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Physics investigates: Is Spider-Man a killer for lack of physical knowledge?

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Abstract.

The present paper looks for an alternative form of covering the Physics Teaching in the high school, through the analysis, of a very famous cartoon character: the Spider-Man. The paper consists not only in obtaining boundary conditions for the discussion and reflection of physical concepts with the students, but also, it aims at elaborating a different method to be used in the classroom as didactic material by other teachers, when seeking another type of support material.

Introduction

In search of an alternative proposal to teach Physics in a fun and playful way, this paper reconstructs the scene of a famous crime in the universe of superhero comics: the death of Gwen Stacy during the fight between Spider-Man and the Green Globin (The Amazing Spider-Man 121, Jun-Jul, 1973, pp. 121-122).

When cast from the top of the quoted bridge in history as George Washington (although the comic depicts the Brooklyn Bridge) in New York, the character has a broken neck for Spider-Man's attempt to hold it with his web.

The goal of the proposal is to put teachers and students in the role of detectives whose purpose is to reconstitute the crime. For this was used some physical concepts and measurements that can be made inferred from the image.

Real statistical data was used to establish the boundary conditions expressed in physical quantities in order to determine what actually the cause of the character's death was and find out if Spider-Man was responsible.

Materials and Methods

The scene of the comic to be analyzed in this paper, is the fall of Gwen Stacy from the top of the George Washington Bridge (The Amazing Spider-Man # 121, jun.-jul., 1973, p. 121-122).

This comic scene **(figure 1)** will provide us with the necessary conditions to calculate the parameters that will help us to find out if it was Spiderman or not who was responsible for the death of his girlfriend.
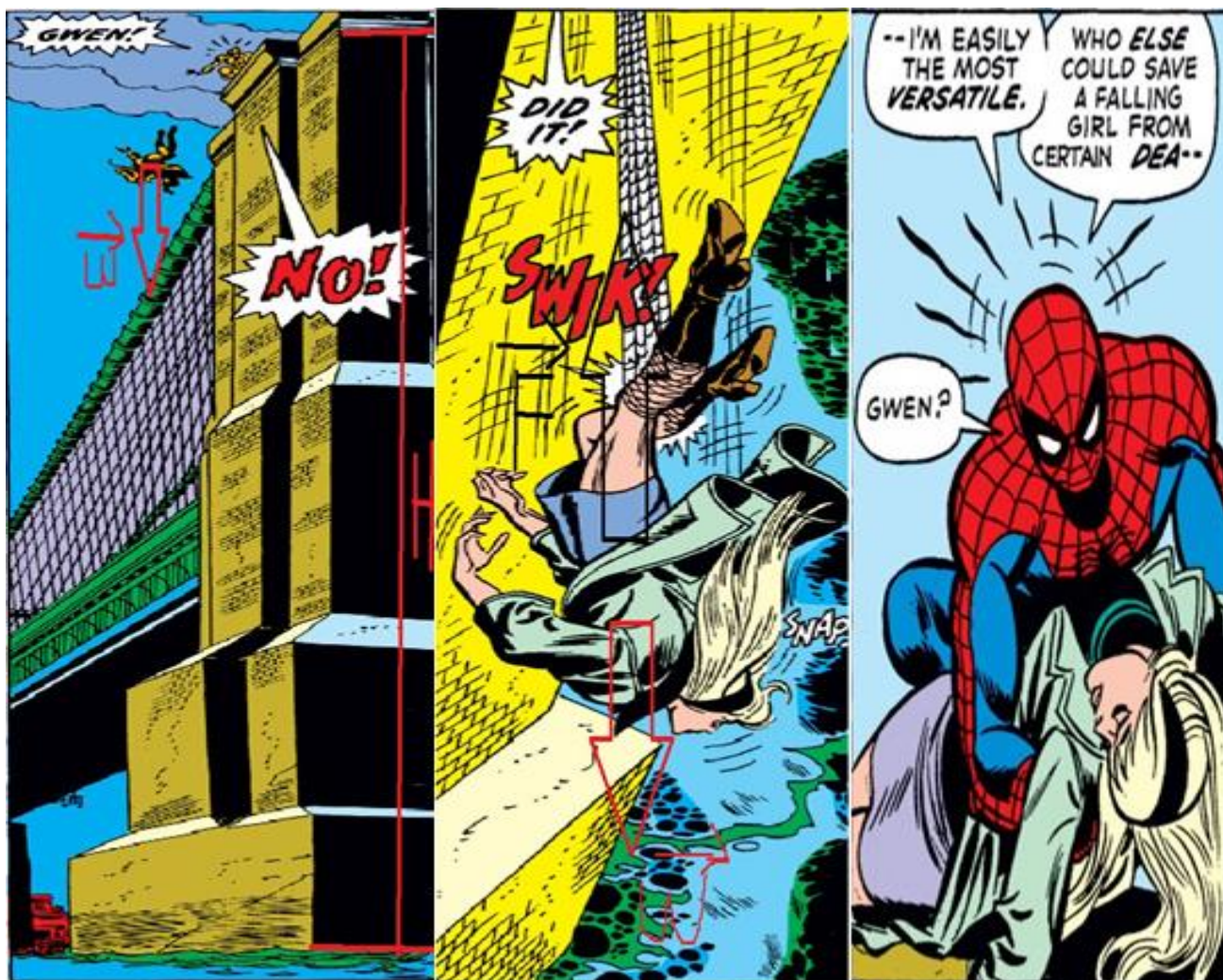

Figure 1 – Scene of the comic to be investigated by teachers and students.

Source – Marvel Comics (1973), "The Amazing Spider Man #121", New York: Marvel Comics, 1973.

We are interested in knowing what force value Spider-Man's web will apply to Gwen when he can get her. First, we need to calculate the velocity (v) with which Gwen is falling.

For this, it is necessary to know the height (h) of the tower of the George Washington Bridge. This value can be obtained in the literature, but the idea of this work is to obtain the height of the bridge through measurement in the image.

With this measured parameter, you can calculate the velocity of her fall. The velocity **(1)** depends only on the height it was thrown and the acceleration value of gravity.

$$V = \sqrt{2gh} \qquad (1)$$

Another concept that we need on this investigation is the impulse (2) and for this we need to know Gwen's mass.

$$I = F.\Delta t \quad (2)$$

It is not possible to know the value of Gwen's mass without being in accordance with the comics. For this parameter, the average weight of a young American woman in the 1960s was used according to an NCBI article that contains aesthetic information such as: weight and height.

Remembering that Impulse **(I)** is also numerically equal to the quantity of linear momentum, we can modify equation **(2)** in such a way as to obtain:

$$I = m.\Delta V$$

$$m.\Delta V = F.\Delta t$$

$$F = (m.\Delta V)/\Delta t \quad (3)$$

Through equation **(3)** it is possible to calculate the value of the force exerted by the Spider-Man, provided that we have the values of Gwen's mass, the change of velocity with which it is she falling and the time interval that the Spider-man's web can reach it.

Results and Discussion

The height (h) that was found through the measurement of **figure (1)** was **530 feet (161 meters).** However, according to the image, Spider-Man can reach it when Gwen is halfway down the bridge, so the height used in the equation is only half the height, that is, **265 feet (80.5 meters)**

We also know that the acceleration value of gravity is practically the same in the whole Earth and has a value of 9.81 m / s².

Putting these values in **equation (1),** we will get that the `velocity` with which Gwen is falling is approximately **89, 5 mph (40 m / s)**. When the Spider-Man web reaches Gwen, it will change the velocity from **89, 5 mph** to **0,** because the Spider-Man will make her stop. Therefore, the modulus of our ΔV is **89, 5 mph (40 m / s)**.

According to NCBI's article, the average mass of a young girl (between 18 and 24 years old) near the time of the publication of this comic was **65 kg**. This implies that Gwen has a weight of **637 N**.

The last item we need to calculate to obtain the force is the time interval. One of the powers of Spider-Man is the spider sensor that makes him alert when the danger is near. For this reason, he had a very fast reaction and the time interval should be less than 1 second. The time interval adopted for this analysis was **0.5 seconds.**

With all the parameters obtained, we can now finally calculate the value of the force that Spider-Man exerts on Gwen. Putting the above values in equation (3), we will obtain that the force exerted by him is **5200 N**.

This force is about eight times larger than Gwen's weight and is being applied in a short time. The "SNAP" that appears in the image indicates the consequence of this force, making us then conclude that the force that Spider-Man did on Gwen was responsible for causing his death.

Conclusions

Currently, superheroes are a theme that is on the rise and inserted among the students again, thanks to its popularization through the movies. Trying to use this theme for Physics Teaching, but through the comics, it is hoped that students will be able to have new conceptions about Physics and develop a more critical look at Science as a whole. In addition, teachers will be able to use this same method in

their classes for a differentiated way of learning. Other heroes can be used to discuss subjects from other areas such as: electromagnetism, thermodynamics or quantum physics.

From this analysis, it is hoped to favor the learning of new physical concepts by the students through an instigating and different approach.

References

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