Buggy Car Lab

Questions to be investigated

1. How do we describe the motion of an object?
2. What characterizes constant velocity?
3. What type of graph best illustrates constant velocity?
4. What does the slope of a line tell you?

Objectives

1. Define constant velocity.
2. Collect and organize data of the car's motion.
3. Create a position vs. time graph using data collected.
4. Define the meaning of the slope (i.e. what does it tell you about the car's motion?)

Materials

- 1 Constant velocity car (for each group)
- 10 small pieces of masking tape (for each group) & a starting line tape
- 1 Stop watch (for each group)
- 1 meter stick (for each group)

Teacher Notes

Before beginning the lab it is important to elicit the students' knowledge related to the physics. The question; "is the car moving at a constant speed?" seems like it should be easy and the kids will probably say "yes" but when you ask "How do you know?" they may not be able to justify their answer.

Holding class conversations about the lab before the lab happens is crucial! Students who think science is just following recipe labs is missing out on valuable pedagogy. Therefore, ask questions! Below you'll find some questions that will help you engage the students.

Be sure to refer to elaborated teacher notes in the document: Unit II: Particle Moving with Constant Velocity. This document provides further discussion on pre- and post- lab discussion, word choice and the care needed when discussing various models for motion such as motion maps, graphs and equations.

Experimental Design:

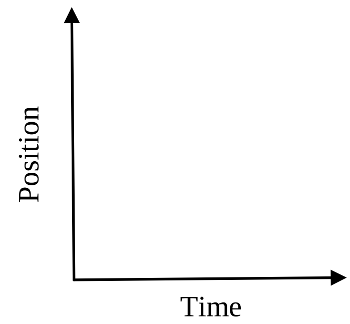
Having students aid in the design of their experiments aids in not only their participation and ownership of the lab but also aids in the process of doing science while learning science. Therefore it is important that students are part of the process. Even though the procedure of the lab is described below the teacher's responsibility is to get the kids to come up with the method of data acquisition through some dialogue.

Run the car along a table and ask the students what they notice. When prompted the students will say that, "Yes the car moves at a constant speed." The next questions is; "Is speed something that you can measure directly?" Since the cars don't have speedometers and we aren't equipped with radar guns they cannot measure speed. That leads us to the question, "What can you measure?" Since they can really only measure distance and time they will want to do so.

The next question, "Does the starting point matter?" is important to draw out the distinction between distance traveled by the car and the position of the car relative to a starting (or reference) line. Make that distinction before moving on.

Prediction:

With any lab it is important that students predict the outcome before actually attempting the lab. Since they know they are measuring position and time, is it possible to predict what a graph of position vs. time might look like? Have the students draw the following graph and create a qualitative predictive sketch of what they think the graph will look like for their car.



The Lab:

When discussion is done the students will have come up with something like the following (which lab is best done in a large space or outside).

Divide students into groups of four. One person is assigned each of the following roles in this investigation:

- time keeper
- data recorder
- tape marker
- measurer & car operator

This lab is divided into three parts:

- slow-constant speed
- fast-constant speed
- other

During part 3 (other), the teacher will assign groups a new challenge. The challenges may include:

- changing the starting position of the car (+ or -)
- placing the car at the positive or negative end
- having the car travel backwards
- etc.

Just before groups are ready to begin collecting data, have students turn on the car and place it before the starting line. When the car reaches the starting position, the timer begins saying, “MARK” at two second intervals. This will increase the accuracy in data collection.

Procedure/Description of Lesson

1. Define the purpose of the lab.
2. Review requirements for a position vs. time graph.
3. Review slope.
4. Go over the materials needed and assign roles to students.
5. Provide student handout.

Assessment Ideas

1. Analysis questions (lab report)
2. Conclusion (lab report)
3. Using whiteboards have students graph a scenario that the teacher speaks
4. Unit II: Review (handout from the modeling workshop)

Sources:

http://www.arborsci.com/ArborLabs/ASLab_3.aspx
http://www.compadre.org/precollege/items/detail.cfm?ID=8313
http://modeling.asu.edu/Modeling-pub/Mechanics_curriculum/2-Constant%20v/01_U2%20Teachernotes.pdf

Constant Velocity Lab: Buggy Cars

Record names of your group members according to their jobs during the lab:

Time Keeper: ____

Data Recorder: ____

Tape Marker: ____

Measurer & Car Operator: ______________________________________

Purpose

The purpose of the lab is to examine the motion of the buggy.
Students should be able to:

- Measure the position of the buggy with respect to time
- Create a position vs. time graph for the buggy
- Develop a mathematical model for the motion of the buggy

Materials

Dune buggy
Meter stick
Stop watch
Tape (marking device)

Procedure

Part 1

1. Set the buggy car to a slow speed using the dial.
2. Mark the starting point on the floor using a piece of masking tape. (This is the 0 cm point.) When you begin, the front of the car should be at the starting point.
3. As the timer reads the time aloud (every 2 seconds) the marker should mark the position of the front of the car with a small piece of masking tape. Take 10 data points.
4. Measure the displacement of all the marks from the starting point and record the data in data table 1 and repeat.

Part 2

5. Set the buggy car to a fast speed using the dial.
6. Remove the tape marks from part 1.
7. Repeat steps 2-3 from part 1.
8. Measure the displacement of all the marks from the starting point and record the data in data table 2 and repeat.

Part 3

9. Remove the tape from part 2.
10. See your teacher for the instructions for Part 3.
11. Record your data in table 3 and repeat.

Data

Part 1	
Time (s)	Position (cm)

Part 2	
Time (s)	Position (cm)

Part 3	
Time (s)	Position (cm)

Graphing

1. Put your name at the top of the graph paper.
2. Create one graph and plot all your data points (you should have two or three lines).
3. Use different colored pencils for each of the three parts.
4. Draw a line of best fit for **each** of your data sets.
5. A complete graph includes:
   - title
   - x and y variables and units (time on the x-axis and position on the y-axis)
   - scale
   - line(s) of best fit
6. Calculate the slope of each line.
7. Record the slope of all three parts using the coordinating colored pencil from your graph.

Analysis Questions

Refer to your graphs from part 1 and 2 to answer the following questions.

1. Do your data points fall in a somewhat-straight line? YES / NO
2. What physical quantity is represented by the slope of the line?
3. How does the slope of graph 1 and graph 2 compare? What does that really mean?
4. Is the velocity of the car constant or not constant? ____________________ How do you know?
5. How would you recognize a graph of an object traveling at a constant velocity?

Refer to your graph from part 3 to answer the following questions.

6. What do you notice about the shape of your graph? (Is it similar to graphs 1 and 2, or different? Explain.)
7. How does the slope of the line in graph 3 compare to the slopes of graphs 1 and 2? What does that tell you about the motion of the car?
8. Is the velocity of the car constant or not constant? ____________________ How do you know?

List any factors that may have contributed to sources of error in this lab.

Conclusion

Write a conclusion that includes the following items at a minimum:

- the purpose of the lab
- what you did in this lab (all three parts)
- how your data compares (for all three parts)
- what a constant speed graph looks like
- additional information you learned

Wrap Up

How do we get the students to share their answers when finished? One way is through the use of some sort of "Formal Lab Report". The above questions can be used to structure such a report. However, if we want to students to engage in think and discussion about their learning (metacognition) then we need a different methodology.

The use of 3 ft by 2 ft white dry erase boards has been shown to be very useful in prompting student discussion. In their groups you can have the students answer some or all of the questions above. When they are finished, gather the groups and have them each present their boards.

The role of the teacher here is crucial in that your job is to facilitate discussion related to the questions – not to answer the questions. This departure from the traditional set up will allow the students to begin to rely on their own answers instead of waiting for the correct answers from the teacher.