

# Ivy Global

# SSAT MATH

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### Version 1.3

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# BASIC STRATEGIES

## SECTION 2

Use this section to review some of the best test-taking strategies for the SSAT Math section. As you practice, keep in mind that not all problems are solved in the same manner. As a student with your own unique learning style, you may also find that some strategies work better for you than others. Try out all of the methods below, and identify the strategies that work best for you.

Most of the math questions on the SSAT are word problems, so your job is to find a way to convert the wording of these questions into math concepts that you can recognize and solve. When you first encounter a problem, use the following steps to get started.

### **READ THE QUESTION CAREFULLY**

Read through the whole question. Don't assume you understand the question just by reading the first few words! Reading the whole question will help you avoid making assumptions that can lead to careless errors.

If you see unfamiliar or difficult-looking material, stay calm and keep reading until the end of the question. There might be more information in the question that will help you figure out the solution. If you still think a question is too difficult after you have finished reading the whole thing, then you should circle it in your question booklet, skip it, and come back to it if you have time. Don't get anxious that you couldn't solve a question; not every student is expected to answer every question, and some questions might be beyond your grade level.

Here is a simple example that we will work through to demonstrate these basic test-taking strategies. Read the whole question carefully:

A triangle has three sides with lengths 3, 4, and 5. What is the perimeter of the triangle?

- (A) 3
- (B) 7
- (C) 9
- (D) 12
- (E) 15

## UNDERLINE KEY WORDS

Underline or circle any information given in the question that will help you solve it. Our example question should now look something like this:

A triangle has three sides with lengths 3, 4, and 5. What is the perimeter of the triangle?

## IDENTIFY WHAT THE QUESTION IS ASKING

Ask yourself, “What is the question asking me to solve?” This is especially important for word problems. Sometimes the wording of a question can be confusing, so make it simpler for yourself and summarize in your own words what the question is asking for.

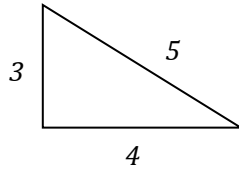
In our example question, you are being asked to find the perimeter of the triangle. This was one of the words we underlined in the question. To remind yourself that this is what the question is asking, you might want to underline this word again:

A triangle has three sides with lengths 3, 4, and 5. What is the perimeter of the triangle?

How would you explain the “perimeter,” in your own words? You might remember that the perimeter is the length of the outline of the triangle.

## DRAW A CHART OR DIAGRAM

Charts and diagrams are great tools to help you visualize the problem and organize your information. In our example question, you might try drawing a quick sketch of a triangle. Then, fill in any information you are given in the question. You can write in the lengths of all three sides:



## COME UP WITH A STRATEGY

Strategize the best way to solve the question. Sometimes finding the answer requires some thought if there are multiple steps involved. Think about all of the information provided in the question and how it is related. Think about where you have seen this type of question before, and what methods you have used to solve similar types of questions. If there is a formula that you know that could help, write it down.

Here's a strategy we could use to solve our example question.

- *We know:* the lengths of the sides of the triangle are 3, 4, and 5.
- *We want:* the perimeter, which is the length of the outline of the triangle.
- *Our strategy:* add up the lengths of all three sides of the triangle.

$$\text{perimeter} = 3 + 4 + 5 = 12$$

Is our solution one of the answer choices? It is indeed! The answer is (D) 12.

## CHECK YOUR ANSWER

Always check your work to make sure that you picked the best answer among all of the options the SSAT gave you! Double-check all of your arithmetic to make sure that you didn't make any careless errors.

Make sure that you solved for what the question was asking. For example, if the question asked to solve for perimeter, make sure you didn't solve for area.

Try to determine whether or not your answer seems reasonable based on context. For example, if the length of one side of the triangle is 3, the perimeter cannot be 3, so answer (A) in our example is unreasonable.

Finally, check that you bubbled in the answer on your answer sheet correctly. It would be a shame to have solved the question correctly and not get credit!

## PUTTING IT ALL TOGETHER

Here is another example question that is a bit more complicated. Use the same question-solving steps to try it out.

### 1. Read the question:

The width of a rectangular field is one-quarter its length. If the length is 16, what is the perimeter of the field?

- (A) 4
- (B) 24
- (C) 36
- (D) 40
- (E) 64

### 2. Underline key words:

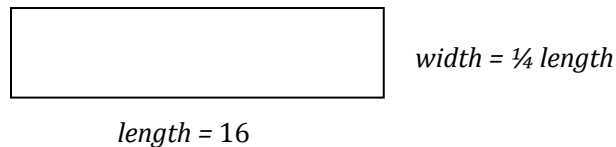
The width of a rectangular field is one-quarter its length. If the length is 16, what is the perimeter of the field?

### 3. Ask yourself, "What is the question asking me to solve?"

Just like our first example, you are being asked to find the perimeter of the rectangle. Put this in your own words: the perimeter is the length of the outline of the rectangle.

### 4. Draw a diagram.

Try drawing a quick sketch of a rectangle and fill in any information given in the question:



### 5. Strategize a solution.

*We know:* length = 16

$$\text{width} = \frac{1}{4} \text{ of length} = \frac{1}{4} \text{ of } 16 = \frac{1}{4} \times 16 = \frac{16}{4} = 4$$

*We want:* the perimeter of the whole rectangle.

*Our strategy:* we can use a formula that relates a rectangle's perimeter to its length and width.

$$perimeter = (2 \times length) + (2 \times width)$$

We can now plug in the values and solve:

$$perimeter = (2 \times 16) + (2 \times 4) = 32 + 8 = 40.$$

If you did not remember this formula, look at the diagram again. To find the perimeter, we need to add up the lengths of the four sides of the rectangle. Our sides include two lengths and two widths, so here's how we would add them up:

$$perimeter = 16 + 4 + 16 + 4 = 40$$

There are often many different ways to solve a problem, so think creatively to find a strategy that works for you!



# IF YOU GET STUCK

## SECTION 3

If you are having trouble solving a problem mathematically, here are a few useful strategies. Try to use these strategies while doing practice exams so that you become familiar with them.

### PROCESS OF ELIMINATION

It is worthwhile to guess on a question if you can eliminate any answer options that you know are wrong. So how do you eliminate wrong answers? Read the question and the answer choices, and determine whether any of them seem unreasonable. For example:

Which of the following fractions is less than  $\frac{1}{3}$ ?

- (A)  $\frac{4}{18}$
- (B)  $\frac{4}{12}$
- (C)  $\frac{3}{3}$
- (D)  $\frac{12}{9}$
- (E)  $\frac{12}{4}$

Even if you forget how to solve the question above, you can eliminate wrong answers. You know that  $\frac{1}{3}$  is less than 1. Remember that an “improper fraction” has a numerator that is greater than its denominator, and any improper fraction is greater than 1. Because answers (D) and (E) are both improper fractions, they must be greater than 1, so they can’t be less than  $\frac{1}{3}$ . You can eliminate both of those choices right away.

You might also remember that a fraction with the same numerator and denominator is always equal to 1. Answer (C) has the same numerator and denominator, so it must be equal to 1 and can’t be less than  $\frac{1}{3}$ . You can also eliminate answer (C).

If you don’t know how to proceed with the arithmetic, you can guess between (A) and (B) and you will have pretty good odds of getting the correct answer. Or, you can look at answer (B) and reduce  $\frac{4}{12}$  to  $\frac{1}{3}$ . Because the question is asking for a fraction that is less than  $\frac{1}{3}$ , (B) can’t be the correct answer. You are left with only one possible answer: (A).

## GUESS AND CHECK

Sometimes you can narrow your choices down to one based on what seems reasonable, and then check to see if this is actually the correct answer. This is often true with geometry questions or problems where a diagram is given. For example:

Julia arrived at Jenny's house at 6:35 PM. Her mother picked her up at 8:04 PM. How long did Julia spend at Jenny's house?

- (A) 29 minutes
- (B) 1 hour, 9 minutes
- (C) 1 hour, 29 minutes
- (D) 2 hours, 9 minutes
- (E) 2 hours, 29 minutes

We can guess an answer for this question by rounding the times. 6:35 PM is approximately 6:30 PM and 8:04 PM is approximately 8:00 PM. The time between 6:30 to 7:00 is half an hour, and the time from 7:00 to 8:00 is another hour. Therefore, the time between 6:30 to 8:00 is about an hour and a half.

Looking at the answer choices, this is very close to (C) 1 hour, 29 minutes, so you can guess that this is the right answer. If you're running out of time, you might want to circle (C) as your best guess and move on.

In order to check that (C) is actually the right answer, subtract 6:35 PM from 8:04 PM:

$$\begin{array}{r} 8:04 \\ -6:35 \\ \hline \end{array}$$

8 hours and 4 minutes is the same as 7 hours and 64 minutes. Use borrowing and re-write 8:04 as 7:64 so you can subtract properly:

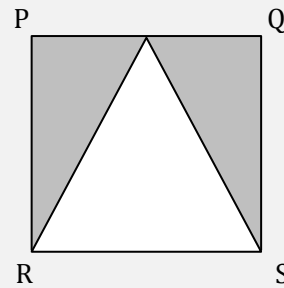
$$\begin{array}{r} 7:64 \\ -6:35 \\ \hline 1:29 \end{array}$$

Our estimation by rounding was close to the actual answer, and our guess was correct.

Now, try the guess-and-check method for a more challenging question:

Figure PQRS (drawn to scale) is a square with side length of 12. What is the area of the shaded region?

- (A) 50
- (B) 72
- (C) 100
- (D) 120
- (E) It cannot be determined from the information given.



Because PQRS is a square, its area is  $12 \times 12 = 144$ . We're told that the diagram is drawn to scale, and it looks like that the shaded area is approximately half of the area of the square. Based on this estimate, let's see if we can eliminate any answers that seem unreasonable. Answer (D) is too large, and so is (C). (A) seems too small because 50 is about  $1/3$  of 144. (B) seems about right, so we can circle (B) as our best guess.

Now we can check to see if (B) is actually correct. The area of the unshaded triangle is  $1/2 \times \text{base} \times \text{height} = 1/2 (12)(12) = 1/2 (144) = 72$ . Subtract this from the area of the square to find the shaded area:  $144 - 72 = 72$ .

Our initial estimate was exactly right! If you were short on time and didn't have time to check all of the calculations for this problem, you would have been correct with this guess.

## PICKING NUMBERS

Sometimes an algebra question may seem difficult or abstract because it contains a lot of variables—those letters or symbols that stand for numbers. The quickest way to solve these questions is to simplify the algebra. However, you can also make any question more concrete by picking an easy number to work with and plugging in this number instead of a variable.

The “picking numbers” method is typically used to solve questions whose answer choices are algebraic expressions. For example, you might be asked to state someone's age or height “in terms of” variables, remainders, percentages, or fractions of variables. You might also be asked to determine whether an expression or variable is even or odd. Both of these situations are excellent times to use the “picking numbers” method. For example:

Michelle is 3 years older than Tommy. If Tommy is  $t$  years old, then how old is Michelle, in terms of  $t$ ?

- (A)  $t + 3$
- (B)  $t - 3$
- (C)  $3t$
- (D)  $t \div 3$
- (E)  $3 - t$

This example has variables in the answer choices, so we can use the “picking numbers” method. Pick an age for Tommy to replace  $t$ . Let’s pick 10. (You could have chosen any number.) If Tommy is 10 years old, Michelle is 3 years older than Tommy, so Michelle is  $10 + 3 = 13$  years old. The next step is to replace  $t$  with Tommy’s age (10) in each of the answer choices:

- (A)  $10 + 3 = 13$
- (B)  $10 - 3 = 7$
- (C)  $3 \times 10 = 30$
- (D)  $10 \div 3 = 3\frac{1}{3}$
- (E)  $3 - 10 = -7$

If Tommy is 10 years old, we’ve already determined that Michelle must be 13 years old. Therefore, answer (A) is correct.

Let’s try another slightly more challenging example:

Nathan is three inches taller than Joseph, who is five inches shorter than Ethan. If  $e$  represents Ethan’s height in inches, then how many inches tall is Nathan, in terms of  $e$ ?

- (A)  $e + 6$
- (B)  $e + 4$
- (C)  $e + 2$
- (D)  $e$
- (E)  $e - 2$

This example has variables in the answer choices, so we can apply the “picking numbers” method. Let’s say that Ethan is 50 inches tall, so  $e = 50$ . (You can choose any number and this method will still work. Try it!) If Ethan is 50 inches tall, we know that Joseph is five inches shorter, so Joseph is  $50 - 5 = 45$  inches tall. Nathan is three inches taller than Joseph, so he is  $45 + 3 = 48$  inches tall.

The question is asking for Nathan’s height in terms of  $e$ . The next step is to replace  $e$  with Ethan’s height (50) into each of the answer choices, and figure out which one matches Nathan’s height (48):

- (A)  $50 + 6 = 56$
- (B)  $50 + 4 = 54$
- (C)  $50 + 2 = 52$
- (D) 50
- (E)  $50 - 2 = 48$

We know that Nathan’s height is 48 inches when Ethan’s height is 50 inches, so answer (E) is correct.

## BACK-SOLVING

Back-solving is a method that allows you to work backwards from the multiple-choice answers you are given. Unlike the “picking numbers” method, you can only use back-solving if your answer choices don’t include variables. When your answer choices are numbers, you can expect them to be given in order from largest to smallest or smallest to largest. Take the middle answer (C) and plug it into your problem. If it works, it is right. If not, you can usually determine whether to try a larger or smaller answer. For example:

Two consecutive numbers have a sum of 13. What is the smaller of the two numbers?

- (A) 5
- (B) 6
- (C) 7
- (D) 8
- (E) 9

Start with answer choice (C). If 7 is the smaller number, then the two consecutive numbers are 7 and 8, which have a sum of 15. The correct numbers must add up to 13, so we’re looking for a starting number that is smaller. We’ll try (B) next. If 6 is the smaller of the 2 numbers, then the two numbers are 6 and 7, which have a sum of 13! (B) is the right answer.

If (B) gave us a sum that was still larger than 13, we would have known that (A) was correct. If we started with answer (C) and it gave us a sum that was less than 13, our next step would have been to try answer (D).

Here’s another more challenging example:

Four consecutive multiples of 5 have a sum of 90. What is the greatest of these four numbers?

- (A) 10
- (B) 15
- (C) 20
- (D) 30
- (E) 40

Start with answer (C). If 20 is the greatest of the four numbers, we need to find the next three multiples of 5 that are smaller than 20. These are 15, 10, and 5, so our four numbers would be 20, 15, 10, and 5. However, the sum of these four numbers is  $20 + 15 + 10 + 5 = 50$ . The correct numbers must add up to 90, so we know (C) is incorrect.

Because 90 is greater than 50, we know that the greatest of the four numbers must be larger than 20. Therefore, we'll try answer (D) next. If 30 is the greatest of the four numbers, then the numbers are 30, 25, 20, and 15. The sum of these four numbers is  $30 + 25 + 20 + 15 = 90$ . (D) is correct.

If (D) gave us a sum that was less than 90, we would have known that (E) was the correct answer. If answer (C) gave us a sum that was greater than 90, we would have then tried answer (B).

# NUMBERS AND OPERATIONS

## SECTION 1

Look over the definitions of the number properties in the table below. In this section, we will explore what these definitions mean and how to use them.

NUMBER PROPERTIES		
Word	Definition	Examples
Integer	Any negative or positive whole number	-3, 0, 5, 400
Positive	Greater than zero	2, 7, 23, 400
Negative	Less than zero	-2, -7, -23, -400
Even	Divisible by two	4, 18, 2002, 0
Odd	Not evenly divisible by two	3, 7, 15, 2001
Factor	An integer that evenly divides into a number	3 and 4 are factors of 12.
Multiple	The result of multiplying a number by an integer	36 and 48 are multiples of 12.
Prime	Only divisible by itself and 1	3, 5, 7, 11, 19, 23
Composite	Divisible by numbers other than itself and 1	4, 12, 15, 20, 21
Consecutive	Whole numbers that follow each other in order	2, 3, 4, 5, 6 ...

## INTEGERS

An **integer** is any positive or negative whole number. Fractions and decimals are not integers. **Zero** is an integer, but is neither positive nor negative.

## OPERATIONS

An **operation** is a fancy name for a process that changes one number into another. The most common operations are addition, subtraction, multiplication, and division. Know the following vocabulary related to operations:

OPERATIONS		
Word	Definition	Examples
Sum	The result of adding numbers	The sum of 3 and 4 is 7.
Difference	The result of subtracting numbers	The difference between 5 and 2 is 3.
Product	The result of multiplying numbers	The product of 6 and 4 is 24.
Quotient	The result of dividing numbers	The quotient when 40 is divided by 5 is 8.
Remainder	The amount left over when a number cannot be evenly divided by another number	When 11 is divided by 2, the result is 5 with a remainder of 1.

Students are not allowed to use a calculator on the SSAT. As a result, you will need to be able to solve arithmetic calculations quickly and accurately on paper. In order to make sure that you have mastered all of the basics of long addition, subtraction, multiplication, and division, look through the review below and try the drills that follow.

## ADDITION

To add large numbers, break up the question into parts based on the **place** of the digits. Each digit in a number has a place value, as shown in the following chart. For a more complete chart including place values with decimals, see Section 5.



thousands	hundreds	tens	ones
5	4	1	2

For the number 5,412 above, 5 is in the thousands place, 4 is in the hundreds place, 1 is in the tens place, and 2 is in the ones place.

Use your knowledge of place values to add large numbers by hand. For example, if you had the question:

$$\begin{array}{r} 32 \\ + 14 \\ \hline \end{array}$$

First add the ones place digits together, and then add the “tens place” digits together. 2 and 4 are both in the ones place, and  $2 + 4 = 6$ . 3 and 1 are both in the tens place, and  $3 + 1 = 4$ . Therefore, your answer will be:

$$\begin{array}{r} 32 \\ + 14 \\ \hline 46 \end{array}$$

Always start from the rightmost column and move to the left when you are adding.

Recall that sometimes you will need to use **carrying** in addition problems. For example, look at the following problem:

$$\begin{array}{r} 45 \\ + 17 \\ \hline \end{array}$$

Your ones place digits are going to add up to a double-digit number:  $5 + 7 = 12$ .

If you have a double digit number when you add two numbers together in a column, you will need to use carrying. In this case, you will take the ones digit from 12, which is 2, and place it under the ones digit column. Then you will “carry” the tens digit, which is 1, over the top of the tens digit column.

$$\begin{array}{r}
 1 \leftarrow \\
 45 \\
 + 17 \\
 \hline
 2
 \end{array}$$

Finally, you will add together all of the digits in the tens column, including the 1 that you carried over.  $1 + 4 + 1 = 6$ , so your answer will be:

$$\begin{array}{r}
 1 \\
 45 \\
 + 17 \\
 \hline
 62
 \end{array}$$

If you are adding together larger numbers, you may have to carry multiple times. For example:

$$\begin{array}{r}
 11 \\
 7658 \\
 + 1571 \\
 \hline
 9229
 \end{array}$$



**VIDEO**  
ADDITION REVIEW

Watch at:  
<http://videos.ssatprep.com>

## SUBTRACTION

In subtraction, just like in addition, focus on the place of the digits. Start subtracting the digits in the ones place and then move to the left. For example, if you had the question:

$$\begin{array}{r}
 85 \\
 - 23 \\
 \hline
 \end{array}$$

You would start by subtracting the ones place digits, which are 5 and 3, and then subtract the tens place digits, which are 8 and 2.  $5 - 3 = 2$  and  $8 - 2 = 6$ . Therefore, your answer will be:

$$\begin{array}{r}
 85 \\
 - 23 \\
 \hline
 62
 \end{array}$$

Sometimes in subtraction problems, the digits in your first number will be smaller than the digits in your second number. For example:

$$\begin{array}{r} 34 \\ - 18 \\ \hline \end{array}$$

As you can see, in our ones place column, 4 is smaller than 8. Therefore, you will need to use **borrowing**. You will need to “borrow” from the tens place digit in order to continue with your subtraction.

34 is the same thing as 3 tens and 4 ones. We can borrow from the 3 tens in order to make our ones place larger than 8. To do this, take one of the 3 tens and add it to the 4 ones, turning the 3 tens into 2 tens and the 4 ones into 14:

$$\begin{array}{r} 2 \ 14 \\ \cancel{3}4 \\ - 18 \\ \hline \end{array}$$

14 is larger than 8, so we can subtract the digits in our ones and tens columns as usual.  $14 - 8 = 6$  and  $2 - 1 = 1$ , so:

$$\begin{array}{r} 2 \ 14 \\ \cancel{3}4 \\ - 18 \\ \hline 1 \ 6 \end{array}$$

Some problems will require you to borrow multiple times. For example:

$$\begin{array}{r} 8762 \\ - 3914 \\ \hline \end{array}$$

We can solve this problem step-by-step, starting with the ones place column and moving to the left.

Our first number has a ones place digit that is smaller than the ones place digit of our second number. As a result, we will need to borrow from the 6 tens in the tens place:

$$\begin{array}{r} 5 \ 12 \\ 8 \ 7 \ \cancel{6}2 \\ - 3 \ 9 \ 14 \\ \hline 4 \ 8 \end{array}$$

In our hundreds place, our first number is also smaller than our second number, so we will need to borrow from the 8 in our thousands place. After we have subtracted all of the columns, we can come up with our final answer:

$$\begin{array}{r}
 717 \\
 8762 \\
 -3914 \\
 \hline
 4848
 \end{array}$$



**VIDEO**  
SUBTRACTION REVIEW

Watch at:  
<http://videos.ssatprep.com>

## MULTIPLICATION

You should be very comfortable multiplying whole numbers from 1 to 12 in your head. If you have trouble remembering your **multiplication table**, put this information on flashcards and quiz yourself regularly.

MULTIPLICATION TABLE												
	1	2	3	4	5	6	7	8	9	10	11	12
1	1	2	3	4	5	6	7	8	9	10	11	12
2	2	4	6	8	10	12	14	16	18	20	22	24
3	3	6	9	12	15	18	21	24	27	30	33	36
4	4	8	12	16	20	24	28	32	36	40	44	48
5	5	10	15	20	25	30	35	40	45	50	55	60
6	6	12	18	24	30	36	42	48	54	60	66	72
7	7	14	21	28	35	42	49	56	63	70	77	84
8	8	16	24	32	40	48	56	64	72	80	88	96
9	9	18	27	36	45	54	63	72	81	90	99	108

	1	2	3	4	5	6	7	8	9	10	11	12
<b>10</b>	10	20	30	40	50	60	70	80	90	100	110	120
<b>11</b>	11	22	33	44	55	66	77	88	99	110	121	132
<b>12</b>	12	24	36	48	60	72	84	96	108	120	132	144

To solve multiplication problems with larger numbers, rely on your knowledge of the multiplication table for smaller numbers. For example, let's look at this problem:

$$\begin{array}{r} 17 \\ \times 6 \\ \hline \end{array}$$

Even though you probably do not have your 17 times tables memorized, you can still easily solve this problem by breaking it down into parts. In this problem, take the number 6 and multiply it first by the ones place, and then by the tens place of the larger number (17).

First, multiply 6 by 7, which is the number in the ones place. Recall from your multiplication table that  $6 \times 7 = 42$ . Since 42 is a two-digit number, we will need to carry the 4:

$$\begin{array}{r} 4 \\ 17 \\ \times 6 \\ \hline 2 \end{array}$$

Then, we will multiply 6 by 1, which is the number in the tens place. Afterwards, we will add 4, the number that we carried.  $6 \times 1 + 4 = 10$ , so our final answer will be:

$$\begin{array}{r} 4 \\ 17 \\ \times 6 \\ \hline 102 \end{array}$$

Now take a look at a slightly more complicated problem:

$$\begin{array}{r} 45 \\ \times 13 \\ \hline \end{array}$$

In this problem, our second number has two digits. We will need to go through the multiplication process for each digit separately. Let's start with the ones digit, which is 3, and ignore the tens digit for now.

Just like we did in our first example, we'll multiply 3 first by the ones place, followed by the tens place. 5 is the number in the ones place, and  $3 \times 5 = 15$ . Since we have a two-digit number, we will need to carry the 1. We'll then multiply by 4, which is the number in the tens place, and add the number we carried.  $3 \times 4 + 1 = 13$ , so we get:

$$\begin{array}{r} 1 \\ 45 \\ \times 13 \\ \hline 135 \end{array}$$

But we're not done yet! Now that we have finished with the "3" in "13", we need to work on the "1." We'll start a new line under the answer. The "1" in 13 is really a "10", because 13 is the same thing as 1 ten plus 3 ones. In order to make our multiplication problem reflect that our "1" is really a "10," we will need to add a zero under our answer:

$$\begin{array}{r} 45 \\ \times 13 \\ \hline 135 \\ 0 \end{array}$$

After we have added the zero, we'll multiply 1 first by the ones place, followed by the tens place. 5 is in the ones place, and  $1 \times 5 = 5$ . 4 is in the tens place, and  $1 \times 4 = 4$ . Therefore, we are left with:

$$\begin{array}{r} 45 \\ \times 13 \\ \hline 135 \\ 450 \end{array}$$

To get our final answer, we need to add the two lines together:

$$\begin{array}{r} 45 \\ \times 13 \\ \hline 135 \\ + 450 \\ \hline 585 \end{array}$$

Our final answer is 585.

When you are multiplying even larger numbers, remember to always add another zero when you start a new line. For example:

$$\begin{array}{r}
 524 \\
 \times 212 \\
 \hline
 1048 \\
 5240 \\
 + 104800 \\
 \hline
 111088
 \end{array}$$



**VIDEO**  
MULTIPLICATION

Watch at:  
<http://videos.ssatprep.com>

## DIVISION

In order to divide with large numbers, you can also apply your knowledge of the multiplication table.

For example, let's see how we would divide 2406 by 3:

$$3 \overline{)2406}$$

To solve this problem, we need to take 3 and divide it into each number, one at a time. Unlike multiplication, however, we're going to work from left to right. 3 does not divide evenly into 2, which is the digit farthest to the left. As a result, we will move onto the next digit, and try to divide 3 into 24.

3 does divide evenly into 24. Recall from your multiplication tables that  $3 \times 8 = 24$ . We'll therefore write "8" above "24." To check our work, we'll multiply  $3 \times 8$  again, and write the product below "24." We'll then subtract to see what remainder we get:

$$\begin{array}{r}
 8 \\
 3 \overline{)2406} \\
 \underline{-24} \\
 0
 \end{array}$$

$24 - 24 = 0$ , so we'll write "0" as the remainder to finish this step.

In the next step, we'll bring down the next number in 2406, which is 0, and write this next to the remainder from our last step:

$$\begin{array}{r} 8 \\ 3 \overline{) 2406} \\ \underline{-24} \downarrow \\ 00 \end{array}$$

Our new number is "00," which is the same thing as 0. We'll then divide 3 into this number. 3 goes into 0 zero times. Following the same process as above, we'll therefore write "0" above the division symbol and multiply by 3 to check our work:

$$\begin{array}{r} 8 \\ 3 \overline{) 2406} \\ \underline{-24} \downarrow \\ 00 \\ \underline{-0} \\ 0 \end{array}$$

Finally, we'll bring down our last number, which is 6, and we'll divide 3 into this number. Recall that  $3 \times 2 = 6$ . 3 divides into 6 two times, so we'll write "2" above the division symbol and check whether we have a remainder:

$$\begin{array}{r} 802 \\ 3 \overline{) 2406} \\ \underline{-24} \downarrow \\ 00 \\ \underline{-0} \downarrow \\ 06 \\ \underline{-6} \\ 0 \end{array}$$

3 divides evenly into 2406, so there is no remainder. Our final answer is 802.

In some cases, your divisor will not divide evenly into your dividend. In such a case, you will be left with a remainder. Let's look at the following example:

$$4 \overline{) 6571}$$

Starting with the first number to the left, we see that 4 goes into 6 only once, but not evenly.  $4 \times 1 = 4$ , and when we subtract 4 from 6, we will have a remainder of 2:

$$\begin{array}{r} 1 \\ 4 \overline{) 6571} \\ \underline{-4} \\ 2 \end{array}$$



When we bring down the next number, 5, we'll write this next to the remainder and get a new number, 25. 4 goes into 25 six times because  $4 \times 6 = 24$ . We'll write "6" above the division symbol.  $25 - 24 = 1$ , so here we will be left with a remainder of 1:

$$\begin{array}{r} 16 \\ 4 \overline{)6571} \\ \underline{-4} \phantom{0} \phantom{0} \phantom{0} \\ 25 \phantom{0} \phantom{0} \phantom{0} \\ \underline{-24} \phantom{0} \phantom{0} \phantom{0} \\ 1 \phantom{0} \phantom{0} \phantom{0} \end{array}$$

Our next step is to bring down the next number, 7, and write this next to our remainder to get 17. 4 goes into 17 four times because  $4 \times 4 = 16$ . We'll write "4" above the division symbol.  $17 - 16 = 1$ , so we have a remainder of 1 again:

$$\begin{array}{r} 164 \\ 4 \overline{)6571} \\ \underline{-4} \phantom{0} \phantom{0} \phantom{0} \\ 25 \phantom{0} \phantom{0} \phantom{0} \\ \underline{-24} \phantom{0} \phantom{0} \phantom{0} \\ 17 \phantom{0} \phantom{0} \phantom{0} \\ \underline{-16} \phantom{0} \phantom{0} \phantom{0} \\ 1 \phantom{0} \phantom{0} \phantom{0} \end{array}$$

Finally, we will bring down the last number, 1, and write this next to our remainder to get 11. 4 goes into 11 two times because  $4 \times 2 = 8$ . We'll write "2" above the division symbol.  $11 - 8 = 3$ , so we have a remainder of 3.

$$\begin{array}{r} 1642 \\ 4 \overline{)6571} \\ \underline{-4} \phantom{0} \phantom{0} \phantom{0} \\ 25 \phantom{0} \phantom{0} \phantom{0} \\ \underline{-24} \phantom{0} \phantom{0} \phantom{0} \\ 17 \phantom{0} \phantom{0} \phantom{0} \\ \underline{-16} \phantom{0} \phantom{0} \phantom{0} \\ 11 \phantom{0} \phantom{0} \phantom{0} \\ \underline{-8} \phantom{0} \phantom{0} \phantom{0} \\ 3 \phantom{0} \phantom{0} \phantom{0} \end{array}$$

Because we have no more numbers to bring down, our final answer is 1,642 with a remainder of 3. We can write this remainder as "R3" above the division line:

$$\begin{array}{r} 1642 \text{ R}3 \\ 4 \overline{)6571} \end{array}$$



**VIDEO**  
DIVISION REVIEW

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## **EVEN AND ODD NUMBERS**

Remember that an even number can be evenly divided by 2, and an odd number cannot be evenly divided by 2. This means that an odd number will have a remainder when you try to divide by 2, and an even number will have no remainder.

Here's a fun fact about even and odd numbers: you can predict whether the sum or product of two numbers will be even or odd.

- $\text{even} + \text{even} = \text{even}$
- $\text{odd} + \text{odd} = \text{even}$
- $\text{odd} + \text{even} = \text{odd}$
  
- $\text{even} \times \text{even} = \text{even}$
- $\text{odd} \times \text{odd} = \text{odd}$
- $\text{odd} \times \text{even} = \text{even}$

Test this on any pair of numbers you can find, and you'll see that it is always true!

# WORD PROBLEMS

## SECTION 7

Many questions on the SSAT ask you to solve a word problem with your knowledge of math and logic. We've already discussed many word problems that involve arithmetic, fractions, ratios, decimals, and percents. In this section, we'll look at a few more concepts that are helpful for solving SSAT word problems.

### TIME

In math problems involving time, you will be dealing with seconds, minutes, hours, days and weeks. These quantities of time are related to each other as follows:

- There are 60 seconds in a minute.
- There are 60 minutes in an hour.
- There are 24 hours in a day.
- There are 7 days in a week.

The day is divided into 24 hours. These 24 hours are split into two 12-hour periods denoted by AM (morning hours) and PM (night hours). Be sure to pay attention to whether the question states AM or PM! The format used to represent time has a colon separating the hours from minutes with AM or PM following. For example, 12:34 PM represents the time twelve hours and 34 minutes in the afternoon.

Important! Remember that midnight is 12:00 AM and noon is 12:00 PM.

### MONEY

When dealing with questions involving money amounts, it is important to pay attention to the location of the decimal point. Always write your dollar amounts with two digits to the right of the decimal. For example, if you wanted to say that you have 5 dollars, you would write it as \$5.00, showing two digits on the right of the decimal. If you had 5 dollars and 25 cents, it would be written as \$5.25. When you are doing addition and subtraction problems involving money, make sure you line up your decimal points so that you won't mix up your place values.

You should be familiar with the following coins and how much they are worth:

COIN	VALUE
Penny	\$0.01
Nickel	\$0.05
Dime	\$0.10
Quarter	\$0.25
Dollar	\$1.00

## UNITS

Units are standard quantities of measurement. Seconds, minutes, hours, and days are all units of time. Dollars and cents are units of money.

There are two systems of units frequently used to measure mass, length, and volume. The **imperial system** is used frequently in the United States. The imperial system measures weight in pounds (abbreviated lb), and it uses the following units to measure length:

- Inch
- Foot: 12 inches
- Yard: 3 feet
- Mile: 5,280 feet

The imperial system uses the following units to measure volume:

- Cup
- Pint: 2 cups
- Quart: 2 pints (4 cups)
- Gallon: 4 quarts (16 cups)

The **metric system** is very important to learn because it is used more commonly internationally and in the scientific community. In the metric system, mass is measured in grams, length is measured in meters, and volume is measured in liters. Each of these units can be abbreviated as g for grams, m for meters and l for liters.

The metric system also has prefixes, or different word beginnings, that indicate different multiples of 10. These prefixes can be combined with any units (grams, meters, or liters) to result in the multiplied amounts:

- Kilo = 1000
- Hecto = 100
- Deca = 10
- Deci = 1/10
- Centi = 1/100
- Milli = 1/1000

For example, a kilometer is 1000 meters, a decaliter is 10 liters, and a milligram is 1/1000 of a gram, or 0.001 grams.

Each prefix also has a short form that is combined with the unit to make writing simpler.

- Kilo: k
- Hecto: h
- Deca: D
- Deci: d
- Centi: c
- Milli: m

Instead of writing “kilogram,” we can write the abbreviation “kg.” Instead of “millimeter,” we can write “mm.” Questions on the SSAT may be written in abbreviations, so it is important to know what these mean.

Here’s a quick way to remember the correct order of prefixes. If you write out the prefix abbreviations from biggest to smallest, you’ll get

k h D d c m

A common phrase to remember this order is **King Henry Died Drinking Chocolate Milk**.

The SSAT may also ask you to convert between different prefixes. As you move up the list of prefixes, the next unit is 10 times greater than the unit below it. As you move down the list, the next unit is one-tenth the unit above it. To move from one prefix to another, set up a ratio between the two units. For example:

How many meters are equal to 16 kilometers?

From our chart above, we know that one kilometer equals 1,000 meters. To figure out how many meters equal 16 kilometers, we can set up the following ratio:

$$\frac{\text{meters}}{\text{kilometers}} = \frac{1000}{1} = \frac{?}{16}$$

$$\frac{\text{meters}}{\text{kilometers}} = \frac{1000 \times 16}{1 \times 16} = \frac{16,000}{16}$$

Because there are 1,000 meters in 1 kilometer, there must be 16,000 meters in 16 kilometers.

## PATTERNS

SSAT word problems may also involve **patterns**, or lists that follow a rule. This rule tells you what to do to get the next item in the pattern. For example, the counting numbers follow a pattern where you take the first number 1, and you add one to get the second number 2. Then you add one to this number to get the third number 3, and so on.

A pattern involving numbers is called a **sequence**, and the numbers in the pattern are called **terms**. There are two categories of sequences:

- In the first category, a number is *added* to each term to get the next term. For example, if we start with the number 5 and add 2 to get 7, then add 2 to 7 to get 9, and continue adding 2, we get the sequence 5, 7, 9, 11, 13. In this sequence, 5 is the first term, 7 is the second term and 13 is the fifth term of the sequence.
- In the second category, a number is *multiplied* by a term to get the next term. For example, if we start with the number 5 and multiply it by 2 to get 10, and then multiply 10 by 2 to get 20, and keep multiplying by 2, we get the sequence 5, 10, 20, 40, 80.

If you are asked to determine a specific term in a sequence, you must first figure out the rule that is being used. If you have an “adding sequence,” look for the constant number that is added to each term to get the next one. This can be found by subtracting any number in the list from the number after it.

For example:

How would you find the next number in the list below?

5, 7, 9, 11, 13

To determine the rule in this sequence, we can subtract any two consecutive numbers in the list. For example, we can calculate  $9 - 7 = 2$ , or  $13 - 11 = 2$ , or  $7 - 5 = 2$ . This tells us the rule for this sequence: add 2 to any term in the sequence and you’ll find the next term.

Now that we know the rule, we can find the next number in the sequence by adding 2:

$$13 + 2 = 15$$

The next number in this sequence is 15.

If the list is a “multiplying sequence”, look for the constant number that each term is multiplied by. This can be found by dividing any term by the term before it.

For example:

What comes next in the sequence below?

5, 10, 20, 40, 80

To determine the rule in this sequence, we can divide any of the terms by the term before it. For example, we can calculate  $\frac{40}{20} = 2$  or  $\frac{20}{10} = 2$  or  $\frac{10}{5} = 2$ . This tells us the rule for this sequence: multiply any term in the sequence by 2, and you’ll find the next term.

Now that we know the rule, we can find the next number in the sequence by multiplying the last number by 2:

$$80 \times 2 = 160$$

The next number in this sequence is 160.

If you are trying to determine whether a sequence is produced by adding or multiplying, try out both of these methods and see which one works for all of the terms that you are given.

## PRACTICE QUESTIONS: WORD PROBLEMS

1. Thomas arrived at the park 18 minutes before noon. His sister arrived at the park 25 minutes later. At what time did his sister arrive at the park?
2. A play started at 8:30 PM and ended at 10:09 PM. How long was the play?
3. It takes two and a half hours to drive to the zoo. If Sam's family wants to arrive at the zoo when it opens at 10:15 AM, at what time should they leave home?

*For questions 4-7, write the total dollar and cent amount for the following combinations of coins:*

4. Four dollars, 8 dimes, 3 nickels, 8 pennies
5. 8 dollars, 9 quarters, 6 dimes, 7 nickels, 2 pennies
6. 7 quarters, 6 nickels, 8 pennies
7. One \$20 bill, 6 dollars, 8 quarters, 5 dimes, 5 pennies

*For questions 8-11, write a combination of coins that would equal the following totals:*

8. \$0.45
9. \$2.64
10. \$1.03
11. \$3.57
12. After spending \$15.92 on a skateboard, Joe has \$2.08 left. How much money did Joe have before he bought the skateboard?

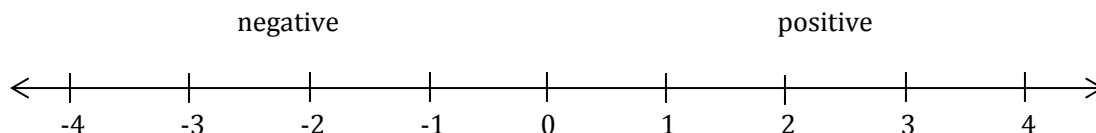


13. Corwin has \$32.55 to spend on hamburgers. If each hamburger costs \$7.00, how many hamburgers can Corwin buy?
14. Raquel divides the money in her piggybank by 3 and adds \$7. The result is \$15. How much money did Raquel start with?
15. Jean earns \$12 per hour. She was paid \$444.00 for this week of work. How many hours did she work this week?
16. 25 kilograms is equal to how many grams?
17. 478 milliliters is equal to how many liters?
18. Cleo measured a length of string equal to 0.047 km. If she cuts the string into equal pieces that are each 50 cm long, how many pieces will she have?
19. What number comes next in the pattern below?  
37, 41, 45, 49, 53, \_
20. What is the missing number in the pattern below?  
64, 32, 16, \_\_, 4, 2
21. On his first day at school, Tommy made 1 friend. On his second day, he made 3 friends. On his third day, he made 9 friends, and on his fourth day, he made 27 friends. If this pattern continues, how many friends will Tommy make on his fifth day of school?
22. Gita sorted her marbles into bags. She placed 3 marbles in the first bag, 4 marbles in the second bag, 6 marbles in the third bag, and 9 marbles in the fourth bag. If she continued this pattern, how many marbles did she put in the sixth bag?

# NEGATIVE NUMBERS

## SECTION 8

**Positive numbers** are greater than zero. **Negative numbers** are smaller than zero and have a negative sign ( $-$ ) in front of them. They are found to the left of zero on a number line. Zero itself is neither positive nor negative:



You might ask why negative numbers are useful. It is true that we rarely talk about quantities smaller than zero. However, we frequently use negative numbers when talking about losses, deficits, or decreases in quantities over time. For instance, we could say, "There was a  $-3^\circ$  change in temperature between 4pm and 9pm." This means that the temperature dropped  $3^\circ$ . Or, your bank statement for your checking account could read  $-\$50$ . This means that you have a deficit of \$50: you accidentally spent \$50 more than you had in your checking account, and you owe money to the bank!



**VIDEO**  
INTRODUCTION TO NEGATIVE  
NUMBERS

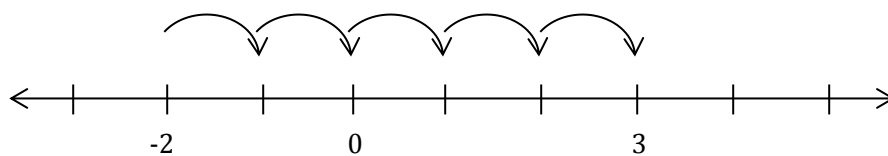
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## ADDING AND SUBTRACTING NEGATIVE NUMBERS

It is easiest to visualize addition and subtraction with negative numbers if you use a number line.

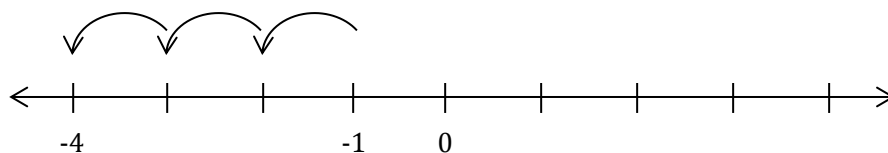
To add a positive number, you need to move right a certain number of places on the number line. For instance, if we wanted to add  $-2 + 5$ , we would start with  $-2$  on the number line and move 5 places to the right:

$$-2 + 5 = 3$$



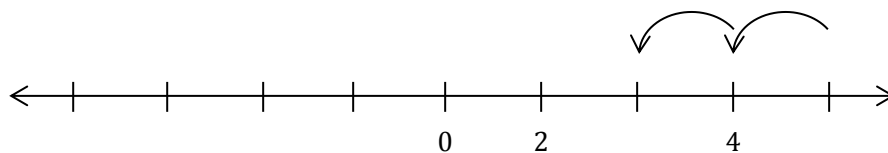
To subtract a positive number, you need to move left a certain number of places on the number line. For instance, if we wanted to subtract  $-1 - 3$ , we would start with  $-1$  on the number line and move 3 places to the left:

$$-1 - 3 = -4$$



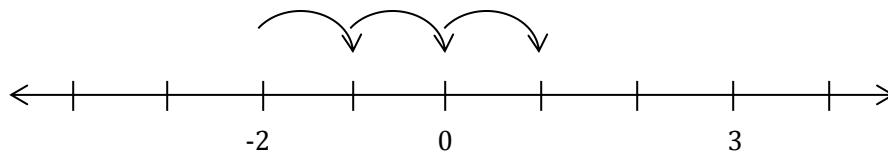
To add a negative number, you actually need to move a certain number of spaces left on the number line—adding a negative number is the same thing as subtracting a positive number! For instance, if we wanted to add  $4 + (-2)$ , we would start with 4 on the number line and move 2 spaces to the left:

$$4 + (-2) = 2$$



Similarly, to subtract a negative number, you need to move a certain number of spaces right on the number line—subtracting a negative number is the same thing as adding a positive number! For instance, if we wanted to subtract  $-2 - (-3)$ , we would start with  $-2$  on the number line and move 3 spaces to the right:

$$-2 - (-3) = 1$$



To add or subtract negative numbers without a number line, follow these three rules:

- To add two numbers with the same sign, add the numbers as usual and keep their sign:

$$7 + 13 = 20$$

$$-7 + (-13) = -20$$

- To add two numbers with different signs, subtract the two numbers and keep the sign of the number that is farthest away from zero:

$$5 + (-4) = +(5 - 4) = 1$$

$$-6 + 2 = -(6 - 2) = -4$$

- To subtract any two numbers, flip the sign of the second number to its opposite, and then add the two numbers:

$$-4 - 5 = -4 + (-5) = -9$$

$$17 - (-4) = 17 + 4 = 21$$



**VIDEO**  
ADDING AND SUBTRACTING  
NEGATIVE NUMBERS

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## MULTIPLYING AND DIVIDING NEGATIVE NUMBERS

Multiplying and dividing negative numbers is simpler than adding or subtracting. Multiply and divide as usual, then determine the sign of the product or quotient. If both of your numbers have the same sign, the product or quotient will be positive. If the numbers have different signs, the product or quotient will be negative:

- positive  $\times$  positive = positive

$$3 \times 4 = 12$$

- negative  $\times$  negative = positive

$$-3 \times (-4) = 12$$

- positive  $\times$  negative = negative

$$3 \times (-4) = -12$$

- negative  $\times$  positive = negative

$$-3 \times 4 = -12$$

- positive  $\div$  positive = positive

$$10 \div 5 = 2$$

- negative  $\div$  negative = positive

$$-10 \div (-5) = 2$$

- positive  $\div$  negative = negative

$$10 \div (-5) = -2$$

- negative  $\div$  positive = negative

$$-10 \div 5 = -2$$



**VIDEO**  
MULTIPLYING AND DIVIDING  
NEGATIVE NUMBERS

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## PRACTICE QUESTIONS: NEGATIVE NUMBERS

1.  $-10 + 8 =$

2.  $5 + (-15) =$

3.  $-4 - 7 =$

4.  $3 - (-9) =$

5.  $-1 + (-6) =$

6.  $144 + (-214) =$

7.  $9 - (-9) =$

8.  $-8 - (-2) =$

9.  $14 + (-14) =$

10.  $-100 + 8100 =$

11.  $6 \times (-3) =$

12.  $-5 \times (-7) =$

13.  $-24 \div 4 =$

14.  $8 \times (-5) =$

15.  $18 \div (-2) =$

16.  $-32 \div (-4) =$

17.  $-12 \times 2 =$

18.  $-45 \div (-3) =$

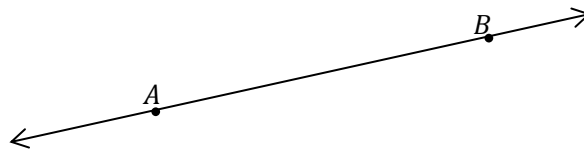
19.  $-120 \div 20 =$

20.  $-25 \times (-4) =$

# LINES AND ANGLES

## SECTION 1

A **line** is a straight, one-dimensional object: it has infinite length but no width. Between any two points, you can draw exactly one line that stretches in both directions forever. For instance, between the points  $A$  and  $B$  below, you can draw the line  $\overleftrightarrow{AB}$ . We name a line by drawing a horizontal bar with two arrows over two points on the line.

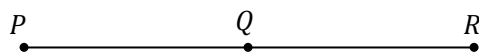


### LINE SEGMENTS AND MIDPOINTS

A **line segment** is a portion of a line with a finite length. The two ends of a line segment are called **endpoints**. For instance, in the figure below, the points  $M$  and  $N$  are the endpoints of the line segment  $\overline{MN}$ . We name a line segment with a plain horizontal bar over its two endpoints.



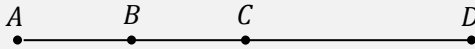
The point that divides a line segment into two equal pieces is called its **midpoint**. For instance, in the figure below, the point  $Q$  is the midpoint of the line segment  $\overline{PR}$ .



Because  $Q$  is the midpoint, it divides the segment into two equal pieces. Thus, we know  $PQ = QR$ .

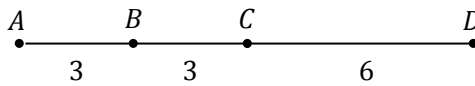
You might be asked to find the length of a line segment based on the sum of its parts, or to find the length of one part of a line segment based on its total length. For example, consider the following question:

In the figure below,  $B$  is the midpoint of  $\overline{AC}$  and  $C$  is the midpoint of  $\overline{AD}$ . If  $AD = 12$ , what is the length of  $\overline{AB}$ ?



If  $C$  is the midpoint of  $\overline{AD}$ , this means that  $C$  divides  $\overline{AD}$  into two equal segments:  $AC = CD$ . We're told that  $AD = 12$ , which means that  $AC = 6$  and  $CD = 6$ .

We also know that  $B$  is the midpoint of  $\overline{AC}$ , which means that  $AB = BC$ . If  $AC = 6$ , we know that  $BC = 3$  and  $AB = 3$ .

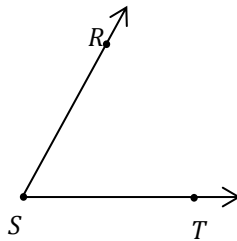


**VIDEO**  
LINES AND LINE SEGMENTS

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## ANGLES

An **angle** is formed when two lines or line segments intersect. The point where the lines meet is called the **vertex** of the angle, and the two sides of the angle are called the **legs**. An angle can be named either with a single letter representing its vertex, or by three letters representing three points that define the angle: a point on one of its legs, the vertex, and a point on the other leg. In this case, the vertex is always in the middle. For example, the angle below can be called  $\angle RST$  or simply  $\angle S$ :

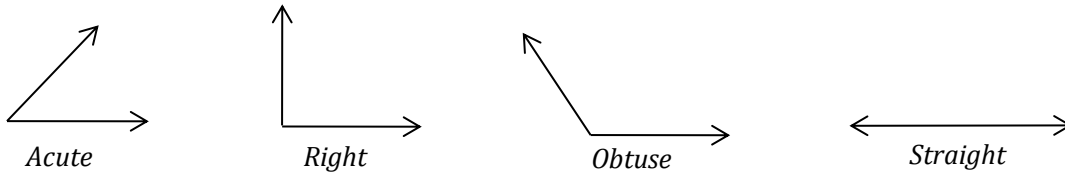


Angles are measured in degrees from  $0^\circ$  to  $360^\circ$ , which represents a full circle. Angles can be classified according to their degree measurements. Two angles that have equal measures are called **congruent**.

- An **acute** angle measures less than  $90^\circ$ .

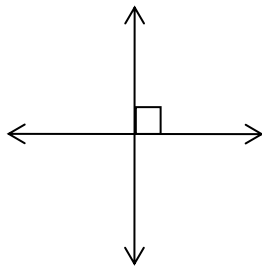


- A **right** angle measures exactly  $90^\circ$ .
- An **obtuse** angle measures between  $90^\circ$  and  $180^\circ$ .
- A **straight** angle measures exactly  $180^\circ$ .

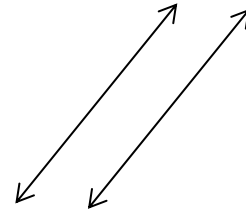


## PERPENDICULAR AND PARALLEL LINES

Two lines are **perpendicular** if they intersect to form a right angle. Right angles are often designated by a small square in the corner of the angle. If two lines are **parallel**, then they will never intersect.



Perpendicular Lines



Parallel Lines



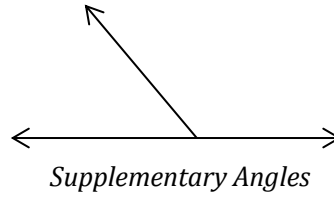
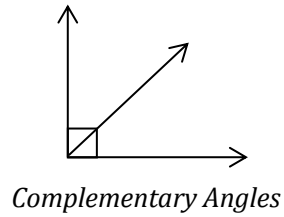
**VIDEO**  
INTRO TO ANGLES

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## COMPLEMENTARY AND SUPPLEMENTARY ANGLES

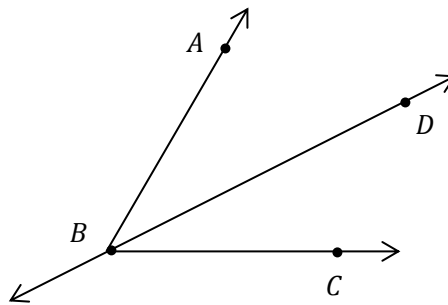
Here are some facts to know about angle sums:

- The sum of any number of angles that form a straight line is  $180^\circ$ .
- The sum of any number of angles around a point is  $360^\circ$ .
- Angles that add up to  $90^\circ$  are called **complementary angles**.
- Angles that add up to  $180^\circ$  are called **supplementary angles**.



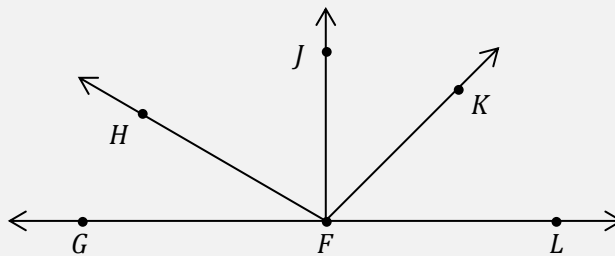
## BISECTING ANGLES

A line that **bisects** an angle divides it into two equal parts. In the figure below, line  $\overleftrightarrow{BD}$  bisects  $\angle ABC$  and divides it into two congruent angles,  $\angle ABD$  and  $\angle DBC$ :



You may be asked to find the sum of several angles, or find the measure of one angle based on the sum of several angles. For example, consider the following question:

In the figure below, four angles intersect to form a straight line. If  $\angle GFH$  and  $\angle HFJ$  are complementary, and line  $\overleftrightarrow{FK}$  bisects  $\angle JFL$ , what is the measure of  $\angle KFL$ ?



We know that any number of angles forming a straight line add up to  $180^\circ$ . Therefore, we can write:

$$\angle GFH + \angle HFJ + \angle JFK + \angle KFL = 180^\circ$$

We are also told that  $\angle GFH$  and  $\angle HFJ$  are complementary, which means that they add up to  $90^\circ$ :

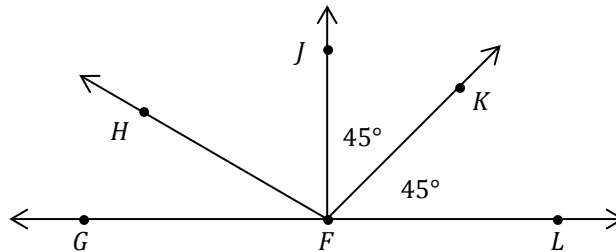
$$\angle GFH + \angle HFJ = 90^\circ$$

If  $\angle GFH$  and  $\angle HFJ$  add up to  $90^\circ$ , this means that  $\angle JFK$  and  $\angle KFL$  also add up to  $90^\circ$ :

$$90^\circ + \angle JFK + \angle KFL = 180^\circ$$

$$\angle JFK + \angle KFL = 180^\circ - 90^\circ = 90^\circ$$

Finally, we are told that line  $\overleftrightarrow{FK}$  bisects  $\angle JFL$ , which means that  $\angle JFK$  and  $\angle KFL$  be congruent. If  $\angle JFK$  and  $\angle KFL$  are congruent and add up to  $90^\circ$ , then  $\angle KFL$  must equal  $90^\circ \div 2 = 45^\circ$ .

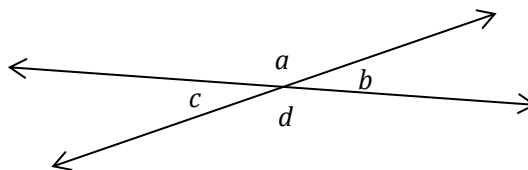


**VIDEO**  
ANGLE SUMS

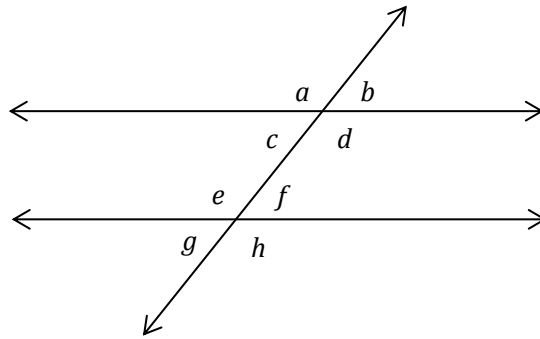
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### PROPERTIES OF INTERSECTING LINES: UPPER LEVEL ONLY

Two intersecting lines form two sets of **vertical angles**, which are congruent. In the figure below,  $a = d$  and  $b = c$ .



If a third line (**transversal**) intersects a pair of parallel lines, it forms eight angles, as in the following figure.

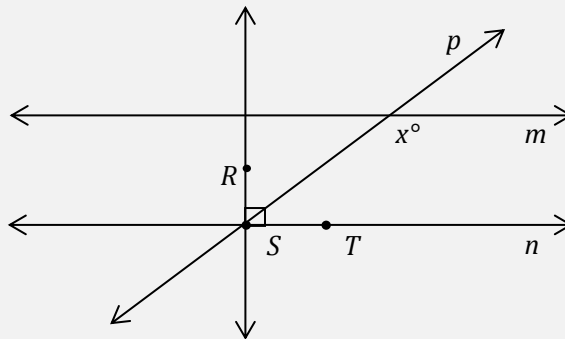


Know the following properties of transversals:

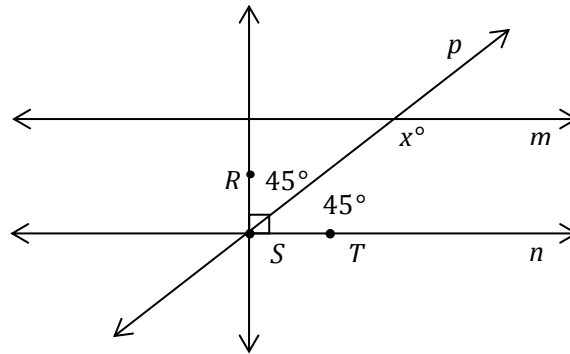
- The pairs of **corresponding** angles are congruent:  $a = e$ ,  $b = f$ ,  $c = g$ , and  $d = h$ .
- The pairs of **alternate interior** angles are congruent:  $c = f$  and  $d = e$ .
- The pairs of **alternate exterior** angles are congruent:  $a = h$  and  $b = g$ .
- The pairs of **same side interior angles** are supplementary:  $c + e = 180^\circ$  and  $d + f = 180^\circ$ .

For example, consider the following question:

In the figure below, line  $m$  and line  $n$  are parallel, and line  $p$  bisects  $\angle RST$ . What is the value of  $x$ ?



Based on the figure, we can see that  $\angle RST$  is right angle and therefore measures  $90^\circ$ . If line  $p$  bisects this angle, it must divide it into two angles measuring  $45^\circ$  each. We can label these on the figure.



Because line  $p$  intersects two parallel lines, we know that pairs of same-side interior angles are supplementary. Thus, we know that  $x^\circ$  and  $45^\circ$  must add to equal  $180^\circ$ . We can write an algebraic equation and solve for  $x$ :

$$\begin{aligned}x + 45 &= 180 \\x + 45 - 45 &= 180 - 45 \\x &= 135^\circ\end{aligned}$$

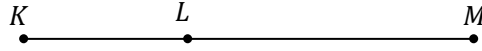


**VIDEO**  
PROPERTIES OF INTERSECTING  
LINES

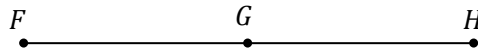
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## PRACTICE QUESTIONS: LINES AND ANGLES

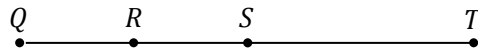
1. In the figure below,  $KM = 5$ . If  $LM = 3$ , what is the length of  $\overline{KL}$ ?



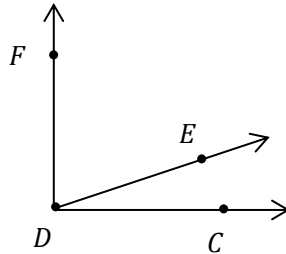
2. In the figure below,  $G$  is the midpoint of  $\overline{FH}$ . If  $FG = 4$ , what is the length of  $\overline{FH}$ ?



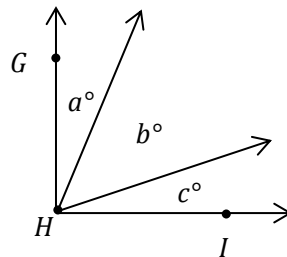
3. In the figure below,  $R$  is the midpoint of  $\overline{QS}$ , and  $S$  is the midpoint of  $\overline{QT}$ . If  $QR = 2$ , what is the length of  $\overline{RT}$ ?



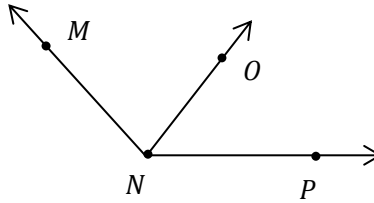
4. In the figure below, angles  $CDE$  and  $EDF$  are complementary. If  $\angle CDE$  measures  $20^\circ$ , what is the measure of  $\angle EDF$ ?



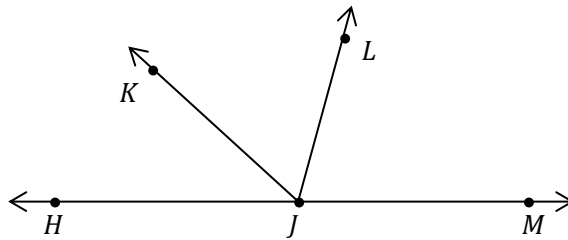
5. In the figure below, angle  $GHI$  is a right angle and  $b = 50^\circ$ . If  $a = c$ , what is the value of  $c$ ?



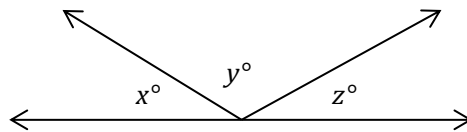
6. In the figure below, line  $\overleftrightarrow{NO}$  bisects  $\angle MNP$ . If  $\angle MNO$  measures  $60^\circ$ , what is the measure of  $\angle MNP$ ?



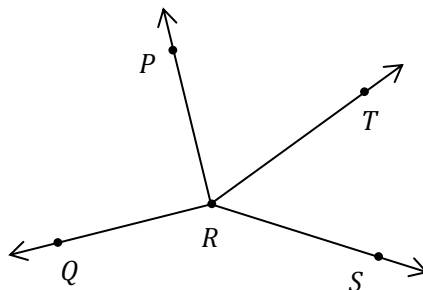
7. In the figure below,  $\angle HJK$ ,  $\angle KJL$ , and  $\angle LJM$  are supplementary. If  $\angle LJM$  measures  $70^\circ$  and line  $\overleftrightarrow{JK}$  bisects  $\angle HJL$ , what is the measure of  $\angle KJL$ ?



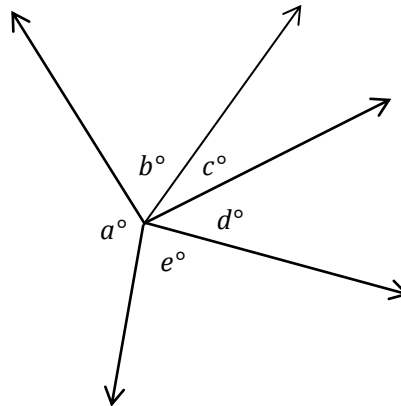
8. The three angles in the figure below form a straight line. If  $y = 120^\circ$ , what is the value of  $x + z$ ?



9. In the figure below, four lines intersect in point R to form four angles, and  $\angle PRT$  is congruent to  $\angle TRS$ . If  $\angle PRQ$  is a right angle, and  $\angle QRT$  measures  $150^\circ$ , what is the value of  $\angle TRS$ ?

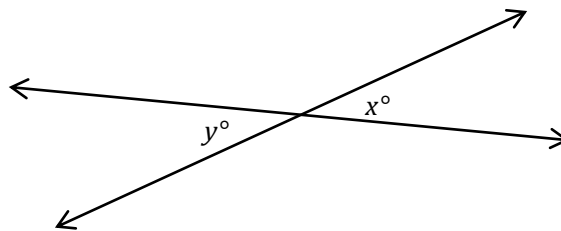


10. In the figure below, five lines intersect in a point to form five angles. If  $a = 170^\circ$  and  $b = 60^\circ$ , what is the value of  $c + d + e$ ?

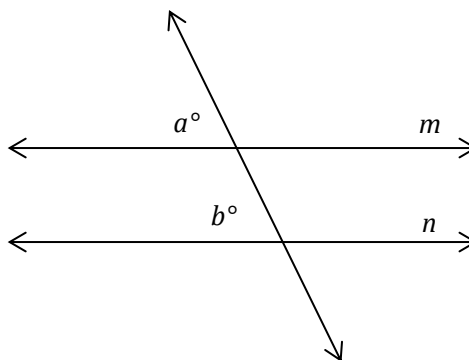


**Questions 11-18 are Upper Level Only.**

11. In the following diagram, two lines intersect to form four angles. If  $x = 30^\circ$ , what is the value of  $y$ ?

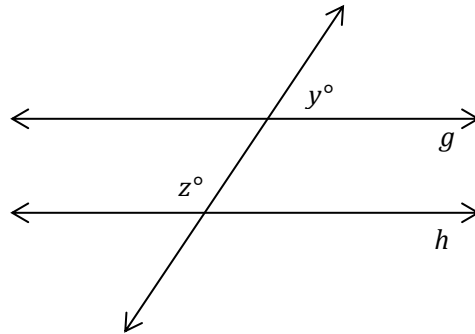


12. In the following diagram, lines  $m$  and  $n$  are parallel. If  $a = 70^\circ$ , what is the value of  $b$ ?

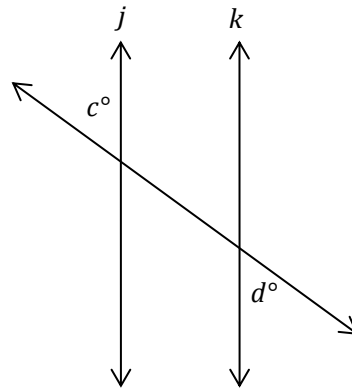




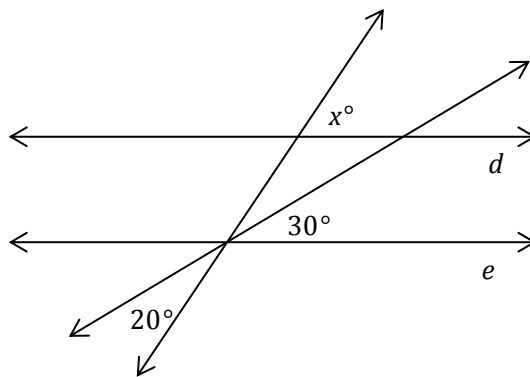
13. In the following diagram, lines  $g$  and  $h$  are parallel. If  $z = 120^\circ$ , what is the value of  $y$ ?



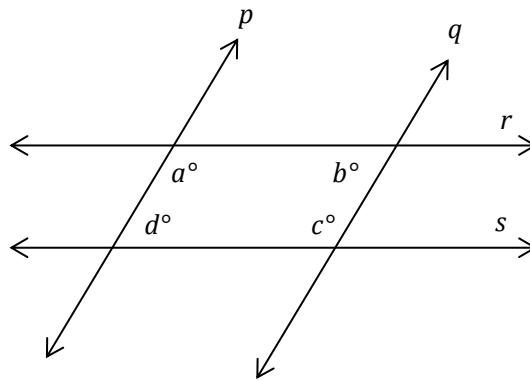
14. In the following diagram, lines  $j$  and  $k$  are parallel. If  $c = 50^\circ$ , what is the value of  $d$ ?



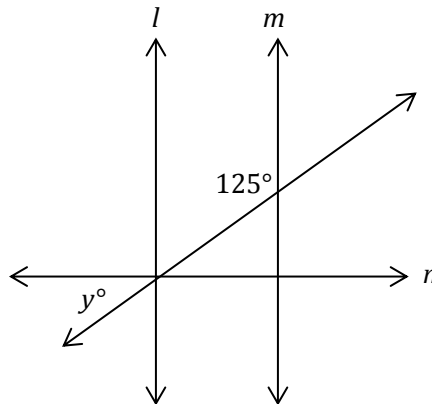
15. In the following diagram, lines  $d$  and  $e$  are parallel. What is the value of  $x$ ?



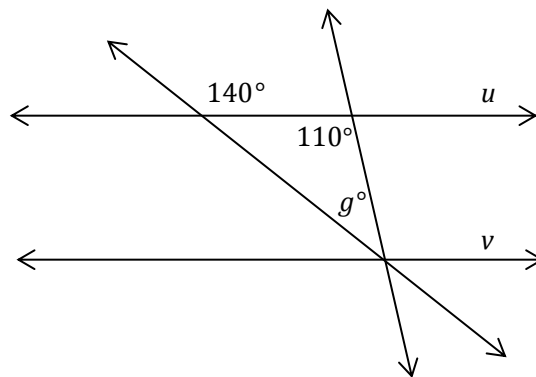
16. In the following diagram, lines  $p$  and  $q$  are parallel, and lines  $r$  and  $s$  are parallel. What is the value of  $a + b + c + d$ ?



17. In the following diagram, lines  $l$  and  $m$  are parallel and are both perpendicular to line  $n$ . What is the value of  $y$ ?



18. In the following diagram, lines  $u$  and  $v$  are parallel. What is the value of  $g$ ?



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