SCIENCE NORTH SCIENCE NORD
SUDBURY, ONTARIO, CANADA

Driverless Cars and Analysis of Motion | **Grade 12 – Motion and its Applications**

Lesson Plan

Assessment	AFL, AOL
Cross-curricular	Mathematics

Big Ideas

- All motion involves a change in the position of an object over time.
- Motion can be described using mathematical relationships.
- Many technologies that utilize the principles of motion have societal and environmental implications.

Learning Goals

- I can use terms related to motion, such as distance, displacement, speed, velocity, and acceleration.
- I can draw position-time and velocity-time graphs and use these graphs to determine average velocity, average acceleration, and displacement of an object moving in one dimension.
- I can analyse the uses of driverless cars and evaluate their social and environmental impact.

Specific Expectations:

A1.5 conduct inquiries, controlling relevant variables, adapting or extending procedures as required, and using appropriate materials and equipment safely, accurately, and effectively, to collect observations and data

A1.6 compile accurate data from laboratory and other sources, and organize and record the data, using appropriate formats, including tables, flow charts, graphs, and/or diagrams

A1.8 synthesize, analyse, interpret, and evaluate qualitative and/or quantitative data; solve problems using quantitative data; determine whether the evidence supports or refutes the initial prediction or hypothesis and whether it is consistent with scientific theory; identify sources of bias and/or error; and suggest improvements to the inquiry to reduce the likelihood of error

B1.1 analyse the design and uses of a transportation technology (e.g., snowmobiles, automobiles, motorized personal water craft), and evaluate its social and environmental impact, including the impact on risk behaviour and accident rates [AI, C]

B2.1 use appropriate terminology related to motion, including, but not limited to: distance, displacement, position, speed, acceleration, instantaneous, force, and net force [C]

B2.2 plan and conduct investigations to measure distance and speed for objects moving in one dimension in uniform motion [IP, PR]

B2.4 draw distance–time graphs, and use the graphs to calculate average speed and instantaneous speed of objects moving in one dimension [PR, AI, C]

B2.5 draw speed–time graphs, and use the graphs to calculate average acceleration and distance of objects moving in one dimension [PR, AI, C]

Description:

In this lesson students will accelerate a block or toy car using a rubber band rope. They will collect data using an app and graph position-time and velocity-time graphs in order to analyse the motion of the object. Prior to this lesson students should be familiar with, and able to describe the relationships between the terms position, distance, displacement, speed, velocity, and acceleration in one dimension. **This lesson is intended for the college level.**

Materials

How do Driverless cars work? Video
Graphing Motion (Student and Teacher)
Rules for Making Graphs (Student)
Accelerated Car Activity (Student)
Accelerated Car Activity Pre-Activity Questions and Discussion Questions (Teacher)
Accelerated Car Rubric
Accelerated Car Activity Group Materials**:**

- Mobile phone or tablet
- Vernier Video Physics app
- Elastic bands
- 200-500 g block or toy car, approximately the size of a blackboard eraser
- A track -- books, boards, boxes, Styrofoam, or other materials with which to make barriers
- Books or other weights to hold an elastic rope taut.

Driverless Car Assignment (Student)
Driverless Car Assignment (Teacher)
Driverless Car Rubric

Safety Notes

There are no safety issues in this lesson plan.

Introduction

First students will watch "How do Driverless cars work?"

http://www.telegraph.co.uk/motoring/motoringvideo/11308777/How-do-driverless-cars-work.html
Telegraph
James Armstrong
February 11, 2015

Driverless cars require a combination of live map and sensor data, along with fast and accurate processors to calculate speeds, accelerations, stopping times, and distances, in order to identify navigation paths and obstacles. The car's computer must interpret physical information and make almost instantaneous "decisions" which are programmed by robotics engineers and scientists. However, these motion calculations are based on the basic equations and tools used to analyze motion in one dimension.

Information about the motion of an object can be recorded and presented in different ways. From math class, you may be familiar with tables and graphs. Data about ***position***, ***displacement (distance)*** or

velocity (speed) can be collected either manually or using simple software and recorded in a table. This information can also be presented in graphic form to facilitate interpretation.

Next, they will practice graphing data using the activity; Graphing Motion (Student) (See Link) but they should first review Rules for Making Graphs (See Link). The teacher should review the graphs for formative assessment.

Action

Students will perform the Accelerated Car Activity (See Link) in groups of 3. In their groups of three, students answer the introductory questions before proceeding with the set-up.

When the students are using the Vernier Video Physics app, the position and velocity graphs will be automatically produced and can be printed out or shared with the teacher. The acceleration-time graph must still be produced. The teacher should collect the introductory questions, discussion, and graphs for summative assessment using the Accelerated Car rubric (See Link).

Accelerated Car Activity (See Link)

Prior Knowledge Questions

1. What will be the motion of the device? Sketch the position vs. time graph you expect for this motion.
2. Will the velocity of the device ever be negative? Sketch the velocity vs. time graph you expect for this motion.
3. Will the acceleration of the device be constant? Will the acceleration ever be negative?

Group Materials

- Mobile phone or tablet
- Vernier Video Physics app
- Elastic bands
- 200-500 g block or toy car, approximately the size of a blackboard eraser
- A track -- books, boards, boxes, Styrofoam, or other materials with which to make barriers
- Books or other weights to hold the elastic rope taut.

Instructions

1. Create a horizontal track, at least 5 m long. You will want to make sure that the track is straight, with barrier walls set up along the width of the device so that it neither flies off course nor is damaged.

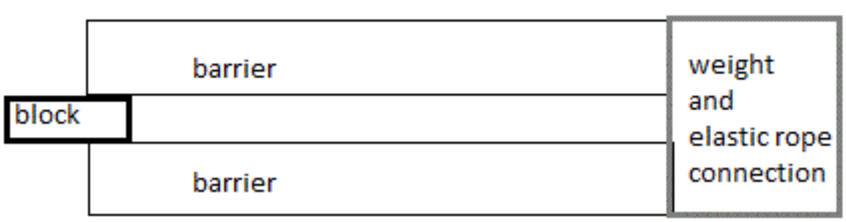

Figure 1: The experimental set-up for the activity.

2. Attach the loose end of the rubber band string around the perimeter of the block (or car). You may need to tape the elastic in place.
3. Begin recording using the Vernier Physics app.
4. Release the device, allowing the rubber band string to accelerate the device down the track.

Analysis

1. Record the position vs. time data in a table and create a scatter plot from this data.
2. Calculate the velocity vs. time data, record it in a table and create a scatter plot.
3. Calculate the acceleration vs. time data, record it in a table and create a scatter plot.

Discussion

A. Does your data agree with your predictions as made in the Introductory Questions? If not, why not?

B. In what way could you improve or modify this experiment to demonstrate constant acceleration?

C. What are some specific sources of error in this experiment? How could you improve the experiment to reduce (or eliminate) these sources of error?

This activity is adapted from
https://www.teachengineering.org/view_lesson.php?url=collection/uno_/lessons/uno_accelerometer/uno_accelerometer_lesson02.xml

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Consolidation/Extension

Finally, students will investigate the pros and cons of the increase uses of driverless (or automated) cars. They will create a graphic organizer (or chart) and write a reflection on the impact of this transportation technology on society and the environment.

Driverless Car Rubric (See Link)