On May 26th, 2018, it was reported in the French news that a four-year-old child fell from the 5th floor’s balcony of a building in Paris (France), and was able to catch the railing of the 4th floor’s balcony. An immigrant, Mamoudou Gassama, who was passing by decided to climb the building and rescued the child. Subsequently, Mamoudou was congratulated by French president, Emmanuel Macron, and was naturalized. In this paper, by using kinematic equations and Newton’s laws, it is shown that it is actually impossible for a four-year-old child (and probably for an adult too) to fall from a balcony and catch the railing of the lower balcony. This suggests that the rescue of the child could have been staged.

INTRODUCTION

It was about 8:00 pm on Saturday, May 26th, 2018, when firemen were alerted by pedestrians that a child was hanging on the railing of the 4th floor of a building in Paris (France). When they arrived on the scene, the child had been rescued by Mamoudou Gassama, a Malian immigrant. The scene was recorded, showing Mamoudou climbing the four stories in about 30 seconds, grabbing the kid’s arm, lifting him over the railing, and putting him in safety. Subsequently, Mamoudou was congratulated by president Emmanuel Macron, who proposed to engage right away a procedure of naturalization, which Mamoudou accepted.

One question that arises is how the four-year-old child ended up hanging on the 4th balcony’s railing, where supposedly nobody else was present, and where the windows were locked from the inside. It was reported that the child didn’t talk but indicated with his finger that he fell from above, presumably the 5th floor, although there is no testimony of anybody having seen him falling. However, the concierge of the building later declared that the 5th floor is uninhabited, which suggests that the child fell from the 6th floor, where he lives.

In this paper, it is shown by using kinematic equations and Newton’s laws that the above scenario is impossible. It is important here to point that we don’t claim that the rescue of the child by Mamoudou is staged, we only consider it as a possibility. The only claim that we make is that, as opposed to what was reported in the news, the child didn’t fall from one or more stories. We don’t make any hypotheses on whether the child was put on the 4th balcony’s railing by irresponsible parents in order to provide Mamoudou with an opportunity to accomplish his exploit, or if Mamoudou was totally unaware of the reasons why the child was hanging up there. We also don’t even comment on the fact that the child didn’t lose his flip-flops during the reported fall, and leave it to the reader’s consideration. Indeed, Mamoudou declared that once he put the child in safety, he noticed that he was wearing Spiderman flip-flops, a funny coincidence for the so-called “French Spiderman”.

MODEL

In the following, a calculation that largely underestimates the force that the child would have had to produce in order to stop his fall is presented, so that it clearly shows that such an exploit is impossible. Although the child supposedly fell from two stories, we assume that he fell from only one, Fig. 1 and that the distance between two consecutive balcony railings is \( h = 3.00 \text{ m} \) (standard distance). In order to make sure that the calculated average force is underestimated, the ideal case where the child manages to slow down and come to a stop over the largest possible distance is considered. Typically, the braking distance is equal to about the child’s arm length. Considering that, on average, the arm length of a four-year-old child is 11.0 in, this corresponds to a distance of 27.9 cm. However, in the following we purposefully overestimate this distance and take it to be \( d = 50.0 \text{ cm} \), in order to make sure that the calculated average force is underestimated.

As is shown below, the velocity that the child reaches before catching the railing is much smaller than the terminal velocity of a skydiver. This justifies that air resistance can be neglected. Also, during the fall, since there is no horizontal force pushing the child against the railing and the balcony’s concrete, the friction force due to his nails, clothes, and flip-flops rubbing against the railing and the balcony’s concrete vanishes quickly as soon as he starts to fall. Indeed, this dynamical friction force is proportional to the normal (horizontal) force that the railing and balcony’s concrete exert on the child. If this normal force is initially present, it is the only horizontal force acting on the child, who is therefore accelerated away from the building. Thus the force that he is able to apply on it (equal in magnitude to the normal reaction force) quickly vanishes. This friction force can therefore be neglected as well. As a result, during the fall, only gravity is at play so that the child is in a free fall.
FIG. 1. (Color online) Ideal situation where the child falls from the height of a single story, \( h = 3.00 \) m, and slows down and comes to a complete stop over a distance of \( d = 50 \) cm.

**KINEMATIC EQUATIONS**

The child is in a free fall over a distance \( D \) equal to the distance between the balconies, minus the braking distance, \( D = h - d = 2.50 \) m. During this free fall, the child’s acceleration is constant, equal to \( g = 9.80 \) m/s\(^2\). Using the well known kinematic equations for constant acceleration,

\[
y = y_o + v_o t + \frac{1}{2} a t^2 \quad v = v_o + at,
\]

where \( y, y_o, a, t, v, v_o \) are respectively the final height, initial height, acceleration due to gravity, time, final velocity, and initial velocity, and substituting \( v_o = 0 \) (child initially at rest), we can eliminate the time and express the velocity as a function of the free-fall distance \( D = |y - y_o| \):

\[
v = \sqrt{2a|y - y_o|}
\]  
(2)

Substituting \( |y - y_o| = 2.50 \) m, and \( a = g = 9.80 \) m/s\(^2\), we get:

\[
v = 7.00 \) m/s = 25.2 km/h
\]  
(3)

This is the child’s velocity right before he catches the railing. Note that, as already announced, this velocity is much smaller than the terminal velocity of a skydiver (about 200 km/h), which justifies neglecting air resistance. At this point, one could think that the challenge for the child is to catch the railing. But even more challenging is for him to slow down and come to a complete stop over the distance \( d \). Indeed, let us calculate the average acceleration (deceleration) needed by solving Eq. (2) for \( a \):

\[
a = \frac{v^2}{2|y - y_o|}
\]  
(4)

Substituting \( v = 7.00 \) m/s and the braking distance \( |y - y_o| = 0.500 \) m, the average acceleration needed to come to a stop is:

\[
a = 49.0 \) m/s\(^2\)
\]  
(5)

This corresponds exactly to an average acceleration of 5\( g \).

**NEWTON’S 2\textsuperscript{nd} AND 3\textsuperscript{rd} LAWS**

Let us denote by \( m \) the mass of the child. During the braking, two forces are acting on him: His weight \( \vec{w} \) with magnitude \( w = mg \), and the railing’s reaction force \( \vec{R} \), as shown on the free-body diagram, Fig. 2.

![Free-body diagram of the child](image)

**Free-body diagram of the child**

According to Newton’s 2\textsuperscript{nd} law, the net force \( \vec{F}_{\text{net}} \) acting on the child is:

\[
\vec{F}_{\text{net}} = \vec{R} + \vec{w} = m\vec{a}
\]  
(6)

Solving for \( \vec{R} \), we get:

\[
\vec{R} = m\vec{a} - \vec{w}
\]  
(7)

In term of magnitudes, this becomes:

\[
R = m(a + g)
\]  
(8)

Substituting \( a = 49.0 \) m/s\(^2\), \( g = 9.80 \) m/s\(^2\), and assuming an average mass of 20.0 kg for a four-year-old child, the average force exerted by the railing onto the child has a magnitude of:

\[
R = 1176 \) N
\]  
(9)

According to Newton’s 3\textsuperscript{rd} law, this force is equal in magnitude and opposite in direction to the force exerted by the child against the railing. This force is precisely equal to **six times his own weight** (this holds true for any mass \( m \)). In other words, this is the force necessary to lift a mass of 120 kg. It is hard to believe that a four-year-old child could be able to accomplish such an exploit.
Also, note that this is just the average force during the braking. The instantaneous force could easily be an order of magnitude greater. In addition, this average force is way underestimated, since we have purposely overestimated the braking distance \( d \), and considered a fall from the height of a single story, whereas the child supposedly fell from two. As a result, it is clear that the reported scenario is impossible.

**CRITICS OF THE MODEL**

A common critic of the model is that it does not take into account frictional forces due to the child trying to grab anything on his way during the fall. As explained in section “model”, the dynamical friction force quickly vanishes as soon as the child starts to fall. It was reported by the neighbor on the 4th floor (who didn’t attempt anything to rescue the child) that he noticed that the child had a torn toe nail\(^1\). Assuming that this information is correct, the force necessary to tear the nail must be compared to the force of 1176 N necessary to stop the fall. Common sense clearly allows us to conclude that these two forces cannot compete.

Another common critic is that the child could have slowed down his fall with his feet or legs hitting the railing first. This doesn’t make any sense either, since conservation of horizontal momentum guarantees that the child’s center of mass cannot move towards the railing. If during the fall the feet or legs of the child move toward the building, then his upper body must necessarily move away from it, as illustrated in Fig. 3. He would therefore fall backward, without any chance of catching the railing with his hands. In addition, such a collision with the railing would clearly have led to injuries, which have not been reported.

**CONCLUSION**

It was reported in worldwide news that the child rescued by Mamoudou Gassama fell from one or more stories\[^1-7\]. However, in this paper, it is shown that this scenario is impossible. This raises the question about determining how the child actually ended up hanging on the railing of the 4th balcony, where supposedly nobody else was present, while he lives on the 6th floor, where it was reported by his father that he was left alone. Given these facts, it is hard to avoid the idea that the rescue of the child could have been staged. It should also be noted that one could have arrived to the same conclusion (namely the scenario being impossible) without any calculations, just by using common sense. More than one month after the facts, it is very surprising that nobody has made a public claim that the reported scenario is impossible. It is even more surprising that, presumably, president Emmanuel Macron wasn’t advised about the glitches of the case, and decided to proceed right away with the naturalization of Mamoudou\[^6\].

[1] LCI (national TV channel): [https://www.lci.fr/faits-divers/l-enfant-raphael-sauve-par-mamoudou-gassama-avait-deja-chute-d-un-etage-2088748.html](https://www.lci.fr/faits-divers/l-enfant-raphael-sauve-par-mamoudou-gassama-avait-deja-chute-d-un-etage-2088748.html)
[2] Le Parisien (national newspaper): [http://www.leparisien.fr/faits-divers/enfant-suspendu-dans-le-vide-il-est-tombe-d-un-etage-avant-de-se-rattraper-au-balcon-28-05-2018-7740636.php](http://www.leparisien.fr/faits-divers/enfant-suspendu-dans-le-vide-il-est-tombe-d-un-etage-avant-de-se-rattraper-au-balcon-28-05-2018-7740636.php)
[3] France Soir (national newspaper): [http://www.francesoir.fr/societe-faits-divers/mamoudou-gassama-enfant-etait-en-fait-tombe-du-6e-etage](http://www.francesoir.fr/societe-faits-divers/mamoudou-gassama-enfant-etait-en-fait-tombe-du-6e-etage)
[4] CNews (French digital channel) [https://www.cnews.fr/2018-05-28/enfant-sauve-par-mamoudou-gassama-etait-deja-tombe-du-6e-etage-783141](https://www.cnews.fr/2018-05-28/enfant-sauve-par-mamoudou-gassama-etait-deja-tombe-du-6e-etage-783141)
[5] ChinaDaily [http://www.chinadaily.com.cn/a/201805/29/WS5b0d5767a31001b82571cfd4.html](http://www.chinadaily.com.cn/a/201805/29/WS5b0d5767a31001b82571cfd4.html)
[6] France Soir (national newspaper): [http://www.leparisien.fr/faits-divers/mamoudou-gassama-va-etre-naturalise-et-devenir-pompier-28-05-2018-7739604.php](http://www.leparisien.fr/faits-divers/mamoudou-gassama-va-etre-naturalise-et-devenir-pompier-28-05-2018-7739604.php)
[7] 20 Minutes (daily newspaper): [https://www.20minutes.fr/](https://www.20minutes.fr/)