309 Mull, Ware College House  
Franklin and Marshall College  
Lancaster, PA 17604-3220

15th November, 2011

Dear Justin,

I am sorry to hear the death of Daneila and Tara's accusation of murder. All you need to do now is be calm and stay positive as I have found sufficient evidences to prove that Tara is not guilty of this murder.

According to your letter, you claimed that you have witnessed and took a picture of the jar that killed Daneila when you were standing on your apartment's balcony. You also mentioned that according to the surveillance video, your ex-girlfriend Franciny handed the detonator to Tara exactly five seconds before the jar hit and killed Daneila. If my assumption of the canon that shot the jar up in the air was placed on the ground level when the crime was happening, then the jar would have to take at least eight seconds for it to reach Daneila. There was not sufficient time for Tara to activate the canon as she only got a hold of the box for five seconds. Air resistance is also ignored in this calculation as it would only increase the air time of the jar. I will explain the math procedure below. I drew a diagram of the crime as it was happening in the crime scene:

![Diagram of the crime scene](image-url)
There are three possible situations that were occurring to the jar when you snapped the picture of it on your balcony: the jar was falling after reaching its highest point in the projectile motion, the jar was on its way to the highest point in the projectile motion, or the jar was at the highest point of the projectile motion. Since we would like to find the shortest time the jar spent in the air in order to prove Tara's innocence (if the shortest time the jar spent in the air is still longer than five seconds, then Tara is innocent), we assume that the jar was at the highest point of its projectile motion when you snapped its picture.

We then researched from the internet the standard projectile motion formula

\[ h = V_i t - \frac{1}{2} gt^2, \]

where \( h \) stands for height of the jar travelled in feet measured from the ground during its projectile motion, \( V_i \) stands for initial velocity of the jar in feet/sec after it was shot from the canon, \( t \) stands for time in seconds the jar spent in the air after it was shot from the canon, and \( g \) stands for the acceleration caused by gravity, to determine the amount of time the jar spent in the air. We then plugged in the height from the ground to your apartment (256 feet) and the acceleration caused by gravity (32 feet/second\(^2\)) into \( h \) and \( g \) respectively into the formula and we acquired this equation:

\[ 256 = V_i t - 16t^2. \]

After numerous tests and plugging in numbers into \( V_i \) and limiting its range, we discovered that 128 feet/s is the only possible initial velocity of the jar in order to reach only 256 feet in the air. I drew another graph to explain the projectile motion of the jar clearer.

![Graph of the jar's projectile motion](image)

*Figure 2: Graph of the jar's projectile motion*
According to the above graph, it took the jar four seconds to reach its highest point in the projectile motion. Therefore, the time of the complete projectile motion of the jar would be at least eight seconds after it was fired from the canon on the ground. Since Tara only got a hold on the detonator for five seconds, this is a strong enough evidence to prove her innocence.

We also calculated how high the jar would travel if it only took five seconds to reach Daneila after it was shot from the canon with an initial velocity of 128 feet/sec. We then realized that it could only travel up to 240 feet in the air from the ground, which is impossible for you to snap a picture of it while standing on your balcony 256 feet from the ground.

I received help from my professor and Rosa for this calculation. I also acquired the standard projectile motion formula from Wikipedia. I hope this solution can prove Tara innocent on trial next Monday. I am looking forward to hear good news from her and remember not to let her go after everything is over as she has a strong feeling for you too :).

Yours Sincerely,

Allen Yuen

Calculus I Student

Franklin & Marshall College

P.S. I hope you realize too that you ex-girlfriend is extremely suspicious and probably has some mental issues. You may want to further investigate her as she may assault Tara again after she is proved to be innocent by the judges.