

Bobo the Clown: Murder or Suicide?

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Intro

A clown from a local circus was fired out of a cannon into the canyon it was next too and the clown died. The police force believes that it was murder and has a suspect, however they are unable to prove it was not suicide.

Some of the facts of the case include the following: Bobo the clown has been performing for the Upsy-Daisy Traveling PU Circus for about 2 years. The circus is located in the mountains that border the Big City; they practice at high altitudes where the air is thin. One of Bobo's performances include being shot out of a cannon and parachutes into the canyon. During the time of the accident they were rehearsing for their next show on November 8.

During the afternoon of November 1, Bobo climbed into the cannon for unknown reasons. According to eyewitness accounts the only living things that were close to the cannon was the owner of the circus, Rick Rasterdy along with 5 elephants. The cannon was somehow fired and Bobo was not wearing his parachute. He was shot across the gorge hitting the wall about 310 meters down.

The distance across the canyon is at least 200 meters in length. The mouth of the cannon is 3 feet in the air and it is only 5 feet long, but is able to launch a human at 30 meters per second. The question is whether Bobo fired the cannon or if Rasterdy did. It takes about a half second push the ignition button. One witness claims Rasterdy pushed the button and another says that he didn't. Another witness claims Rasterdy and Bobo have been arguing about money and another claiming they were best friends.

Rasterdy's account of what happens is as follows:
 "I was filming the elephants for the rock video. I figure if MTV likes sex, violence, and raw, bestial emotion, why not use elephants, eh? Bobo-gee, I still can't believe the changed his name legally-it used to be Winifred Dieselblock-well, he was in the cannon, probably checking things out. He often does before a gig; just to make sure everything's working okay. I didn't pay much attention because I had the elephants there; if you had to choose between 5 elephants or a clown you'd [] well pick the elephants, wouldn't you? So we're getting to the tricky part where they all stand up on their hind legs and put their front legs on each other, and I hear a 'boom!' I turn around, and there's Winifred sailing off. I kept waiting for his chute to open and think it's a [] fine time for him to pull this, knowing we'll have to send the jeep down to get him, but his chute never opens and he bangs into the all on the opposite side and then tumbles on down. I can't believe it was suicide I just can't. It must have been an accident. He pushed that button by mistake."

The video camera confirms his story to a point, but has no sound. It also has a digital clock which leaves an imprint on the film. As the elephants were rearing up at 15:52:20 the camera moved and was dropped. Bobo was wearing a watch that was fixed a week prior, which the watchmaker said it was keeping excellent time during the week she fixed it, she said it did not gain or lose a second from her master clock. Bobo was wearing it when he died and it stopped at 3:56:50. The video camera time was 4 minutes and 16 seconds slow.

The questions that the police force has are as follows: does Rasterdy's story hold water and can we convince the jury that it doesn't? How fast was Bobo going at the time of impact, and was this sufficient to cause death? How far across the gorge did Bobo fly?

Abstract

USING CALCULUS TO SOLVE THE MYSTERY OF BOBO THE CLOWN'S DEATH

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This poster helps to explain how to solve a mystery using calculus. The problem is that there was a clown named Bobo who was shot out of a cannon and found dead at the bottom of a canyon 310 meters deep. No one knows for sure if his death was a suicide, an accident, or a murder. All of the available witnesses have contradicting stories. The only thing known is that the ring master was the only person near the cannon at the time it was fired. The ring master claims that he was video-taping elephants when he heard the cannon go off. Looking at the tape, there is no sound and it stops at 3:56:36. The time that Bobo's watch stopped at was 3:56:50, thus showing that the possible time of flight was 14s. Since the cannon's dimensions were 5ft by 3ft by 4ft the angle of projection was calculated using trigonometry. Using the equation for range of the arc between the tip of the cannon to the level with the tip of the cannon in the air, the time of that arc was calculated. Thus the actual total time of flight was calculated using the equation $Y_f - Y_i = V_{iy}t - (5)(g)(t)^2$. The total time was now determined and the impact speed was calculated using the equations: $V_{fy} = V_{iy} + (a)(t)$ and $V_x^2 + V_{fy}^2 = V^2$, and the total horizontal distance was calculated using the equation $X_f - X_i = (V_x)(t)$. After all of these calculations were performed we were able to better understand the situation and propose a solution to the mystery.

Useful Equations

$$V_f = V_i + (a)(t)$$

$$V_x = V \cos(\Theta)$$

$$V_y = V \sin(\Theta)$$

$$V_f = V_i + (a)(t)$$

$$X_f - X_i = (V_x)(t) + (1/2)(a)(t)^2$$

$$-b \pm \frac{\sqrt{b^2 - (4)(a)(c)}}{2a}$$

$$A^2 + B^2 = C^2$$

1 meter = 3.2808399 ft

Step 1: Find the Angle measure Theta

The first step to solving this problem is to find the measure of the angle Theta of the cannon. The cannon's measurements include: length of barrel is 5ft, the height from the end of the barrel to the ground is 3ft, and the length of the ground beneath the cannon is 4ft. To measure angle Theta, simply take the arcsine of the height divided by the hypotenuse. After this calculation is made the measure of the angle Theta is determined to be **36.87 degrees**.

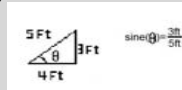


Figure 1

Step 2: Decompose the Initial Velocity

The next step to solving the problem is to determine the Initial Velocity horizontal and vertical components. The process of calculating the components is fairly simple. Since the speed of Bobo the clown is known to be **30 meters per second**, then we can just multiply the angle by the speed. The Initial Velocity Y component is equal to the sine of Theta multiplied by the Initial speed. The Initial Velocity X component is equal to the cosine of Theta multiplied by the initial speed.

$$V_{iy} = \sin(\Theta) \cdot (30\text{m/s})$$

$$V_{ix} = \cos(\Theta) \cdot (30\text{m/s})$$

Figure 2

Diagram of Scenario

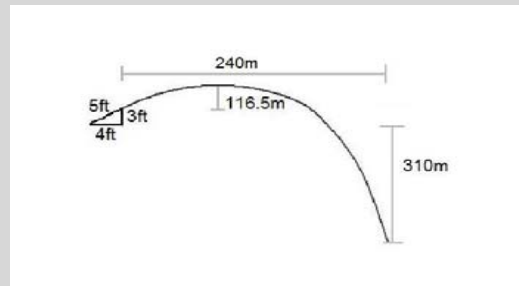


Figure 3

Not Drawn to Scale

Step 3: Determine Time of Flight of the arc

To determine the time of flight to max height, simply determine the range by using the following equation: $R = ((2V_i^2)(g)(\sin \Theta)(\cos \Theta))$. After the range is calculated to be 88.6, the equation $R = (V_i^2 \cos \Theta)t$ is used to determine the time. The time is calculated to be 3.67s.

Step 4: Determine Total Time

The correct total time is calculated by using the equation $Y_f - Y_i = V_{iy}t - (5)(g)(t)^2$. By simply subtracting the camera time from the watch time we get a time of about **14s**. The camera was **4minutes and 16seconds slow**, this was added to the camera time. When you use the equation to find the actual time of flight, the time is only about **10s**.

$$3:56:50 - (3:52:20+4:16)=0:14: \text{False}$$

$$Y_f - Y_i = V_{iy}t - (5)(g)(t)^2 = 10\text{s}: \text{True}$$

$$-310 - 915 = 18t - 4.905t^2$$

$$-310.915 = 18t - 4.905t^2$$

$$0 = -4.905t^2 + 18t + 310.915$$

$$\text{Use } -b \pm \sqrt{b^2 - 4 \cdot a \cdot c}$$

$$t = 10\text{s} \quad 2a$$

Step 5: Calculate Final Velocity of Bobo

The final velocity of Bobo before he hit the wall is calculated by first determining the final vertical velocity after **10.4s**. Then calculating the final horizontal velocity. Once these two velocities were calculated, the next step was to use the Pythagorean theorem to determine the general final velocity before impact. Since **84.2m/s** is approximately **188.35mph** it is logical to say that the impact would have a sufficient amount of force to kill a man.

$$V_{fy} = V_{iy} + (a)(t)$$

$$10 - 3.6=6.4$$

$$V_{fy} = 18\text{m/s} + (9.81)(6.4)$$

$$V_{fy}=80.7\text{m/s}$$

$$V_x=24\text{m/s}$$

$$V_x^2 + V_{fy}^2 = V^2$$

$$V_f=84.2\text{m/s}$$

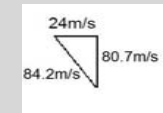


Figure 4

Step 6: Calculate the total Distance

The total distance is calculated by the equation $X_f - X_i = (V_x)(\cos 36.87)(t)$. The initial position of Bobo is zero meters at the end of the cannon. The final horizontal velocity is about 24m/s, and the total time was 10s. Thus the total distance was calculated to be about **336 meters**.

$$X_f - 0 = (30)(\cos 36.87)(10)$$

$$X_f = 240\text{m}$$

Conclusion

Based on the calculations above we determined that the ring master was lying about the time of the boom. Since his camera was dropped at 3:56:36 and Bobo's watch died at 3:56:50, the supposed time of flight was 14s. However, upon further investigation and calculations the actual time of flight was determined to be around 10s. Because of this 4 second gap between the two times and the fact that the tape recording had no sound, we believe that the ringmaster was lying about when he heard the cannon go off. Since all of the witnesses contradicted each other we had to rule them out. We knew that it only takes about half a second to fire the cannon, and we found that the speed of impact is sufficient enough to kill someone. The total distance that Bobo flew was 240m across the canyon. In short we have determined that the Ringmaster was lying and that he could have easily fired the cannon, thus killing Bobo.