

2008
Winning Lesson Plan
from Campbell River,
B.C, Canada

Analysis of a Boxing Punch

by Gregg Mitchell
Timberline Secondary
School

Subject: Physics 11
Lab Activity
Actual experiment time is
0.7 seconds.
One class period and one
hour of homework time for
completion.
Extensions and follow-up
activities take one
additional class period.

Overview and Purpose

Students will produce a short duration, non-uniform data set by performing a boxing punch while pulling ticker tape through a timer.

Purposes

To interpret both **distance-time (d-t)** graphs and **velocity-time (v-t)** graphs.

To show the relationships between these graphs for the same data set.

To practice graphing skills prior to switching to computer based graphing.

To make the transition from physical measurements and manipulation of data to computer based data acquisition. (follow-up activity)

Innovation

Doing a simplified analysis of your own “fighting ability” is highly motivational.

Context

This is the final activity of the Kinematics unit in Physics. It draws connections between **d-t**, **v-t** and **acceleration-time (a-t)** graphs, and introduces the concept of non-uniform acceleration, which is an extension to the Physics 11 course.

Educational Standards Addressed

This lab addresses the following British Columbia Physics 11 Prescribed Learning

Outcomes

C1: It is expected that students will apply knowledge of the relationships between time displacement, distance, velocity, and speed to situations involving objects in one dimension.

C2: It is expected that students will apply knowledge of the relationships between time, velocity, displacement, and acceleration to situations involving objects in one dimension.

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Assessment

The lab will be graded using a standard lab marking rubric. This activity is particularly good at providing opportunities for students at all levels. For example, it is possible to find the point of highest velocity from either graph (**v-t** or **d-t**) without recognizing that each graph gives the same answer.

Materials

- Ticker tape timer
- 1.5 m ticker tape

Required for Extensions

Pasco Science Workshop 500 interface and motion sensor.

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Physics 11 Lab: Analysis of a Boxing Punch

Method

Take a punch at an imaginary target.

Pull a piece of tape through the ticker-tape timer as you do this.

Hints – keep your fist level... don't punch in an arc.

Ease up a bit... you can probably punch too fast for the timer. (you need at least six dots.)

Analysis

1. Set up a data table to record the following:
 - a) Dot number
 - b) Time – we will not use seconds as our time unit. To simplify our numbers we will use an interval of 1/60 second.
 - c) Total distance – this is measured from the starting dot to each other dot.
 - d) Distance between every pair of dots.
 - e) Velocity between every pair of dots.
2. Divide a graph page in half. (Use the same time scale for both graphs.)
 - a) On the top half plot “TOTAL DISTANCE vs. TIME”
 - b) On the bottom half plot “VELOCITY vs. TIME”
3. Find the point on the **d-t** graph where the slope is the steepest. Clearly mark it “X”. Draw a tangent at this point and find its slope.
4. Find the point on the **v-t** graph where the slope is the steepest. Clearly mark it “X”. Draw a tangent at this point and find its slope.

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Physics 11 Lab: Analysis of a Boxing Punch (Cont'd)

Discussion

1. Look at the **d-t** graph. At what time was your fist moving fastest?
2. Look at the **v-t** graph. At what time was your fist moving fastest?
Compare this to your answer to #1. (Now, use this result to answer #3.)
3. If energy depends on velocity, at what time did your punch have the most energy?
4. Look at the **v-t** graph. At what time was the acceleration maximum?
(Now, use this result to answer #5.)
5. If force depends on acceleration, at what time was there most force behind your punch?
6. Based on your experiment, for your most effective self-defense, should you concentrate on short jabbing punches, or should you stand a long way off (about the end of your reach). Or what?

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Follow-Up Activities: Day 2

A: Optional extension.

1. Draw tangents at about six different points on your **velocity-time** graph.
2. Find the slope of each tangent.
3. Use this data to plot and **acceleration** vs. **time** graph.
4. Describe how the shape of this new **a-t** graph relates to the shape of your **v-t** graph.

B: Computer based data acquisition.

1. Set up the Pasco Motion Sensor as per directions.
2. Select graphs to display: **d-t** and **v-t**
3. Take a punch towards the motion sensor.
4. Compare your computer graphs to those you drew by hand yesterday. Look for differences in slopes, maximum height, etc. Explain why there are differences.

Extension

Produce the following **distance-time** graphs by moving your hand towards the motion sensor:

- a) A straight line with a constant positive slope.
- b) A horizontal line.
- c) A straight line with a constant negative slope.
- d) A curve that gets steeper.

Produce the following **velocity-time** graphs by moving your hand towards the motion sensor:

- a) A straight line with a constant positive slope.
- b) A horizontal line.
- c) A straight line with a constant negative slope.
- d) A curve that gets steeper.