

PROJECTILES & KINEMATICS Unit 9,4,5 Dr John P. Cise, Professor of Physics, Austin

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Fleas' 'Feet' Unleash That Spectacular Leap

One moment, the 10 fleas were happily sucking blood from hedgehogs being treated at [Tiggywinkles Wildlife Hospital](#) in Aylesbury, which, of course, is in England.



Graphic

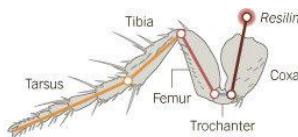
INTRODUCTION: This flea said to have an acceleration of 100g while leaping to a max. height of 3 inches. He leaps at a 45° angle. He goes from 0 velocity to V while extending legs $1/16$ inch. **QUESTION:** Show that he does accelerate over the $1/16$ inch at 100 g? **HINT:** Using kinematics on the vertical motion of the flea: $V_{OV} = V \sin 45^\circ$, V_v (final vertical velocity) = 0, $Y = 3''$, $g = -32 \text{ ft/s}^2$ find V (original). Do this first. Knowing : $V_0 = 0$, V (final V after $1/16$ inch extension of legs), & $X = 1/16$ inch....you should be able to Find that $a = \sim 100 \text{ g}$. Convert all measurements in inches to ft.

Flea Power

The next, they were being plucked from their comfortable home and transported to Cambridge, where they ended up in a glass box with a Styrofoam floor. From time to time, bright lights would flood the box, so that a high-speed camera could film them. And the fleas did what fleas do in times of crisis: they jumped. When fleas jump, it is no ordinary leap. **The insects can shoot as high as 38 times their body length, about three inches.** And the acceleration is so intense that fleas have to withstand 100 Gs, or 100 times the force of gravity. "You and I pass out if we experience five Gs," said Malcolm Burrows, an expert on insect jumping at the University of Cambridge.

Flea Power

Scientists using a high-speed camera found that jumping fleas push off the ground with the back sections of their hind legs. But the kneelike trochanter does not press into the ground, as some previous researchers theorized.



THE FLEA'S HIND LEG is divided into five sections. The coxa and femur interlock and store energy before each jump, then quickly pivot apart, pushing the tibia and tarsus into the ground. Spines and hooks on the tarsus provide extra traction. A pad of stretchy protein called resilin is thought to help store energy for the jump.

0 to $1/16''$ extension

The flea can jump as high as 38 times its body length.

The hind leg is fully extended on liftoff.

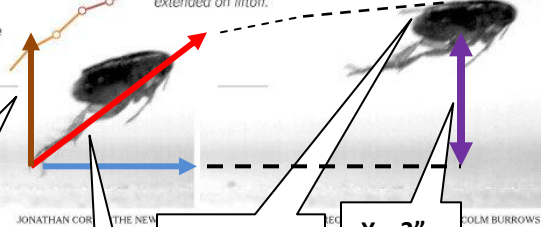
The flea presses femur and coxa together and tilts its body upward.

Jumps begin with a body angle of 28 to 52 degrees.

The femur rotates away from the coxa, driving the back of the leg down.



Source: The Journal of Experimental Biology



$$V_{OV} = V \sin 45^\circ$$

45°

$$V_v = 0$$

$Y = 3''$
Max. Jump height

JONATHAN CORNELL THE NEW YORK TIMES COLM BURROWS