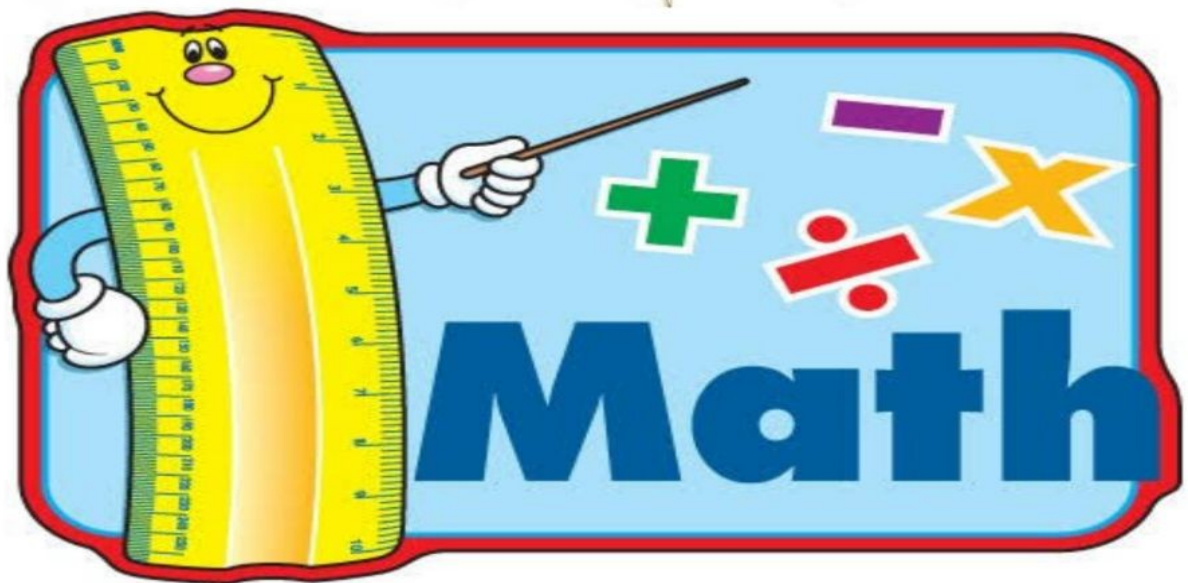
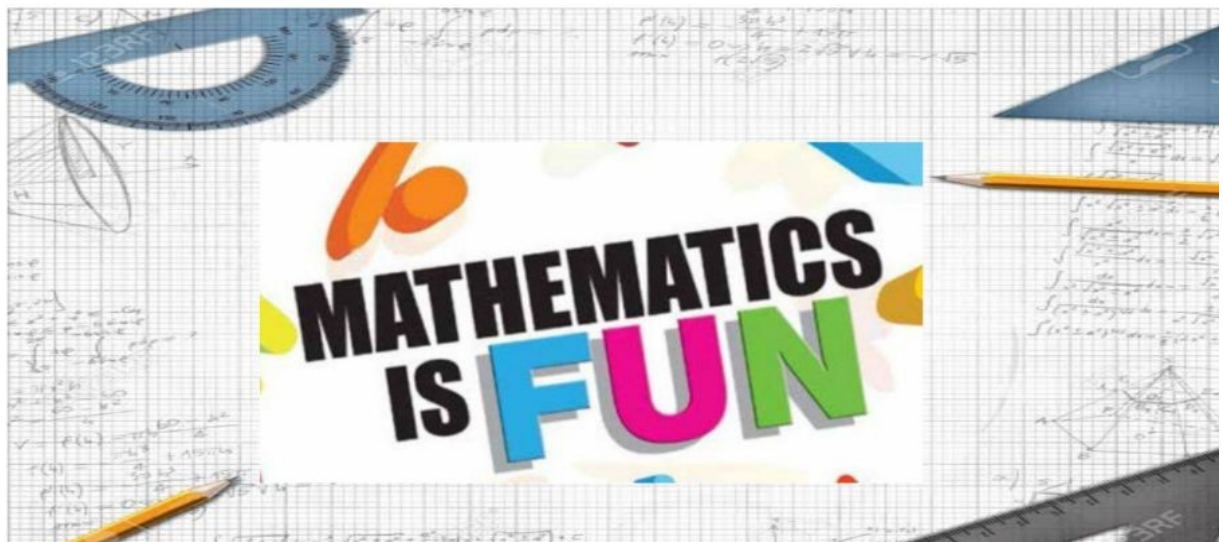


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A Function

A Function is a relation such that no two ordered pairs have the same first coordinates and different second coordinates or A Function is a relation in which domain element has exactly one corresponding range element.

Example :- $R = \{(1, 9), (2, 8), (3, 7)\}$

Note :- Every function is a relation but every relation is not a function.

Domain and range of a function

→ As a function is a special type of relation the domain and range of a function are determined in the same way.

Example :- Consider a relation, $R = \{(4, 5), (6, 7), (8, 9)\}$, Find domain and range of R

Soln :- domain of function are the coordinate i.e. $\{4, 6, 8\}$, range of a function are the second coordinate i.e. $\{5, 7, 9\}$

Combination of functions

Sum of function :- suppose F and G are two functions the sum of these functions is also a function which is defined as

$$F+G \text{ where } F+G(x) = F(x) + G(x)$$

Example :- If $F(x) = 2x - 2$ and $G(x) = 3x + 2$ Find $F+G(x)$

$$\text{Soln :- } F(x) + G(x) = \cancel{2x} + 3x + 2$$

$$= 4x + 2$$

Difference of function :- suppose F and G are two functions the difference of these functions is also a function which is defined as $F-G$ where $F-G(x) = F(x) - G(x)$

Example :- If $F(x) = 3x + 2$ and $G(x) = x - 4$ then find $F-G$ and $F-G(2)$

$$\text{Soln :- } F(x) - G(x) = 3x + 2 - (x - 4)$$

$$= 2x + 6$$

$$= F(2) = 3(2) + 2 = 8, \quad 8 - (-2) = 8 + 2 = 10$$

$$= G(2) = 2 - 4 = -2$$

Example 2 :- Let $f(x) = 3x - 3$ and $g(x) = \frac{2}{x} - 1$ Evaluate $(f-g)(4)$

$$f-g(4) = f(4) - g(4)$$

$$f = 3(4) - 3 = 9, \quad \frac{2}{4} - 1 = \frac{2}{4} - \frac{2}{2} = \frac{2-2}{4} = \frac{0}{4} = 0$$

$$g = \frac{2}{4} - 1 = \frac{2}{4} - \frac{2}{2} = \frac{2-2}{4} = \frac{0}{4} = 0$$

Graphs of function

Graphs of linear function

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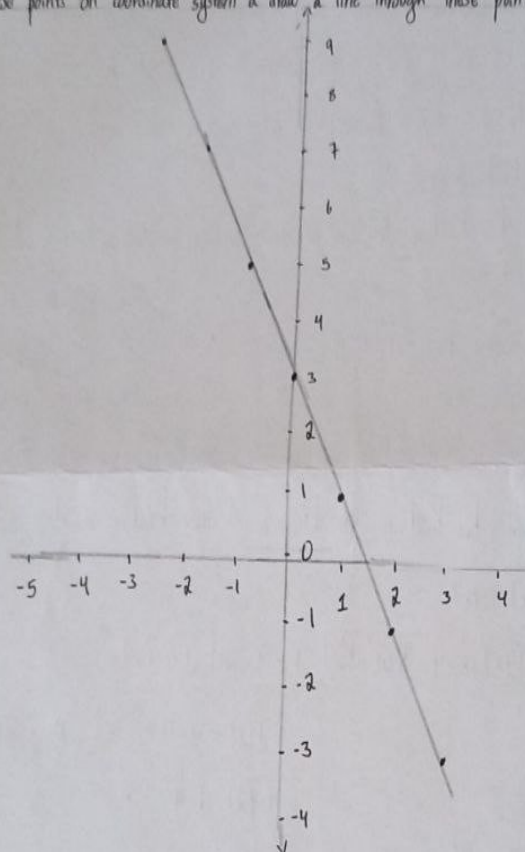
Defn:- If a and b are fixed real numbers $a \neq 0$, then $f(x) = ax + b$, for $x \in \mathbb{R}$ is called a linear function.
If $a = 0$, then $f(x) = b$ is a constant function.

Example:- Draw the graph of the linear function, $f(x) = -2x + 3$

Soln:- First you construct a table of values from the domain

x	-3	-2	-1	0	1	2	3
$f(x)$	9	7	5	3	1	-1	-3

Now you plot these points on coordinate system and draw a line through these points. This line is graph of the linear function $f(x) = -2x + 3$



Graphs of Quadratic Function

Defn:- A quadratic function is a function of the form $f(x) = ax^2 + bx + c$ where a, b, c and $a \neq 0$

- The domain of a quadratic function is the set of real number
- The graph of all quadratic function is called parabola.
- The lowest or highest point of a parabola is called vertex.

- To graph the quadratic function $f(x) = ax^2 + bx + c$ 1st express $f(x)$ as $a(x-h)^2 + k$ where $h = -b/2a$ and $k = f(-b/2a)$

- In a quadratic function $f(x) = a(x-h)^2 + k$, Vertex = (h, k) , axis of symmetry $x = h$

- If $a > 0$ the graph opens up ward, If $a < 0$ the graph opens down ward

- To obtain the graph of $f(x) = a(x-h)^2 + k$ shifting the graph of $f(x) = ax^2$

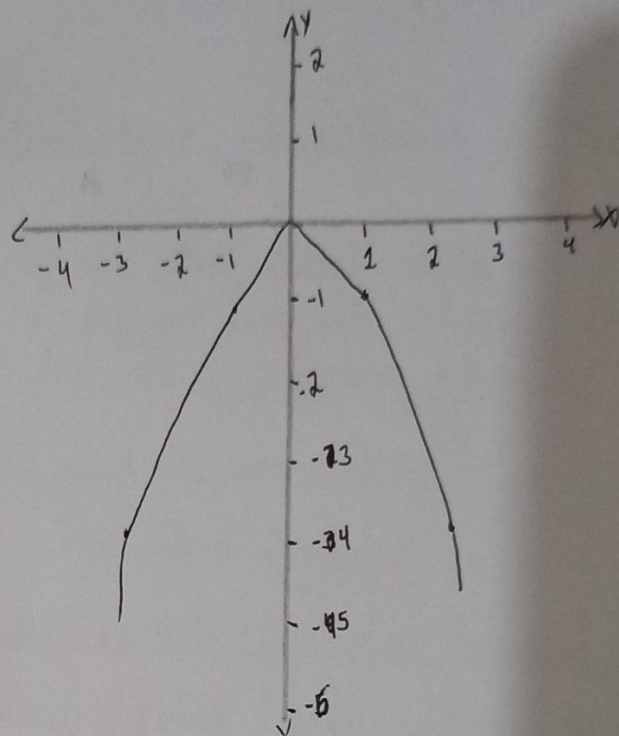
h units to the right if $f(x) = a(x-h)^2 + k$
 h units to the left if $f(x) = a(x+h)^2 + k$

ii, k units up if $k > 0$
 k units down if $k < 0$

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Example :- Draw the graph of $f(x) = -x^2$

X	-2	-1	0	1	2
F(x)	-4	-1	0	-1	-4



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Geometry and measurement Polygons and area of Polygons

Defn: A Polygon is a closed plane figure, formed by three or more line segments.

- * Each line segments are called sides.
- * Each side of polygon intersects exactly two other sides one at each end points, so that two sides with common vertex ~~and~~ are not collinear.

- Convex and Concave Polygon

A Polygon is a convex if no line that contains a side of the polygon contains a point in the exterior of the polygon.

- * Each interior angle of convex polygon is less than 180° .
- * A polygon that is not convex is called concave, one of more of interior angle of concave polygon is greater than 180° .

the sum of the measure of interior angle of polygon

* the sum of the interior angle measures convex polygon depends on the number of sides of polygon.

n -side polygon is

$$S = (n-2) \times 180^\circ$$

Example: - Find the sum of the measures of the interior angle.

a) quadrilateral

$$a, n = (4)$$

$$S = (n-2) \times 180^\circ$$

$$= (4-2) \times 180^\circ$$

$$= 2 \times 180^\circ$$

$$= \underline{360^\circ}$$

b) pentagon

$$b, n = 5$$

$$S = (n-2) \times 180^\circ$$

$$= (5-2) \times 180^\circ$$

$$= 3 \times 180^\circ$$

$$= \underline{540^\circ}$$

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MEASURE Angle of Regular Polygon

A regular polygon is a convex polygon in w/c the length all of its sides are equal and the measure of all its angles are congruent.

- For n -sides regular polygon

i. Each interior angle = $\frac{(n-2)180^\circ}{n}$

ii. Each central angle = $\frac{360^\circ}{n}$

iii. Each exterior angle = $\frac{360^\circ}{n}$

iv. Number of side = $\frac{360^\circ}{\text{Exterior angle}}$

E.g. Find the measure of each interior, central and exterior angle of regular octagon.

Soln, Octagon = 8

Interior angle = $\frac{(8-2)180^\circ}{8} = 135^\circ$

Central angle = $\frac{360^\circ}{8} = 45^\circ$

Exterior angle = $\frac{360^\circ}{8} = 45^\circ$

E.g. Find the number of sides, if the measure of each interior angle, a regular polygon is 150° .

Soln, Each interior angle = $\frac{(n-2)180^\circ}{n}$

$$= \frac{150^\circ \cdot n}{n} = \frac{(n-2)180^\circ}{n}$$

$$= 150^\circ n = 180^\circ n - 360^\circ$$

$$= 360^\circ = 180^\circ n - 150^\circ n$$

$$= \frac{360^\circ}{30} = \frac{30^\circ n}{30}$$

$$n = 12$$

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Properties of Regular Polygon
Radius, Apothem, side length, Perimeter and area
of regular Polygon

- radius (r) of a regular polygon is a distance from the center to vertex.
- Apothem (a) of a regular polygon is a perpendicular distance from the center to the side.
- the formula for side, length, apothem, perimeter and area of regular polygon with n -sides and radius area.

$$i) \text{ Apothem } (a) = r \cos \left(\frac{180^\circ}{n} \right)$$

$$ii) \text{ Side length } (s) = 2r \sin \left(\frac{180^\circ}{n} \right)$$

$$iii) \text{ Perimeter } (P) = 2nr \sin \left(\frac{180^\circ}{n} \right)$$

$$iv) \text{ Area } (A) = \frac{1}{2} aP$$

Note: $\sin 30^\circ = \cos 60^\circ = \frac{1}{2}$
 $\sin 60^\circ = \cos 30^\circ = \frac{\sqrt{3}}{2}$

$$\sin 45^\circ = \cos 45^\circ = \frac{\sqrt{2}}{2}$$

Example: Each side of a regular hexagon is 6cm find
a) Apothem b) Area

$$\text{Soln, a) Apothem} = r \cos \left(\frac{180^\circ}{n} \right)$$

$$s = 6\text{cm} \quad n = 6$$

$$a = r \cos \left(\frac{180^\circ}{n} \right)$$

$$a = r \cos \left(\frac{180^\circ}{6} \right)$$

$$r = ?$$

$$s = 2r \sin \left(\frac{180^\circ}{n} \right)$$

$$6\text{cm} = 2r \sin \frac{180^\circ}{6}$$

$$6\text{cm} = 2r \sin 30^\circ$$

$$6\text{cm} = 2r \left(\frac{1}{2} \right)$$

$$r = 6\text{cm}$$

$$a = r \cos \left(\frac{180^\circ}{6} \right)$$

$$= 6\text{cm} \cos 30^\circ$$

$$= 6\text{cm} \cdot \frac{\sqrt{3}}{2}$$

$$= 3\sqrt{3}\text{cm}$$

$$A = \frac{1}{2} aP$$

$$P = 2nr \sin \left(\frac{180^\circ}{n} \right)$$

$$= 2 \cdot 6 \cdot 6 \sin \left(\frac{180^\circ}{6} \right)$$

$$= 72 \sin 30^\circ$$

$$= 72 \cdot \frac{1}{2}$$

$$P = 36\text{cm}$$

$$A = \frac{1}{2} aP$$

$$= \frac{1}{2} (3\sqrt{3}\text{cm} \cdot 36\text{cm})$$

$$A = 54\sqrt{3}\text{cm}^2$$

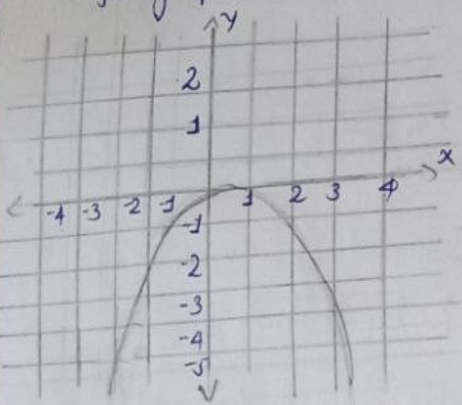
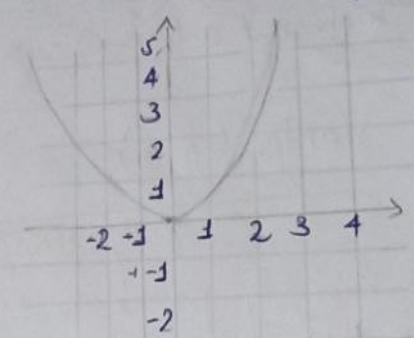
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UNIT FOUR

4.3.2 Graphs of Quadratic Functions

✓ Is a function in the form of $f(x) = ax^2 + bx + c$ where $a \neq 0$
 Domain of function: set of all real numbers
 The graph is called parabolas.
 ↓
 Leading Coefficient

✓ The graph opens upward if $a > 0$

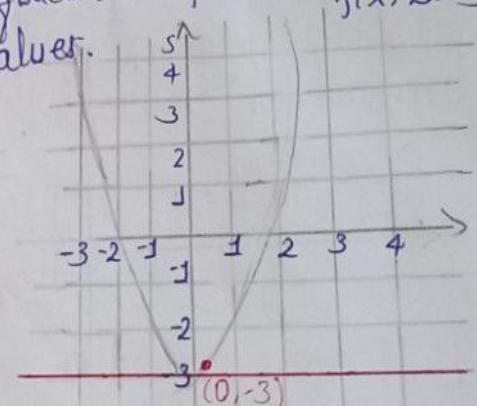
* The graph opens downward if $a < 0$

* Sketching graphs of quadratic function using a table of values.

Eg-1

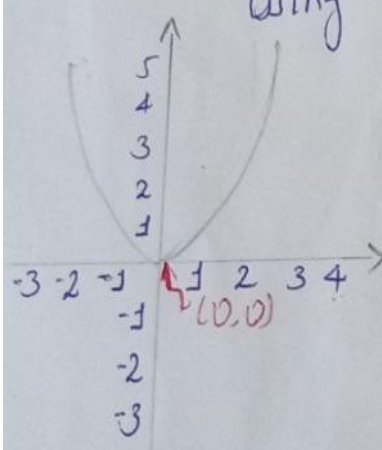
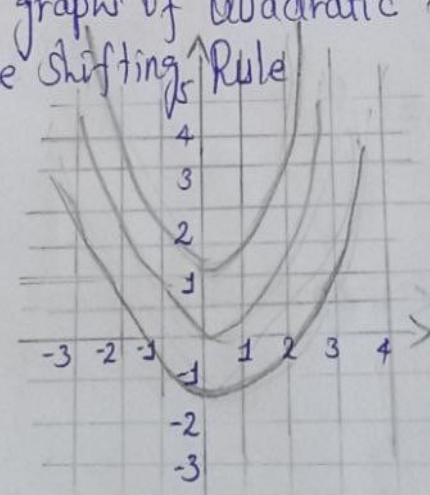
x	-2	-1	0	1	2
f(x)	5	-1	-3	-1	5

Sketch the graph of $f(x) = 2x^2 - 3$



* The vertical line that passes through the vertex is the axis of the parabola

* Sketching graphs of Quadratic function using the Shifting Rule

* $f(x) = x^2 - 1$ obtained by shifting the graph of $f(x) = x^2$ by 1 unit downward, giving a vertex at $(0, -1)$

* $f(x) = x^2 + 1$ is obtained by shifting the graph of $f(x) = x^2$ by 1 unit upward to a vertex at $(0, 1)$.

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Important point to Remember

- $f(x) = a(x+h)^2 + k$ h unit to left and k Unit Upward
- $f(x) = a(x+h)^2 - k$ h unit to left and k Unit downward
- $f(x) = a(x-h)^2 - k$ h Unit to right and k Unit downward
- $f(x) = a(x-h)^2 + k$ h Unit to right and k Unit Upward.

Vertex (h,k)

Key Terms

- The axis of parabola (or axis of Symmetry) is a vertical line that passes through the vertex of parabola.
- A function defined by $f(x) = ax^2 + bx + c$ ($a, b, c \in \mathbb{R}, a \neq 0$) is called quadratic function. a is called leading Coefficient.
- The Vertex is the point on a Coordinate System at which a graph of quadratic functions turn either upward or downward.

Students I think, You have ^{get} some idea please try to do the following Questions

- 3) Determine whether each of the following is increasing or decreasing.

a. $f(x) = 3 - 4x$

b. $f(x) = 2x + 6$

c. $x + 6y - 10 = 2$

Answer.

a) f is decreasing

b) f is Increasing

c) decreasing.

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Minimum and Maximum Value of quadratic function

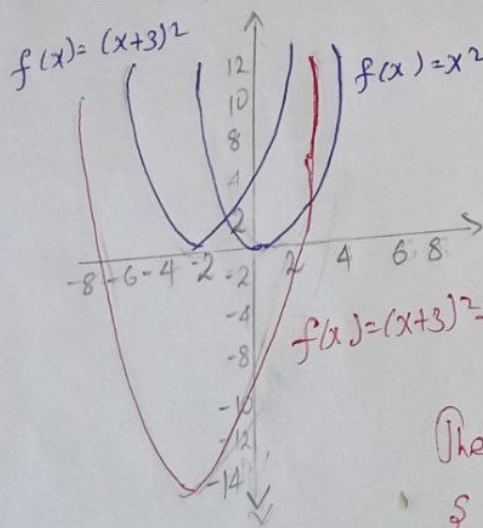
- Obtained at the Vertex
- ax^2+bx+c is +ve or Upward parabola ($a>0$)
It has Minimum Value
- ax^2+bx+c is -ve or downward parabola ($a<0$)
It has Maximum Value.

From this we conclude that Min or Max. value of Quadratic function is equal to k .

The minimum Value of f if $a>0$ } $f\left(-\frac{b}{2a}\right)$

The maximum Value of f if $a<0$ }

Example sketch the graph of $f(x) = x^2 + 6x - 5$ and determine the minimum value of $f(x)$



The graph can be sketched by shifting the graph of $f(x) = x^2$ by 3 Units to the left side and then downward by 14 Units

* The minimum value is -14

The range of this function is

$$\{y: y \geq -14\} = [-14, \infty)$$

The vertex