 = 378
3. 80 + 8, 80, 8, 960 + 96 = 1,056
4. 30 + 5, 30, 5, 210 + 35 = 245
5. 70 + 8, 70, 8, 420 + 48 = 468
6. 40 + 8, 40, 8, 320 + 64 = 384
7. 200 + 68, 200, 68, 2,800 + 952 = 3,752
8. 100 + 60, 100, 60, 1,800 + 1,080 = 2,880
9. 30 + 8, 30, 8, 90 + 24 = 114
10. 70 + 9, 70, 9, 770 + 99 = 869

Properties of Subtraction and Division (p. 10)

1. = 2. = 3. = 4. ≠
5. ≠ 6. ≠ 7. ≠

Properties of Zero/Identity Elements (p. 11)

1. number 2. zero 3. one
4. A 5. B 6. C 7. A 8. B
9. B 10. B 11. B 12. C

Order of Operations (p. 12)

1. 20 + 6 = 26 2. 54 + 24 = 78
3. 32 + 14 = 46 4. 18 + 12 = 30
5. 20 – 6 = 14 6. 54 – 24 = 30
7. 32 – 14 = 18 8. 18 – 12 = 6
9. 24, 24 + 4 = 28 10. 2, 2 + 32, 34, 28
11. 24, 24 – 4 = 31 – 4 = 27
12. 30, 30 – 2, 28, 32 13. 20, 20 + 4, 24, 20

Addition of Integers (p. 13)

1. +11 2. -8 3. -4 4. +3
5. -6 6. -10 7. +8 8. +7

Addition of Integers: Exercises (p. 14)

Rule 1: When adding two integers with the same sign, add the numbers and place the sign of the numbers before the answer.

Rule 2: When adding two numbers with unlike signs, first find the difference between the two numbers. Then place the sign of the larger number before the answer.

1. +10 2. -7 3. +6 4. -5
5. +3 6. -261 7. +68 8. +101
9. -15 10. -65 11. -2 12. +17
13. +114 14. +95 15. -38 16. -58
17. +80 18. -123 19. -476 20. -71
21. +35 22. +297 23. -776 24. +152
25. -103

Subtraction of Integers: Rule/Exercises (p. 16)

1. -10, -10 2. -3, -3 3. -5, -5
4. +5, +5 5. +4, +4 6. +20, +20
7. -1, -1

Addition and Subtraction of Integers: Exercises (p. 17)

1. +8 2. +14 3. -11 4. -19
5. -3 6. +7 7. -4 8. +5
9. -76 10. -47 11. +23 12. -30
13. +3 14. -8 15. +1 16. -4
17. -9 18. -324

Multiplication of Integers (p. 18)

1. Rule 1 2. Rule 1 3. Rule 2 4. Rule 2
5. 8 6. -21 7. 30 8. 48
9. 72 10. 72 11. -40 12. 36
13. 88 14. -49 15. -25 16. -42
17. -144 18. 36 19. -286 20. 180

Division of Integers (p. 19)

1. 4 2. 5 3. -4 4. 8
5. -6 6. -16 7. -4 8. 4
9. -4 10. -15 11. -5 12. 9
13. 4 14. 4 15. 7 16. 6
17. 7 18. -27 19. -7 20. 11

Variables (p. 20)

Answers will vary according to the number chosen for each variable. Variables and constants are:

1. x, 5 2. y, 6 3. m, 9 4. t, 17
5. p, 25

Variables and Multiplication (p. 21)

1. 2, 3, a 2. 7, 4, a 3. 5, 9, n
4. 8, 7, b 5. 4, 12, p 6. 12, 10, x
7. 6, 15, x 8. 5, 20, y 9. 3, 14, t
10. 9, 8, w

Variables and Division/Variable Exercises (p. 22)

1. 7, 14, b 2. 4, 20, t 3. 3, 18, s
4. 6, 24, y 5. 9, 36, y 6. 3, 72, m
7. 11, 88, m 8. 7, 49, x 9. 14
10. 3 11. 4 12. 22 13. 4
14. 4 15. 21 16. 7 17. 18
18. 8 19. 9 20. 60

Exponents (p. 23)

1. base, exponent 2. base, exponent
3. exponent, base 4. base, exponent
5. exponent, base 6. multiplied
7. 4 8. 3 • 3 = 9 9. 2 • 2 • 2 = 8
10. 4 • 4 • 4 = 64 11. 5 • 5 = 25
12. 10 • 10 • 10 = 1,000 13. 8 • 8 • 8 = 512
14. 12 • 12 = 144
15. 5 • 5 • 5 • 5 = 625

Exponents: Maximum Power, Minimum Space (p. 24)

1. ^{2} 2. ^{3} 3. ^{2} 4. ^{4} 5. 9
6. 7 7. 2 8. 5^0 9. 2^1 10. 7^0

Exponents: Rules to Remember (p. 25)

1. 7 2. 1 3. 10 4. 4
5. ^{0} 6. ^{0} 7. ^{0} 8. ^{1}
9. 4 10. 27 11. 4 12. 25
13. -8 14. 16 15. 343 16. -64
17. -125 18. 100 19. -1,000 20. -1,024

Adding and Subtracting Exponents (p. 26)

2. $^{2+3} = 2^5 = 2 \cdot 2 \cdot 2 \cdot 2 \cdot 2 = 32$
3. $5^{2+4} = 5^6 = 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 \cdot 5 = 15{,}625$
4. $6^{1+2} = 6^3 = 6 \cdot 6 \cdot 6 = 216$
5. $2^{1+1} = 2^2 = 2 \cdot 2 = 4$
6. $10^{1+1} = 10^2 = 10 \cdot 10 = 100$
7. $7^{2+1} = 7^3 = 7 \cdot 7 \cdot 7 = 343$
8. $4^{2+0} = 4^2 = 4 \cdot 4 = 16$
9. $5^{0+1} = 5^1 = 5$
11. 4^{-2}
12. $\frac{2^5}{2^4} = 2^{5-4} = 2^1$ 13. $\frac{7^4}{7^6} = 7^{4-6} = 7^{-2}$
14. $\frac{6^5}{6^9} = 6^{5-9} = 6^{-4}$ 15. $\frac{9^3}{9^1} = 9^{3-1} = 9^2$

Multiplying Exponents (p. 27)

2. $^{3 \cdot 2}$, ^{6}, 64 3. $^{2 \cdot 2} = 3^4 = 81$
4. $5^{2 \cdot 2} = 5^4 = 625$ 5. $4^{2 \cdot 2} = 4^4 = 256$
6. $3^{1 \cdot 2} = 3^2 = 9$ 7. $6^{0 \cdot 2} = 6^0 = 1$
8. $2^{3 \cdot 3} = 2^9 = 512$ 9. $3^{3 \cdot 2} = 3^6 = 729$
10. $2^{2 \cdot 3} = 2^6 = 64$ 11. $4^{1 \cdot 2} = 4^2 = 16$
12. $10^{2 \cdot 2} = 10^4 = 10{,}000$

Zero and Negative Integer Exponents (p. 28)

1. 1 2. 5^2, 25 3. $\frac{1}{3^3}$, $\frac{1}{27}$ 4. 1
5. $\frac{1}{100}$ 6. $\frac{1}{100}$ 7. 1 8. 4
9. $\frac{1}{49}$ 10. 100 11. 16 12. 1
13. 64 14. 1,000 15. 1 16. $\frac{1}{8}$
17. $\frac{1}{25}$ 18. $\frac{1}{16}$ 19. $\frac{1}{9}$ 20. 6
21. 125 22. 47 23. 35 24. 17
25. 3 26. 6 27. 145 28. $3\frac{3}{4}$
29. $\frac{35}{72}$ 30. -72

Scientific Notation (p. 29)

2. $20 \cdot 1{,}000{,}000 = 20 \cdot 10^6$
3. $48 \cdot 1{,}000{,}000 = 48 \cdot 10^6$
4. $72 \cdot 1{,}000{,}000 = 72 \cdot 10^6$
5. $97 \cdot 1{,}000{,}000 = 97 \cdot 10^6$
6. $26 \cdot 1{,}000 = 26 \cdot 10^3$
7. $58 \cdot 1{,}000 = 58 \cdot 10^3$
8. $2 \cdot 1{,}000 = 2 \cdot 10^3$
9. $3 \cdot 100 = 3 \cdot 10^2$
10. $20 \cdot 1{,}000 = 20 \cdot 10^3$

Simplifying Large Numbers With Scientific Notation (p. 30)

1. 10^7, 10,000,000
2. $4.8 \cdot 10^7 = 4.8 \cdot 10{,}000{,}000$
3. $2.6 \cdot 10^7 = 2.6 \cdot 10{,}000{,}000$
4. $10^3 = 3.6 \cdot 1{,}000$
5. $3.6 \cdot 10^4 = 3.6 \cdot 10{,}000$
6. $10^3 = 5.5 \cdot 1{,}000$
7. $5.5 \cdot 10^4 = 5.5 \cdot 10{,}000$
8. $5.5 \cdot 10^7 = 5.5 \cdot 10{,}000{,}000$
9. $10^9 = 2.78 \cdot 1{,}000{,}000{,}000$
10. $6.09 \cdot 10^{11} = 6.09 \cdot 100{,}000{,}000{,}000$

Learning About Factoring (p. 31)

1. 1, 2, 4, 8 2. 1, 3, 9
3. 1, 2, 4, 8, 16 4. 1, 3, 5, 15

Learning About Prime Factors (p. 32)

1. 2, 2, 3 2. 2, 2, 2, 3
3. 2, 2, 2, 2, 2 4. 2, 2, 2, 2, 3
5. 2, 2, 2, 2, 2, 3 6. 2, 2, 2, 11
7. 2, 2, 59 8. 2, 2, 2, 2, 2, 2, 2, 2, 2

Finding Prime Factors (p. 33)

1. 2, 7 2. 2, 2, 13
3. 2, 3, 3, 5 4. 2, 3, 3, 7
5. 2, 3, 3, 19 6. 2, 2, 107
7. $2 \cdot 7$ 8. $2 \cdot 2 \cdot 13 = 52$
9. $2 \cdot 3 \cdot 3 \cdot 5$ 10. $2 \cdot 3 \cdot 3 \cdot 7 = 126$
11. $2 \cdot 3 \cdot 3 \cdot 19 = 342$ 12. $2 \cdot 2 \cdot 107 = 428$

Teacher check factor trees.

Finding the Greatest Common Factor (p. 35)

1. prime for 12: 2, 2, 3
   prime for 18: 2, 3, 3 GCF: $2 \cdot 3 = 6$
2. prime for 24: 2, 2, 2, 3
   prime for 12: 2, 2, 3 GCF: $2 \cdot 2 \cdot 3 = 12$
3. prime for 36: 2, 2, 3, 3
   prime for 54: 2, 3, 3, 3 GCF: $2 \cdot 3 \cdot 3 = 18$
4. prime for 18: 2, 3, 3
   prime for 30: 2, 3, 5 GCF: $2 \cdot 3 = 6$
5. prime for 18: 2, 3, 3
   prime for 27: 3, 3, 3 GCF: $3 \cdot 3 = 9$
6. prime for 56: 2, 2, 2, 7
   prime for 16: 2, 2, 2, 2 GCF: $2 \cdot 2 \cdot 2 = 8$
7. prime for 93: 3, 31
   prime for 69: 3, 23 GCF: 3
8. prime for 72: 2, 2, 2, 3, 3
   prime for 216: 2, 2, 2, 3, 3, 3
   GCF: $2 \cdot 2 \cdot 2 \cdot 3 \cdot 3 = 72$

Learning About the Least Common Multiple (p. 36)

1. 10, 15, 20, 25, 30, 35
14, 21, 28, 35, 42, 49 LCM = 35
2. 12, 18, 24, 30, 36
20, 30, 40, 50, 60 LCM = 30
3. 20 4. 42 5. 90 6. 75
7. 180 8. 42 9. 136 10. 132

Radicals and Roots (p. 37)

1. $\sqrt{\ }$ 2. radicand
3. square root of four 4. cube root of eight
5. fourth root of sixteen

Finding Square Roots (p. 38)

1. 2 2. 3 3. 4 4. 6 5. 7
6. 8 7. 10 8. 5 9. 9 10. 12
11. 2 12. 6 13. 10 14. 7
15. $\sqrt{9}$ 16. $\sqrt{64}$ 17. $\sqrt{81}$
18. $\sqrt{25}$ 19. $\sqrt{144}$ 20. $\sqrt{16}$

Adding Radicals (p. 39)

1. 10 2. (4 + 3), 7 3. (2 + 4 + 3), 9
4. $(10 + 8 + 2)\sqrt{3} = 20\sqrt{3}$
5. $(9 + 5)\sqrt{5} = 14\sqrt{5}$ 6. $23\sqrt{29}$
7. $25\sqrt{31}$ 8. (1 + 2), 3
9. (3 + 19 + 1), 23 10. $13\sqrt{7}$

Subtracting Radicals (p. 40)

1. 3, 5
2. $(14 - 7)\sqrt{11} = 7\sqrt{11}$
3. $(32 - 15)\sqrt{7} = 17\sqrt{7}$
4. $(5 - 2 - 1)\sqrt{31} = 2\sqrt{31}$
5. $(8 - 10)\sqrt{15} = -2\sqrt{15}$
6. $(7 - 11)\sqrt{3} = -4\sqrt{3}$
7. $(26 - 5 - 23)\sqrt{8} = -2\sqrt{8}$
8. $\sqrt{6}$
9. $5\sqrt{41}$
10. $(10 + 8 - 5)\sqrt{3} = 13\sqrt{3}$
11. $(27 - 13 + 2 - 8)\sqrt{5} = 8\sqrt{5}$
12. $(14 - 18 + 2)\sqrt{11} = -2\sqrt{11}$

Multiplying and Dividing Radicals (p. 41)

1. $\sqrt{9}$, 3 2. $\sqrt[4]{16}$, 2 3. $\sqrt{16}$, 4
4. $\sqrt{4}$, 2 5. $\sqrt{49}$, 7 6. $\sqrt{64}$, 8
7. $\sqrt[3]{27}$, 3 8. $\sqrt{36}$, 6 9. $\sqrt{25}$, 5
10. $\sqrt{100}$, 10 11. 2 12. 2
13. $\sqrt{9}$, 3 14. $\sqrt{25}$, 5 15. $\sqrt[5]{32}$, 2
16. $\sqrt{25}$, 5 17. $\sqrt[3]{27}$, 3 18. $\sqrt{4}$, 2
19. $\sqrt[4]{625}$, 5 20. $\sqrt{4}$, 2

Simplifying Radicals (p. 42)

1. $\sqrt{4 \cdot 3}$, $\sqrt{3}$, $\sqrt{3}$, $\sqrt{3}$
2. $\sqrt{9 \cdot 2}$, $\sqrt{2}$, $\sqrt{2}$, $3\sqrt{2}$
3. $\sqrt{4 \cdot 5}$, $\sqrt{4}$, $\sqrt{5}$, $2 \cdot \sqrt{5}$, $2\sqrt{5}$
4. $\sqrt{9 \cdot 3}$, $\sqrt{9}$, $\sqrt{3}$, $3 \cdot \sqrt{3}$, $3\sqrt{3}$
5. $\sqrt{4 \cdot 2}$, $\sqrt{4}$, $\sqrt{2}$, $2 \cdot \sqrt{2}$, $2\sqrt{2}$
6. $\sqrt{4 \cdot 6}$, $\sqrt{4}$, $\sqrt{6}$, $2 \cdot \sqrt{6}$, $2\sqrt{6}$
7. $\sqrt{4 \cdot 8}$, $\sqrt{4} \cdot \sqrt{8}$, $2 \cdot \sqrt{8}$, $2\sqrt{8}$
8. $\sqrt{25 \cdot 2}$, $\sqrt{25} \cdot \sqrt{2}$, $5 \cdot \sqrt{2}$, $5\sqrt{2}$
9. $\sqrt{16 \cdot 3}$, $\sqrt{16} \cdot \sqrt{3}$, $4 \cdot \sqrt{3}$, $4\sqrt{3}$
10. $\sqrt{9 \cdot 5}$, $\sqrt{9} \cdot \sqrt{5}$, $3 \cdot \sqrt{5}$, $3\sqrt{5}$
11. 4 12. 7 13. 6 14. 5
15. 3 16. 10 17. 12 18. 8

Multiplying and Simplifying Radicals (p. 43)

1. $\sqrt{45} = \sqrt{9} = 3 \cdot \sqrt{5} = 3\sqrt{5}$
2. $\sqrt{12} = \sqrt{4} = 2 \cdot \sqrt{3} = 2\sqrt{3}$
3. $\sqrt{18} = \sqrt{9} \cdot \sqrt{2} = 3 \cdot \sqrt{2} = 3\sqrt{2}$
4. $\sqrt{24} = \sqrt{4} \cdot \sqrt{6} = 2 \cdot \sqrt{6} = 2\sqrt{6}$
5. $\sqrt{28} = \sqrt{4} \cdot \sqrt{7} = 2 \cdot \sqrt{7} = 2\sqrt{7}$

Dividing and Simplifying Radicals (p. 43)

1. $\sqrt{8} = \sqrt{4} \cdot \sqrt{2} = 2 \cdot \sqrt{2} = 2\sqrt{2}$
2. $\sqrt{12} = \sqrt{4} \cdot \sqrt{3} = 2 \cdot \sqrt{3} = 2\sqrt{3}$
3. $\sqrt{32} = \sqrt{4} \cdot \sqrt{8} = 2 \cdot \sqrt{8} = 2\sqrt{8}$ or
$\sqrt{16} \cdot \sqrt{2} = 4 \cdot \sqrt{2} = 4\sqrt{2}$
4. $\sqrt{28} = \sqrt{4} \cdot \sqrt{7} = 2 \cdot \sqrt{7} = 2\sqrt{7}$

Finding the Value of the Unknown—I (p. 45)

2. 10, 10, 0, 11, $x = 11$, Check: 11
3. 17, 17, 0, 11, $v = 11$, Check: 11
4. $t = 8$ 5. $w = 6$ 6. $b = 17$
7. $n = 29$ 8. $y = 13$ 9. $x = 24$
10. $y = 24$ 11. $z = 18$ 12. $x = 49$
13. $n + 12 = 26$

Finding the Value of the Unknown—II (p. 46)

1. 3, 3, 0, 21, $y = 21$, Check: 21
2. 5, 5, 0, 25, $x = 25$, Check: 25
3. $b = 19$ 4. $t = 12$ 5. $w = 14$
6. $v = 4$ 7. $y = 3$ 8. $x = 13$
9. $x = 9$ 10. $t = -4$ 11. $y = 18$

Reviewing Simple Equations (p. 47)

1. mathematical, two 2. $x + 4$, 9
3. subtract
4. **a.** Choose any letter **b.** 38
c. $n - 38$ **d.** 64¢
5. $n - 6 = 12$ or $12 + 6 = n$; $n = 18$

Solving Equations With Multiplication (p. 48)

1. $x = 2$, 2 2. 14, 14, $x = 2$, 2
3. 8, 8, $x = 3$, 3
4. 5 5. 3 6. 8 7. 2
8. 2 9. 4 10. 11 11. 12
12. 8 13. 4 14. 14 15. 10

Solving Equations With Division (p. 49–50)

1. 4, 4, $y = 24$, 24, 6
2. 2, 2, $x = 14$, 14, 7
3. 5, 5, $t = 30$, Check: 30, 6
4. 8, 8, $w = 32$, Check: 32, 4 = 4
5. 9, 9, $p = 72$, Check: 72, 8 = 8
6. 3, 3, $x = 36$, Check: 36, 12 = 12
7. 12, 12, $y = 144$, Check: 144, 12 = 12
8. 16, 16, $c = 64$; Check: 64, 4 = 4
9. 2, 2, $x = 64$, Check: 64, 32 = 32
10. 3, 3, $y = 21$, Check: 21, 7 = 7

Ratios (p. 51)

1. 3 to 7 2. 2 to 9 3. 5 to 6
4. 4 to 7 5. 8 to 11 6. 2:3
7. 2:10 8. 1:5 9. 12:17
10. 9:13 11. $\frac{5}{12}$, 5 to 12, 5:12
12. $\frac{7}{12}$, 7 to 12, 7:12 13. $\frac{10}{5}$, 10 to 5, 10:5
14. $\frac{6}{4}$, 6 to 4, 6:4 15. $\frac{9}{11}$, 9 to 11, 9:11

Proportions (p. 52)

2. 5:3::10:6; 5 • 6 as 3 • 10
3. 1:3::3:9; 1 • 9 as 3 • 3
4. 3:5::9:15; 3 • 15 as 5 • 9
5. 2:3::4:6; 2 • 6 as 3 • 4
6. 5:7::10:14; 5 • 14 as 7 • 10
7. 3:8::6:16; 3 • 16 as 8 • 6
8. 9:1::27:3; 9 • 3 as 1 • 27

Cross Product Exercises (p. 53)

2. $2 \cdot 6 = 12$, $12 = 3x$, $\frac{12}{3} = \frac{3x}{3}$, $x = 4$
$3 \cdot x = 3x$
3. $1 \cdot 8 = 8$, $8 = 4x$, $\frac{8}{4} = \frac{4x}{4}$, $x = 2$
$4 \cdot x = 4x$
4. $1 \cdot 9 = 9$, $9 = 3x$, $\frac{9}{3} = \frac{3x}{3}$, $x = 3$
$3 \cdot x = 3x$
5. $5 \cdot 12 = 60$, $60 = 6x$, $\frac{60}{6} = \frac{6x}{6}$, $x = 10$
$6 \cdot x = 6x$
6. $1 \cdot 27 = 27$, $27 = 9x$, $\frac{27}{9} = \frac{9x}{9}$, $x = 3$
$9 \cdot x = 9x$

Finding the Mean (p. 54)

Step 2. 12, 14, 14, 16, 16, 18, 20, 40, 150
Step 3. 150 ÷ 8 = 18.75
Step 4. Mean = 18.75

1. 17; 2.8 2. 49; 7 3. 121; 15.1
4. 359; 59.8 5. 261; 32.6 6. 1,073; 178.8

Finding the Mode (p. 55)

Step 1. 12, 14, 14, 16, 16, 16, 18, 20, 40
Step 2. Mode = 16

1. 8 2. 12 3. 77
4. 31 5. 200 6. 11

Finding the Median (p. 56)

Step 1. 20, 24, 27, 30, 35, 38, 40, 42, 45
Step 3. Median = 35

1. 7 2. 57 3. 32
4. 187 5. 6 6. 8.5
7. 18.5

Probability (p. 57)

1. 1; 2 2. 1; 5 3. 1, 4
4. 3, 10 5. 2, 50 6. 1, 100

Probability Exercises (p. 58)

1. 3 2. 1 3. b 4. c 5. b
6. a 7. d 8. b 9. d

Probability Prediction (p. 59)

1. d 2. a 3. a 4. d
5. b 6. d 7. b 8. c

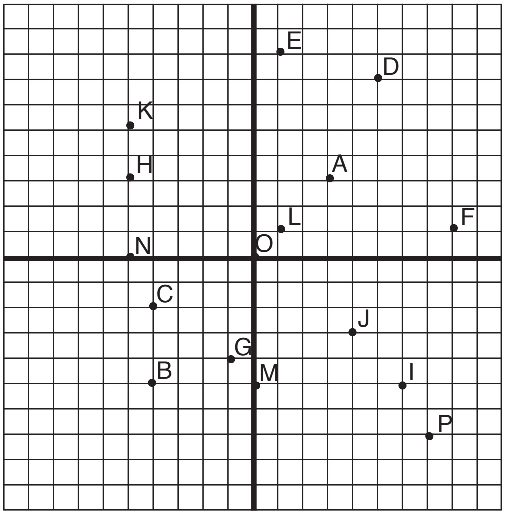
Learning About the Rectangular Coordinate System (p. 60)

1. 2, *x*-axis, positive **2.** -4, *x*-axis, negative
3. -2, *y*-axis, negative **4.** 4, *y*-axis, positive

Learning About Coordinates (p. 62)

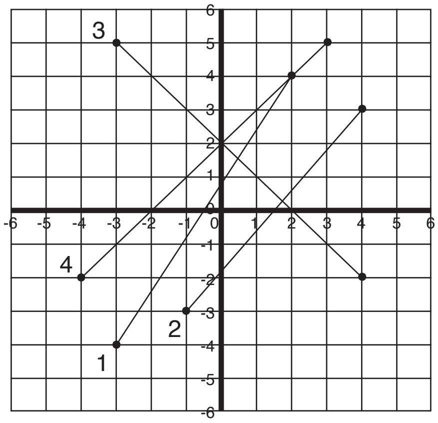
1. -2, 3 **2.** 2, -1 **3.** -2, -6 **4.** 5, 9
5. -6, 6 **6.** -7, 2 **7.** -7, -6 **8.** 5, -6
9. 7, -3 **10.** 2, -7 **11.** 3, -4 **12.** -8, -3
13. -5 **14.** 3 **15.** -1 **16.** -2
17. 9 **18.** -6 **20.** 5 **21.** -6
22. -3 **23.** -3 **24.** -9

Plotting the Point (p. 63)

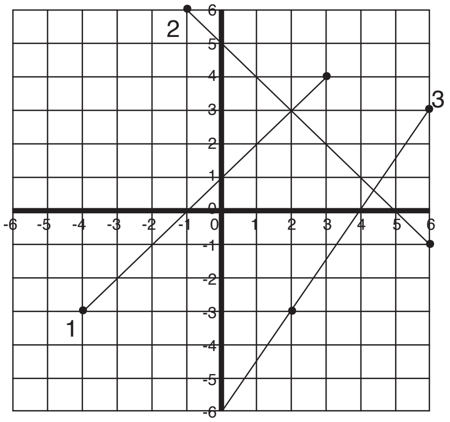


The Rectangular Coordinate System and Equations (p. 64)

Rectangular Coordinate System E



Rectangular Coordinate System F



1. -1, 0; 0, 1 **2.** 5, 0; 0, 5 **3.** 4, 0; 0, -6

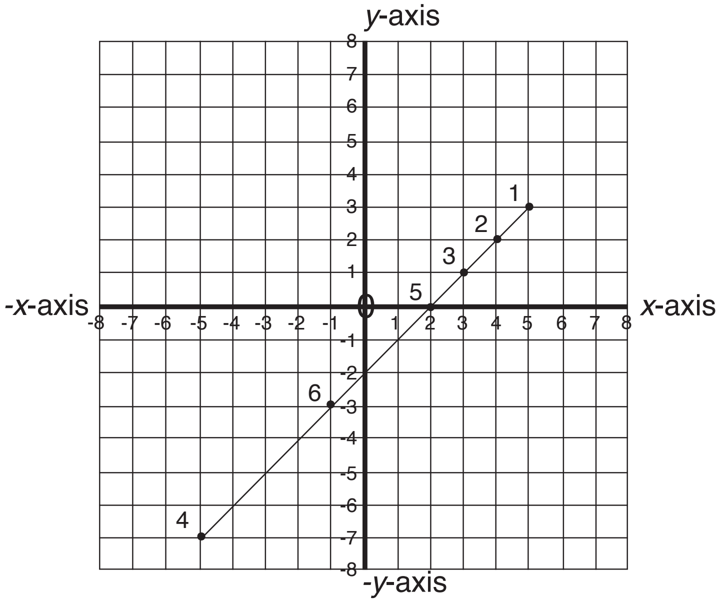
Linear Equations With Two Variables (p. 65)

1. 9, 8, 3 **2.** 6, 10, 4 **3.** 19, 17, 8
4. -20, -10, -5 **5.** 3, 4.5, 6 **6.** 1, 2, 8
7. 4, 16, -14 **8.** -7, -11, -15

Plotting Points for Linear Equations (p. 66–67)

1. 5, 3 **2.** 4, 2 **3.** 3, 1
4. -5, -7 **5.** 2, 0 **6.** -1, -3

Rectangular Coordinate System G



8. 2, 0 **9.** 0, -2 **10.** $x = y + 2$
11.–13. Plotted points will vary. Teacher check points and graph.

Finding the Slope and *y*-Intercept of a Straight Line (p. 69)

1. 2
2. -8
3. 0, -8
4. $y = 2x + 4$
5. $y = 2x + 1$
6. $y = \frac{1}{2}x - 3$ or $y = \frac{x}{2} - 3$
7. (0, 4)
8. (0, 1)
9. (0, -3)

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