7 The Physics of Skateboarding

Skateboarding is not just a mode of transportation, but also a popular sport as many tricks can be performed on it. A skateboard basically consists of a deck, truck and wheels as shown in Fig. 7.1. The deck is usually made of wood and covered with a layer of grip-tape which increases the friction between the skateboarder and the deck. The front and tail ends of the deck are inclined slightly upwards. The truck connects the wheels to the deck. The truck can be adjusted to vary the height of skateboard above the ground.

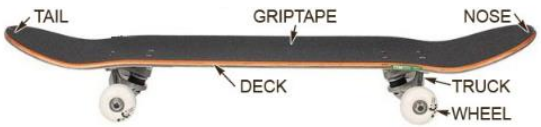
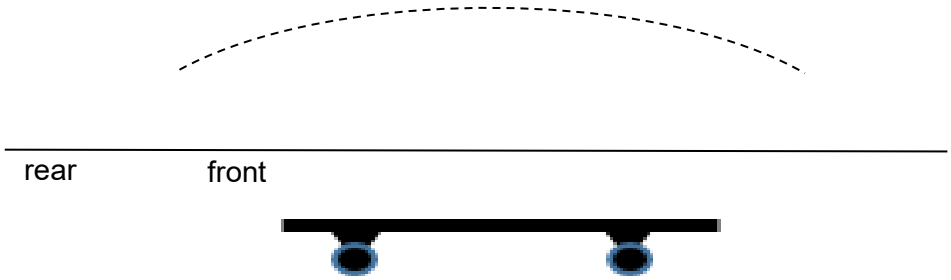


Fig. 7.1

While many tricks can be performed on the skateboard, two of the most basic ones are known as the Hippie Jump and the Ollie.

In the Hippie Jump, a skateboarder rides the skateboard on a horizontal surface and jumps by exerting a downward force on the skateboard as shown in Fig. 7.2. The skateboard continues to move forward while he is airborne allowing him to land back onto the skateboard.



In the Ollie, the skateboarder jumps into the air together with the skateboard as shown in Fig. 7.3. This can be performed while the skateboarder is initially at rest. To do this, the skateboarder starts in a crouching position with one feet on the tail end of the skateboard and the other feet at the middle of the skateboard as shown in step 1 in the figure below. In step 2, he pushes down hard on his foot that is on the tail end and launches himself into the air. The skateboard follows shortly after. In step 3, the skateboarder then slides his forward foot that is in contact with the skateboard towards the front wheel and pushing downward slightly so that the skateboard returns to a horizontal position and gets lifted higher as shown in step 4, allowing him to land safely thereafter.

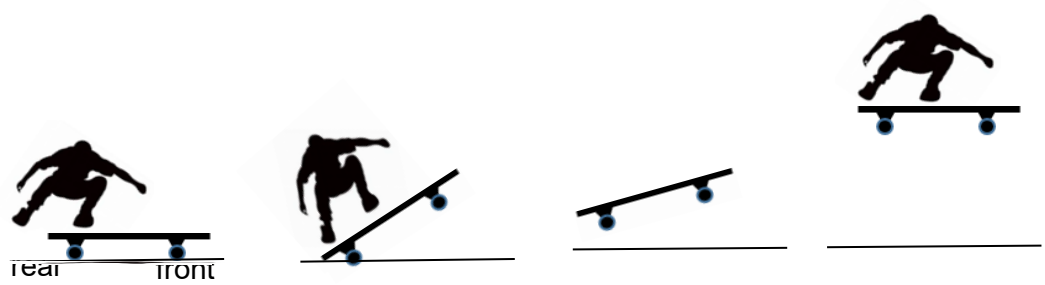


Fig. 7.3 The Ollie

A skateboarder that is moving on a horizontal surface is subjected to considerable resistive forces due to ground resistance which is relatively constant as well as air resistance which increases significantly as his speed increases. In order to investigate the resistive forces present, a skateboard is fitted with an electric motor of power *P* and the maximum speed *v* that can be achieved on different surfaces is recorded with a skateboarder standing on it where *m* is the combined mass of the skateboarder, motor and skateboard. The following graphs are obtained.

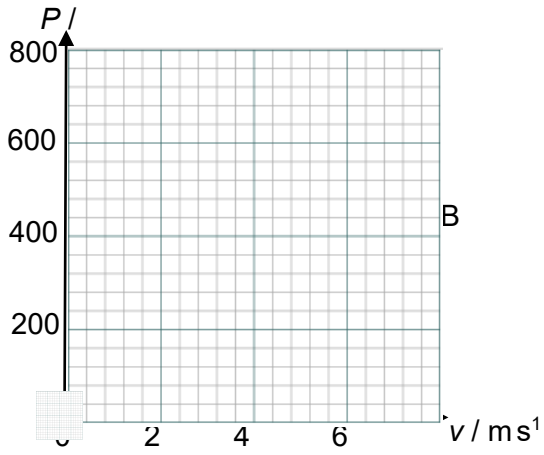


Fig.7.4 *P–v* graph for the same skateboarder on different surfaces

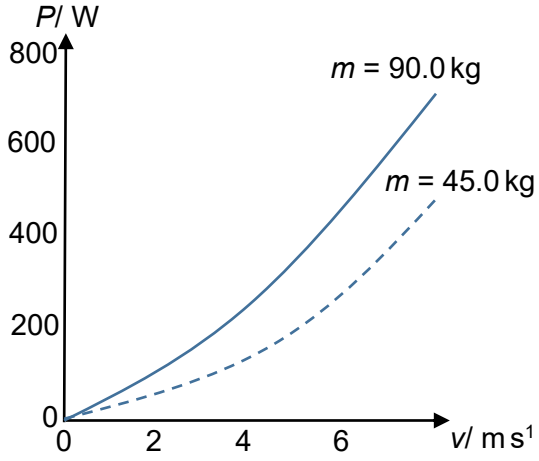


Fig. 7.5 *P–v* graph for different skateboarders on same surface

We can see that the resistive force varies significantly on different surfaces and also depends on the skateboarder's mass. Hence for a less tiring ride, one might choose a smaller and hence lighter skateboard.

Since the 1950s, the popularity of skateboarding has gone through several cycles of ups and downs. Along the way, key changes to its design, such as inclining the tail end of the deck, has made tricks like the Ollie possible making the sport even more popular. The popularity of the sport has also led to further engineering and refinement of the design of a skateboard. While tall skateboarders tend to have an easier time with the Ollie, a shorter skateboarder can make it easier to learn the trick by choosing a skateboard with a shorter truck.

(a) When performing the Hippie Jump, it is not advisable for the skateboarder to jump too high.

Explain why this is so with reference to the resistive forces experienced by skateboarder and skateboard

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(b) **(i)** On Fig. 7.6, draw and label the missing force F acting on the skateboard in step two of the Ollie at the instance where the skateboarder pushes down on his rear foot just before he launches himself into the air. [2]

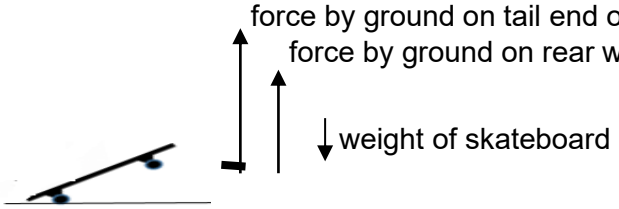

Fig. 7.6

(ii) Explain why the skateboard returns to a horizontal position and lifts higher when the skateboarder shifts his forward foot towards the front end of the skateboard in step three of the Ollie.

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(c) **(i)** Use Fig. 7.4 to determine the resistive force on the skateboarder and skateboard when he is traveling at a maximum speed of $4.0\,m\,s^{-1}$ on surface A.

resistive force = _____ N [3]

(ii) Use Fig. 7.4 to determine the resultant force acting on the skateboarder at the instance where he moves from surface A onto the surface B given that he was traveling at maximum speed of $6.0\,m\,s^{-1}$ while on the surface A.

resultant force = _____ N [4]

(iii) Use Fig. 7.5 to estimate the ground resistance for the case where the combined mass of the skateboarder, motor and skateboard is 90.0 kg.

Explain your workings clearly.

ground resistance = _____ N [3]

(iv) Use Fig. 7.4 and Fig. 7.5 to suggest two factors that can lead to a larger ground resistance.

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(d) Suggest why a shorter skateboarder will need a shorter truck in order to have an easier time performing the Ollie.

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[Total: 21]

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