School of Science and Technology, Singapore
Mathematics Department
Secondary 2 Mathematics Performance Task 2

Name of Member 1: _____( )

Name of Member 2: _____( )

Class: _____ Date: _____

Topic	Application of Linear Graph - Kinematics
Weighting	10% of overall 2013 Sec 2 Mathematics Assessment
Focus	Assessment of the CONCEPTUAL UNDERSTANDING of Students
Assessment	Students' response will be assessed based on BLOOM's TAXONOMY. The specifications will be designed in RUBRIC form.

1. Format of Report

- Title of Report: Secondary 2 Semester 2 Performance Task
- Name:
- Index Number:
- Class:
- Must be typewritten in Pages or Word
- Font type: Arial
- Font size: 12
- Not more than 4 pages using the given template

2. Submission of Draft

- Deadline: **13 Sept 2013**
- Submit softcopy by electronic dropbox
  - Search "2013 Sec 2 Performance Task 2" in Google Drive and upload draft

3. Submission of Final Report

- Deadline: **16 Sept 2013**
- Submit **BOTH** a hardcopy **AND** a softcopy by electronic dropbox.
- Submission by Google Drive will be disabled after 16 Sept 2013.
- Late submission will result in deduction of marks.

Due Date: Term 4 Week 1 (Monday)

1.1 Introduction

The **roller coaster** is a popular amusement ride developed for amusement parks and modern theme parks. In essence a specialized railroad system, a roller coaster consists of a track that rises in designed patterns, sometimes with one or more inversions that briefly turn the rider upside down. The track does not necessarily have to be a complete circuit, as shuttle roller coasters demonstrate. Most roller coasters have multiple cars in which passengers sit and are restrained. [1]

Ride designers must carefully ensure the accelerations experienced throughout the ride do not subject the human body to more than it can handle. The human body needs time to detect changes in force in order to control muscle tension. Failure to take this into account can result in severe injuries and strain to the rider.

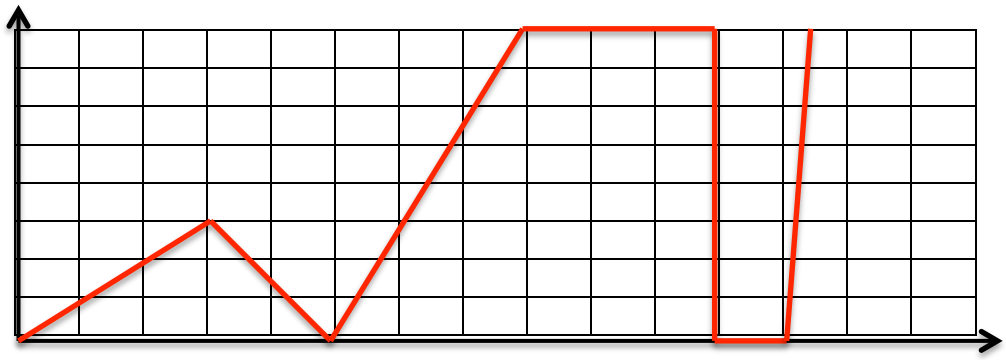
The accelerations accepted in roller coaster design are generally from 40 to 60 m s^{-2} for positive vertical (pushing you into your seat), and from 15 to 20 m s^{-2} for the negative vertical (flying out of your seat as you crest a hill).This range safely ensures the majority of the population experiences no harmful side effects.

[1] "Roller coaster - Wikipedia, the free encyclopedia." 2003. 18 Aug. 2013 <http://en.wikipedia.org/wiki/Roller_coaster>

1.2 Getting Warmed Up

The diagram shows a speed-time graph. Fill in the speed-time graph with appropriate values and compose a story that fits your speed-time graph.

Speed (m/s)



Time (s)

1.3 The Challenge

You are a roller coaster designer/engineer. Your partner and you have been invited by Walt Disney to design a thrilling roller coaster for the brand new Disneyland in Singapore.

You are to construct a 2-D mock up for the roller coaster. Your challenge involves building a safe but adrenaline-pumping roller coaster and selling your idea to the key decision-makers of the theme park.

Here are some of the instructions and deliverables:

i. Read up the following website[2] to understand more about the design of a roller coaster. Make a rough sketch or a video of your roller coaster design. You have to ensure that the accelerations experienced by the rider must be of acceptable range and at the same time it creates adrenaline in the body.

ii. Observe and analysis the motion of the car and make a rough sketch of both the distance-time graph and the speed-time graph.

iii. Devise a workable plan that will allow you to obtain the speed-time graph of car more accurately. Write down your plan in details. You will need to illustrate your plans with diagrams.

[2] "Amusement Park Physics -- Design a Roller Coaster." 18 Aug. 2013 <http://www.learner.org/exhibits/parkphysics/coaster/>

iv. With the help of one or more of the recommended software, or by building a physical model of the roller coaster, try out your plan and refine it if necessary. *If your team decides to build a physical model, tabulate your distance measurements at regular time interval (speed) and plot the speed-time graph as accurate as possible. If your team uses software simulation, an accurate plot is needed. An Algodoo template is attached to start you off.*

v. Compare the above speed-time graph and compare it with the first graph that you have drawn by intuition. Are they similar? Which one is correct? Explain the shape of the graph.

vi. Answer the following questions using your speed-time graph:
   (a) Along which parts of the track was the roller coaster travelling quickly and which parts was it travelling slowly?

   (b) Where was the roller coaster accelerating and decelerating?

vii. Do you notice any connection between the shape of the distance-time graph and a speed-time graph? If so, write down your observation. Explain your answer.

viii. Do you notice any connection between the shape of a roller-coaster track and the shape of its graph? If so, write down your observation. Explain your answer.

Recommended Software list

- Simulation Software: Algodoo[3]
- Spreadsheet Software: Microsoft Excel
- Graphing Software: Desmos (Online)[4], Grapher (Mac) / Geogebra[5]

Materials for Physical Model

- Tennis ball
- Cardboard or foam board
- Scissors
- Meterstick
- Glue
- Stopwatch
- Learning Device

[3] "Algodoo." 2008. 18 Aug. 2013 <http://www.algodoo.com/>
[4] "Desmos Graphing Calculator." 2011. 18 Aug. 2013 <https://www.desmos.com/calculator>
[5] "cms/download - GeoGebra." 2010. 18 Aug. 2013 <http://www.geogebra.org/cms/download>

1.4 Individual Reflection

Write a paragraph less than 200 words summarising the mathematics concepts that you learnt in this performance task.

In another paragraph, summarise in less than 150 words your learning journey and contributions in this performance task. You may also comment on your partner's contribution in this project.

1.5 Bibliography

Roller coaster. (2013, August 17). In *Wikipedia, The Free Encyclopedia*. Retrieved 23:26, August 17, 2013, fromhttp://en.wikipedia.org/w/index.php?title=Roller_coaster&oldid=568975261

1.6 Rubrics for Assessment

Category	4	3	2	1
Mathematical Concepts	Showed complete understanding of the mathematical concepts used to solve the problem(s).	Explanation shows substantial understanding of the mathematical concepts used to solve the problem(s).	Explanation shows some understanding of the mathematical concepts needed to solve the problem(s).	Explanation shows very limited understanding of the underlying concepts needed to solve the problem(s) OR is not written.
Diagrams	Diagrams and/or sketches are clear and greatly add to the reader's understanding of the procedure(s).	Diagrams and/or sketches are clear and easy to understand.	Diagrams and/or sketches are somewhat difficult to understand.	Diagrams and/or sketches are difficult to understand or are not used.
Mathematical Explanation	Explanation is detailed and clear.	Explanation is clear.	Explanation is a little difficult to understand, but includes critical components.	Explanation is difficult to understand and is missing several components OR was not included.
Quality of Product/Model	Excellent	Good	Satisfactory	Poor
Working with Partner **(1) _____** **(2) _____**	Works well with partner and contributions is significant and resulted in project of very good quality.	A satisfactory group member who does what is required.	Some contribution to the project but contribution is not good enough to meet the requirements of the project.	Very little or no contribution to project.

Bonus Score : Creativity +2	**Total (10% to nearest 1 dp)** **Score 1: _____** **Score 2: _____**