Logic is the use and study of valid reasoning (inductive, deductive, and abductive). In other words…it's the study of how to make inferences (educated guesses) and reason out problems. Logic is used in most intellectual activities but studies primarily in the disciplines of Philosophy, Mathematics, Semantics, and Computer Science.

The two main types of logic are:
Informal Logic – study of language arguments
Mathematical Logic – formal logic and the study of inferences; symbolic logic and the study of abstractions.

In Mathematical Logic, the study of valid inferences is using formal language and symbols to derive a logical conclusion. An example would be a mathematical proof.

This section introduces symbolic logic by studying the truth value of statements (semantics). We will look to see if statements or arguments are true or false.

I. Statements, Compound statements, and Negation

A statement is A declarative sentence that is either true or false but not both. State a fact. make a promise.

EXAMPLE: Determine if the following is a statement or not:

1. Some numbers are negative. yes, declares a fact about numbers
2. Where are you going tomorrow? no, it's a question
3. Yield to oncoming traffic. no, it's a command
4. $5 + 9 \neq 12$ and $4 - 2 = 5$ yes, declares a math operation

A compound statement is two or more statements combined using simple connectives, such as, "And" "or" "if... then"

EXAMPLE: Determine if each statement is compound or not:

1. I read the Wall Street Journal and I read People Magazine. yes, two ideas connected using "and"
2. My brother got married in France. no, only one idea
3. Jay's wife loves Ben and Jerry's ice cream. no, "and" is part of the title

A negation of a true statement is to make it false

A negation of a false statement is to make it true

EXAMPLE: Write the negation of each statement:

1. Her sister's name is Julie. Her sister's name is not Julie.
2. The moon is a planet. The moon is not a planet.
3. I drive a purple car. I do not drive a purple car.

Negation of mathematical inequalities: we use symbols in inequalities which represent opposite directions on a number line.

Less than $<$
Less than or equal to $\leq$
Greater than $>$
Greater than or equal to $\geq$

EXAMPLE: Write the negation of each inequality:

1. $x < 9$ $x \geq 9$ $x \geq -3$ $x < -3$
2. $7x + 11y \leq 77$ $7x + 11y > 77$

II. Quantifiers

Quantifiers (quantity) are used to show "how many" cases of a situation exists.
Universal quantifiers: **all, each, every, no or none**
Existential quantifiers: **some, there exists, at least one**

When negating a statement that uses a quantifier, you need to think! Negating a quantity is not an all or nothing idea. It does not have to go from one extreme to the other.

all do...........some do not, not all do

some do ....none do, all do not

none do...........at least one does

EXAMPLE: Write the negation of each statement:

1. No rain fell in Arizona today. Some rain fell in Arizona today.
2. Some books are longer than this one. No books are longer than this one.
3. No cats have fleas. Some cats have fleas.
   At least one cat has fleas.

EXAMPLE: Refer to the group of flower pictures and frames. Each row is labeled A, B, C. Use the letters to identify which group of pictures is given by the statements below using quantifiers.

A

B

C

1. All pictures have frames. C
2. No picture has a frame. B
3. At least one picture does not have a frame. A B
4. Not every picture has a frame. A B
5. At least one picture has a frame. A C
6. All pictures do not have frames. B

III. Logic Symbols

In logic, statements are represented by letters, such as ***p*** and ***q*** and ***r***.
In logic, connectives are represented by symbols:

Connective	Symbol	Type of Statement
and	$\wedge$	Conjunction
or	$\vee$	Disjunction
not	$\sim$	Negation

EXAMPLE: Translate the logic symbols to words:

p = Today is Sunday.

q = It is cold outside.

$\sim p$ = Today is not Sunday

$\sim q$ = It is not cold outside

$p \vee q$ = Today is Sunday or it's cold outside

$\sim p \wedge q$ = Today is not Sunday and it's cold outside

$p \vee \sim q$ = Today is Sunday or it's not cold outside

$p \wedge q$ = Today is Sunday and it's cold outside.