INTERACTIVE PHYSICS1 "Lab"   NAME_____

VELOCITY AND ACCELERATION

1) Simulations 1-4

2) 6 Made Up Investigations

FIRST:

       Follow the directions for simulations 1-4.

The files are under Users:Physics:Unit1:

Sim1 (Car with constant Acc)

Sim2 (Constant Acc with Vel Graph)

Sim3 (Constant Acc with Position graph

Sim4 (Car Race)

Do not save any files….. (except if you want to type your answers)

Answer the questions on the paper and attach.

THEN (on another piece of paper) write observations and answer the questions for each:

Under

Users: Physics:Unit1:IP

CarPassingVan.ip

Describe how the time it takes to reach the same speed, pull even, and safely pass varies as you vary the four sliders.

CarWagon.ip

Police Chasing Car

Describe how distance time graphs and the velocity time graphs vary as the sliders are varied. What does the track indicate?

P-V-A graph.ip

Adjust the mass and force to different values and compare the graphs of position, velocity and acceleration. Describe the qualities of the graphs that are different and the qualities that are the same for different values of force and mass.

Comparisons of accelerations.ip

Comparison of the motion of Objects Undergoing Constant Acceleration with Different Initial Velocities. Try all four combinations of velocities and accelerations (+/-) and describe how they compare. At what different values for each color can you make three ball's return to the start? How about four?

Space Time diagram.ip

Space Time diagram of one dimensional motion

Examine all possible combinations.. Then try and make each two of the objects hit... How about three of the objects???

 FallingBody.ip

Object in Freefall

Adjust the initial velocity to different values and compare the graphs of position, velocity and acceleration. Describe the qualities of the graphs that are different and the qualities that are the same for different values of initial velocity.

Use the Word Problem file to help solve the Acceleration1 problems

Interactive Physics
Simulation I: <u>Sim1</u>
Found at X:Users:Physics:Unit1:Sim1

Review: Average velocity is defined as the change in an object's displacement in a time interval (Δt) and average acceleration is defined as the change in an object's velocity in a time. (See formulas below) As the time interval is made smaller and smaller, these average values approach what we call the instantaneous values (for example, the velocity of the car at 3 seconds is 10 m/s) . Velocity and acceleration are vector quantities, that is they have a magnitude (amount) and direction. Speed is the same as the magnitude of the velocity. We will start by studying the motion of a car moving in one dimension (it can only go back and forth along a straight road) with constant acceleration. In this special case, the acceleration and velocity of the car will be specified by the sign (+ is one direction to the right, and – is the direction to the left). When we use only one-dimensional motion with CONSTANT acceleration, we can use the scalar equation shown below to solve for the instantaneous velocity at a time t, given the acceleration and initial velocity .

Formulas you should be familiar with:
Average Velocity = Vavg, Instantaneous velocity = V or Vf, Starting velocity = Vi
Change in time = ΔT, Change in displacement = ΔD,
Acceleration = A,

$$Vavg= ΔD/ΔT \qquad A=ΔV/ΔT \qquad V=Vf=Vi + A*T$$

In the simulation:
The car has an initial velocity that you can adjust with sliders or type in a number (+ is to the right).
You can also use a slider to set the acceleration of the car to different values and PREDICT then observe the results.
When you run the simulation, you will see the vectors representing the magnitude (size) and direction of both the velocity and the acceleration of the car. You can stop the simulation at any time and then either click run to continue from that point or reset to initial conditions. Reset THEN change the sliders.
To see the simulation from the point of view of the car, click the CAR… It's like you are riding in the car!
To see the simulation from the point of view of the ground, click the GROUND button.
Use the scroll bars at the bottom to tell where the car is, as well as the grid markings. Rolling the mouse gives you the x position. The tape player at the bottom allows you to step or scroll through the motion again.
The simulation will automatically stop after 12.2 seconds.

*** 1) Set the initial velocity of the car to any positive value. Set the acceleration of the car to a positive value. Click RUN and observe the motion of the car. You can reset and run again as many times as you like, or stop and continue running from that point.

Is the acceleration vector pointing to the left or the right? Is its size changing? How?

Is the velocity vector pointing to the left or the right? Is its size changing? How?

****2) Click RESET. Set the initial velocity of the car to +2 m/s and the acceleration to − 0.25 m/s^2. Click GROUND to view the simulation from the side of the road. Click RUN and observe the motion of the car.

Is the acceleration vector pointing to the left or the right? Is its size changing? How?

Is the velocity vector pointing to the left or the right? Is its size changing? How?

Did the car ever come (momentarily) to a stop? Is its velocity ever zero?

Did the car change direction? Once it does, is the magnitude of the velocity increasing or decreasing?

Do you THINK the car will also reverse its direction if the initial velocity is negative and the acceleration is positive?

LETS TEST AND SEE!!! ☺

****** 3 Click RESET. Set the initial velocity to − 2 m/s and the acceleration to +.25 m/s^2.

Did the car reverse direction?

You should now have seem that the car can reverse direction only if the initial velocity and acceleration vectors are opposites. It does not matter which is positive and which is negative. But, will it always turn around? No, not if it runs out of time.

Use the tape player at the bottom to find out:

The net displacement of the car_____

The total distance the car traveled _____

Describe the difference between these two things.

Which car do you think will travel farther after the 12.2 sec?

CAR A------- Initial velocity of +4 m/s and acceleration of + 0.5 m/s^s ?
CAR B ------- Initial velocity of + 2 m/s and acceleration of 1.0 m/s^2

Click RESET. Try each of the above cases running each until the simulation stops. Record the final position of each car:

A:_____

B: _____

Self Test for Simulation 1

TRUE OR FALSE:

___ 1. A car that has a positive velocity that is increasing in magnitude must have a positive acceleration.

____2. A car that has a negative acceleration must be slowing down in speed.

____ 3. A car that has a velocity and acceleration in opposite directions must start slowing down in speed.

_____ 4. A car that has a constant velocity must have zero acceleration.

_____ 5. If a car reverses direction, there must be an acceleration opposite in sign to its original velocity.

SIMULATION 2 A Car moving with Constant Acceleration (Graphs)
CLOSE simulation 1. OPEN Simulation 2.

Remember to use the tape player to go back and forth. Pay attention to the graphs as the motion progresses.

***2-1) Set the initial velocity of the car to any positive value. Set the acceleration of the car to zero. Click RUN and observe the motion of the car.

Sketch the velocity and acceleration graphs, shown in the simulation, in the space below:

v
e
l
o
c
i
t
y   time

a
c
c
e
l
e
r
a
t
i
o
n   time

How do the graphs correlate with what is happening to the vectors for velocity and acceleration?

**** 2-2) Click RESET then click the CAR button to get in the driver's seat. Set the initial value of the velocity to + 2 m/s and the acceleration to _0.25 m/s^s. Click RUN and observe the motion of the car until the simulation stops.

Sketch the velocity and acceleration graphs, shown in the simulation, in the space below:

v
e
l
o
c
i
t
y   time

a
c
c
e
l
e
r
a
t
i
o
n   time
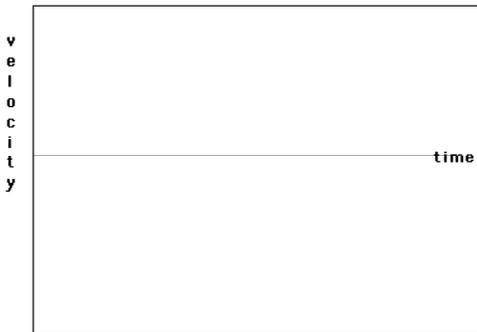
If the acceleration were doubled, how would the graphs be different?

***** 2-3) Click RESET. Keep the same value of the initial velocity (+ 2 m/s) of the car and set the acceleration to + 0.5 m/s². Click RUN to test your predictions.

Have the acceleration and velocity graphs changed in the way that you thought they would?

BEFORE resetting, PREDICT and SKETCH what the velocity and acceleration graphs will look like if the initial velocity is +5 m/s and the acceleration is – 1 m/s², and sketch them in the areas below.

velocity   time   acceleration   time
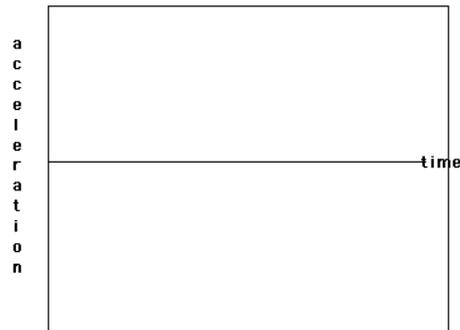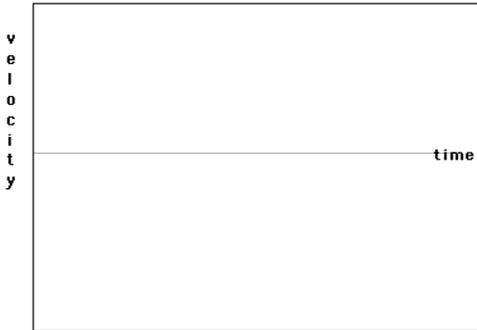
***** 2-4) Click RESET. Set the initial velocity of the car to +5 m/s and the acceleration to -1 m/s². Click RUN and observe the motion of the car until the simulation stops.

Sketch the graphs from the simulation data in the area below and then answer the questions on the following page.

velocity   time   acceleration   time
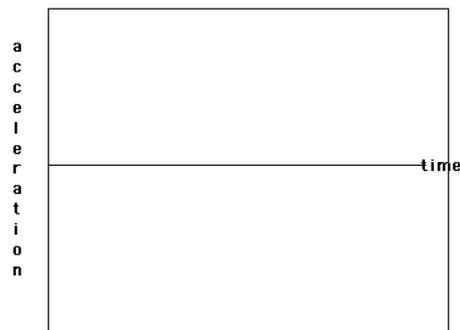
What differences (if any) are there between your predictions and the graphs from the simulation?

Mark each graph with an X (on the time line) at the point where the car turns around. Does the velocity change at that point? What happens to the acceleration at the at point?

Self Test Questions for Simulation 2.

All the questions refer to these graphs of velocity vs/ time for a car moving in one dimension.
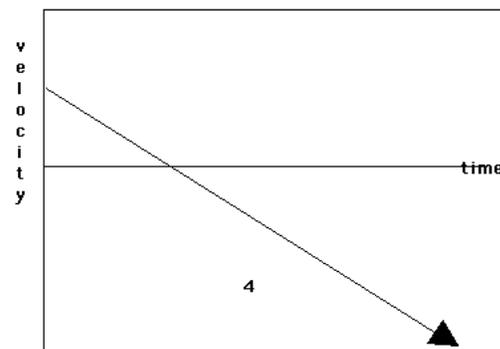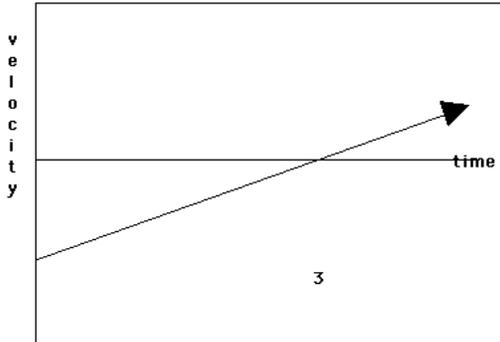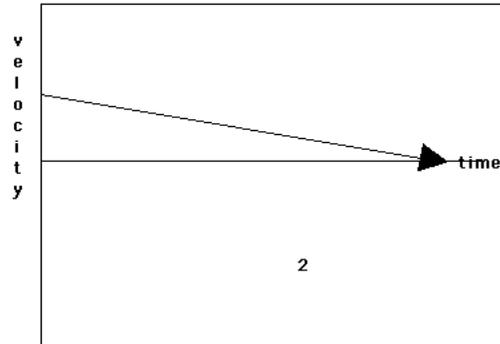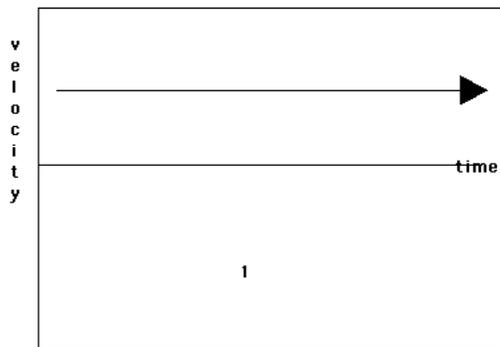
1. In which graph(s), if any, does the car come to a stop?

2) In which graph(s), does the car change direction?

3) Which graph represents the car whose acceleration has the largest magnitude? Largest value?

4) Which graph represents the car with the largest initial speed?

5. In which graph is the car moving at a constant speed?

SIMULATION 3 Car Moving With Constant Acceleration (Graphs with Dis)
**** close the other files and open sim3 Sim3

Formulas you should be familiar with:
Average Velocity = Vavg, Instantaneous velocity = V or Vf, Starting velocity = Vi
Change in time = ΔT, Change in displacement = ΔD,
Acceleration = A,

Vavg= $\Delta D/\Delta T$ A=$\Delta V/\Delta T$ V=Vf=Vi + A*T

Vavg = (Vi + Vf) / 2 ΔD = Vi T + ½ A T^2

In the prior simulations, you investigated the relationships between the velocity and the
acceleration of a car moving in one dimension. Now, you will study position too. The
initial position of the car is x = 0 m, and the simulation will stop when 12.2 seconds have
elapsed.

***** 3-1) DO NOT RUN YET!

Predict what the graphs of velocity and position will look like with a car with a + 5 m/s
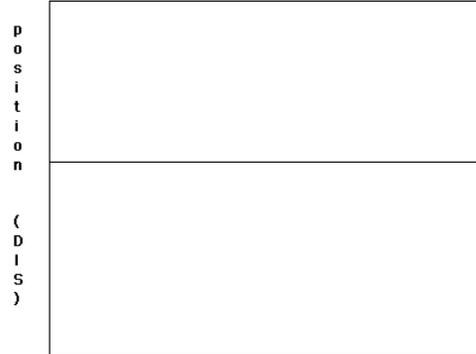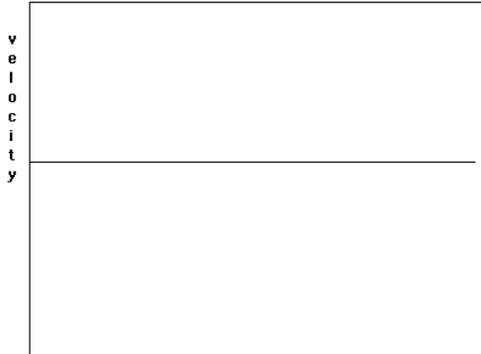velocity and zero acceleration and draw them in the spaces below.
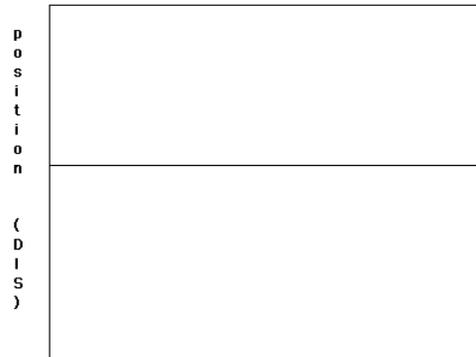
 Set the initial velocity of the car to + 5 m/s and the acceleration to zero. Click RUN.
What differences(if any) are there between your predictions and the graphs in the
simulation?

Look at the graphs in the simulation. Is either graph a straight line? Why or why not?

***** 3-2) DO NOT RUN YET!

Predict what the graphs of velocity and position will look like with a car with a + 2m/s velocity and acceleration of 1 m/s^2 and draw them in the spaces below.

```
v                              p
e                              o
l                              s
o                              i
c                              t
i                              i
t                              o
y                              n

                               (
                               D
                               I
                               S
                               )
```

 Set the initial velocity of the car to + 2 m/s and the acceleration to 1 m/s^2. Click RUN. What differences(if any) are there between your predictions and the graphs in the simulation?

Look at the graphs in the simulation. Is either graph a straight line? Why or why not?

Using the formula Vf=Vi + A*T: Assume an initial velocity of + 3m/s and calculate the acceleration needed to have a car truly stop (vf=0) when the simulation stops (12.2 s).

Acceleration = _____ m/s^2

What will the AVERAGE velocity be over this time Vavg= (Vi+Vf)/2 ?
Vavg = _____ m/s

What will the distance traveled be for this time? (ΔD= Vavg* T)
ΔD = _____m

****** 3-4 Click RESET. Set the initial velocity to + 3 m/s and the acceleration to the value you just calculated. (Type it into the box). Click RUN and observe the motion until the simulation stops.
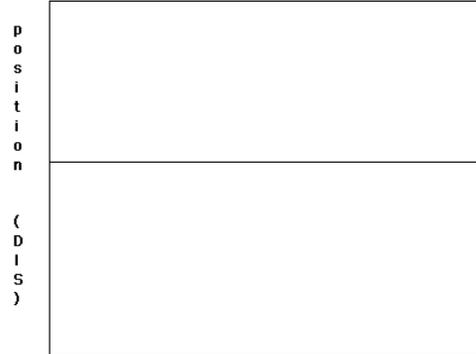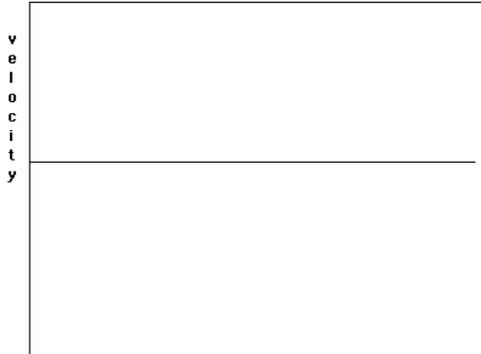
From the simulation data, record or calculate the following:
        Final velocity of the car= _____
   Distance traveled= _____

***** 3-5) DO NOT RUN YET!

Predict what the graphs of velocity and position will look like with a car with a -5 m/s velocity and acceleration of +1 m/s^2 and draw them in the spaces below.

velocity

position (DIS)

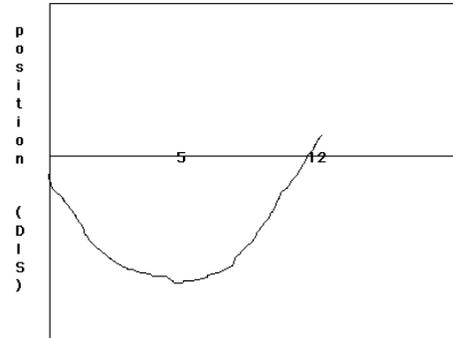 Set the initial velocity of the car to -5 m/s and the acceleration to +1 m/s^2. Click RUN.

Sketch the simulation graphs in the space below. Mark each graph with an X where the car turns around. Mark the position graph with a Y where the car is back at its initial position.

velocity
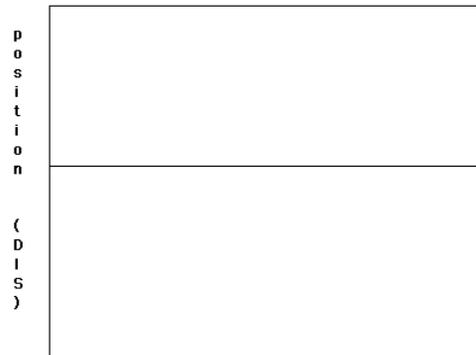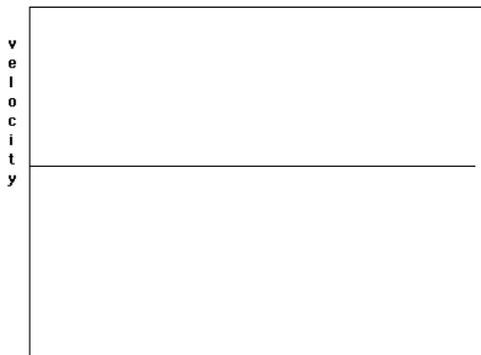
position (DIS)

Crossing the axis means something different for position and velocity graphs. What does it mean in each case?

Self Test Questions for Simulation 3

All questions refer to these graphs of position and velocity of a car.
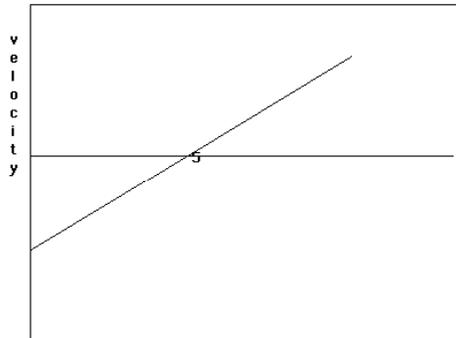
1. Is the acceleration of the car positive or negative?

2. Is the initial velocity of the car positive or negative?

3. Which way is the car moving for the first 5 seconds? To the right or to the left?

4. At what time does the car come momentarily to a stop?

5. Does the car ever return to its starting position? If so, at what time?

SIMULATION 4 THREE CARS RACING

In the previous simulations, you *set up* situations for cars moving in one dimension. You decided on the initial velocity and the acceleration and then you predicted and studied the resulting motion. You looked at numbers and vectors and graphs of position and velocity. Now you are going to go the other way and figure out the accelerations and initial velocities given only position data. You can approximate the velocity at a certain time, by using the first formula shown.

$V = \Delta D/\Delta T \quad = (D2-D1)/(T2-T1)$

For example, if the position is 0.1 meters at T=0.2 sec, and 0.4 meters at T = 0.3 seconds, then
$V = \Delta D/\Delta T \quad = (D2-D1)/(T2-T1) = (0.4-0.1)/(0.3-0.2) = .3 /.1 = 3$ m/s

Gives the approximate value of the velocity at T= 0.25 seconds (the midpoint of the interval). Once you have calculated the velocity at different times, you can use the definition of acceleration to calculate the acceleration.
$V_{avg} = \Delta D/\Delta T \qquad A = \Delta V/\Delta T \qquad\qquad V = Vf = Vi + A*T$

$V_{avg} = (Vi + Vf) / 2 \qquad\qquad \Delta D = Vi\, T + \frac{1}{2} A\, T^2$

****** Close other files and open Sim4. Sim4 DO NOT DO ANYTHING YET!!!
        In this simulation, there will be three cars that will be racing. You are not given any information on the initial velocities or whether or not the cars are capable of accelerating (maybe they have broken accelerator pedals!) You must watch them move across the screen and try to figure out what each is doing. Tracking will be on, and therefore you will have snapshots of each car at regular time intervals. The simulation will pause at 1 second, 3.2 sec, and the end. Stop and answer the questions each time.

**** Make sure you can see all three cars on the screen. Click RUN to begin. The simulation will pause after 1 sec. BEFORE GOING ON, answer the questions:

Which car has traveled the greatest distance at this time? (1 sec)
Car 1 ___.5___ m   Car 2 __1__ m   Car 3 _____ m

Can you tell which car is accelerating?

****** Click RUN Once to continue watching. The simulation will pause after 3.2 sec.
BEFORE GOING ON, answer the questions:

Which car has traveled the greatest distance at this time?
Car 1 _____ m   Car 2 _____ m   Car 3 _____ m

Can you tell which car is accelerating?

Which car do you think will win the race?

*** Click Run to continue watching till the end of the race. Look at the tracks of the cars
and answer the following questions:

Which cars are NOT accelerating?

For these two cars, how far have they gone at the end (8 sec) ?
_____ Car 1   _____ Car 2

What is the approximate ratio of their velocities? (How many times faster is Car2 than
Car1?)

From your four points for car 1 & 2 make a position time graph. Use the tape recorder at
the bottom to see the times and the mouse to see the approximate distances.
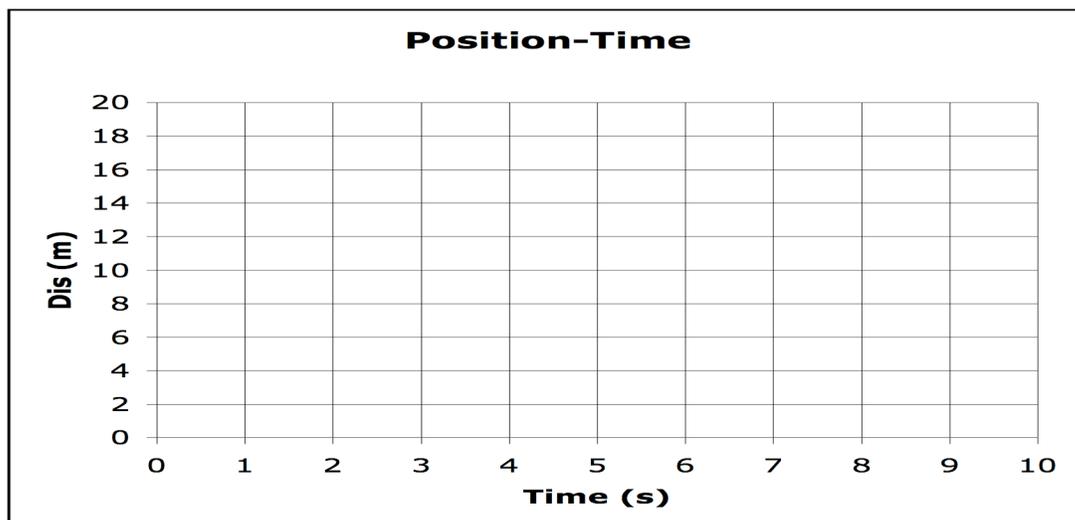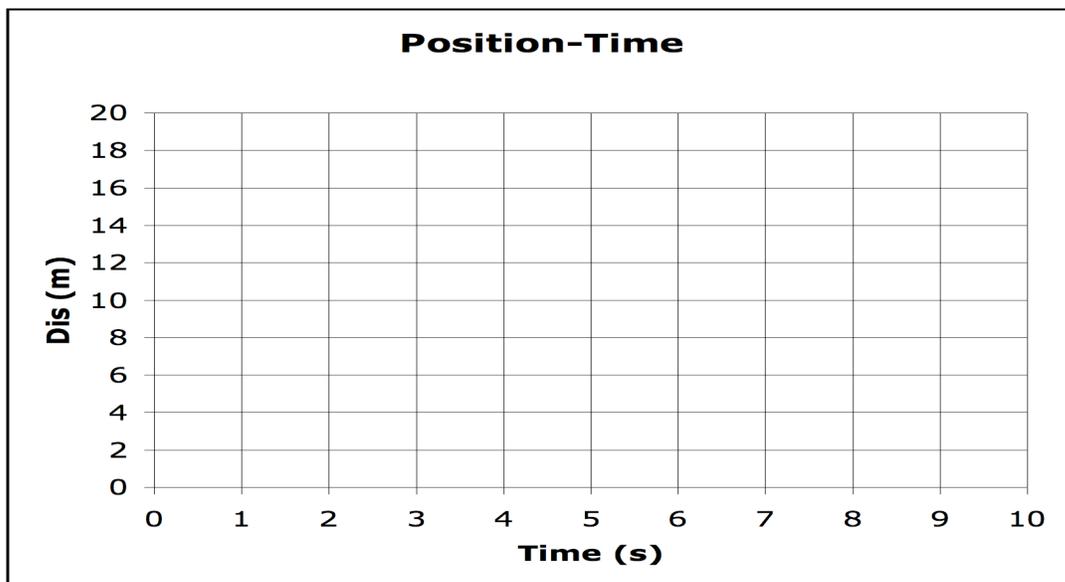
From your position data and the graph, find the velocity for car 1 and car2

_____ m/s Car1   _____ m/s Car2

Does this correlate with what you predicted?

From the simulation data available for Car3, make a position time graph. Make sure to use five to six points. Use the tape recorder if needed.

Position-Time

A line chart titled "Position-Time" with x-axis labeled "Time (s)" ranging from 0 to 10, and y-axis labeled "Dis (m)" ranging from 0 to 20 in increments of 2. The plot area is empty (blank grid).

What is the AVERAGE velocity for Car3 over the entire trip? (0-8 sec)

When was it going this speed?

What was the FINAL velocity at T=8 sec for Car3?

What was the STARTING velocity for Car3?

What was the acceleration for Car3?
***** GO ON TO THE OTHER SIMULATIONS LISTED ON THE FRONT