

A car with 4 passengers travels on a rough road with "bumps" at distance d from each other. Because of these bumps the car begins to bounce on its suspensions, with maximum amplitude when the speed is V . Without the 4 passengers the car increases its height from the road to h . Please find h .

The car with its passengers make a harmonic oscillator. When the car is in motion the period of the oscillation is the time to travel between two bumps of the road.

$$T = \frac{d}{v}$$

For harmonic oscillator

$$T = 2\pi \sqrt{\frac{4m + M}{k}}$$

Therefore

$$k = \frac{4\pi^2(4m + M)}{T^2} = 4\pi^2 \left(\frac{v}{d}\right)^2 (4m + M)$$

When the car is fully loaded the suspensions are pressed with a distance x_1 given by

$$(M + 4m)g = kx_1$$

when the car is unloaded the suspensions are pressed with a distance x_2 given by

$$Mg = kx_2$$

The height the car rises when is unloaded is

$$h = x_2 - x_1 = \frac{4mg}{k}$$

$$h = \frac{4mg}{4\pi^2 \left(\frac{d}{v}\right)^2} \frac{1}{4m + M}$$

$$h = \left(\frac{d}{\pi v}\right)^2 \frac{mg}{(M + 4m)}$$