ME 230 - Dynamics Your Name:_____
Tutorial 1 Section
No.:_____

Partners:_____ _____ _____
_____ _____ _____

Rectilinear Motion

This tutorial will introduce the methods of solving straight line kinematics problems by examining two exercises. In addition, it will provide a look ahead at Newton's Second Law and applications of kinetics.

1. A race car starts from rest and accelerates at $a = 5 + 2t$ ft / sec^2 for 10 seconds. The brakes are then applied, and the car has a constant acceleration of -30 ft/sec^2 until it comes to rest. Determine (a) the maximum velocity; (b) the total distance traveled; (c) the total time of travel.

Ask yourself (and answer!) the following questions (by quick inspection) in order to plan solution strategy:

- Should problem be broken into two parts or intervals? Where should it be divided?
- Does the first interval have either constant acceleration or velocity? How about the second interval? Why does this matter?
- At what time will the velocity be maximum?
- Does determination of maximum velocity depend on the braking phase?
- Will the car ever have a negative acceleration and a positive velocity? Where?

Now execute solution:

i. Derive general equation for *v(t)* during the acceleration phase from *a=dv/dt*.

ii. Find v_{max} at end of acceleration phase.

iii. Derive general equation for *s(t)* during acceleration phase from *v=ds/dt*.

iv. Find *s* at end of acceleration phase.

v. During braking phase, derive general equation for *v(t)* starting with $a=dv/dt$.

vi. Find elapsed time during braking phase.

vii. What is total elapsed time during acceleration and braking?

viii. Derive general equation for *s(t)* during braking phase, starting with $v=ds/dt$.

ix. Compute total distance traveled by car during acceleration and braking.

2. A rubber ball is dropped to the floor from a height of 4 feet. The height of the ball on rebound is measured to 3.7 feet.

Ask yourself these questions:

- Is vertical acceleration constant? Is vertical velocity constant?
- Do you know what the vertical acceleration is at every point? Where do you know it?

Determine:

i. The time it takes for the ball to reach the floor .

ii. The velocity of the ball just before it hits the floor

iii. The velocity of the ball just as it leaves the floor on the first bounce.

iv. The total time elapsed from release of the ball (at 4 feet) until it reaches zero velocity at the peak of its first bounce.

v. Optional Suppose the ball would have been dropped from rest from a position such that it strikes the floor 0.5 s later and then remains in contact with the floor for 0.05 s before it rebounds in a vertical direction. Draw a graph of the acceleration *a(t)* versus time *t* and derive an equation for the velocity as a function of time.

vi. Suppose that the ball weighs 0.08 lb. and it receives an upward force from the floor of 0.5 lb. for 0.15 sec. Use Newton's Second Law to determine the average acceleration of the ball from the bounce, and the maximum height the ball will reach after the bounce.