Chapter 2

Terms

Be able to define or discuss the following terms and ideas, with their SI units if appropriate.

1. instant of time
2. time interval
3. point particle
4. position
5. displacement
6. distance (between two points)
7. distance traveled
8. one dimension (and one dimensional motion)
9. positive displacement
10. negative displacement
11. average velocity (in one dimension)
12. average speed
13. instantaneous velocity
14. speed (i.e. instantaneous speed)
15. uniform motion
16. non-uniform motion
17. slope of a position vs. time graph
18. vertical intercept of a position vs. time graph
19. slope of a velocity vs. time graph
20. vertical intercept of a velocity vs. time graph
21. average acceleration
22. instantaneous acceleration
23. uniform acceleration (i.e. constant acceleration)
24. free-fall
25. gravitational acceleration
26. gravitational acceleration due to Earth
27. motion diagram

Equations

Understand the meaning and know the SI units of all symbols in these equations; know how to perform each mathematical operation, such as trig functions; know how to solve for any unknown quantity; understand how changing one quantity affects another quantity (if all other quantities remain constant); be able to apply one or more equations to solve a problem.

- $\Delta t = t_2 - t_1$
- $\Delta x = x_2 - x_1$
- average velocity:

$$\bar{v} = \frac{\Delta x}{\Delta t} \tag{1}$$

- average speed:

$$\text{average speed} = \frac{\text{distance travelled}}{\Delta t} \tag{2}$$

- instantaneous velocity:

$$v = \lim_{\Delta t \to 0} \frac{\Delta x}{\Delta t} \tag{3}$$

- for uniform motion (i.e. constant velocity):

$$x = x_0 + vt \tag{4}$$

- average acceleration

$$\bar{a} = \frac{\Delta v}{\Delta t} \tag{5}$$

- instantaneous acceleration

$$\bar{a} = \lim_{\Delta t \to 0} \frac{\Delta v}{\Delta t} \tag{6}$$

- useful equations for a particle moving with constant acceleration:

$$\begin{aligned} x - x_0 &= v_0 t + \frac{1}{2} a t^2 && (7)\\ x - x_0 &= \frac{v + v_0}{2} t && (8)\\ v &= v_0 + at && (9)\\ v^2 &= v_0^2 + 2a(x - x_0) && (10)\\ & && (11) \end{aligned}$$

- magnitude of gravitational acceleration near Earth's surface:

$$g = 9.8 \text{ m/s}^2 \tag{12}$$

- if +y is defined to be upward, then for an object in vertical free-fall near Earth's sufrace

$$a = -g = -9.8 \text{ m/s}^2 \tag{13}$$

- If the +y direction is defined to be upward, then these equations describe an object in free fall (i.e. no interactions except with Earth's gravitational field) if it only moves vertically:

$$y - y_0 = v_0 t - \frac{1}{2} g t^2 \quad (14)$$

$$y - y_0 = \frac{v + v_0}{2} t \quad (15)$$

$$v = v_0 - g t \quad (16)$$

$$v^2 = v_0^2 - 2g(y - y_0) \quad (17)$$

Skills

1. identify from a motion map, graph, or verbal description whether the motion of an object is "uniform motion" or "non-uniform motion."
2. identify from a motion map, graph, or verbal description whether the motion of an object is "constant acceleration" or "non-constant acceleration."
3. sketch and/or interpret a motion diagram for an object.
4. sketch and/or interpret a position vs. time graph for an object.
5. sketch and/or interpret a velocity vs. time graph for an object.
6. solve problems dealing with uniform motion.
7. solve problems dealing with constant acceleration.
8. solve problems dealing with free-fall.

Lab Skills

1. use video analysis software to measure the position of an object as a function of time and calculate velocity from the x vs. t graph (or y vs. t graph) and acceleration from the v vs. t graph.