Physics — Kinematics in One Dimension

Kinematics Study of Motion

Distance Total distance traveled from start to finish.

Displacement Straight line distance between the start point and ending point of the problem.

Speed A scalar quantity (no direction specified) that shows the rate that distance ***d*** is covered.

- ***Instantaneous*** The speed at an instant in time. Right now. Your speedometer reading when you glance it at.
- ***Average*** The total distance divided by the total time for the entire trip.
- ***Constant*** If the same speed is maintained over the entire trip

Velocity A vector quantity consisting of magnitude and direction. Displacement ***x*** divided by time.

Acceleration Change in velocity (change in speed and/or direction)

Kinematic Equations

You can only use the constant velocity equation when there is no acceleration. If acceleration is present (Question contains terms such as: starts from rest, final velocity of, accelerates, comes to rest, etc.), then you must use the three Kinematic equations in the highlighted boarder boxes below.

Speed	***Constant Velocity***	**Average Velocity**	***Acceleration***
$\boxed{\bar{v}_s = \frac{d}{t}}$	$\boxed{v = \frac{x}{t}}$ **or** $\boxed{x = vt}$	$\bar{v} = \frac{x - x_o}{t}$	$a = \frac{v - v_o}{t}$

Equation	Description
$\bar{v} = \frac{v_o + v}{2}$	***Another Way of Looking at Average Velocity*** One of the four Kinematic Equations. But it is mostly used in conjunction with the above equations to derive the next three equations. Occasionally it is useful in problems.
$\boxed{v = v_o + at}$	***Velocity*** Rearranged the acceleration equation from above. Useful for determining ***v***, when ***a*** and ***t*** are given. However, if any three variables are available and the fourth is needed rearrange this as necessary.
$\boxed{x = x_o + v_o t + \frac{1}{2}at^2}$	***Position*** Key equation to determine distance when ***a*** is involved. Used extensively in falling body problems. Its derivative is the velocity equation above.
$\boxed{v^2 = v_0^2 + 2a(x - x_0)}$	***When no time is given*** When ***v***, ***a***, and/or ***x*** are known, but no information is given about ***t***, then this can be used to solve for the unknown variable.

x_o initial position, x final position, v_o initial velocity, v final velocity, a acceleration, t time

Problem Solving Strategy

1. Draw a picture (Mental or on Paper)
2. List known and unknown variables.
   a) Caution; some may be extraneous, and are not necessary to solve the problem.
   b) Often either the starting or ending point is at rest, meaning a value of zero.
3. Do **<u>necessary</u>** conversions.
4. Choose an equation that can be solved with the known variables.
   a) This equation may or may not be the answer you are looking for.
   b) It may provide a new variable for use in another equation.
   c) This may lead to a succession of equations.

+ or – ????: " **+** " & "**–** " can be used to indicate direction

–9.8 *m/s*^{2} Be careful here. Remember you can set your own coordinate system and call up positive or negative. You just have to indicate it in your givens.

Falling Bodies

Displacement:	$y_o = 0$	Initial position. We can choose the reference frame / coordinate axis.
	$y = 0$	If the object ends the problem at the same elevation it started at.
	$y = +$	If the object ends the problem at a higher elevation than it started.
	$y = -$	If the object ends the problem at a lower elevation than it started.
	$y = y_0$	If it lands at the same elevation that the problem began at.
Velocity, initial:	$v_o = 0$	If it is dropped from rest.
	$v_o = +$	If fired upward.
	$v_o = -$	If fired downward.
Velocity, final:	$v = 0$	At the moment it reaches maximum altitude, right before falling back to earth.
	$v = +$	If it hits something on the way up and never reaches max altitude (Rare problem).
	$v = -$	On the return trip.
Acceleration:	$g = -9.8\, m/s^2$	if down is negative and the object is falling on Earth