Chapter 2 Motion Along A Straight Line

2-2 Instantaneous Velocity, 2.3 Acceleration

- Velocity $v = \frac{dx}{dt}$
  (Example) v=10m/s: travels a distance of 10m every second, namely, the position changes by 10m every second
- Acceleration $a = \frac{dv}{dt} = \frac{d^2x}{dt^2}$
  (Example) a= $10\frac{m}{s^2} = \frac{10m/s}{s}$: The velocity changes by 10m/s every second
  (Example) v_0=0, $a = 10\ m/s^2$

t(s)	0	1	2	3
v(m/s)	0	10	20	30

- Note: deceleration=negative acceleration
  (Example) $v_0 = 10\ m/s,\ a = -10\ m/s^2$

t(s)	0	1	2	3
v(m/s)	10	0	-10	-20

2-4 Constant Acceleration

- Motion with constant velocity: $v = v_0,\ x - x_0 = v_0 t$
- Motion with constant acceleration:

$$v = v_0 + at \ (1), \quad x - x_0 = v_0 t + \frac{1}{2}at^2 \ (2), \quad 2a(x - x_0) = v^2 - v_0^2 \ (3)$$

- Derivation of (2)

$$x - x_0 = v_{avg} t = \frac{v_0 + v}{2} t = \frac{v_0 + v_0 + at}{2} t = v_0 t + \frac{1}{2}at^2$$

- Derivation of (3)
  From (1), $t = \frac{v - v_0}{a}$.
  Substitute this into (2), $x - x_0 = v_0 \frac{v - v_0}{a} + \frac{1}{2}a\frac{(v - v_0)^2}{a^2} = \frac{v^2 - v_0^2}{2a}$
- (Problem) Determine the stopping distance for a car travelling at 50km/h. Assume that the reaction time of the driver is 0.5 seconds and that, when the brake is applied, the car decelerates at a uniform rate of $6\frac{m}{s^2}$.

2-5 Free-Fall Acceleration

- Freely falling bodies, or objects thrown vertically upward: motion with constant acceleration $a = \pm g = \pm 9.8\ m/s^2$
- Note: $a = +9.8\ m/s^2$ if the downward direction is taken to be the positive direction.
  $a = -9.8\ m/s^2$ if the upward direction is taken to be the positive direction
- (Problem) A good fastball pitcher can throw the ball at 150 km/h. How high up the air can he throw the ball?

Problems from Chapter 2: Problems 28, 39, 40, 45, 48, 58