

# YEAR 10 SCIENCE

# Physics Practical Investigation

# (Modelling a car’s stopping distance)

Due: date Friday17th March

Introduction  
  
It is said that by going 5 kph over the speed limit a person significantly increases the minimum stopping distance they can stop their car in. It is possible to model this situation by using a marble to represent the car and a polystyrene cup catching the marble to act as the brakes stopping the car.

# Task

You are to conduct a controlled scientific investigation to investigate the factor(s) that influence the stopping distance of a marble rolled down a ramp. A polystyrene cup will be used to represent the brakes.

You will need to research how the motion energy of a car is dissipated when a car brakes.

What equations will be useful?

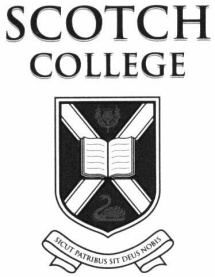
How will you control the speed of your marble?

What data will you need to collect and what graphs will you need to construct?

Can you represent your data by a suitable equation?

# Other Information

* Tables and diagrams should be used where necessary and should be captioned and numbered.
* Data tables will require uncertainties, and graphs equations and error bars.
* References should be cited in the usual manner.
* The investigation will be marked according to criteria B and C of the IB MYP (refer to the links in Coneqt).
* The assignment must be electronically submitted through [www.turnitin.com](http://www.turnitin.com) where the overall similarity index must be less than 30%. You must also provide your teacher with a hard copy of the assignment.

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**MYP SCIENCE**

**INVESTIGATION FORMAT**

**INTRODUCTION**

**(Criterion B)**

Many people think that driving a car just over the speed limit is doesn’t harm anyone and is more beneficial than driving slowly. For example if a driver were to be in a zone where the speed limit is 60km/h they would happily drive 5km/h over the speed limit (known as low level speeding)as they know it is within the law to do so. However what they don’t know is that by increasing their speed by just 5km/h they are significantly increasing the chances and severity of a car crash occurring. While most people know the effects of high level speeding

**HYPOTHESIS**

**(Criterion B)**

You need to include an hypothesis. A hypothesis is a ***stated*** ***belief*** that is to be tested by ***experiment***. For example, “making a pendulum longer increases its period (the time for one swing away and back)” is a testable hypothesis. An experiment is a test through which a hypothesis is either ***supported*** or it is ***falsified***,

You must also use your scientific knowledge to try and explain why you think your hypothesis will happen.

**VARIABLES (Criterion B)**

List the independent, the dependent variable and the control variables and list these in order of priority.

There are three types of variables that must be considered:

* ***Independent variable*** - the one factor that will be intentionally changed during the experimental procedure in order to find out what effect it has on something else. An example of an independent variable is changing a pendulum’s length in order to see the effect that this has on the period of the pendulum.
* ***Dependent variable*** - the one factor that is observed and measured to see if it is affected by the change made in the independent variable. The dependent variable in our example is the pendulum’s period.
* ***Controlled*** ***variables*** – all the factors that must be kept ***constant*** (exactly the same) for all pendulum lengths to make sure that they *can* *not have any effect on the dependent variable*. Two obvious variables that would need to be controlled in the pendulum experiment would be the mass of the pendulum and the angle of release of the pendulum (and there are others). In a valid (fair) test, all possible variables that can affect the dependent variable, other than the independent variable chosen, are controlled

The procedure must describe every step taken, including how the independent variable is manipulated, how the dependent variables are measured, and how controlled variables are kept constant.

**MATERIALS (Criterion B)**

Materials used in the experiment need to be **listed** in specific amounts and sizes. (Example - three five - gram weights). This allows other people to ***replicate*** (repeat) the experiment exactly to see if they get the same results to ***verify*** them.

**EXPERIMENTAL PLAN**

**(Criterion B)**

The procedure used in an experiment must be written in a clear, sequential manner in order to allow someone else to follow the same steps to replicate the experiment. Numbering the steps followed in the procedure is helpful to someone who is reading the procedure. In determining the procedure that will be used in the investigation the factors that will affect the outcome of the experiment, called ***variables***, must be identified. **You must ensure that the procedure leads to a controlled experiment, that is fair, valid and repeatable. Make mention also of any changes you have to the design as a result of the preliminary trials.** Include diagrams of your set up. Based on your knowledge of the problem, make a list of all possible factors which could contribute to it.

**RESULTS**

**(Criterion C)**

The results of an experiment include any ***measurements*** and ***observations*** (using any of the five senses) recorded. The best format in which to present information collected (***data****)* is in a ***table***. When ***tabulating*** data (entering data into a table) measurements from repeated ***trials*** of the experiment must be recorded as well as the average of the trial measurements. Averaging measurements from several trials makes data more ***reliable*** (dependable) as a basis for coming to a conclusion regarding the hypothesis. Remember heading for rows and include units.

Averaged data can then be plotted on a ***graph*** so that the data illustrated in the table can be visually interpreted. The two most commonly used types of graphs for science experiments are detailed below. Make sure the tables have header information as well as units.

**Line graphs** are used to display ***continuous*** data (data that can go on without a break, like a pendulum’s length, for example). Experiments that have dependent variables involving temperature, time, length or distance will usually yield data that should be graphed as a line graph. Line graphs are useful to help to analyze ***relationships*** between the independent and dependent variables. In particular, line graphs can show trends in data - increasing, decreasing, or staying the same. The data collected from experimenting on the effect of changing the length of a pendulum upon its period is an example of data best displayed on a line graph.

The independent variable is usually represented on the ***horizontal*** axis of a graph and the dependent variable is represented on the ***vertical*** axis of a graph. The graph should also have:

* *numbers* in even intervals (1's, 2's, 5's, 10's, 100's, etc.)
* *labels* for both the horizontal and vertical axes
* a *title* that reflects the information that is being represented on the graph
* a number of points plotted
* draw a smooth curve or “line of best fit”.

**DATA PROCESSING**

**(Criterion C)**

Very often you have to processes your data in some way. This may be a simple as calculating means or it may involve modifying your data so that you can achieve a straight line when you graph it. For example you may have to square the independent variable and then graph this against the dependent variable to get a straight line. Remember to create a new data table and then plot your new data. You should be able to suggest the mathematical relationship between the variables.

**DISCUSSION**

**(Criterion C)**

Here you discuss your results; the trends, patterns or relationships between the variables. Terms such as “linear” or “inverse” should be used. Try and explain the results you obtained and the shape of the graph

**CONCLUSION**

**(Criterion C)**

You need to draw a clear conclusion based on the data and from this you can state whether the hypothesis is supported or falsified. You need to provide an explanation of your conclusion using scientific reasoning.

**EVALUATION**

**(Criterion C)**

How well did you think your investigation went? Did you have any problems that you dealt with while carrying out the experiment.

**Reliability: Can you trust the evidence?** Did you collect sufficient and reliable data? What errors are there in your measurements? How precise and accurate do you think that your results are? Did you repeat your readings enough times? Was your sample well chosen and large enough?

**Validity: Were you really able to answer the research question?** Was it truly a fair test? Were you measuring the right things and correctly? Was your experimental method basically OK?

**Improvements:** Write down how you might make your investigation better, especially to improve the reliability and validity i.e. better experimental design or ways of reducing errors. Write down any further experiments you could carry out to get more evidence or to extend this investigation.

**International Baccalaureate Middle Years Programme**

**Science Year 5**

**Criterion B: Inquiring and designing**

# Assessment Title: Stopping Distances Teacher:

# Student Name: Similarity: \_\_\_\_%

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| --- | --- | --- | --- |
| Level | Descriptor | | What you have to watch |
| 0 | | You do not reach a standard described by any of the descriptors given below. |  |
| 1-2 | | **state** a problem or question to be tested by a scientific investigation  **outline** a testable hypothesis  **outline** the variables  design a method, **with limited success**. | No problem or research question **MAX 1**  Is the method detailed enough to allow someone else to follow the method. If not, **MAX 2**  No variables mentioned-**MAX 1** |
| 3-4 | | **outline** a problem or question to be tested by a scientific investigation  **formulate** a testable hypothesis **using scientific reasoning**  **outline** how to manipulate the variables, and **outline** how **relevant data** will be collected  design a **safe method** in which he or she **selects materials and equipment.** | No scientific reasoning for hypothesis then **MAX 3**  You must include independent, dependent and control variables. If any missing then **MAX 3.** Include a complete equipment list.  If no risk assessment table then **MAX 3** |
| 5-6 | | **describe** a problem or question to be tested by a scientific investigation  **formulate and explain** a testable hypothesis **using scientific reasoning**  **describe** how to manipulate the variables, and **describe** how **sufficient, relevant data** will be collected  design a **complete and safe method** in which he or she **selects appropriate materials and equipment**. | Describe means a detailed account.  Formulate means to express precisely and systematically what the hypothesis is.  Description must include repeated measurements and averages or **MAX 4** |
| 7-8 | | **explain** a problem or question to be tested by a scientific investigation  **formulate and explain** a testable hypothesis using **correct scientific reasoning**  **explain** how to manipulate the variables, and **explain** how **sufficient, relevant data** will be collected  **design** a **logical, complete and safe method** in which he or she **selects appropriate materials and equipment**. | A detailed account is needed method.  You must include independent, dependent and control variables; how to measure them; repeat trials and ensure that it is a fair test.  “Manipulate”- you must explain how you controlled and measured the variables. |

# Teacher Comment and Level

**International Baccalaureate Middle Years Programme**

**Science Year 5**

**Criterion C: Processing and evaluating**

# Assessment Title: Stopping Distances Teacher:

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| Level | Descriptor | What you have to watch |
| --- | --- | --- |
| 0 | You do not reach a standard described by any of the descriptors given below. |  |
| 1-2 | You are able to:   * **collect and present** data in numerical and/or visual forms * **interpret** data * **state** the validity of a hypothesis based on the outcome of a scientific investigation * **state** the validity of the method based on the outcome of a scientific investigation * **state** improvements or extensions to the method. | You can show all your results in a really simple table. If values missing **MAX 2**  No table **MAX 1**  Validity of method means collection of sufficient data and manipulation of data.  Insufficient data collected **MAX 2**  No improvements or only one improvement then **MAX 1** |
| 3-4 | You are able to:   * **correctly collect and present** data in numerical and/or visual forms * **accurately interpret** data and **explain** results * **outline** the validity of a hypothesis based on the outcome of a scientific investigation * **outline** the validity of the method based on the outcome of a scientific investigation * **outline** improvements or extensions to the method that would benefit the scientific investigation. | Table has header row with units and quantity.  A detailed account of result interpretation.  Outline means a brief account  Sufficient data collected  Not a fair test **MAX 3**  No graph **MAX 3** |
| 5-6 | You are able to:   * **correctly collect, organize and present** data in numerical and/or visual forms * **accurately interpret** data and **explain** results **using scientific reasoning** * **discuss** the validity of a hypothesis based on the outcome of a scientific investigation * **discuss** the validity of the method based on the outcome of a scientific investigation * **describe** improvements or extensions to the method that would benefit the scientific investigation. | Graph with some elements missing  **MAX 5**  Discuss here means a balanced review of the hypothesis and method. At least one point is required for each or **MAX 4**  “validity of method” means whether the method has allowed for the collection of sufficient valid data. |
| 7-8 | You are able to:   * **correctly collect, organize, transform and present** data in numerical and/or visual forms * **accurately interpret** data and **explain** results **using correct scientific reasoning** * **evaluate** the validity of a hypothesis based on the outcome of a scientific investigation * **evaluate** the validity of the method based on the outcome of a scientific investigation * **explain** improvements or extensions to the method that would benefit the scientific investigation. | Table to include uncertainties if no uncertainties then **MAX 6**  Transform here means to draw a graph and to average data. If no graph then **MAX 3**.  If no error bars on graph then **MAX 7**  An equation must be used to explain the proposed relationship and this will usually entail manipulating the data (by linearising).  No equation and explanation. **MAX 7**  Equation must be in the form of the variables being graphed or **MAX 7**  Evaluate means to make a judgment by weighing up the strengths and limitations |

Teacher comment and level