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## 3.1 Analysis of the problem

### 3.1.1 Problem identification

#### The problem:

Sixth form students work hard throughout the year in order to achieve good grades in their A levels. Many of them like to play videogames to relax. However, these videogames are seldom beneficial to their education. It would be better to have games that are linked to the subjects studied at school as this could lead to improved academic performance.

Many students in my year 12 Physics class struggled with kinematics, especially projectile motion. Therefore, I will create a game which involves users firing projectiles at objects. The game will require mathematical and scientific knowledge as users will need to calculate the path the projectile needs to take. For example, they may need to consider variables such as air resistance and gravity as these may change the motion of the projectile. The game will have many levels that get progressively harder as the difficulty of the calculations required increases.

#### Why the problem is amenable to a computational approach:

This problem is amenable to a computational approach for two main reasons. The first reason is because the solution will use algorithms to calculate the projectile path whilst taking in user outputs. The second reason is because the solution will output the motion of the projectile onto the screen using animations and graphics.

#### Why the problem is solvable by computational methods:

There are several computational methods that can be used to solve this problem.

##### Problem recognition:

The overall problem is being able to accurately animate the path that a projectile will take. The underlying problem is calculating the path that the projectile will take by taking into account the variables that may affect its motion. When the underlying problem is overcome, the rest of the solution is simply applying the information relating the motion of the projectile to the animation so that the user can see what happens.

##### Problem decomposition:

This problem can be decomposed into smaller steps.

For each level in the game:

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1. Set up projectile and target at certain distances and angles away from each other.
2. Set up the variables such as terrain, air resistance, gravity.
3. Allow the user to input the speed and angle of release of the projectile
4. Use mathematical calculations to work out the motion of the projectile and see if it hits the target.
5. Animate this, making sure to account for the scale of the screen and other potential computer configurations.

#### Use of divide and conquer:

The overall problem can be divided into these smaller steps. Each of these steps can then be conquered individually and combined together to make the final program. Using this method means that the complex overall problem is split into more manageable smaller problems which makes development easier.

#### 3.1.2 Stakeholders

My solution will be of interest to two different groups of people.

The first group is comprised of those that study Physics or Mathematics at A level and struggle with the topic of projectile motion. For them, my solution will be of academic interest as it could help improve their understanding of the topic. They would be most interested in the mathematical and scientific calculations behind the projectile motion.

The second group is comprised of those that have an interest in videogames but also want to be intellectually challenged by the game. For them, my solution will be for personal enjoyment. They would be most interested in the playability and the graphics of my solution.

My main stakeholder will be David Kuc. He studies Mathematics and Physics at A level so my solution will benefit him by allowing him to recap projectile motion. He also enjoys playing computer games, so the solution will benefit him through increasing his personal enjoyment.

Therefore, he will be able to represent to two main groups of people who would have an interest in my solution.

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### 3.1.3 Research the problem

#### Existing similar solution 1 – ‘Angry Birds 2’:



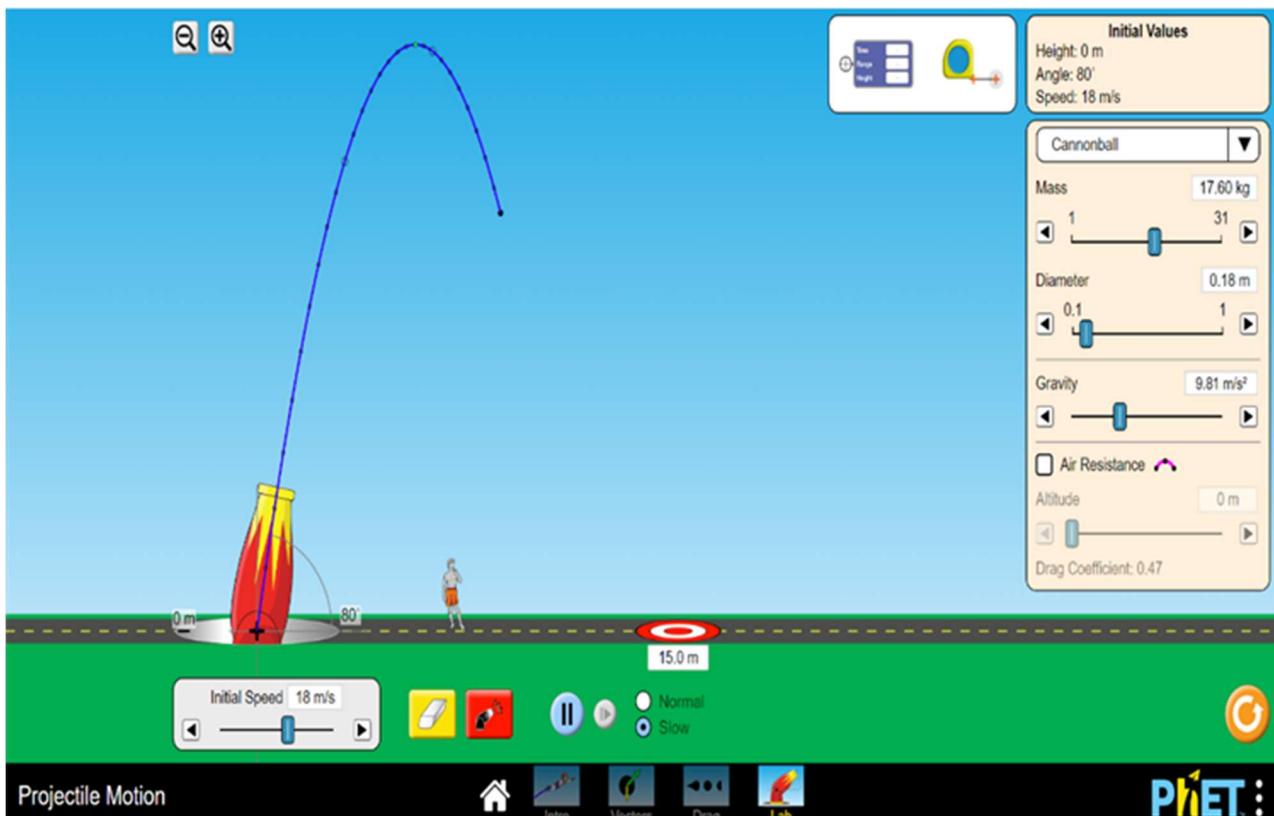
‘Angry Birds 2’ is a game where players use a slingshot to launch birds at nearby targets. The game can be played on multiple platforms but I tested the game on a mobile phone. The slingshot is directed using hand movement on the screen. The game shows the path that the bird will take using green dots. The game has music in the background. There are multiple levels and the difficulty increases as you progress.

**There are many features of the game that I like and could possibly apply to my solution:**

- Shows the user the path that the bird will take.
- Graphics are detailed and in 3d.
- The slingshot is easy to control and adjust using hand movement.
- There are rewards for hitting targets.

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**Existing similar solution 2 – ‘PhET Projectile Motion’:**



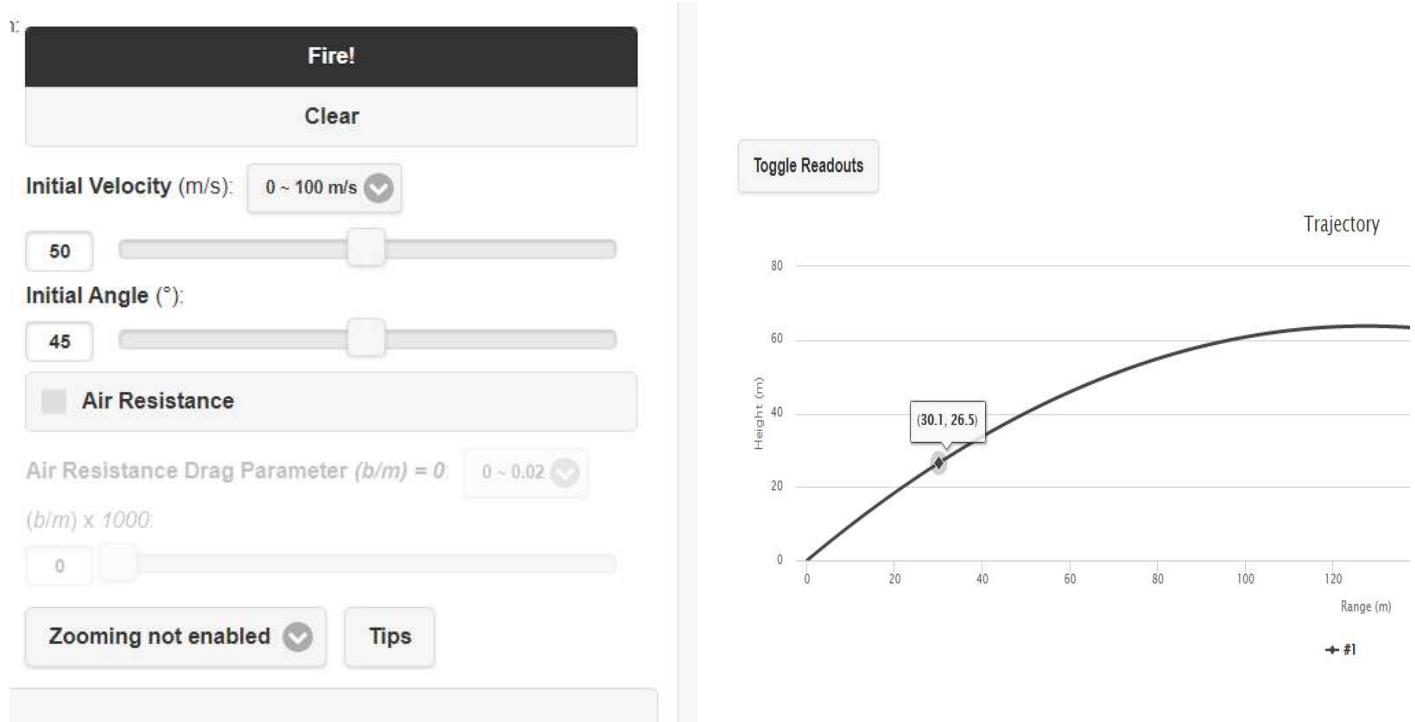
‘PhET Projectile Motion’ is a simulator where you can fire projectiles. It is not a game but is instead used for educational purposes.

**There are several features of the simulator that I like and can apply to my solution:**

- Shows the path that the projectile takes using a series of blue dots connected together with a blue line.
- Angle that the projectile is fired at is easily adjustable through mouse movement.
- Speed of the projectile is easily changed through a slider bar.
- Can change the speed of the animation.

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**Existing similar solution 3 – ‘Galileo and Einstein Projectile Motion’:**



‘Galileo and Einstein Projectile Motion’ is a simulator where you can plot the paths of projectiles. It is not a game but is instead used for educational purposes.

**There are several features of the simulator that I like and can apply to my solution:**

- Shows the path that the projectile takes using a series of blue dots connected together with a blue line.
- Angle that the projectile is fired at is easily adjustable through mouse movement.
- Speed of the projectile is easily changed through a slider bar.
- Can change the speed of the animation.

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**Survey:**

I conducted of stakeholders. I decided to ask the following questions to find out the general features that my users wanted from my solution and their experience of any similar solutions.

1. *How big should the game screen be?*
2. *How would you like to fire the projectile?*
3. *Do you want the game to save your progress?*
4. *What would be your preferred method of playing the game?*
5. *What features would you like the game to contain?*
6. *If you have ever played a similar game, what features did you like?*
7. *Would you like music in the game and if so, what type?*
8. *Any other comments*

Q1: How big should the game screen be?

- *Full screen [42.86%]*
- *Window [57.14%]*

**Analysis: The majority of stakeholders prefer a window.**

Q2: How would you like to fire the projectile?

- *Entering values manually [42.86%]*
- *Slider bar [57.14%]*

**Analysis: The majority of stakeholders prefer a slider bar system.**

Q3: Do you want the game to save your progress?

- *Yes [85.71%]*
- *No [14.29%]*

**Analysis: Overwhelming consensus is for the game to save user progress.**

Q4: What would be your preferred method of playing the game?

- *Computer/ Laptop [85.71%]*

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- *Mobile phone [14.29%]*
- *Other [0%]*

**Analysis:** Overwhelming consensus is for the game to be computer/ laptop based.

Q5: What features would you like the game to contain?

- *It should be fun, not too ugly and not boring or too challenging. It should have different levels or difficulties.*
- *Some kind of goal - i.e. a reason to play the game. Maybe make an adventure mode or something with different levels of difficulty as you progress.*
- *Choice of colour for the projectile*
- *Good graphics.*
- *Projectile skins.*
- *Easy controls.*

**Analysis:** Wide range of opinions received. Most stakeholders want some kind of customisability.

Q6: If you have ever played a similar game, what features did you like?

- *Angry birds: it had intuitive controls and was fun.*
- *The game would report back on how close/far I was.*
- *Angry birds had fun physics and structures to destroy. Was pretty satisfying.*
- *The sound when the object hits the target or misses it.*
- *Chain reactions objects, like hit an explosive barrel to cause a greater effect.*
- *Being able to aim easily.*

**Analysis:** Wide range of opinions received. Some stakeholders played 'Angry Birds' which I had already analysed as an existing solution. Other interesting features were mentioned.

Q7: Would you like music in the game and if so, what type?

- *Yes. Ambient or relaxing music. It can be fast paced energetic music if it suits the game, but it shouldn't be too distracting. There should always be an in-game option to turn music and sound effects off.*

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- Yes. Any kind is fine. If it's not too complex, making the option to switch between different tracks might be nice.
- Yes. Instrumental music.
- Yes. Happy uplifting stuff.
- Yes. Upbeat music.
- Yes. Chiptune could be cool
- Yes. Non distracting.

**Analysis:** All stakeholders would like music. However, there is no consensus on the type.

### **Interview with main stakeholder:**

Once I had the results of the survey, I decided to conduct an interview with my main stakeholder. I asked him (David Kuc) the same questions but was looking to gain more detailed and specific answers, especially where the opinions from my survey had been more unclear.

Q1: How big should the game screen be?

*I would like it to be a window. There are a few reasons why.*

*Primarily, by using a screen, the user can easily switch between the game and other applications at will without the hassle of the processor having to refocus other tasks.*

*Also, a screen can be resized to the desirable size and resolution by the user.*

*Overall, a screen is more beneficial for using other applications simultaneously which is why I prefer it.*

*The only downside to a screen is that the CPU and GPU are also being used by other processes so you may experience lag or limited FPS. Though given that this game is unlikely to use excessive amounts of processing power, it isn't much of an issue.*

**Analysis:** The main stakeholder has a clear preference for a window.

Q2: How would you like to fire the projectile?

*A slider bar system would be preferable. This is because it allows the user to adjust the values without having to type them in.*

*This decreases the accuracy of the number selection; however, it is a lot easier to slide a bar than manually type out a value.*

*For this game, it is unlikely that the user will need to be too specific about their values, which is why I'd recommend focusing on usability over accuracy.*

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**Analysis:** The main stakeholder has a clear preference for a slider bar system.

Q3: Do you want the game to save your progress?

*Yes, definitely.*

**Analysis:** The main stakeholder would like the game to save user progress.

Q4: What would be your preferred method of playing the game?

*I would like to play the game on my laptop.*

**Analysis:** The main stakeholder would like the game to be computer/laptop based.

Q5: What features would you like the game to contain?

*I think that generally, users like customisability. You shouldn't restrict the users by using set systems for everything, but instead try to allow for options and variety wherever possible.*

*The more that a user can customise the game; the more likely they are to do so. And if a person spends a long time setting something up, they are unlikely to give up all of that effort easily, so it's another way of drawing people in and having them keep playing.*

**Analysis:** This answer is particularly helpful. It shows that I should give the users as much flexibility and control as possible.

Q6: If you have ever played a similar game, what features did you like?

*I have played Wii bowling and Angry Birds. However, I have played a variety of other games where you need to complete similar objectives as side tasks or minigames.*

*I liked having to avoid obstacles, and having other external elements act on the system like wind and gravity.*

**Analysis:** This answer gives me some ideas of the successful features of similar games.

Q7: Would you like music in the game and if so, what type?

*Yes, but the music should depend on the theme of the game. For example, if the setting is in space, then the audio should complement that setting.*

*I'd recommend creating a variety of themes, which can either be toggled by the player, appear randomly, or occur for certain predetermined levels, where the background, sprites and music all change and are all linked together.*

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*For example, if there is a nature theme where the background is a forest, the sprites should be natural colours and the music should be like something from 'The Hobbit'.*

**Analysis:** The main stakeholder would like the music to represent the 'mood' of the game.

### **Essential features of the computational solution:**

From conducting the survey and the interview, I was able to find out what the essential features of my solution will be.

Feature	Justification
Game screen will be windowed	Most stakeholders would prefer a windowed screen compared to a full screen.
Projectile will be fired using a slider bar	Most stakeholders would prefer a slider bar system compared to a manual entry system.
Game will save user progress	Most stakeholders would prefer the game to save their progress.
Users will be able to register / login	This is necessary in order for the game to save user progress.
Game will be playable on a computer / laptop	Most stakeholders would prefer the game to be playable on a computer / laptop.
Game will have several levels which increase in complexity	This provides a purpose to the game.
Users will be able to toggle music between on and off	This allows the user to have more control over the game.

### **Limitations of the solution:**

The main limitation of my solution will be the precision of the projection motion calculation. This is because the calculation will involve imprecise values. For example, a slider bar system will limit the precision to which the user can specify the speed of the projectile. This will mean that the calculations carried out by the program may result in values that are slightly different to what the user intended.

To fix this limitation, I will include a margin of error in all calculations meaning that slight variations in values will be accepted. This will make it easier for users to hit the target with their projectile.

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### 3.1.4 Specify the proposed solution

The solution requirements were agreed with my main stakeholder, David Kuc.

#### Hardware and software requirements:

Requirement	Justification	Type
Windows/Linux/UNIX/Mac OS X Operating System	These operating systems are supported by Python.	Software
Python with Tkinter & Pygame	Needed to run the program.	Software
Computer with keyboard, mouse and monitor	Needed to use the program.	Hardware

#### Design requirements:

Requirement	Explanation	Justification
Game will be windowed.	Allow users to have other programs open whilst playing the game.	This was a key stakeholder requirement.
User instructions	Shows the users how to play the game and use the software.	This will improve the user experience.
Lightweight design	The game design should be simple and easy to follow.	This will improve the user experience.

#### Functionality requirements:

Requirement	Explanation	Justification
Projectile fired using a slider bar system.	Allows users to adjust the flight of the projectile.	This was a key stakeholder requirement.
Game progress saved	Allows users to come back to the level they have got to.	This was a key stakeholder requirement.
Login/ registration system – linked to a database	Allows users to create their own account which is linked to their game progress.	This will allow game progress to be saved.
Settings menu	Allows users to adjust settings e.g. music	No general stakeholder consensus on the type of music so will give users options to toggle music on or off.
Unique game levels	Each game level is different as the settings and variables that need to be taken into account will change.	Requested by a stakeholder. Gives a purpose to the game.

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**Success criteria:**

The following success criteria was generated through the survey and interview with my main stakeholder.

Criteria Number	Criteria	How it will be evidenced
1	The game will be windowed	Screenshot of the window
2	User instructions will be provided	Screenshot of the game window
3	The game design will be lightweight	Screenshot of the game window
4	Use of slider bar system to fire projectile	Screenshot of the game window
5	Progress of user in the game is saved	Screenshot of the game window + coding + testing
6	A login/ registration system for users	Screenshot of the game window + coding + testing
7	User details will be stored in a database	Coding + testing
8	Settings menu with option to toggle music	Screenshot of the game window
9	Each game level will be unique e.g. have different values of gravity	Screenshot of the game window + coding