Physics Name:

Date	Hr	Score

Activity - Measuring the motion of toys!

Purpose: To use a timing device to measure the velocity and acceleration of various moving toys and to draw distance vs. time and velocity vs. time graphs of that motion.

Materials:

Electric Timer	timer tape and masking tape
Ruler	moving toys

Background: Recall that velocity is the rate of change of position with respect to time: So, in order to measure the velocity (or speed) of an object we must know the distance it travels and the amount of time it takes to traverse that distance. Similarly, the acceleration of an object is the rate of change of velocity with respect to time. In this activity you will use a Tape Timer to record distance and time data for various moving objects. You will use this data to determine the velocity and acceleration with which objects travel.

Procedure:

$$v = \frac{\Delta x}{\Delta t} \qquad a = \frac{\Delta v}{\Delta t}$$

A. Calibrating the timer

(a) Set the timer to 60Hz.

(b) In order to use the timer one must first know the period of the sparks. That is, how many times per second it makes a spark. To do this, start the timer and carefully pull a sample piece of recording paper through the timer at a constant speed while a second person records how much time is passing (2-4sec should be adequate).

(c) when time is up, stop the timer and count the dots. Record your data. Calculate the number of dots per second. If it is not close to 60 repeat the calibration.

Table 1 - Timer Calibration

	time (s)	# dots	Dots/sec
Trial 1			
Trial 2			
Trial 3			

*Note: the period for the trials should be fairly close in each trial.

B. Measuring Velocity

(a) Thread 1 meter of timer tape through the timer and attach it to the toy with masking tape.

(b) Start the timer and let the device move. Record dots until out of tape. NOTE: You do NOT need to time the truck!

(c) Draw a line on the tape after the first clear dot that appears and choose 20-30 dots to use for the velocity measurement.

(d) Carefully measure the distance FROM THE FIRST DOT to each successive dot and record in the table (you may wish to choose every second or third dot etc...depending on how close they are together. If you do this be sure to account for the new timer period!)

(e) Calculate the average velocity for each interval using the formula above. Then find the change in velocity and use that to calculate the average acceleration of the device being studied.

Table 2 - Motion data (sample)

time (s)	x (cm)	ave. v (cm/s)	change in v (cm/s)	ave. a (cm/s/s)
0	0			

Analysis:

(a) Use your data to make graphs of position vs. time and velocity vs. time. If you know how to use a spreadsheet that may be very useful.

(b) Draw a line of best fit on the position vs. time graph. Find the slope of this line. What does this slope represent?

(c) Locate a relatively straight section (small interval) of your position vs. time graph and find the slope of the graph on that interval. What does this slope represent?

(d) Locate a relatively straight section on the velocity vs. time graph. Find the slope of the graph on that interval. What does this slope represent?

(e) Find the total **area** under the velocity vs. time graph. Do this by dropping a line from the first point to the time axis and the last point to the time axis. Shade the region formed. What shape is it? This area represents the total displacement of the moving device.

Questions:

1.) What does the slope of the best fit line on your position vs. time graph represent?

2.) What does the slope of the line through the straight section of your position vs. time graph represent?

3.) Was the area under the velocity vs. time graph close to the distance that you measured for the moving device? Calcualte it and compare to the final distance in your data table. Account for any differences.

4.) What does the slope of the straight section of the velocity vs. time graph represent?

5.) Draw pictures of how the dots *should* look on a piece of tape representing constant speed, acceleration, and deceleration.

6.) When constant speed was attained what was the speed of your device **in mph**?

Conclusion:

What did you learn from this activity? In your own words, describe how speed and acceleration are measured then describe--in detail--the motion of your device using the graphs and data tables you made. Discuss any sources of error in this activity.