

Ticker Tape Motion

Teacher's Notes

Main Topic	Motion
Subtopic	Acceleration
Learning Level	High
Technology Level	High
Activity Type	Student

Description: Use a ticker tape timer to observe and graph the motion of an accelerating toy car.
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Required Equipment	Stopwatch, ticker tape timer, ticker tape, calculator, meter stick, ring stand support, pull-back car, computer with Excel
Optional Equipment	

Educational Objectives

- Use a ticker tape timer to record the motion of an accelerating toy car.
- Create graphs of velocity and acceleration versus time, and show how these graphs demonstrate constant acceleration.

Concept Overview

The ticker tape timer works by making dots on a paper tape at equal time intervals (approximately every 0.1s in this experiment). It is an excellent way for beginning physics students to experience the measurement of motion.

Students will record and graph the motion of a car that moves with constant acceleration. Results of this lab are typically very good. The velocity vs. time graph will be a straight line with positive slope, where the slope is equal to the car's acceleration. The position vs. time graph will be a parabola.

Lab Tips

Make sure students understand the difference between measuring the total displacement from the start (for finding position) and measuring the displacement between each time interval (for finding velocity).

Students will set the ticker at 10 Hz, but this does not necessarily mean that the ticker will operate at exactly 10 Hz, placing ten dots every second. They will measure the period between the dots in the first part of the experiment.

Acknowledgement

Thank you to Dwight Putnam for his assistance in developing this lab.

Ticker Tape Motion

Name: _____

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Helpful Equations:

$$v = \frac{\Delta d}{\Delta t} \quad a = \frac{\Delta v}{\Delta t}$$

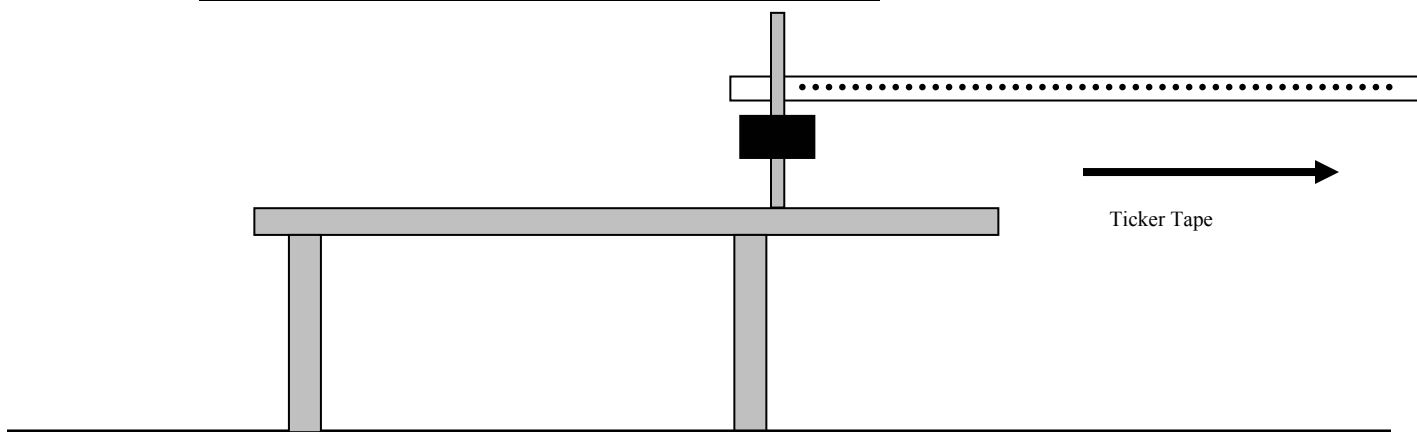
Materials:

- Stopwatch, ticker tape machine & ticker tape, calculator, meter stick, ring stand support, pull-back car, computer with Excel

Procedure:

Part I – Finding the Period (Time between the dots)

1. Thread the end of **one arm's length** of a strip of ticker tape into your timer.
2. Set your tape timer at **10 Hz**. Turn on the Tape Timer and pull the tape through the timer at a **reasonable** constant speed and record the time from your stopwatch. (The **time** is from when you **begin** to pull until the tape **leaves** the timer.)
3. **Record** the time in the table below and **count all of the dots** from where the **stopwatch started to where the stopwatch stopped**.



*** Be careful of significant digits!**

TRIAL #	Number of Dots	Time [sec]	Frequency [dots/sec]	Period [sec/dot]
1				
2				
3				

_____ Your Average Period (T) → The Time between EACH dot.

*** THIS AVERAGE PERIOD WILL ACT AS YOUR TIMER IN PART II.**

Ticker Tape Motion

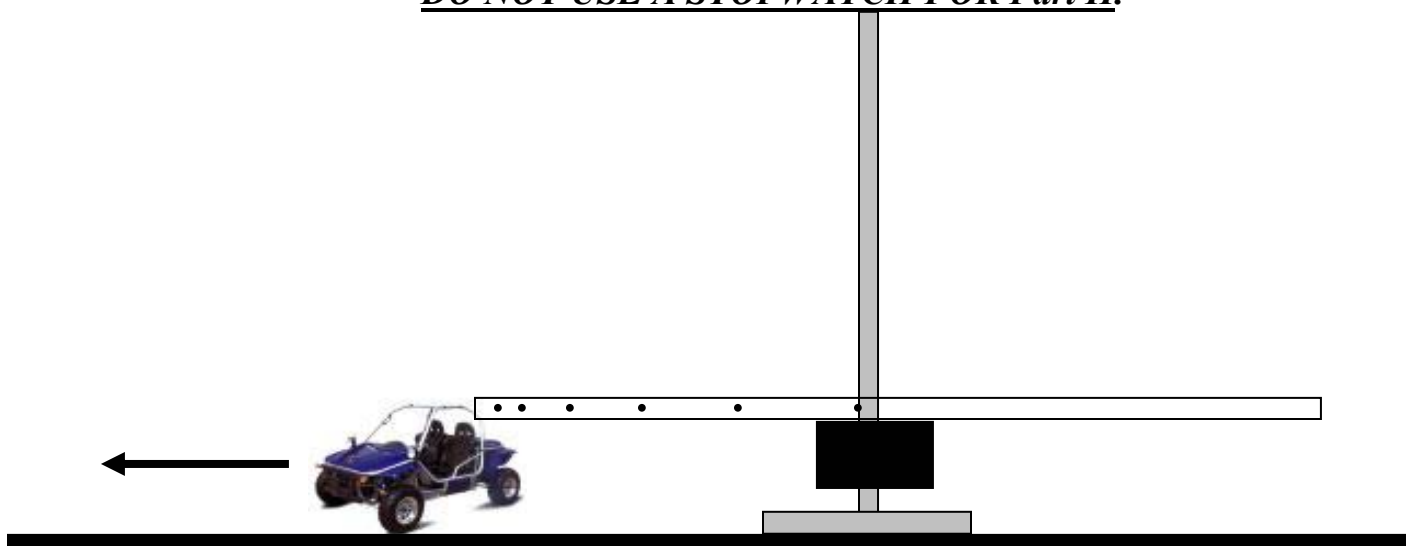
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Class: _____

Part II – Dune Buggy Acceleration

1. Using the Ticker Tape Machine as your timing device, place the ring stand support w/ Ticker Tape Timer on the floor as shown in the diagram.
2. Tape approximately 2 meters of Ticker Tape to the crossbar of the pull-back dune buggy and thread the other end through the Ticker Tape Timer.
3. Wind up the dune buggy and turn on the Ticker Timer (set to 10 Hz) and release the car.
4. The dune buggy should accelerate and the Ticker Timer will indicate the acceleration by increasingly spaced dots.

*** DO NOT USE A STOPWATCH FOR Part II.**



Part III – Making the Motion Graphs of Velocity and Acceleration

For THIS section, you and your partner(s) will need...

- your ticker tape data calculator meter stick computer w/Excel

1. Using the ticker tape you made in Part II, pick the 1st distinct (clear) dot on your ticker tape and mark a “Starting Line”. This is your “0” mark.
2. Start numbering the next dot #1, the next dot #2 and so on until you label up to the 20th dot on the ticker tape.
3. Measure the **Distance** (in cm) from the “**Starting Point**” to **Dot #1** and record the Distance in the table under the column labeled “**Total Distance**”.
4. Now measure the Distance between the “**Starting Point**” and **Dot #2** and record in the table. Repeat this with the “**Starting Point**” to **Dot #3** and so on until you have completed the column for “**Total Distance**”. (See in-class example below)

- **The Total Distance Measured/Time (Dot Period) = Average Velocity**

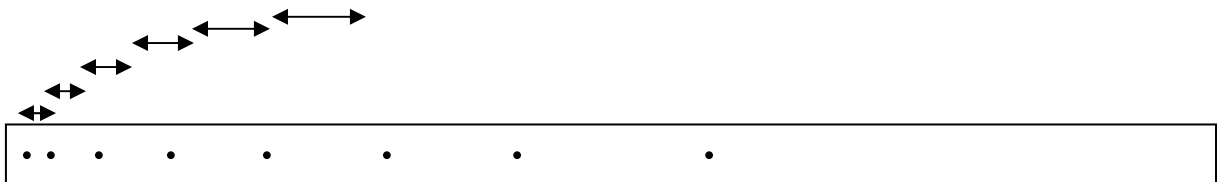


Ticker Tape Motion

Name: _____

Class: _____

5. Now measure the **Distance** (in cm) from the **“Starting Point” to Dot #1** and record the Distance in the table under the column labeled **“Average Velocity”**.
6. Now measure the Distance between **Dot #1 and Dot #2** and record in the table. Repeat this with **Dot #2 to Dot #3** and so on until you have completed the column for **“Average Velocity”**. (See in-class example below)
 - **The Distance measured between individual Dots is = to the Velocity.**
 - **Velocity/Time (Dot Period) = Acceleration**



Time (Dots)	Total Distance (cm)	Velocity (cm/dot)
1		
2		
3		
4		
5		
6		
7		
8		
9		
10		
11		
12		
13		
14		
15		
16		
17		
18		
19		
20		

For Full Credit...

Using **Excel**, make **TWO** graphs for this lab.

- A. Create a **Total Distance vs. Time graph** for the Dune Buggy.
- B. Create a **Velocity vs. Time graph** for the Dune Buggy.

Ticker Tape Motion

Name: _____

Class: _____

- Your graphs MUST have...
 - Proper Title
 - Labeled axis with units
 - Best Fit “Shape” trendline
 - Equation for the plotted trendline

Lab Questions

1. For the **Distance vs. Time** graph, what does your plotted line represent?
2. Describe the motion of the dune buggy according to your graph.
3. For the **Velocity vs. Time** graph, what does the plotted line represent?
4. Why is the plotted line a “straight line” for the **Velocity/Time** graph?
5. According to your Velocity/Time graph and the equation for your graph, what does the **slope** of the line represent?