Group Coursework Assignment Specification

(50 % of the module assessment)

Submission Deadline: 5pm, 14th December 2018.

# Problem description

You are working as part of a research group involved in the construction of high-quality building materials. To provide maximum safety and peace of mind to their contractors, your company is interested in providing detailed data on how their building materials hold up, on average, under a variety of extreme conditions. As part of this research, you are currently performing an exhaustive investigation into the penetration of various, different bullets into different material types.

After much research, the experimental team have collected data on the speed of different bullet types through different building materials for a variety of gun setups. In general, the average time taken by a bullet to travel through a material provides an indication of how safe that material is, however there are trade-offs for the safety of each material type depending on the specific firearm employed.

As chief software engineer, your job is to give the experimental team the essential critical data to help decide which material type to utilize, so as to ensure maximal safety for the end user. The experimenters have provided you with the following data, in order to develop this decision-making software.

# Background data

Initially the experimental team intend to test the penetration of different bullet types through three different material of fixed sizes, which the financial team have recommended on the basis of cost. As a means to do so, they have created an experimental setup whereby a bullet is shot from a gun at a target through different types and sizes of materials. Specifically, they will use the following materials with the following distances from gun to target:

|  |  |
| --- | --- |
| Wood | 800m |
| Steel | 500m |
| Titanium | 250m |

Table 1: Distance of material to be considered by the experimental team.

When there are no modifications applied to the gun, a normal bullet travels at the following average speeds in each material

|  |  |
| --- | --- |
| Wood | 323.5 m /s |
| Steel | 180.8 m/s |
| Titanium | 100.3 m/s |

Table 2: Speed of a bullet in each of the three materials.

The time taken (t) by the bullet to reach the target may be calculated using the following equation:

Through detailed experimentation, the experimental team has calculated the effect of each gun setup on the **speed** (and hence time) for each individual material as follows:

|  |  |  |  |
| --- | --- | --- | --- |
|  | Wood | Steel | Titanium |
| Blanks | -3% | -5% | -12% |
| Lead Bullets | +20% | +12% | +5% |
| Armor-Piercing Bullets | -30% | +5% | +30% |
| Brown Gunpowder | +35% | -8% | -12% |
| Sulphur-free Gunpowder | -10% | +8% | +5% |

# What you must do

**Question 1: 20 marks**

1. Write a Visual Basic program to apply the given formula above to complete the following table, for when the bullet is fired WITHOUT ANY of the optional modifications (that is, using the quoted value for the speed of a normal bullet in each material). Rather than hard-coding the distances for each material allow the user to enter the values (m) in table 1 of the distances for each of the three materials.

|  |  |
| --- | --- |
| Material | Time Taken (s) |
|  |  |
|  |  |
|  |  |

Output the table in two columns with column 1 on the left and column 2 on the right. Because of the importance of accuracy, calculate all results to 3 decimal places. Output a friendly message to the user to confirm the values entered, such as  
  
For distance in wood you entered: XXX metres

For distance in steel you entered: XXX metres

For distance in titanium you entered: XXX metres

**NB**: ensure the correct (consistent) units are used to give the time output in **seconds**.

1. Output a friendly message to the user informing the experimental team of the time taken by the bullet to reach the target **on average** (that is, the average of the time taken in each of the three media).
2. Force the user to enter logical values for each material such as positive doubles.
3. You **must** define at least three appropriate functions and use those functions, the Visual Basic array and Loop structures in the program code.

**(save as q1.vb)**

**(save the output screenshot after successfully running the code as q1capture.jpg)**

**Question 2: 30 marks**

1. Consider all the possible combinations of bullet and gunpowder. Modify the program in Question 1 (q1.vb) to calculate the average time taken in all three materials for all separate combinations of using a different type of bullet and a different type of gunpowder. Output the results in tables of a design to your liking. Remember that the layout should be user friendly, give all the information needed and show accuracy to 3 decimal places.

You need to display several tables to show all the possible combinations of 3 possible bullets with 2 possible types of gunpowder. You must use a loop when outputting the tables, with 1 table per iteration of the loop.

1. The key values of average time taken and chosen combination of bullet and gunpowder must be held in an array.
2. Sort the list in (b) in the order of average time taken, descending. Save the contents of the ordered array with suitable messages into a text file in order to demonstrate to the experimental team the time differences of using all combinations of optional items.

Options Average time taken

===== ================

…….. | .

…….. | .

……. | .

……. | .

1. Take the data from the text file and Plot the times as a **bar chart** (copy and paste the data into Excel), including the additional average time taken without any modifications applied to the gun. Save the graph to an image file called **q2a.png.** Remember to label the graph appropriately.
2. Define some more functions to increase the maintainability of the code and utilize the functions defined in q1.vb

**(save as q2.vb)**

**(save the output screenshot after successfully running the code as q2capture.jpg)**

**Question 3: 20 Marks**

1. The experimental team will not always be interested in the same fixed distance for each material and will sometimes need to test at a variety of different material sizes. As such, allow the user to enter 3 different distances for each of the 3 different materials (that will give 3 different sets of 3 lengths, one for each material – i.e., 9 total numbers). Applying the optimized setup found in Question 2; display a user-friendly message on the screen to show the average time taken by the bullet for each of the 3 total distances entered by the user.
2. Print a short discussion (max 200 words) on the screen, in order to explain what you find. Could there be a particular material distance where the optimized setup identified in Question 2 is no longer the best option?

**NB**: You can assume the bullet’s average speed is not affected by different material distances.

1. Utilise the appropriate functions defined in Q2.

**(save as q3.vb)**

**(save the output screenshot after successfully running the code as q3capture.jpg)**

**Question 4: 20 marks**

Upon extensive additional testing, the experimental lab has come to the conclusion that the use of different gunpowder causes the bullet to deviate from a straight-line trajectory. Specifically, it Is found that, depending on the type of gunpowder used, the bullet will exit the gun at a random angle uniformly-distributed between 0 and θmax where θmax has the values

|  |  |
| --- | --- |
| Gunpowder | θmax |
| Brown Gunpower | 15° |
| Sulphur-free Gunpowder | 10° |

The experimental team would like you to provide an estimate of the accuracy of the gun using the two different gunpowder types, for each of the three materials listed previously. They have told you that the target is a height of 100m above the ground. If the bullet travels at an angle of θ (radians), through a fixed horizontal distance, then it’s final height will be

and the time taken to reach the target will be

Use the built-in mathematical functions when calculating these quantities.

1. Your final task will be to produce 1000 random angles for each of the two gunpowder types. For each of these random angles, calculate the time taken to travel the fixed horizontal distance previously specified in **Table 1**. Plot the results as a scatter diagram (time taken vs angle) using Excel. Keep measurement units consistent and ensure the plot has suitable titles. Save it as **q4a.png.**
2. Store the random angles in an array and use a loop to calculate the height and time taken for each angle. Use this array to calculate the average time taken by the bullet to reach the target. Should a bullet miss the target (height > 100m) do not record the time as part of the average. Use these numbers to inform the user of the average time taken and the accuracy (percentage of bullets which hit the target).
3. Examine the effect that the random scatter has on the accuracy and time taken in different materials, and the effect that the distance has on both accuracy and average time taken. Present your findings for the three material types and for a range of different distances by making your code output a table. Do so for both types of gunpowder. Make your code give an explanation of how both factors (material type and distance) change the accuracy and average time taken.
4. Utilise the appropriate functions defined in Q2.

**(save as q4.vb)**

**(save the output screenshot after successfully running the code as q4capture.jpg)**

# Report (10 marks)

In addition to the files mentioned you may write a short text file called README. This is to provide

* + any special instructions or warnings to the user (or assessor!) such as the situations in which the code does not work,
  + or to draw attention to any aspects of the program that you are particularly proud of (i.e. reusability, maintainability aspects of the code.)

The size of the report is two pages (1500 words, +/- 10 %).

# Notes on Expectations:

Below follows a qualitative description of some general expectation associated with this piece of coursework.

**Technical mastery of Visual Basic** Your programs should show mastery of what you have been taught.

**Design** Your programs should be well structured for the task in hand so that it is as easy as possible for:

* a user to use the program for any likely purpose,
* a programmer to understand the code structure and be able to develop it further,
* a programmer to be able to re-use as much as possible of the code in a related application.

**Clarity and Self-Documentation**

Given the structure of your programs, they should be as easy to read and understand as possible. Sensible names should be chosen for all variables, methods etc. Documentation strings should be included for each:

**Program** Fully explain what the program does and how it should be used.

Also state who wrote it and when.

**Function** State what each function does and explain the roles of its parameters.

In addition, you should include occasional comments in your code; these may be (a) to introduce a new section in the code, or (b) to explain something that is not obvious. Bear in mind that pointless comments make your code harder to read, not easier.

# Group Submission

All the files (including pictures, README and the text file) should be compressed into a zip file and submitted electronically as directed on Learn.

# Individual Submission

In addition to the group submission, each group member is required to submit an individual assessment of how the project has gone by 5.00pm on the Friday of Week 11 (14th December 2018). This report assesses the way the group carried out the task and what contribution each member of the group made to the work (identify strengths and weaknesses of each individual including yourself). Include an estimation of the percentage contribution each team member contributed to the project. Use the cover sheet provided on Learn for this information.

The individual report will not be directly assessed as part of the group mark, but will be taken into consideration when individual marks are awarded. Individual mark will be calculated by using 70% of the group mark achieved and 30% of the contribution made towards to the project.