REVIEWER IN MATHEMATICS 9
FIRST TERM

Relation - is any set of ordered pairs (x,y)
Domain - the set of all first coordinations, x-values (inputs)
Range - the set of all coordinates, y-values (outputs)

REPRESENTATION OF A RELATION

1. **Ordered Pairs**
2. **Tables**
3. **Mapping Diagrams**
4. **Graph**
5. **Rule/Equation**

TYPES OF CORRESPONDENCE

1. **One-to-One** - is a type of correspondence where every element in the domain is mapped to a unique element in the range.
2. **Many-to-One** - is a type of correspondence where two or more elements of the domain are mapped to the same element in the range.
3. **One-to-Many** - is a type of correspondence where each element in the domain is mapped to any two or more elements in the range.

Remember:

- One-to-One and Many-to-One relations are functions.
- One-to-Many relations are not functions.

Function - is a relation in which each element of the domain corresponds to exactly one element of the range, a set of ordered pairs is a function if **no two distinct ordered pairs have equal abscissas**.
Vertical Line Test - If a line is drawn anywhere in the graph and the line intersects the graph at exactly one point, then the relation defined by the graph is a function.

Remember:
In an equation defining a relation, if **the exponent of y is odd, the relation is a function**. But if **the exponent of y is even, the relation is not a function.**

Function Notation - the f(x) notation can be used to define a function and to denote the value of the function f at a given value of x. The letters such as g, h, and the like can also denote functions.
Domain of a Function - is the set of all permissible values of x that will give a real number value for y or f(x).
Range of a Function - is the set of all permissible values of y or f(x) that will give real number values for x.

METHODS OF WRITING OR REPRESENTING SETS

1. **Roster Method(Listing Method)**
2. **Rule Method(Set-Builder Notation)**
3. **Interval Notation**

THE CORE SYMBOLS IN INTERVAL NOTATION

- **Parentheses ()** represent exclusive endpoints (strictly less than or greater than). The endpoint itself is not included in the set.
- **Brackets []** represent inclusive endpoints (less than or equal to or greater than or equal to). The endpoint itself is included in the set.
- **Infinity (infty or -infty)** is used when a set continues endlessly. It always gets a parenthesis because infinity is a concept, not a reachable number.

COMMON INTERVAL TYPES

- **Open Interval:** The inequality $a<x<b$ is written in interval notation as (a,b), which describes numbers

between a and b while excluding both endpoints.

- **Closed Interval:** The inequality $a \le x \le b$ is written in interval notation as [a,b], which describes numbers between a and b while including both endpoints.
- **Half-Open / Half-Closed Interval (Including a):** The inequality $a \le x < b$ is written in interval notation as [a,b), which includes the endpoint a but excludes the endpoint b.
- **Half-Open / Half-Closed Interval (Including b):** The inequality $a < x \le b$ is written in interval notation as (a,b], which excludes the endpoint a but includes the endpoint b.

INFINITE INTERVALS

- x > a can be written as (a, infty).
- x >= a can be written as [a, infty).
- x < a can be written as (-infty, a).
- x <= a can be written as (-infty, a].
- All real numbers can be written as (-infty, infty).

QUICK RULE

- **Use [or] (Square Brackets) if the endpoint is included (<=, >=, or a solid dot).**
- **Use (or) (Parentheses) if the endpoint is excluded (<, >, or an open circle).**
- **Always write numbers in order from left to right (smallest number on the left, largest on the right).**
- **Always gets a parenthesis (or). Infinity is a concept, not a reachable number.**

THE UNION SYMBOL (U)

If a set of numbers is divided into two or more separate, disconnected intervals, they are combined using the union symbol.

Example:x < 2 or x >= 5 can be written as

(-infty, 2) U [5, infty)

When CAN'T you use the interval notation?

- **Discrete sets/Individual numbers**
  - **Example:** {2, 4, 6, 8}
  - **Reason:** Interval (2, 8) would include 3, 5, 7,... which are not in the set.
- **Sets with gaps/holes**
  - **Example:** All integers from 1 to 10 {1, 2, 3, 4, 5, 6, 7, 8, 9, 10}
  - **Reason:** Interval [1, 10] would include 1.5, 2.7, pi,.. but those are not integers.
- **Non-numerical sets**
  - **Example:** {a, e, i, o, u}
  - **Reason:** You cannot put letters on a number line with < or > signs.
- **Sets described by a property, not a range**
  - **Example:** {xix is a prime number}
  - **Reason:** Prime numbers are 2, 3, 5, 7, 11,.. with gaps everywhere. There is no single interval for it.

Asymptote- is a line which the graph approaches but never intersects.

Variable - is an alphabet or term that represents an unknown number or unknown value or unknown quantity. It is a quantity that can be changed or which is not fixed according to the mathematical operation performed.

Dependent Variable - is a variable whose value depends on another variable.

Independent Variable - is a variable whose value never depends on another variable.

Independent variable = the variable you choose or change

Dependent variable = the variable that changes because of the independent variable

In a function:

y = f(x)

- x is the **independent variable**
- y is the **dependent variable** because the value of y **depends on** the value of x.

CHARACTERISTICS OF A LINEAR FUNCTION

- **It has a constant rate of change.** If one variable increases, the other increases or decreases by the same amount each time.
  Example: S = 50w
  The savings increase by 50 pesos for every 1 week.
  Constant rate = 50 pesos per week
- **Its equation can be written as y = mx + b.**
  Here, **m** is the constant rate, and **b** is the starting value.
  Example: y = -3x + 5, f(x) = 2x - 6
- **The variable has an exponent of 1 only.**
  Example: x is linear, but x^2 is not linear.
- **Its graph is a straight line.**

NOTE:

- **No variable in a linear function is used as the denominator of a fraction.**
  Example: f(x) = 3/x + 2 is not a linear function
- **Each term of a linear function must contain only one variable.**
  Example: f(x) = 4xy + 5 is not a linear function
- **No variable in a linear function is found inside the radical sign.**
  Example: f(x) = 3{x} + 4 is not a linear function.
- In the Graph, it appears as a straight line.
- In the table, the change in the values is consistent.
- In the equation, it is usually written in the form y = mx + b or f(x) = mx+b, where m is the slope and b is the y-intercept.

A **linear function** always involves **slope** because slope helps us describe how the line goes up or down.

Slope tells us **how steep a line is** and shows the direction of the line. It tells us how much the value of y changes for every change in x.

The symbol for slope is "m"

Remember this: the bigger the slope, the steeper the line.

This means that as the slope gets larger, the line goes up faster.

THE SLOPE OF A LINEAR FUNCTION

- **Positive Slope (m>0):** When the slope m is positive, the line rises from left to right (increasing).
- **Negative Slope (m<0):** When the slope m is negative, the line falls from left to right (decreasing).

- **Zero Slope (m=0):** When the slope m equals zero, the graph is a completely flat horizontal line.
- **Undefined Slope:** When the slope m is undefined, the graph is a straight vertical line.

Equation:

Graphs:m=rise/run

Table of Values:m=change in y/change in x

THE ZERO OF A LINEAR EQUATION

- The zero of a linear function is the value of x that makes the function equal to zero.
- In other words, it is the x-value when y = 0.
- The zero of a linear function can be determined in different ways depending on how the function is represented.
- In a graph, the zero is found by locating the point where the line crosses the x-axis.
- Since all points on the x-axis have a y-value of 0, the x-coordinate of that point is the zero of the function.
- In a table of values, the zero is found by looking for the value of x that corresponds to y = 0.
- If the table shows that y = 0 when x = 3, then the zero of the function is 3.
- In an equation, the zero is found by replacing y or f(x) with 0 and solving for x.
- For example, in the equation y = 2x - 4, let y = 0. Then, 0 = 2x - 4. Solving gives x = 2, so the zero of the function is 2.

WAYS TO GRAPH A LINEAR FUNCTION

1. **Using two points**
    - Assign any two values for x
    - Substitute each assigned value of x into the equation and solve for y
    - Plot the points in the Cartesian plane and connect them
2. **Using x and y intercept**
    - Let x be equal to 0 and substitute this value into the equation to solve for y
    - Let y be equal to 0 and substitute this value into the equation to solve for x
    - Plot the points in the Cartesian plane and connect them
3. **Using slope and y intercept**
    - Determine the given
    - Plot the y-intercept
    - Use the slope to find the other point
    - Connect the two points
4. **Using slope and a point**
    - Determine one point of the graph by substitution any value for x in the equation
    - Plot the point on the Cartesian plane
    - Use the slope to find the other point

PROBLEM SOLVING WORDS TO WATCH FOR

Per / Each: The words "per" or "each" usually mean the slope or rate of change.
Starting at: The phrase "starting at" usually means the y-intercept or initial value.
Initial fee: An "initial fee" usually means the y-intercept.
Constant rate: A "constant rate" usually means a linear relationship.
Increases by: The phrase "increases by" usually means a positive slope.
Decreases by: The phrase "decreases by" usually means a negative slope.

Total cost: The "total cost" usually means the output, represented by y.
Number of items: The "number of items" usually means the input, represented by x.
How much: The phrase "how much" usually means to solve for y.

Parallel Lines - Two Lines are parallel if and only if they are coplanar and do not intersect.

CONDITIONS FOR PARALLELISM OF LINES

1. CACP Theorem

If two coplanar lines are cut by a transversal and corresponding angles are congruent, then the lines are parallel.

2. AIACP Theorem

If two coplanar lines are cut by a transversal and alternate interior angles are congruent, then the two lines are parallel.

3. AEACP Theorem

If two coplanar lines are cut by a transversal and alternate exterior angles are congruent, then the two lines are parallel.

4. SSIASP Theorem

If two coplanar lines are cut by a transversal and same-side interior angles are supplementary, then the two lines are parallel.

5. SSEASP Theorem

If two coplanar lines are cut by a transversal and same-side exterior angles are supplementary, then the two lines are parallel.

6. The Three Parallel Lines Theorem

In a plane, if two lines are both parallel to a third line, then the two lines are parallel.

7. In a plane, if two lines are perpendicular to the same line, then the two lines are parallel.

Perpendicular Lines- Two lines that intersect to form right angles. Line segments and rays can also be perpendicular.

CONDITIONS FOR PERPENDICULARITY OF LINES

1. If two intersecting lines form adjacent congruent angles, then the lines are perpendicular.
2. If a transversal is perpendicular to one of two parallel lines, then it is perpendicular to the other parallel line.

SLOPE CONDITIONS FOR THE PARALLELISM AND PERPENDICULARITY OF LINES

- Two lines are parallel if their slopes are equal but their y-intercepts are not equal.
- Two lines are perpendicular if their slopes are negative reciprocals of each other.

Quadrilateral - a closed geometric figure with four sides and four vertices. Its segments intersect only at their endpoints.

Quadri - four

Latus - side

Rules

To name a quadrilateral, list its four vertices in consecutive alphabetical order, either clockwise or counterclockwise, starting at any corner and use the symbol: square

Parts

- Vertex
- Side
- Diagonal

Consecutive Sides- any two sides of a quadrilateral that share a common endpoint

Nonconsecutive Sides- any two sides of a quadrilateral that do not share a common endpoint

Diagonal of a Quadrilateral- a straight-line segment that connects two opposite, non-adjacent vertices. Every standard simple quadrilateral has exactly **two diagonals**.

Types of Quadrilaterals

- Parallelogram
- Square
- Rectangle
- Rhombus
- Trapezoid
- Trapezium
- Kite

Parallelogram- a quadrilateral with two pairs of parallel sides

Properties:

1. Opposite sides are equal and parallel.
2. Diagonals are not equal.
3. Diagonals bisect each other.
4. Opposite angles are equal.
5. Consecutive angles are supplementary.
6. Diagonals divides the quadrilateral into two congruent triangles

Square- a parallelogram with four congruent sides and four right angles

Square Properties:

1. Opposite sides are parallel and all sides are equal.
2. Diagonals are equal.
3. Diagonals bisect each other at right angles.
4. All angles are right angles.

Rectangle- a parallelogram with four right angles.

Properties:

1. Opposite sides are equal and parallel.
2. Diagonals are equal.
3. Diagonals bisect each other.
4. All angles are right angles.

Rhombus- a parallelogram with four congruent sides.

Properties:

1. Opposite sides are parallel and equal.
2. Diagonals are not equal.
3. Diagonals bisect each other at right angles.
4. Opposite angles are equal.
5. Consecutive angles are supplementary.

Trapezoid- a quadrilateral with one pair of parallel sides.**I**f the non-parallel sides, called legs, are congruent, then the trapezoid is isosceles.

Properties:

1. Has one pair of opposite sides which are parallel.
2. Diagonals are not equal.
3. Diagonals of trapezoids do not bisect each other.
4. Angles at the end of non-parallel sides are supplementary.

Trapezium- a quadrilateral with no pair of parallel sides.

Properties:

1. No sides are parallel.
2. Sides have different lengths.
3. Diagonals are not equal and do not bisect each other.

Kite- a quadrilateral with two pairs of adjacent sides congruent.

Properties:

1. Two pairs of adjacent sides are equal.
2. Longer diagonal bisects shorter diagonal.
3. One pair of opposite angles are equal.

Quadrilateral Hierarchy Diagram

Quadrilateral: The top-level category representing any four-sided polygon, which branches down into three main groups: Parallelograms, Kites, and Trapezoids.

Parallelogram: A main branch under quadrilaterals that further divides into **Rectangles** (parallelograms with four right angles) and **Rhombuses** (parallelograms with four equal sides).

Square: Positioned at the bottom, a square is a special type of quadrilateral that combines all the properties of both a **Rectangle** and a **Rhombus**.

Kite: Directly connected to the quadrilateral, a kite shares a two-way relationship with a **Rhombus**, as a rhombus can be considered a special symmetrical type of kite where all four sides are equal.

Trapezoid: A distinct branch of quadrilaterals characterized by having a pair of parallel sides, which further specializes into an **Isosceles Trapezoid** when its non-parallel sides are congruent.

IMPORTANT PROPERTIES TO REMEMBER
Parallelogram: Opposite sides are equal, opposite angles are equal, and adjacent angles add up to 180°.
Rectangle: Opposite sides are equal, and all angles measure 90°.
Square: All sides are equal, and all angles measure 90°.
Rhombus: All sides are equal, opposite angles are equal, and adjacent angles add up to 180°.

Parallelogram

- **Perimeter: $P = 2a + 2b$ (where a and b are adjacent side lengths)**
- **Side Equivalence: $a = c$ and $b = d$ (opposite sides are equal)**

Rectangle

- **Perimeter: $P = 2l + 2w$ (where l is length and w is width)**
- **Side Equivalence: $l_1 = l_2$ and $w_1 = w_2$**

Square

- **Perimeter: $P = 4s$ (where s is side length)**
- **Side Equivalence: $s_1 = s_2 = s_3 = s_4$**

Rhombus

- **Perimeter: $P = 4s$ (where s is side length)**
- **Side Equivalence: $s_1 = s_2 = s_3 = s_4$**