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A5_1 Did Superman really save Lois Lane?

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Abstract

This article investigates an implication of being caught after falling from great height. This is seen in the film Superman (1978). The scene depicts Lois Lane falling from a helicopter at the top of a skyscraper, only to be caught safely by Superman. It was found that the impact of landing on Superman's arms would have been 9x10^4 Pa and would not have caused harm to Lois Lane.

Introduction

In the classic film Superman (1978), Lois Lane falls out of a helicopter at the top of a skyscraper. Superman witnesses this and flies straight towards Lois and rescues her without delivering any injuries. We investigate whether this is plausible or whether Lois would get injured in the process of her rescue. We examine the event using free-fall concepts and the known lethal values of pressure.

Theory and Results

After reviewing the scene in the film it can be seen that Lois Lane is in free fall for approximately 10 seconds. Using the equation of linear motion

$$v = u + at, \tag{1}$$

where v is the final velocity, u is the initial velocity, a is the acceleration and t is the time of flight. Assuming that Lois is stationary before she starts her free fall so that $u = 0^{-1}$, we find that the velocity Lois would be falling at when Superman catches her would be 98.1 ms^{-1}.

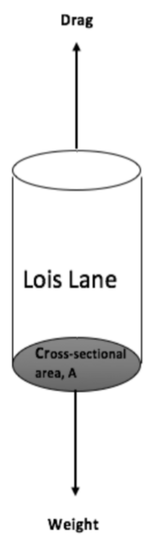

Figure 1: Diagram representing our simplistic model of the forces acting upon Lois Lane as she falls through the air.

However, this is not taking into consideration air resistance.

To find the velocity that Lois would have been falling while taking into account air resistance we use the drag equation given below [1]

$$v = \sqrt{\frac{2mg}{\rho A C_d}} \tanh\left(t\sqrt{\frac{g\rho A C_d}{2m}}\right), \qquad (2)$$

where m is the mass of Lois, g is the acceleration due to gravity, ρ is the density of air, A is the cross-sectional area of Lois, C_d is the drag coefficient and the terminal velocity is given by

$$v_t = \sqrt{\frac{2mg}{\rho A C_d}}. \qquad (3)$$

For this we make the assumptions that the mass of Lois is 65kg [2] and that the density of air is 1.293kgm^{-1}[3]. We calculated the cross-sectional area of Lois when falling using the average hip size of women. Assuming that Lois is a cylinder with the flat face having a circumference size of 0.914m [4]. This corresponds to an area of 0.067m^2. We take a value for the drag coefficient of 1.2 as this is the value of a human in an upright position [5]. Substituting these values into equation (2) we calculated the velocity that Lois would be falling when caught by Superman to be 78.558ms^{-1}.

To calculate the pressure that would be transferred to Lois when Superman catches her we first need to work out the change in momentum, dp. Assuming that Superman is stationary when he catches Lois then

$$dp = mdv. \qquad (4)$$

Therefore, $dp = 5113$ kgms^{-1}. The force at which Superman catches Lois can now be calculated using the rate of change of momentum

$$F = \frac{dp}{dt}, \qquad (5)$$

where dt is the time it takes Superman to decelerate Lois to a stationary position. After careful revision of the film we estimate it takes approximately 1 second for this deceleration. This means that the force required to stop Lois is 5113N. Assuming that this force is split equally between Superman's arms which we assume to have a length of 35cm and a width of 8cm giving the area of both his arms as 0.056m^2. Using the pressure equation

$$P = \frac{F}{A}, \qquad (6)$$

where P is the pressure we find that the pressure that Lois is subjected to would be 9x10^{4}Pa.

Conclusion

The pressure was determined to not cause damage to her body as the pressure necessary to break the skin is 689476Pa [6], and to break one of the small bones in the body is 172369Pa [7]. However, Lois may incur some bruising, though this is difficult to ascertain as there is no definitive pressure required to cause bruising. We suggest that the implications of Superman's impact upon Lois Lane can be looked at, in the case when Superman is not stationary when he catches her.

References

[1] https://en.wikipedia.org/wiki/Drag_(physics) (28/10/2016)

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[3] Paul A. Tipler and Gene Mosca *Physics For Scientists and Engineers* 6th Edition Pg. 424

[4] http://www.telegraph.co.uk/news/health/news/8335282.html (28/10/2016)

[5] https://en.wikipedia.org/wiki/Drag_coefficient#cite_note-29 (28/10/2016)

[6] http://www.bcmj.org/worksafebc/updates-worksafebc (28/10/2016)

[7] http://scienceline.ucsb.edu/getkey.php?key=3088 (28/10/2016)