• I can explore inductive and deductive reasoning.
• I can find counterexamples to disprove conjectures.
• I can correctly interpret geometric diagrams by identifying what can and cannot be assumed.

- Inductive Reasoning - reasoning that uses a number of specific examples to arrive at a conclusion.
- Conjecture - a concluding statement that is reached using inductive reasoning. An educated guess like a hypothesis.
- Counterexample – a false example. It can be a number, a drawing or a statement. It is used to prove conjectures false and all it takes is one counterexample to make a whole conjecture false.

1. Write a conjecture that describes the pattern in each sequence. Then use your conjecture to find the next item in the sequence.
   (a) 2, 4, 12, 48, 240,.....
   (b) Follow-up visits: December, May, October, March
   (c) 10, 4, -2, -8,.....

2. Make a conjecture of each value or geometric relationship. List or draw some examples that support your conjecture.
   (a) The sum of an odd number and an even number

   (b) For points L, M, and N, LM = 20, MN = 6, and LN = 14. Make a conjecture and draw a figure to represent your conjecture.

   (c) The sum of two even numbers.

   (d) The relationship between AB and EF, if AB = CD and CD = EF.

   (e) The sum of the squares of two consecutive natural numbers.

   (f) $\angle 1$ and $\angle 2$ form a right angel.

   (g) $\angle ABC$ and $\angle DBE$ are vertical angles.

   (h) Point S is between R and T.

   (i) $\angle E$ and $\angle F$ are right angles.
3. Find a counterexample to show that each conjecture is false.

(a) If \( n \) is a real number, then \( -n \) is a negative number.

(b) Given: Collinear points \( D, E, \) and \( F \)

Conjecture: \( DE + EF = DF \)

(c) If \( \angle ABC \cong \angle DBE \), then \( \angle ABC \) and \( \angle DBE \) are vertical angles.

(d) If \( S, T, \) and \( U \) are collinear then \( ST = TU \)

4. Determine if the following statement is true or false. If it is false, give a counter example.

(a) If \( \angle 1 \) and \( \angle 2 \) are adjacent angles, then \( \angle 1 \) and \( \angle 2 \) form a linear pair.

(b) If \( \overline{GH} \) and \( \overline{JK} \) form a right angle and intersect at \( P \), then \( \overline{GH} \perp \overline{JK} \).
Section 2-2 – Logic

- I can identify, write, and analyze the truth value of conditional statements.
- I can construct truth tables to determine the truth value of logical statements.
- I can find counterexamples to disprove conjectures.

- **Statement** – a sentence that is either true or false. They are often represented by a “p” or “q”

- **Negation** – has an opposite meaning of the original statement. Statements use the symbol ~ to represent “not”. For example ~p or ~q (not p or not q)
  *examples: p: a rectangle is a quadrilateral (True)
    OR ~q: a rectangle is not a quadrilateral (False)

- **Compound Statement** – two or more statements joined by the words “and” (conjunction) or “or” (disjunction)

- **Conjunction** – a compound statement using the word “and.” These statements are true only when both parts of the statement are true. (example: both p and q must be true for these to be true).
  Conjunctions use the symbol ^ to represent “and” such as p^q
  Example: p: a rectangle is a quadrilateral (true hypothesis)
    q: a rectangle is convex (true conclusion)
  so: p ^ q: A rectangle is a quadrilateral, and a rectangle is convex (TRUE CONJUNCTION)

- **Disjunction** – a compound statement using the word “or.” These statements are true if at least one of the statements (p or q) are true. Disjunctions use the symbol v to represent “or” such as p v q.
  Example: p: Malik studies Geometry
    q: Malik studies Chemistry
  so pvq: Malik studies Geometry or Malik studies Chemistry.
1. Use the following statements to write a compound statement for each conjunction. Then find its truth value and explain your reasoning.
   p: The figure is a triangle.
   q: The figure has two congruent sides.
   r: The figure has three acute angles.
   (a) p and r
   (b) p ^ q
   (c) q ^ ~r
   (d) not p and not r

2. Use the following statements to write a compound statement for each disjunction. Then find its truth value and explain your reasoning.
   p: January is a fall month.
   q: January has only 30 days.
   r: January 1 is the first day of a new year.
   (a) r or p
   (b) q v ~r
   (c) p v ~q
   (d) ~p or r

---

SCHOOL  The Venn diagram shows the number of students in the band who work after school or on the weekends.

a. How many students work after school and on weekends?

b. How many students work after school or on weekends?
Two hundred people were asked what kind of literature they like to read. They could choose among novels, poetry, and plays. The results are shown in the Venn diagram.

How many people said they like all three types of literature?
How many like to read poetry?
What percentage of the people who like plays also like novels and poetry?
Section 2-3 – Conditional Statement

• **I can write and analyze biconditional statements.**

• **I can write converse, inverse, and contrapositive of a conditional statement.**

- **Conditional Statement** – a statement that can be written in if-then form.

- **If-Then statement** – is the form of if \( p, \) then \( q \). (written as: \( p \rightarrow q \)). It is made up for two parts (the hypothesis and conclusion)

- **Hypothesis** – the phrase immediately following the word “if.” (the “p” statement)

- **Conclusion** – the phrase immediately following the word “then.” (the “q” statement). Sometimes the word then is left out of the conclusion statement.

  Example: IF you would like to speak to a representative, THEN you will need to press 0.
  
  Hypothesis: you would like to speak to a representative
  Conclusion: you will need to press 0

  *Note – that if the word “if” is not used in the hypothesis, then “then” is not used in the conclusion.

1. Identify the hypothesis and conclusion of the statement
   (a) If a polygon has 6 sides, then it is a hexagon.

   (b) Tamika will advance to the next level of play if she completes the maze in her computer game.

2. Identify the hypothesis and conclusion of each conditional statement. Then write each statement in if-then form.
   (a) Measured distance is positive.

   (b) A five-sided polygon is a pentagon.
3. Determine the truth value of each conditional statement. If true, explain your reasoning. If false, give a counterexample.

(a) If you subtract a whole number from another whole number, the result is also a whole number.

(b) If the last month was February, then this month is March.

• **Conditional** – The original statement given (ex: \( p \rightarrow q \))

• **Converse** – formed by exchanging the hypothesis and conclusion of the conditional (ex: \( q \rightarrow p \))

• **Inverse** – formed by negating both the hypothesis and conclusion of the conditional (ex: \( \sim p \rightarrow \sim q \))

• **Contrapositive** – formed by negating both the hypothesis and conclusion of the converse of the conditional – you change the if and then and put not’s on both (ex: \( \sim q \rightarrow \sim p \))

• A conditional and its contrapositive are logically equivalent
• The converse and inverse of a conditional are logically equivalent.

4. Write the converse, inverse, and contrapositive of each true conditional statement. Determine whether each related conditional is true or false. If a statement is false, find a counterexample.

(a) If two angles have the same measure, then they are congruent.

(b) A hamster is a rodent.
Section 2-4 – Deductive Reasoning

- I can apply the Law of Detachment and Law of Syllogism in logical reasoning.

- Deductive Reasoning – uses facts, rules, definitions, or properties to reach logical conclusions from given statements.

- Inductive Reasoning – uses a pattern of examples or observations to make a conjecture.

- Law of Detachment – offers us a way to draw conclusions from if-then statements. It states that whenever a conditional is true and its hypothesis is true, we can assume that the conclusion is true.
  
  SO - If \( p \rightarrow q \) is a true conditional and \( p \) is true, then \( q \) is true (always in this order)
  
  Ex: Given: If a car is out of gas, then it will not start.
  Sarah’s car is out of gas
  Valid Conclusion: Sarah’s car will not start.

- Law of Syllogism - A second law of logic. It is similar to the Transitive Property of Equality. If the true conditional \( (p \rightarrow q) \) and \( (q \rightarrow r) \) are true, then the conclusion of \( (p \rightarrow r) \) is true.
  
  SO - If \( p \rightarrow q \) and \( q \rightarrow r \) are true conditionals, then \( p \rightarrow r \) is also true.
  
  *By the Law of Syllogism – In order for \( p \rightarrow r \), both \( p \rightarrow q \) and \( q \rightarrow r \) must be true statements.
  
  Ex: Given: If Elena goes to the store, then she will buy groceries.
  If she buys groceries, then she will cook dinner.
  Valid Conclusion: If Elena goes to the store, then she will cook dinner.

1. Determine whether each conclusion is based on inductive or deductive reasoning.

   (a) All of the signature items on the restaurant’s menu shown are noted with a special symbol. Kevin orders a menu item that has this symbol next to it, so he concludes that the menu item that he has ordered is a signature item.

   (b) None of the students who ride Raul’s bus own a car. Ebony rides a bus to school, so Raul concludes that Ebony does not own a car.

2. These examples attempt to follow the Law of Detachment. Determine whether the conclusion is valid based on the given information. If not, write invalid. Explain your reasoning.

   (a) Given: If a figure is a square, then it is a parallelogram.

      The figure is a parallelogram.

      Conclusion: The figure is a square.

   (b) Given: If a student turns in a permission slip, then the student can go on the field trip.

      Felipe turned in his permission slip.

      Conclusion: Felipe can go on the field trip.
(c) Given: If three points are noncollinear, they determine a plane.

Points A, B, and C lie in plane G.

Conclusion: Points A, B, and C are noncollinear.

3. These examples attempt to follow the Law of Syllogism. For part (a) Determine which statement follows logically from the given statements. For parts (b-e), determine if a valid conclusion can be drawn from the given information using the Law of Syllogism. If so, what would a valid conclusion be?

(a)  (1) If you do not get enough sleep, then you will be tired.

(2) If you are tired, then you will not do well on the test.

(3) (F) If you are tired, then you will not get enough sleep.
     (G) If you do not get enough sleep, then you will not do well on the test.
     (H) If you do not do well on the test, then you did not get enough sleep.
     (J) There is no valid conclusion.

(b) If an angle is supplementary to an obtuse angle, then it is acute. If an angle is acute, then its measure is less than 90.

(c) If two angles are complementary, then the sum of their measures is 90. If the sum of the measures of two angles is 90, then both of the angles are acute.

(d) If two angles form a linear pair, then the two angles are supplementary. If two angles are supplementary, then the sum of their measures is 180.

(e) If an angle is a right angle, then the measure of the angle is 90. If two lines are perpendicular, then they form a right angle.
4. Determine whether a valid conclusion can be made based on the following statements. Then determine which law was used to find the conclusion if possible.

(1) If Jamal finishes his homework, he will go out with his friends.

(2) If Jamal goes out with his friends, he will go to the movies.

(3)

5. Determine whether a valid conclusion can be made based on the following statements. Then determine which law was used to find the conclusion if possible.

(1) If it snows more than 5 inches, school will be closed.

(2) It snows 7 inches.

(3)
Section 2-5 – Postulates and Paragraph Proofs

- I can order statements based on logic when constructing my proof.
- I can correctly interpret geometric diagrams by identifying what can and cannot be assumed.
- I can identify and apply the basic postulates about points, lines, and planes.

**Proof** - a logical argument in which each statement you make is supported by a statement that is accepted as true. To prove a conjecture, you use deductive reasoning to move from the hypothesis to the conclusion.

**Postulates** - statements that are accepted as true without proof.
See page 125 for postulates 2.1 to 2.7.

2.1 Through any two points, there is exactly one line.

2.2 Through any three noncollinear points, there is exactly one plane.

2.3 A line contains at least two points.

2.4 A plane contains at least three noncollinear points.

2.5 If two points lie in a plane, then the entire line containing those points lies in that plane.

2.6 If two lines intersect, then their intersection is exactly one point.

2.7 If two planes intersect, then their intersection is exactly one line.

1. Explain how the picture in Example 1 illustrates that each statement is true. Then state the postulate that can be used to show each statement is true.
   (a) Points F and G lie in plane Q and on line m. Line m lies entirely in plane Q.
   (b) Points A and C determine a line.
   (c) Points A, B, and C determine a plane.
   (d) Planes P and Q intersect in line m.
2. Determine whether each statement is always, sometimes or never true. Explain your reasoning.
(a) If plane T contains line EF and line EF contains point G, then plane T contains point G.

(b) Line GH contains three noncollinear points.

(c) Two lines determine a plane.

(d) Three lines intersect in two points.

**Theorems** – a statement or conjecture that has been proven true. It can be used as a reason to justify statements in other proofs.

Ex. The proof for the Midpoint Theorem is on p.127 so it may be used as a statement in other proofs.

2.1 **Midpoint Theorem**: If M is the midpoint of \( \overline{AB} \), then \( \overline{AM} \cong \overline{MB} \).

**Paragraph proof**: also known as an informal proof. This a paragraph to explain why the conjecture is true. You must use postulates and theorems to support your statements.

3. Given \( \overline{AC} \) intersects \( \overline{CD} \), write a **paragraph proof** to show that A, C, and D determine a plane.
Section 2-6 – Algebraic Proof

- I can order statements based on logic when constructing my proof.
- I can identify and use properties of congruence and equality (reflexive, symmetric, transitive) in proofs.

2-column proof: also know as a formal proof contains statements and reasons organized in two columns. It has the same parts as the paragraph proof except it uses 2 columns for the statements and reasons instead of writing it as a paragraph.

Algebraic proof: made up of a series of algebraic statements and uses the properties of real numbers to support the statements. Basically, solve an equation like you normally would and then name the property that allows you to do each step.

Properties or “reasons” for the proofs are on page 134.

### The following properties are true for any real numbers a, b, and c.

<table>
<thead>
<tr>
<th>Property</th>
<th>Statement</th>
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</thead>
<tbody>
<tr>
<td>Addition Property of Equality</td>
<td>If a = b, then a + c = b + c.</td>
</tr>
<tr>
<td>Subtraction Property of Equality</td>
<td>If a = b, then a - c = b - c.</td>
</tr>
<tr>
<td>Multiplication Property of Equality</td>
<td>If a = b, then a \cdot c = b \cdot c.</td>
</tr>
<tr>
<td>Division Property of Equality</td>
<td>If a = b and c ≠ 0, then ( \frac{a}{c} = \frac{b}{c} ).</td>
</tr>
<tr>
<td>Reflexive Property of Equality</td>
<td>a = a</td>
</tr>
<tr>
<td>Symmetric Property of Equality</td>
<td>If a = b and b = a.</td>
</tr>
<tr>
<td>Transitive Property of Equality</td>
<td>If a = b and b = c, then a = c.</td>
</tr>
<tr>
<td>Substitution Property of Equality</td>
<td>If a = b, then a may be replaced by b in any equation or expression.</td>
</tr>
<tr>
<td>Distributive Property</td>
<td>a(b + c) = ab + ac</td>
</tr>
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</table>

1. Prove that if \(-5(x + 4) = 70\), then \(x = -18\)

<table>
<thead>
<tr>
<th>Statements</th>
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2. Prove that if \(2(5-3a) - 4(a + 7) = 92\), then \(a = -11\)

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<th>Statements</th>
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3. Given: \(\frac{5x+1}{2} - 8 = 0\)
Prove: \(x = 3\)

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</table>
Geometric Proof  Geometry deals with numbers as measures, so geometric proofs use properties of numbers. Here are some of the algebraic properties used in proofs.

<table>
<thead>
<tr>
<th>Property</th>
<th>Segments</th>
<th>Angles</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reflexive</td>
<td>$AB = AB$</td>
<td>$m\angle 1 = m\angle 1$</td>
</tr>
<tr>
<td>Symmetric</td>
<td>If $AB = CD$, then $CD = AB$.</td>
<td>If $m\angle 1 = m\angle 2$, then $m\angle 2 = m\angle 1$.</td>
</tr>
<tr>
<td>Transitive</td>
<td>If $AB = CD$ and $CD = EF$, then $AB = EF$.</td>
<td>If $m\angle 1 = m\angle 2$ and $m\angle 2 = m\angle 3$, then $m\angle 1 = m\angle 3$.</td>
</tr>
</tbody>
</table>

4. Given: $\angle A \cong \angle B$, $m\angle B = 2m\angle C$, and $m\angle C = 45$
Prove: $m\angle A = 90$

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5. If $\overline{CD} \cong \overline{EF}$, then $y = 8$

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Section 2-7 – Proving Segment Relationships

- I can order statements based on logic when constructing my proof.
- I can write proofs involving segment addition and congruence.

Segment Addition Two basic postulates for working with segments and lengths are the Ruler Postulate, which establishes number lines, and the Segment Addition Postulate, which describes what it means for one point to be between two other points.

<table>
<thead>
<tr>
<th>Ruler Postulate</th>
<th>The points on any line or line segment can be put into one-to-one correspondence with real numbers.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Segment Addition Postulate</td>
<td>If $A$, $B$, and $C$ are collinear, then point $B$ is between $A$ and $C$ if and only if $AB + BC = AC$.</td>
</tr>
</tbody>
</table>

Segment Congruence Remember that segment measures are reflexive, symmetric, and transitive. Since segments with the same measure are congruent, congruent segments are also reflexive, symmetric, and transitive.

<table>
<thead>
<tr>
<th>Reflexive Property</th>
<th>$AB \cong AB$</th>
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</thead>
<tbody>
<tr>
<td>Symmetric Property</td>
<td>If $AB \cong CD$, then $CD \cong AB$.</td>
</tr>
<tr>
<td>Transitive Property</td>
<td>If $AB \cong CD$ and $CD \cong EF$, then $AB \cong EF$.</td>
</tr>
</tbody>
</table>

1. Prove that if $AB \cong CD$, then $AC \cong BD$.

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<tr>
<th>Statements</th>
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</table>
2. Given: \( WY = YZ, YZ \cong XZ, \text{ and } XZ \cong WX \)
Prove: \( WX \cong WY \)

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Example: Write a two-column proof.

Given: \( Q \) is the midpoint of \( PR \).
\( R \) is the midpoint of \( QS \).

Prove: \( PR = QS \)

Proof:

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</table>
Section 2-8 – Proving Angle Relationships

- I can order statements based on logic when constructing my proof.
- I can write proofs that involve supplementary and complementary angles, congruence of vertical angles, and congruent and right angles.

**Supplementary and Complementary Angles** There are two basic postulates for working with angles. The Protractor Postulate assigns numbers to angle measures, and the Angle Addition Postulate relates parts of an angle to the whole angle.

<table>
<thead>
<tr>
<th>Protractor Postulate</th>
<th>Given any angle, the measure can be put into one-to-one correspondence with real numbers between 0 and 180.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Angle Addition Postulate</td>
<td>$\angle QRS$ is in the interior of $\angle PQS$ if and only if $m\angle PQS + m\angle QRS = m\angle PQS$.</td>
</tr>
</tbody>
</table>

The two postulates can be used to prove the following two theorems.

<table>
<thead>
<tr>
<th>Supplement Theorem</th>
<th>If two angles form a linear pair, then they are supplementary angles. Example: If $\angle 1$ and $\angle 2$ form a linear pair, then $m\angle 1 + m\angle 2 = 180$.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Complement Theorem</td>
<td>If the noncommon sides of two adjacent angles form a right angle, then the angles are complementary angles. Example: If $GF \perp GH$, then $m\angle 3 + m\angle 4 = 90$.</td>
</tr>
</tbody>
</table>

**Congruent and Right Angles** The Reflexive Property of Congruence, Symmetric Property of Congruence, and Transitive Property of Congruence all hold true for angles. The following theorems also hold true for angles.

<table>
<thead>
<tr>
<th>Congruent Supplements Theorem</th>
<th>Angles supplement to the same angle or congruent angles are congruent.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Congruent Complements Theorem</td>
<td>Angles complement to the same angle or to congruent angles are congruent.</td>
</tr>
<tr>
<td>Vertical Angles Theorem</td>
<td>If two angles are vertical angles, then they are congruent.</td>
</tr>
<tr>
<td>Theorem 2.9</td>
<td>Perpendicular lines intersect to form four right angles.</td>
</tr>
<tr>
<td>Theorem 2.10</td>
<td>All right angles are congruent.</td>
</tr>
<tr>
<td>Theorem 2.11</td>
<td>Perpendicular lines form congruent adjacent angles.</td>
</tr>
<tr>
<td>Theorem 2.12</td>
<td>If two angles are congruent and supplementary, then each angle is a right angle.</td>
</tr>
<tr>
<td>Theorem 2.13</td>
<td>If two congruent angles form a linear pair, then they are right angles.</td>
</tr>
</tbody>
</table>

1. $m\angle 1 = x + 10$
   $m\angle 2 = 3x + 18$

2. $m\angle 4 = 2x - 5$
   $m\angle 5 = 4x - 13$

3. $m\angle 6 = 7x - 24$
   $m\angle 7 = 5x + 14$
4. \( m\angle 13 = 4x + 11 \), 
   \( m\angle 14 = 3x + 1 \)

5. \( \angle 9 \) and \( \angle 10 \) are complementary.
   \( \angle 7 \cong \angle 9 \), \( m\angle 8 = 41 \)

6. If \( \angle 1 \) and \( \angle 2 \) are vertical angles and the \( m\angle 1 = d - 32 \) and the \( m\angle 2 = 175 - 2d \), find the \( m\angle 1 \) and the \( m\angle 2 \). Justify each step (in proof form).

7. In the figure, \( \angle ABE \) and \( \angle DBC \) are right angles. Prove that \( \angle ABD \cong \angle EBC \)

8. In the figure, \( \angle 1 \) and \( \angle 4 \) form a linear pair, and \( m\angle 3 + m\angle 1 = 180 \). Prove that \( \angle 3 \) and \( \angle 4 \) are congruent. Write a proof to show your steps.
Extra Practice:

**Example** Write a two-column proof.

**Given:** \( \angle ABC \) and \( \angle CBD \) are complementary. 
\( \angle DBE \) and \( \angle CBD \) form a right angle.

**Prove:** \( \angle ABC \cong \angle DBE \)

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Complete the following proof.

**Given:** \( \angle QPS \cong \angle TPR \)

**Prove:** \( \angle QPR \cong \angle TPS \)

**Proof:**

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1. **Given:** \( \overline{AB} \perp \overline{BC} \); 
\( \angle 1 \) and \( \angle 3 \) are complementary.

**Prove:** \( \angle 2 \cong \angle 3 \)

**Proof:**

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2. **Given:** \( \angle 1 \) and \( \angle 2 \) form a linear pair.
\( m\angle 1 + m\angle 3 = 180 \)

**Prove:** \( \angle 2 \cong \angle 3 \)

**Proof:**

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Write a two-column proof.

**Given:** \( \angle 1 \) and \( \angle 2 \) form a linear pair.
\( \angle 2 \) and \( \angle 3 \) are supplementary.

**Prove:** \( \angle 1 \cong \angle 3 \)