AP Physics 1
Summer Assignment

Name _____

Fall 2019 – Spring 2020

We have read the policies and expectations for AP Physics 1.
We understand and accept these policies.

Student Signature: _____ Date _____

Parent / Guardian Name (print)   _____

Parent / Guardian Signature: _____ Date _____
_____

I.   AP Physics 1 is a rigorous class that covers A LOT of material.   This necessitates a very fast pace. This summer homework will allow us to start on the Physics subject matter immediately when school begins. This packet is a math review to brush up on valuable skills, and perhaps a means to assess whether you are correctly placed in Advanced Placement Physics. In addition, it will introduce concepts of motion to be studied during the first unit.

II. Physics, and AP Physics in particular, requires an exceptional proficiency in algebra, trigonometry, and geometry. In addition to the science concepts Physics often seems like a course in applied mathematics. The following assignment includes mathematical problems that are considered routine in AP Physics. This includes knowing several key metric system conversion factors and how to employ them. Another key area in Physics is understanding vectors.

III. The attached pages contain a brief review, hints, and example problems. It is hoped that combined with your previous math knowledge this assignment is merely a review and a means to brush up before school begins in the fall. Please read the text and instructions throughout.

IV. Complete the TWO graphing activities. These will require internet access. Please get this done early in the summer so you do not have to worry about it on that last weekend of the summer.

V.   ## What is due the first day of school, August 12, 2019?

   A.   **Signed Class Policies and Expectations Sheet**
      1.   **Read all of the information included in this document.**
      2.   **Complete the section at the top of this form and obtain appropriate signatures (due 8/12/2019).**
      3.   **Complete the math problems section (due 8/12/2019).**
      4.   **Complete the Distance vs. Time and the Velocity vs. Time activities (due 8/12/2019).**
      5.   **Please print out the assignments and do your work on the print-outs.**

VI. ## *There will be a one-dimensional kinematics test on Wednesday, 8/21/2019.*

VII. What if I don't get all the problems or don't understand the instructions?

   A.   Simply do the best you can, but show some work / effort in order to receive credit.

   B.   Come to class the first day with your questions, in order to resolve these issues as quickly as possible.

Summer Work

Since physics is the study of relationships in nature, and these relationships are often expressed in the form of mathematical equations, we are requiring you to spend time this summer learning (memorizing) some equations and units to get started first semester. Expect a quiz in the first couple of days, and 5 or 6 more times in the semester! We will be adding to this list as the course goes on. I suggest making note cards for each one.

Units:

Variable	Symbol	SI unit	"Dead Scientists Society"
Mass	m	kg	
Length/displacement	L or x	m	
Time	t	sec	
Velocity	v	m/s	
Acceleration	a	m/s/s	
Force	F	kg·m/s^2	Newton (N)
Kinetic energy	K	kg·m^2/s^2	Joule (J)
Potential energy	U	kg·m^2/s^2	Joule (J)
Torque	τ	N·m	
Work	W	N·m	Joule
Momentum	p	kg·m/s	
Power	P	J/s	Watt (W)
Spring constant	k	N/m	

Equations (Mechanics)

Prompt	Equation
Average velocity	$$v = \frac{x_f - x_i}{\Delta t}$$
Average acceleration	$$a = \frac{v_t - v_0}{t}$$
Kinematics equation (no x)	$$v_f = v_i + at$$
Kinematics equation (no a)	$$\Delta x = \frac{1}{2}(v_t + v_0)t$$
Kinematics equation (no t)	$$2a\Delta x = v_t^2 - v_0^2$$
Kinematics equation (no v$_f$)	$$\Delta x = v_o t + \frac{1}{2}at^2$$
Newton's second law	$$\sum F = ma$$
Frictional force in terms of the normal force	$$F_f = \mu F_N$$
Torque	$$\tau = F \cdot d$$
Linear momentum	p = mv
Impulse (2 definitions)	$I = \Delta p = F \cdot \Delta t$
Kinetic energy	K = ½ mv^2
Potential energy due to gravity near Earth's surface	U$_g$ = mgh
Work (2)	$W = Fd\cos\theta$ and $W_{net} = KE_f - KE_i$
Mechanical Power (2)	$P = \dfrac{W}{\Delta t}$; P = F·v
Potential energy due to a spring	$$U_s = \frac{1}{2}k(\Delta x)^2$$

Law of gravity	$F_g = \dfrac{GM_1 M_2}{r^2}$
Centripetal acceleration	$a_c = \dfrac{v^2}{r}$
Weight (near Earth's surface)	$F_g = mg$

The following are ordinary physics problems. Place the answer in scientific notation when appropriate and simplify the units (Scientific notation is used when it takes less time to write than the ordinary number does. As an example 200 is easier to write than 2.00×10^2, but 2.00×10^8 is easier to write than 200,000,000). Do your best to cancel units, and attempt to show the simplified units in the final answer.

a. $T_s = 2\pi \sqrt{\dfrac{4.5 \times 10^{-2}\, kg}{2.0 \times 10^3\, kg/s^2}} =$ _____

b. $K = \dfrac{1}{2}\left(6.6 \times 10^2\, kg\right)\left(2.11 \times 10^4\, m/s\right)^2 =$ _____

c. $F = \left(9.0 \times 10^9\, \dfrac{N \cdot m^2}{C^2}\right) \dfrac{\left(3.2 \times 10^{-9}\, C\right)\left(9.6 \times 10^{-9}\, C\right)}{\left(0.32 m\right)^2} =$ _____

d. $\dfrac{1}{R_p} = \dfrac{1}{4.5 \times 10^2\, \Omega} + \dfrac{1}{9.4 \times 10^2\, \Omega}$ \qquad $R_p =$ _____

e. $e = \dfrac{1.7 \times 10^3\, J - 3.3 \times 10^2\, J}{1.7 \times 10^3\, J} =$ _____

f. $1.33 \sin 25.0° = 1.50 \sin \theta$ \qquad $\theta =$ _____

g. $K_{max} = \left(6.63 \times 10^{-34}\, J \cdot s\right)\left(7.09 \times 10^{14}\, s\right) - 2.17 \times 10^{-19}\, J =$ _____

h. $\gamma = \dfrac{1}{\sqrt{1 - \dfrac{2.25 \times 10^8\, m/s}{3.00 \times 10^8\, m/s}}} =$ _____

Often problems on the AP exam are done with variables only. Solve for the variable indicated. Don't let the different letters confuse you. Manipulate them algebraically as though they were numbers.

i. $v^2 = v_o^{\,2} + 2a\left(s - s_o\right)$, $a =$ _____

j. $K = \dfrac{1}{2}kx^2$, $x =$ _____

k. $T_p = 2\pi \sqrt{\dfrac{\ell}{g}}$, $g =$ _____

l. $F_g = G\dfrac{m_1 m_2}{r^2}$, $r =$ _____

m. $mgh = \dfrac{1}{2}mv^2$, $v =$ _____

n. $x = x_o + v_o t + \dfrac{1}{2}at^2$, $t =$ _____

o. $B = \dfrac{\mu_o}{2\pi}\dfrac{I}{r}$, $r =$ _____

p. $x_m = \dfrac{m\lambda L}{d}$, $d =$ _____

q. $pV = nRT$, $T =$ _____

r. $\sin \theta_c = \dfrac{n_1}{n_2}$, $\theta_c =$ _____

s. $qV = \dfrac{1}{2}mv^2$, $v =$ _____

t. $\dfrac{1}{f} = \dfrac{1}{s_o} + \dfrac{1}{s_i}$, $s_i =$ _____

Physics uses the **KMS** system (**SI**: System Internationale). **KMS** stands for kilogram, meter, second. These are the units of choice of physics. The equations in physics depend on unit agreement. So you must convert to **KMS** in most problems to arrive at the correct answer.

    kilometers (*km*) to meters (*m*)   and meters to kilometers   gram (*g*) to kilogram (*kg*)
    centimeters (*cm*) to meters (*m*) and meters to centimeters   Celsius (*°C*) to Kelvin (*K*)

    millimeters (*mm*) to meters (*m*) and meters to millimeters   atmospheres (*atm*) to Pascals (*Pa*)
    nanometers (*nm*) to meters (*m*) and metes to nanometers   liters (*L*) to cubic meters (*m³*)
    micrometers (*μm*) to meters (*m*)
    Other conversions will be taught as they become necessary.

What if you don't know the conversion factors? Colleges want students who can find their own information (so do employers). Hint: Try a good dictionary and look under "measure" or "measurement". Or the Internet? Enjoy.

|						
u.	4008 *g*	= _____ *kg*		bb.	25.0 *μm*	= _____ *m*
v.	1.2 *km*	= _____ *m*		cc.	2.65 *mm*	= _____ *m*
w.	823 *nm*	= _____ *m*		dd.	8.23 *m*	= _____ *km*
x.	298 *K*	= _____ *°C*		ee.	5.4 *L*	= _____ *m³*
y.	0.77 *m*	= _____ *cm*		ff.	40.0 *cm*	= _____ *m*
z.	8.8×10^{-8} *m*	= _____ *mm*		gg.	6.23×10^{-7} *m*	= _____ *nm*
				hh.	1.5×10^{11} *m*	= _____ *km*
aa.	1.2 *atm*	= _____ *Pa*				

Solve the following geometric problems.

a.   Line **B** touches the circle at a single point. Line **A** extends through the center of the circle.

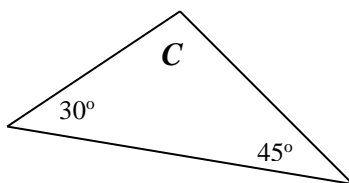   i.   What type of line is line **B** in reference to the circle?

        _____

    ii.   How large is the angle between lines **A** and **B**?
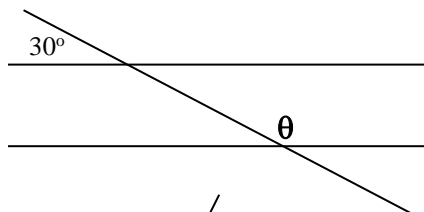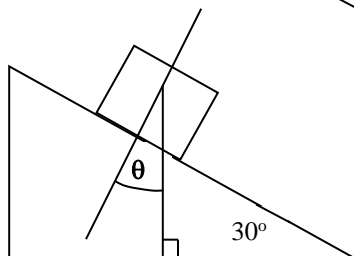
        _____
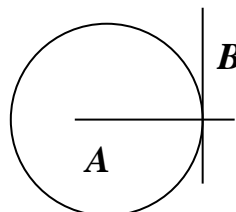
b.   What is angle **C**?

    _____

c.   What is angle θ ?

    _____

d.   How large is *θ*?

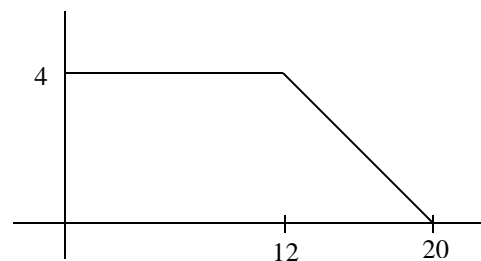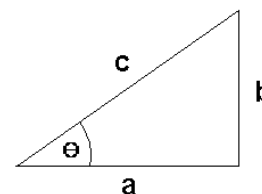   _____

e. The radius of a circle is 5.5 *cm*,

    i. What is the circumference in <u>meters</u>?

        _____

    ii. What is its area in <u>square meters</u>?

        _____

f. What is the area under the curve (function) at the right?

    _____

Using the generic triangle to the right, Right Triangle Trigonometry and the Pythagorean Theorem, solve the following. ***Your calculator must be in degree mode.***

g. $\theta = 55°$ and $c = 32$ *m*, solve for *a* and *b*.

    _____

h. $\theta = 45°$ and $a = 15$ *m/s*, solve for *b* and *c*.

    _____

i. $b = 17.8$ *m* and $\theta = 65°$, solve for *a* and *c*.

    _____

j. $a = 250$ *m* and $b = 180$ *m*, solve for θ and *c*.

    _____

k. $a = 25$ *cm* and $c = 32$ *cm*, solve for *b* and θ.

    _____

l. $b = 104$ *cm* and $c = 65$ *cm*, solve for *a* and θ.

    _____

Vectors

Many of the quantities in physics are vectors. ***This makes proficiency in vectors extremely important***.

Magnitude: Size or extent. The numerical value.

Direction: Alignment or orientation of any position with respect to any other position.

Scalars: A physical quantity described by a single number and units. A quantity described by **magnitude only**.

    Examples: time, mass, and temperature

Vector: A physical quantity with **both a magnitude and a direction**. A directional quantity.

    Examples: velocity, acceleration, force

    Notation: $\vec{A}$ or $\vec{A}$ <u>Length</u> of the arrow is <u>proportional to the vectors magnitude</u>.

                                                  <u>Direction</u> the arrow points <u>is the direction of the vector</u>.

Negative Vectors

    Negative vectors have the same magnitude as their positive counterpart. They are just pointing in the opposite direction.
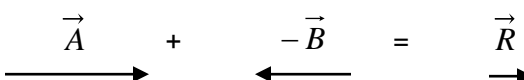
    $\vec{A}$ $-\vec{A}$

Vector Addition and subtraction

    Think of it as vector addition only. The result of adding vectors is called the <u>result</u>ant. $\vec{R}$

    $\vec{A} + \vec{B} = \vec{R}$ $\vec{A}$ + $\vec{B}$ = $\vec{R}$

        So if *A* has a magnitude of 3 and *B* has a magnitude of 2, then *R* has a magnitude of 3+2=5.

When you need to subtract one vector from another, think of the one being subtracted as being a negative vector. Then add them.

$$\vec{A} - \vec{B} \text{ is really } \vec{A} + -\vec{B} = \vec{R}$$

$\vec{A}$ ⟶   + $-\vec{B}$ ⟵   = $\vec{R}$ ⟶

A negative vector has the same length as its positive counterpart, but its direction is reversed. So if **A** has a magnitude of 3 and **B** has a magnitude of 2, then **R** has a magnitude of 3+(-2)=1.

This is very important. In physics a negative number does not always mean a smaller number. Mathematically –2 is smaller than +2, but in physics these numbers have the same magnitude (size), they just point in different directions (180° apart).

There are two methods of adding vectors that will be discussed in our 2-dimensional kinematics unit.

How are vectors used in Physics?

They are used everywhere!

Speed

Speed is a <u>scalar</u>. It only has magnitude (numerical value).

v_s = 10 *m/s* means that an object is going 10 meters every second. But, we do not know where it is going.

Velocity

Velocity is a <u>vector</u>. It is composed of both magnitude and direction. Speed is a part (numerical value) of velocity.

v = 10 *m/s* north, or **v** = 10 *m/s* in the **+x** direction, etc.

There are three types of speed and three types of velocity

Instantaneous speed / velocity: The speed or velocity at an instant in time. You look down at your speedometer and it says 20 *m/s*. You are traveling at 20 *m/s* at that instant. Your speed or velocity could be changing, but at that moment it is 20 *m/s*.

Average speed / velocity: If you take a trip you might go slow part of the way and fast at other times. If you take the total distance traveled divided by the time traveled, you get the average speed over the whole trip. If you looked at your speedometer from time to time you would have recorded a variety of instantaneous speeds. You could go 0 *m/s* in a gas station, or at a light. You could go 30 *m/s* on the highway, and only go 10 *m/s* on surface streets. But while there are many instantaneous speeds there is only one average speed for the whole trip.

Constant speed / velocity: If you have cruise control you might travel the whole time at one constant speed. If this is the case, then you average speed will equal this constant speed.

A trick question

Will an object traveling at a <u>constant speed</u> of 10 *m/s* also always have <u>constant velocity</u>?

Not always. If the object is turning around a curve or moving in a circle it can have a constant speed of 10 *m/s*, but since it is turning, its direction is changing. And if direction is changing then velocity must change, since velocity is made up of speed and direction.

Constant velocity must have both constant magnitude and constant direction.

Rate

Speed and velocity are rates. A rate is a way to quantify anything that takes place during a time interval. Rates are easily recognized. They always have time in the denominator.

10 *m/s*   10 meters / second

The very first Physics Equation

Velocity and Speed both share the same equation. Remember speed is the numerical (magnitude) part of velocity. Velocity only differs from speed in that it specifies a direction.

$$v = \frac{\Delta x}{\Delta t}$$ *v* stands for velocity; Δx stands for displacement (change in position); Δt stands for time

Displacement is a vector for distance traveled in a straight line. It goes with velocity. Distance is a scalar and goes with speed. Displacement is measured from the origin. It is a value of how far away from the origin you are at the end of the problem. The direction of a displacement is the shortest straight line from the location at the beginning of the problem to the location at the end of the problem.

How do distance and displacement differ? Supposes you walk 20 meters down the **+ x** axis and turn around and walk 10 meters down the **– x** axis.

The distance traveled does not depend on direction since it is a scalar, so you walked 20 + 10 = 30 meter.

Displacement only cares about your distance from the origin at the end of the problem. +20 – 10 = 10 meter.

Attempt to solve the following problems. Take heed of the following.

Always use the *KMS* system: Units must be in <u>k</u>ilograms, <u>m</u>eters, <u>s</u>econds.

On the all tests, including the AP exam (Thursday, May 7, 2020) you must:
1. List the original equation used.
2. Show correct substitution.
3. Arrive at the correct answer with correct units.

Distance and displacement are measured in meters　　　(*m*)

Speed and velocity are measured in meters per second　(*m/s*)

Time is measured in seconds　　　　　　　　　　　(*s*)

Example: A car travels 1000 meters in 10 seconds. What is its velocity?

$$v = \frac{x}{t} \qquad\qquad v = \frac{1000m}{10s} \qquad\qquad v = 100\,m/s$$

a.　A car travels 35 *km* west and 75 km east. What distance did it travel?

b.　A car travels 35 *km* west and 75 *km* east. What is its displacement?

c.　A car travels 35 *km* west, 90 *km* north. What distance did it travel?

d.　A car travels 35 *km* west, 90 *km* north. What is its displacement?

e.　A bicyclist pedals at 10 *m/s* in 20 *s*. What distance was traveled?

f.　An airplane flies 250.0 *km* at 300 *m/s*. How long does this take?

g.　A skydiver falls 3 *km* in 15 *s*. How fast are they going?

h.　A car travels 35 *km* west, 90 *km* north in two hours. What is its average speed?

i.　A car travels 35 *km* west, 90 *km* north in two hours. What is its average velocity?

Moving Man – Distance vs. Time Graphs

Background – Graphs are not just an evil thing your teacher makes you create, they are a means of communication. In this activity you will learn to speak and read "graph".

Learning Goals – The students will:
- Develop a general knowledge of distance vs. time graphs.
  - What a graph of a person standing still would look like
  - What a graph of a person moving away from an observer would look like.
  - What a graph of a person moving towards an observer would look like.
  - How differences in speed appear on the graph

Procedure – do the following activity using this web site
http://phet.colorado.edu/en/simulation/legacy/moving-man

Then click on the Play symbol for "The Moving Man" simulation (You may want to save to your computer or you can select Run Now. You may have to update your JAVA for this to run or you may have to "allow" it to run because the JAVA version of the simulation is a bit old.)

Screen 1

1. **Getting started.** After "Moving Man" is open leave the position graph open but close all of the other graphs, velocity and acceleration. You will do this from the Charts tab. To close a graph, just click on the "negative" sign in the upper right corner of the graph. Your screen should look like screen 1.
2. **Making observations.** By either clicking on the man or the slider, cause the man to move back and forth and observe what shows up on the graph. Using the axes provided below make a sketch of the graph that is produced by each action described next to each axis.
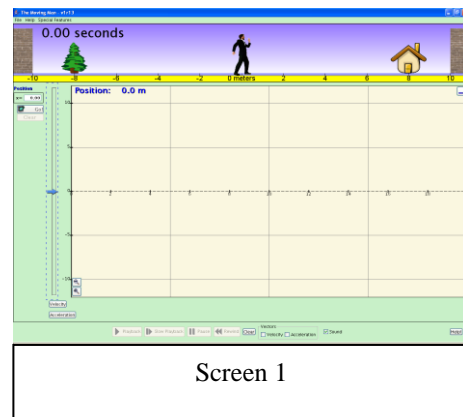
A man moving from 0 m to 10 m at a slow steady pace.
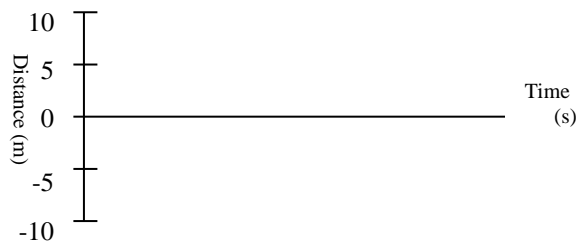
A man moving from 0 m to 10 m at a fast pace.
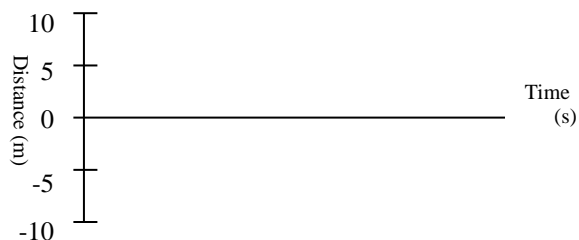

A man standing still at 5 m.

A man moving from 0 m to 10 m at a slow steady pace, then moving back to 0 m at a fast pace.

10
Distance (m)
5
0   Time (s)
-5
-10

A man moving from 0 m to 5 m at a slow steady pace, then moving back to 0 m at a slow steady pace.

10
Distance (m)
5
0   Time (s)
-5
-10

A man moving from 0 m to -10 m at a slow steady pace.

10
Distance (m)
5
0   Time (s)
-5
-10

Apply what you learned. Look at the graph below and for the different parts of the graph that are marked write a statement about what is happening. Be sure to include the direction of motion and the speed of motion.

Position: 0.0 m

Part C   Part D

Part B

Part A   Part E   Part F
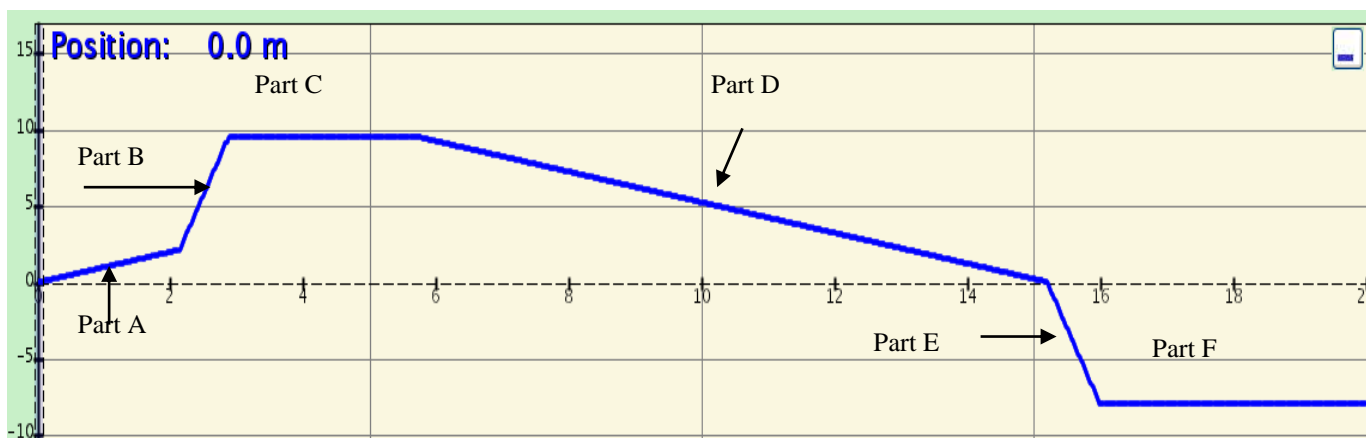
Part	Description of direction and speed
A	
B	
C	
D	
E	
F	

Moving Man – Velocity vs. Time Graphs

Background – Remember graphs are not just an evil thing your teacher makes you create, they are a means of communication. Graphs are a way of communicating by using pictures and since a picture is worth a thousand words knowing how to make and interpret graphs will save you a lot of writing. 🙂

Learning Goals – The students will:

- Develop a general knowledge of "Velocity vs. Time" graphs and "Distance vs. Time" graphs
    - What graphs of a person standing still would look like
    - What graphs of a person moving away from an observer at a constant speed would look like.
    - What graphs of a person moving towards an observer at a constant speed would look like.
    - How differences in speed appear on the graphs

Procedure – Do the following activity using this web site
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Screen 1

Then click on the Play symbol for "The Moving Man"
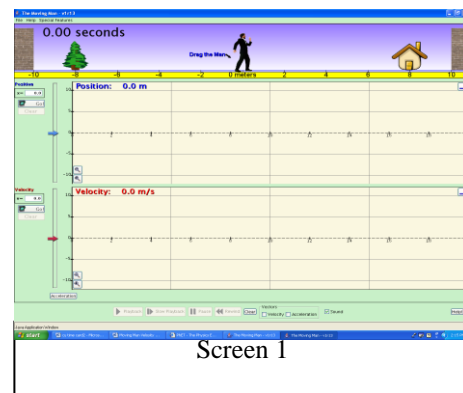
3. **Getting started.** After "The Moving Man" is open leave the position graph and the velocity graph open but close the acceleration graph. Your screen should look like screen 1.
4. **Making observations.** By either clicking on the man or the slider cause the man to move back and forth and observe what shows up on the graphs. Using the axis provided below make sketches of Distance vs. Time and Velocity vs. Time graphs for the actions described next to each axis.
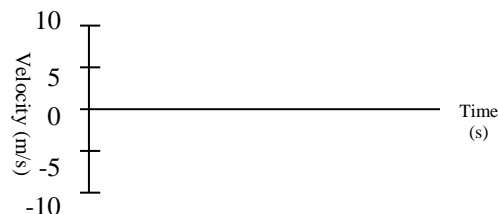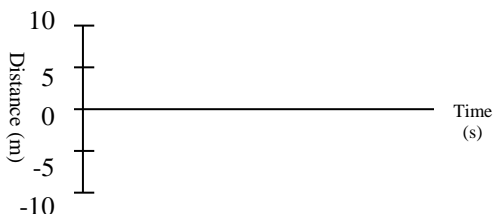
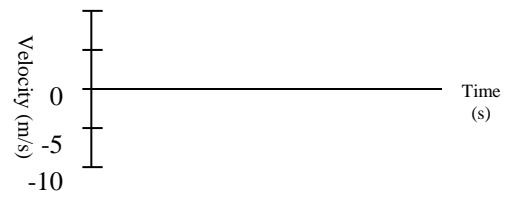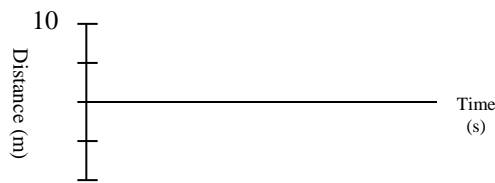A man moving from 0 to 10 at a slow steady pace.
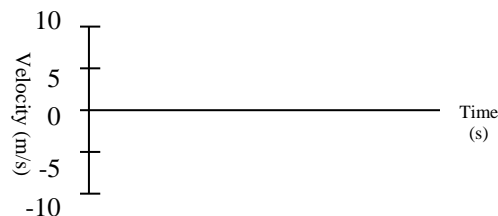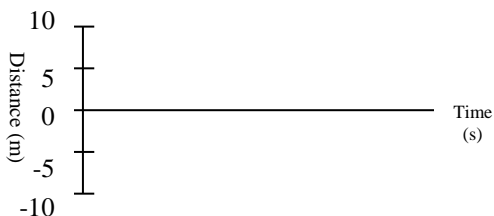
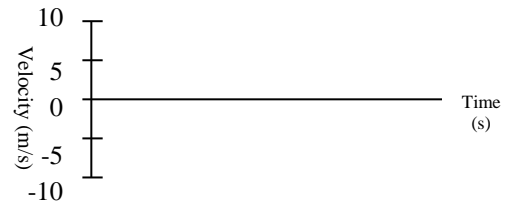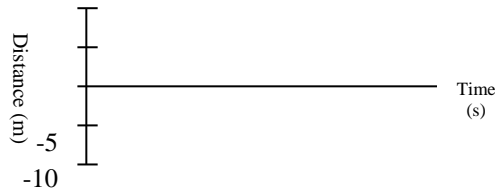A man moving from 0 to 10 at a fast pace.
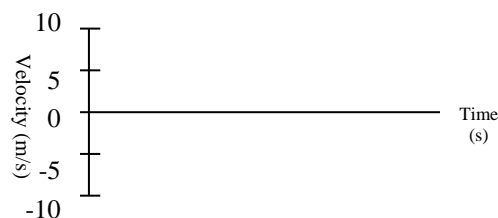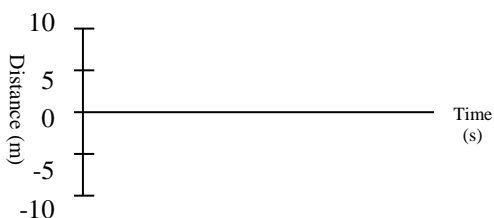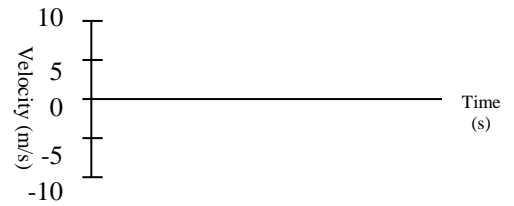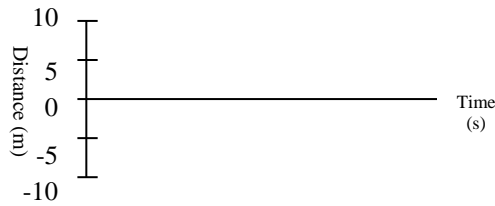

A man standing still at 4 m

A man moving from 0 to 10 at a fast pace the moving back to 0 at a slow pace.

A man moving from 0 to -10 at a fast pace the moving back to 0 at a slow pace.

A man moving from 10 to 0 at a fast pace.

Apply what you learned. Look at the Distance vs. Time graph below and for the different parts of the graph that are marked by the dotted lines make the corresponding Velocity vs. Time graph directly below each part.

Position: 0.0 m