One Dimensional Kinematics With a Constant Acceleration

The book quotes four equations:

$$(2.4)\ v = v_0 + at$$

$$(2.7)\ x = \frac{1}{2}(v_0 + v)t$$

$$(2.8)\ x = v_0 t + \frac{1}{2}at^2$$

$$(2.9)\ v^2 = v_0^2 + 2ax$$

v, x **and** ***a*** **are** ***one dimensional vectors*** **with their** ***algebraic sign*** **determining their directions.** ***v, x*** **and** ***a*** **point either in the plus x or minus x directions.**

$$(2.4)\ v = v(t) = v_0 + at \equiv \text{ velocity at time t}$$

$$(2.7)\ x = x(t) \equiv \text{ position at time t} = \frac{1}{2}\left\{v_0 + v(t)\right\}t = \overline{v}t$$

$$= \text{ (average velocity)} \times \text{time}$$

$$(2.8)\ x = x(t) = v_0 t + \frac{1}{2}at^2 \equiv \text{ position at time t}$$

$$(2.9)\ v^2 = v_0^2 + 2ax \equiv \text{ speed squared at position x}$$

Note that equation (2.9) can be obtained by solving for time ***t*** **in equation (2.4) and substituting into equation (2.8), and that equation (2.8) can be obtained by substituting (2.4) into (2.7) (try these as exercises).**

Note that equation 2.8 assumes that ***x=0*** **at** ***t=0*****, that is the motion starts at the origin at time** ***t=0*****. In many problems it is useful to start the motion at some position** x_0 **away from the origin at time** ***t=0*****. For**

example, we may be examining a problem by breaking the motion into multiple parts and the previous motion may already have moved the object away from the origin. For these situations equations (2.7) and (2.8) can be generalized:

$$(2.7)^{*}\ x(t) = x_0 + \frac{1}{2}\{v_0 + v(t)\}t$$

$$(2.8)^{*}\ x(t) = x_0 + v_0 t + \frac{1}{2}at^2$$

Equations (2.7)* and (2.8)* are quoted in most textbooks.

Since *x, v* and *a* are one dimensional vectors, it is permissible to write equations (2.4)-(2.8) with vector signs as was shown in lecture:

$$(2.4)\ \vec{v} = \vec{v}_0 + \vec{a}t$$

$$(2.7)\ \vec{x} = \frac{1}{2}(\vec{v}_0 + \vec{v})t$$

$$(2.8)\ \vec{x} = \vec{v}_0 t + \frac{1}{2}\vec{a}t^2$$

However, because we are dealing with motion in *one dimension* the vector nature of the equations is accounted for by the *algebraic sign* of the quantities, and the vector notation is usually omitted, as in the textbook.