Kinematics – Particle Motion with Acceleration

1. In each case i) complete the chart assuming constant acceleration and
ii) then describe the motion (moving left, moving right, speeding up, slowing down, at rest, changing direction). Assume right is the positive direction.

a. Particle acceleration is +2.5 ft/sec/sec.

t (secs)	0	1	3	4.5
***v** (ft/sec)*	1			

b. Particle acceleration is -4 mph/sec.

t (secs)	0	1	3	4.5
***v** (mph)*		39		

c. Particle acceleration is +6 m/sec^2.

t (secs)	0	1	2	5.5
***v** (m/sec)*	-33			

Note for next problem: For linear motion with constant acceleration, we can use the 3 basic equations given on page 20 of the text: $\mathbf{v = v_o + a*t}$, $\mathbf{v^2 = v_o^2 + 2*a*(s - so)}$ and $\mathbf{s = s_0 + v_o*t + (1/2)*a*t^2}$.

2. A ball is thrown up at 80.5 ft/sec off a 240-foot-high cliff (ie. the cliff rises 240 feet above the seawater level). Assume air resistance is negligible and that the acceleration due to gravity is 32.2 feet/sec per second. Make "up" the positive direction.

a) Determine the velocity of the ball 2 seconds after it is released.

b) What maximum height above the seawater does the ball reach? How much time elapses from the moment the ball is released until it reaches this maximum height?

c) How many seconds after its release does the ball to return to its initial height? What is the ball's velocity at that time?

d) How much time elapses from the moment the ball is released until it hits the seawater below? What is the ball's speed when it hits the water?

Note for the next problem: For objects going in a curved path, the "normal" acceleration (i.e., acceleration due to direction changing) is given by $a_n = v^2/\rho$ where ρ is the radius of curvature.

3. A car's maximum normal acceleration is 24 ft/s^2. With what maximum speed can it negotiate a turn with radius of curvature 20 feet? Answer in feet/sec and mph.

4. The block below represents a cart moving horizontally and linearly to the right. At time t = 0 seconds, the cart is at position x = -20 ft and is moving to the right with instantaneous speed 44 feet/second (i.e. 30 mph). Also, at time 0, the cart's power is cut off; the cart cruises forward. Because of friction and air resistance, velocity decreases in accordance with $v(t) = 44\ e^{-0.2t}$ ft/second, where t is in seconds.

a) Does the equation $\mathbf{a = v^2/\rho}$ apply to this motion. Why or why not?

b) Determine the cart's speed at times t = 0, 5, 10, 15 and 20 seconds.

c) Determine the limit as t approaches infinity of v(t). What does this limit tell you about the cart's motion?

d) Graph v(t) versus t for the cart's motion. Describe the slope of this graph.

e) Does the equation $\mathbf{v = v_o + at}$ apply for this motion? Why or why not?

f) Find an equation for a(t), the cart's acceleration as a function of time for non-negative t.

g) Check your a(t) equation by using it to determine the following:

- i. a(0)
- ii. the cart acceleration at t = 5 seconds
- iii. the time when the cart's deceleration has decreased to 1 ft/sec^2.
- iv. the limit as t approaches infinity of a(t).

h) Does the equation $\mathbf{x = x_o + v_o\ t + 0.5{*}a{*}t^2}$ apply for this motion? Why or why not?

i) Find an equation for x(t), the cart's position as a function of time for non-negative t.

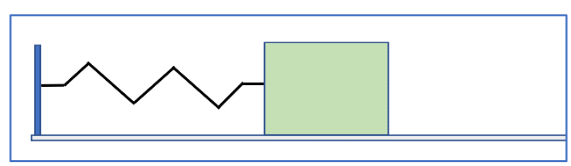
j) Check your x(t) equation by determining

- i. x(0)
- ii. the cart's position at t = 5 seconds
- iii. x(10 seconds)

k) Determine how far the cart travels before stopping.

l) Graph x(t), v(t) and a(t) for non-negative t. "Stack" the graphs (x first, then v, then a) so that the times align vertically. Describe the cart's motion.

5. The block is a mass connected to a spring. Its horizontal position is given by x(t) = 4*cos (1.5708 t) + 5 meters, where t is in seconds and x = 0 is the horizontal position where the spring's left side connects to the vertical surface. Note that for the calculations below your calculator should be in radians mode.



a) Determine the block's position at t = 0, 1, 2, 4, 6 and 8 seconds.
b) Determine a function giving the block's velocity as a function of time.
c) Determine a function giving the block's acceleration as a function of time.
d) Graph x(t), v(t) and a(t) for $0 \le t \le 8$ seconds. "Stack" the graphs (x first, then v, then a) so that the times align vertically. Describe the block's motion.