Ch 2 Motion in One Dimension

I) Displacement & Velocity
   A) One Dimension
      1) Simple
   B) Frame of Reference
   C) Displacement
      1) equation

$\Delta x = x_f - x_i$

      2) position (x)
      3) distance – the length of the route an object travels
      4) units
         (a) SI - meter (m)
         (b) any unit for length
      5) sign - direction
   D) Average Velocity
      1) equation

$v_{ave} = \frac{\Delta x}{\Delta t}$

      2) time interval (Δt) – how much time passes
      3) units
         (a) SI – m/s
         (b) length / time (km/h, mph)
      4) Direction
         (a) Velocity is a vector and so has magnitude and direction
      5) Speed
         (a) equation

$s = \frac{distance}{time}$

   E) Position vs. Time Graph
      1) Two points
         (a) first point = Initial position and time
         (b) second point = Final position and time
      2) Slope
         (a) Instantaneous Velocity

$$m = \frac{rise}{run} = \frac{\Delta y}{\Delta x} = \frac{\Delta x(\Delta position)}{\Delta t} = v_{ave}$$

II) Acceleration – rate of change in velocity
   A) Equation

$$a_{ave} = \frac{\Delta v}{\Delta t} = \frac{v_f - v_i}{t_f - t_i}$$

B) <u>Vector</u> – measures both magnitude (size) and direction

1) (velocity is a vector vs. speed which is a <u>scalar</u>)
2) Changes in speed, direction, or both count as acceleration

C) Signs

1) (+) vel. means object is moving in (+) direction
   - (a) (+) vel. w/ (-) acc. means moving (+), but *slowing down*
   - (b) (-) vel. w/ (+) acc. means moving (-), but *slowing down*
   - (c) (+) vel. w/ (+) acc. means moving (+), and *speeding up*
   - (d) (-) vel. w/ (-) acc. means moving (-), and *speeding up*

D) Velocity vs. Time Graph

1) Interpreting slope:
   - (+) slope means (+) acceleration
   - (-) slope means (-) acceleration
   - if the line is above $v = 0$ (y=0), velocity is positive
   - if the line is below $v = 0$ (y=0), velocity is negative

E) Calculations with constant acceleration

1) Derive **<u>kinematics equations</u>**:

Form to use when accelerating object has an initial velocity	Form to use when accelerating object starts from rest
$\Delta x = \frac{1}{2}(v_i + v_f)\Delta t$	$\Delta x = \frac{1}{2}v_f\Delta t$
$v_f = v_i + a\Delta t$	$v_f = a\Delta t$
$\Delta x = v_i\Delta t + \frac{1}{2}a(\Delta t)^2$	$\Delta x = \frac{1}{2}a(\Delta t)^2$
$v_f^2 = v_i^2 + 2a\Delta x$	$v_f^2 = 2a\Delta x$

2) Problem-solving strategies
   - List variables (both given and target)
   - Find an equation (or system of equations) that includes only constant and relevant variables (known and unknown)

III) Falling objects

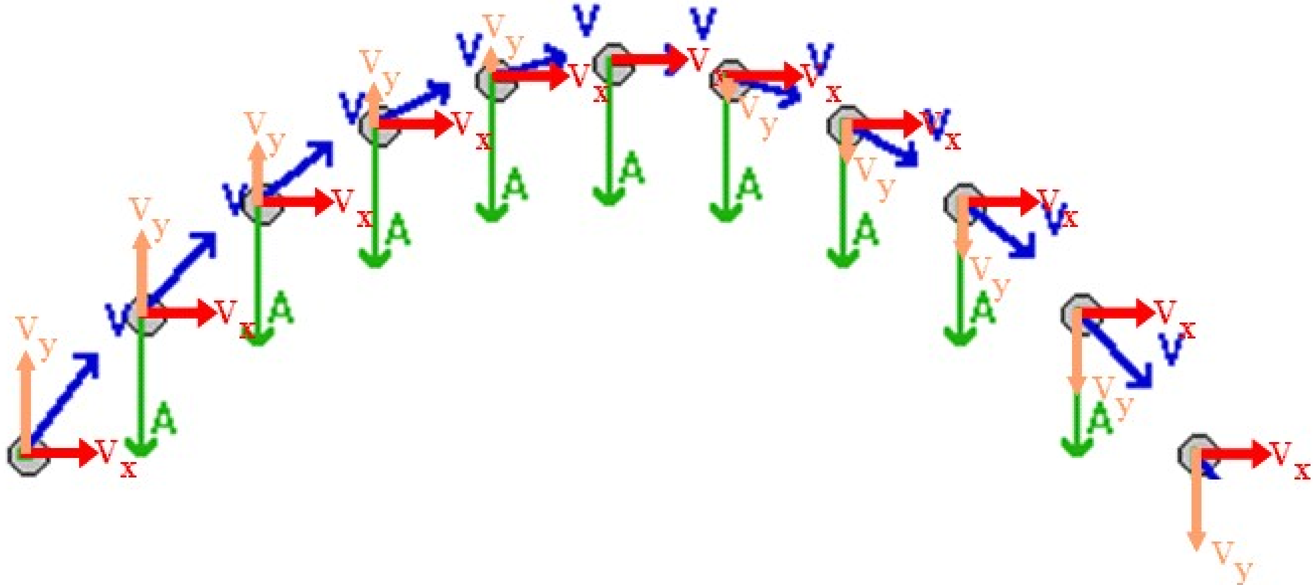
A) Freefall – an object falling with only the force of gravity acting on it

B) The acceleration due to gravity on earth ($a_{gravity}$) is called g (instead of a_g)

1) $g = -9.81 m/s^2$

C) Free-fall acceleration

1) (Ignoring the effects of air resistance) all objects accelerate due to gravity at the same rate
2) This downward acceleration is <u>constant</u>
   - (a) Whether moving up, down, or not at all



- Up: v is (+); a is (-)
- Top: v = 0; a is (-)
- Down: : v is (-); a is (-)
- <u>Moment of impact</u> – means the moment "just before"

D) Notes on free-fall

1) Acceleration *always* = g ($-9.81\,^{m}/_{s^2}$)
2) $v_{top} = 0$
3) If the trip starts and ends at the same height $v_f = -v_i$ (for the trip)
   - (a) because:
     - $a_{up} = a_{down}$ (= g ($-9.81\,^{m}/_{s^2}$)) …and…
     - $\Delta x_{up} = -\Delta x_{down}$ …so…
   - (b) The way up
     - $v_f^2 = v_i^2 + 2a\Delta x$
     - $v_f = 0$ …so…
     - $v_i = \pm\sqrt{(-2a\Delta x)}$
   - (c) The way down
     - $v_f^2 = v_i^2 + 2a\Delta x$
     - $v_i = 0$ …so…
     - $v_f = \pm\sqrt{(2a\Delta x)}$ (= $v_{i,\text{ the way up}}$)
4) Air resistance prevents "true" free-fall
   - (a) Air is composed of molecules bouncing off one another (kinetic molecular theory)
     - Moving means hitting molecules
     - This force opposes motion
     - Moving faster means hitting more molecules
     - Moving faster means more force opposing motion
     - When the force from the air is big enough acceleration stops (Terminal velocity)
   - (b) same effect up and down