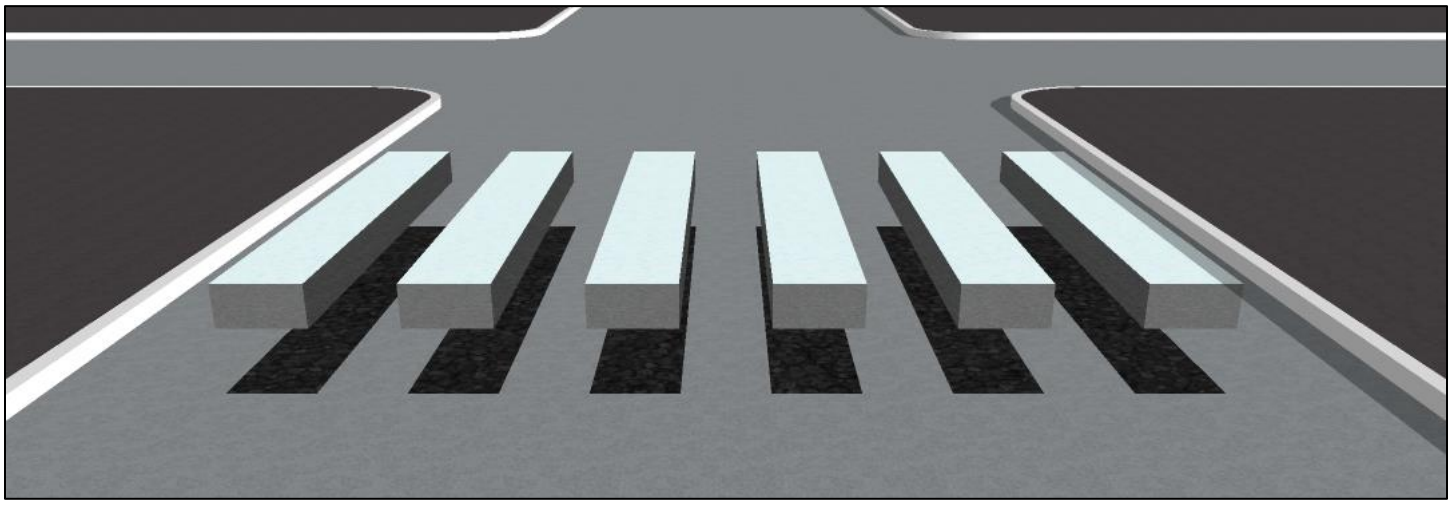
A New Kind of Speed Control

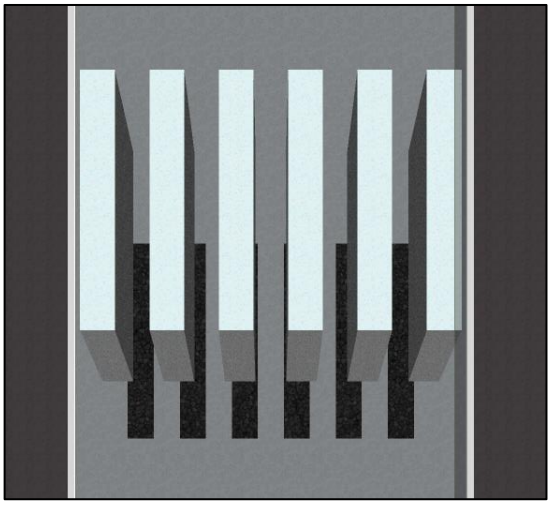
Some countries around the world have begun to experiment with new methods for controlling the speed of traffic. Look at the following zebra crossing. This is the view of a driver who is 5 metres away whose eyes are 2 metres above the ground. Would you slow down if you saw this on the road?



Look closely at the stripe on the right in the image above. The shadow from the pavement falls on the stripe even though the stripe appears to be higher up than the pavement. This suggests that all is not what it seems.

The crossing is actually a 2-dimensional image painted directly onto the road. The image on the right shows the view from above.

The crossing is designed so that when a person whose eyes are 2 metres above the ground is 5 metres away from the crossing the stripes appear as rectangular prisms with dimensions $0.4 \times 0.2 \times 3$ metres floating 30 centimetres above the ground.



Task 1

Use Sketchup to design a zebra crossing that appears to be 3-dimensional. The crossing should appear to be *perspective correct* when a viewer whose eyes are 2 metres above the ground is 5 metres from the crossing. You may decide sensible measurements for everything else (choose different measurements to the example above). Explain how you used Sketchup to create your design.

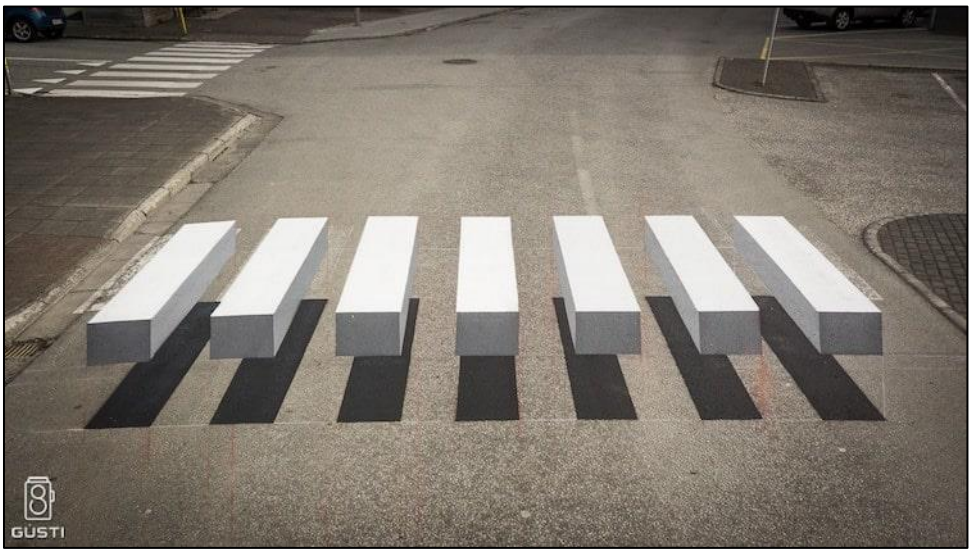
Task 2

Let the coordinates of the viewer be (0,0). Choose one of your stripes (and its shadow) in your model. Explain how we could calculate the coordinates of all vertices in this stripe and its shadow *without* the use of software such as Sketchup. Check the accuracy of your work by comparing it to your Sketchup model.

Create a report of your work. Be sure to include an introduction. Your report should be able to stand on its own without the reader having to refer to this task sheet. You should also include answers to the following questions:

- Would this work best on small local roads, or large main roads?
- Would this work best in one-way streets or two-way streets?

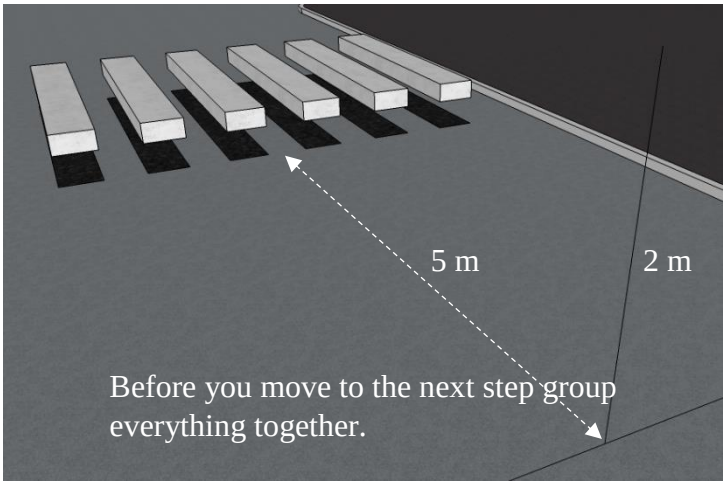
The word limit for your report is 1000 words. Anything exceeding this will not be read.

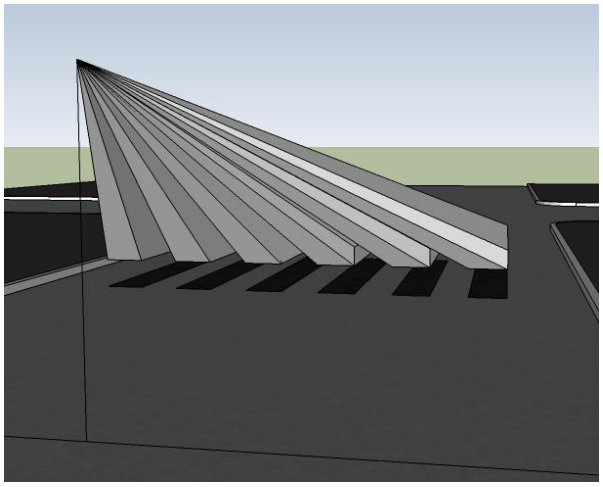


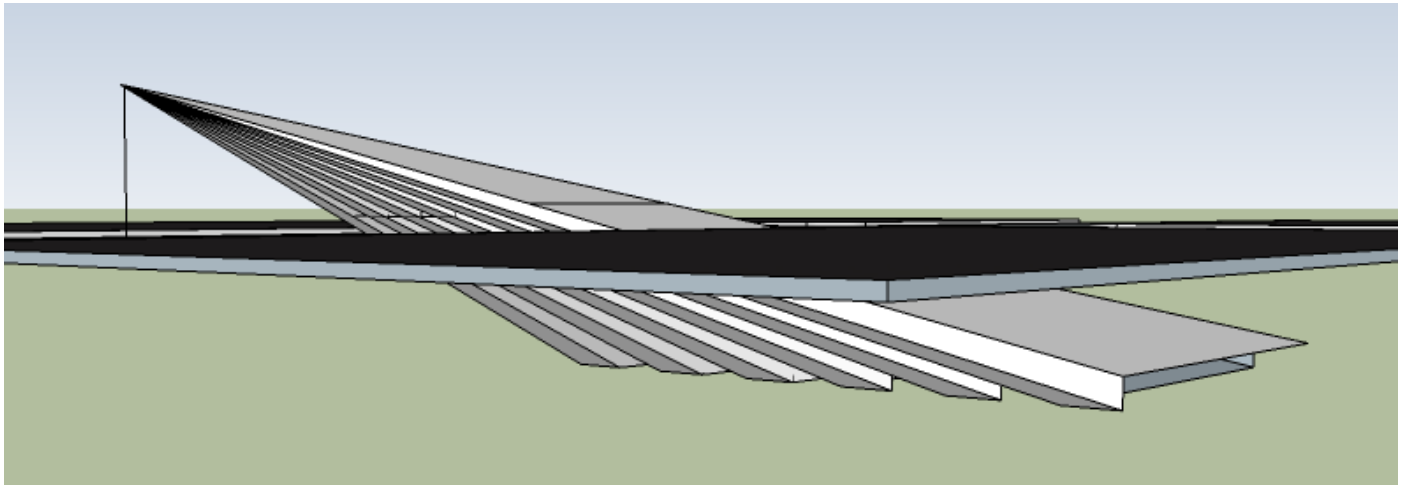
A zebra crossing in Ísafjörður, Iceland,
Photo credit: Gusti Images

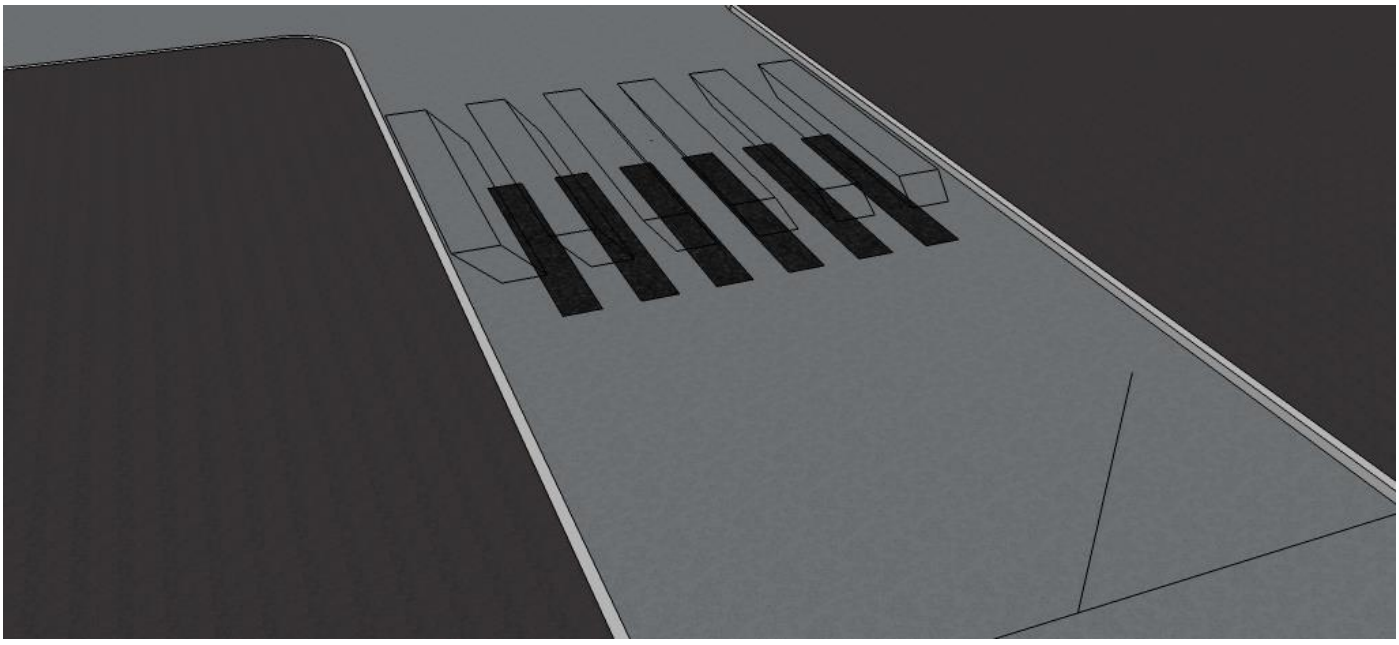
Hints for Task 1

The following screenshots show how you can complete this task.









Criterion C: Communication in Mathematics		
Achievement Level	Level Descriptor	Task Specific Clarification
0	The student **does not** reach a standard described by any of the descriptors below	
1 – 2	The student is able to: I. use **limited** mathematical language II. use **limited forms** of mathematical representation to present information III. communicate through lines of reasoning that are **difficult to interpret**.	The student is able to: o attempt to explain what is being investigated and how it is being investigated
3 – 4	The student is able to: I. use **some appropriate** mathematical language II. use **appropriate forms** of mathematical representation to present information **adequately** III. communicate through lines of reasoning that are **complete** IV. **adequately organize** information using a logical structure.	The student is able to o attempt to explain what is being investigated and how it is being investigated o use diagrams to justify some explanations and calculations o create a report that is able to be understood without referring to the task sheet
5 – 6	The student is able to: I. **usually** use **appropriate** mathematical language II. **usually** use **appropriate forms** of mathematical representation to present information **correctly** III. **usually** move between different forms of mathematical representation IV. communicate through lines of reasoning that are **complete and coherent** V. **present** work that is **usually organized** using a logical structure.	The student is able to o explain what is being investigated and how it is being investigated o use diagrams to justify explanations and calculations o move between explanations, calculations, tables and diagrams with appropriate linking sentences (the following table shows, figure 2 demonstrates etc.) o export Sketchup models as 2D images o create a report that is able to be understood without referring to the task sheet
7 – 8	The student is able to: I. **consistently** use **appropriate** mathematical language II. use **appropriate forms** of mathematical representation to **consistently** present information **correctly** III. move **effectively** between different forms of mathematical representation IV. communicate through lines of reasoning that are **complete**, **coherent and concise** V. **present** work that is **consistently organized** using a logical structure	The student is able to o clearly explain what is being investigated and how it is being investigated o display formulae clearly and accurately using the equation editor o use clear and accurate diagrams to justify explanations and calculations o move effectively between explanations, calculations, tables and diagrams with appropriate linking sentences (the following table shows, figure 2 demonstrates etc.) o export Sketchup models as 2D images o make good use of space on the page (no unnecessary white space, items positioned thoughtfully etc.) o create a report that is able to be understood without referring to the task sheet

Criterion D: Applying mathematics in real-life contexts		
Achievement Level	Level Descriptor	Task Specific Clarification
0	The student **does not** reach a standard described by any of the descriptors below	
1 – 2	The student is able to: I. identify **some** of the elements of the authentic real-life situation II. apply mathematical strategies to **find a solution** to the authentic real-life situation, **with limited success**.	The student is able to o attempt to create an accurate Sketchup model of a zebra crossing satisfying the rules of the task o attempt to explain how Sketchup was used to create the crossing design o attempt to calculate the coordinates of the vertices of one stripe and its shadow without using Sketchup o attempt to discuss whether this method of speed control would work best on local roads or main roads, and on one-way-streets or two-way-streets
3 – 4	The student is able to: I. identify the **relevant** elements of the authentic real-life situation II. select, **with some success**, **adequate** mathematical strategies to model the authentic real-life situation III. apply mathematical strategies to **reach a solution** to the authentic real-life situation IV. **discuss** whether the solution makes sense in the context of the authentic real-life situation.	The student is able to o create an accurate Sketchup model of a zebra crossing satisfying the rules of the task o adequately explain how Sketchup was used to create the crossing design o calculate some of the coordinates of the vertices of one stripe and its shadow without using Sketchup o discuss whether this method of speed control would work best on local roads or main roads, and on one-way-streets or two-way-streets
5 – 6	The student is able to: I. identify the **relevant** elements of the authentic real-life situation II. select **adequate** mathematical strategies to model the authentic real-life situation III. apply the selected mathematical strategies to **reach a valid solution** to the authentic real-life situation IV. **explain** the degree of accuracy of the solution V. **explain** whether the solution makes sense in the context of the authentic real-life situation.	The student is able to o create an accurate Sketchup model of a zebra crossing satisfying the rules of the task o clearly explain how Sketchup was used to create the crossing design o calculate the coordinates of the vertices of one stripe and its shadow without using Sketchup o compare the accuracy of the calculations by comparing them to the Sketchup model o discuss whether this method of speed control would work best on local roads or main roads, and on one-way-streets or two-way-streets
7 – 8	The student is able to: I. identify the **relevant** elements of the authentic real-life situation II. select **appropriate** mathematical strategies to model the authentic real-life situation III. apply the selected mathematical strategies to **reach a correct solution** to the authentic real-life situation IV. **justify** the degree of accuracy of the solution V. **justify** whether the solution makes sense in the context of the authentic real-life situation.	The student is able to o create an accurate Sketchup model of a zebra crossing satisfying the rules of the task o clearly and concisely explain how Sketchup was used to create the crossing design o calculate the coordinates of the vertices of one stripe and its shadow without using Sketchup using appropriate mathematics and clear diagrams o compare the accuracy of the calculations by comparing them to the Sketchup model using appropriate Sketchup tools and clear screenshots o thoroughly discuss whether this method of speed control would work best on local roads or main roads, and on one-way-streets or two-way-streets