

# Kinematic Equations as Quadratic Analogies

Mr. Gullo

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# Standard Form of Quadratic Equation

- Standard form of a quadratic equation:

$$ax^2 + bx + c = 0$$

- Analogous kinematic equation:

$$x = x_0 + v_0t + \frac{1}{2}at^2$$

- Where:
  - $x$  is the position (analogous to  $y$  in the quadratic)
  - $t$  is time (analogous to  $x$  in the quadratic)
  - $x_0$  is the initial position (analogous to  $c$ )
  - $v_0$  is the initial velocity (analogous to  $b$ )
  - $\frac{1}{2}a$  is half the acceleration (analogous to  $a$ )

# Standard Form - Interpretation

- This equation describes the position of an object at any given time
- It considers:
  - Initial position
  - Initial velocity
  - Acceleration
- Useful for analyzing motion in one dimension

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# Vertex Form of Quadratic Equation

- Vertex form of a quadratic equation:

$$y = a(x - h)^2 + k$$

- Analogous kinematic equation:

$$x = x_0 + v_0 t + \frac{1}{2} a(t - t_p)^2$$

- Where:

- $t_p$  is the time at which the position reaches its peak (analogous to  $h$ )
- $x_0 + v_0 t$  represents the position at the peak (analogous to  $k$ )

# Vertex Form - Applications

- Particularly useful for describing projectile motion
- $t_p$  represents the time at which the projectile reaches its highest point
- Helps in analyzing:
  - Maximum height
  - Time of flight
  - Range of the projectile

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# Factored Form of Quadratic Equation

- Factored form of a quadratic equation:

$$y = a(x - r_1)(x - r_2)$$

- Analogous kinematic equation:

$$x - x_0 = v_0(t - t_1)(t - t_2)$$

- Where:
  - $t_1$  and  $t_2$  are the times when the object is at its initial position  $x_0$  (analogous to roots  $r_1$  and  $r_2$ )
  - $v_0$  is a scaling factor (analogous to  $a$ )

# Factored Form - Applications

- Less common in kinematics
- Useful in specific scenarios:
  - Describing an object that returns to its starting position twice
  - Example: A ball thrown vertically upward
- Helps in analyzing:
  - Time of flight
  - Return times to initial position

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# Conclusion

- These analogies illustrate mathematical similarities between:
  - Quadratic equations
  - Motion in one dimension
- Provides a different perspective on both topics
- Helps in understanding:
  - The mathematical nature of motion
  - The physical interpretation of quadratic equations
- Encourages interdisciplinary thinking in mathematics and physics