Kinematic Equations – An Introduction

Lesson Notes

The BIG 4:

$$d = v_o \cdot t + \tfrac{1}{2} \cdot a \cdot t^2$$

$$v_f^2 = v_o^2 + 2 \cdot a \cdot d$$

$$d = (v_o + v_f) / 2 \cdot t$$

$$v_f = v_o + a \cdot t$$

d: displacement
a: acceleration
t: time
v_o: original velocity
v_f: final velocity

Special Conditions

Under the following special conditions, the BIG 4 simplify to shorter equations:

Starts from rest (vo = 0)	Comes to a stop (vf = 0)	Constant Velocity (a=0)
$d = \tfrac{1}{2} \cdot a \cdot t^2$	$d = v_o \cdot t + \tfrac{1}{2} \cdot a \cdot t^2$	$d = v \cdot t$
$v_f^2 = 2 \cdot a \cdot d$	$v_o^2 = -2 \cdot a \cdot d$	$v_f^2 = v_o^2$
$d = (v_f) / 2 \cdot t$	$d = (v_o) / 2 \cdot t$	$d = v \cdot t$
$v_f = a \cdot t$	$v_o = -a \cdot t$	$v_f = v_o$

Problem-Solving Strategy

1. Read the problem carefully. Identify the known values of three of the five variables. Write down the known values. Relate the values to the symbols; e.g., v_o = 15 m/s.
2. Identify the unknown variable. Write in symbol form.
3. Now you have four variable symbols - 3 with known values and one of unknown value. Find the kinematic equation that contains these four variables. Write the equation down.
4. Substitute known values into this equation.
5. Perform algebra and calculations to solve for the unknown variable.

An Important Caution:

The quantities **d**, **v**, and **a** are all vectors; they include a direction. Your substituted values need to include this directional information as a + or – sign.