

The JETS Challenge

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Challenge 58 – The Windy Sign Challenge

Problem:

Wind speed is generally measured 3 meters above the ground. It increases at the cube root of the height. Force (F in Newtons) on high objects are equal to the square of the wind speed (V in m/s) times the fact area (A in m^2) of the objects times the drag coefficient (T , typically 0.47).

$$F = V^2 \cdot A \cdot T$$

You are designing a tall oval (ellipse) Burger King sign that measures 3 m wide by 2 m high to be mounted on a 40-meter high pole. How much force (Newtons) will be on the center on the sign when the measured wind speed is 100 km/h?

Solution:

$$\begin{aligned} \text{Area} &= \pi \cdot r_1 \cdot r_2 \\ &= \pi(1)(1.5) \\ &= 1.5\pi \end{aligned}$$

$$100 \frac{\text{km}}{\text{h}} = \frac{100 \text{ km}}{60^2 \text{ s}} = 27.\bar{7} \text{ m/s at 3 meters height}$$

Wind speed increases at cube root of height

$$v = k\sqrt[3]{h} \text{ and } v = 27.\bar{7} \text{ at } h = 3$$

$$27.\bar{7} = k\sqrt[3]{3}$$

$$k = 19.2600353986$$

$$\text{So } V = 19.2600353986\sqrt[3]{h}$$

Use h at the middle of top of sign, h = 31 (or h = 30)

if h = 31, 8107.637 Newtons

if h = 30, 7932.33 Newtons

$$V = 19.2600353986\sqrt[3]{31}$$

$V = 60.5031025655 \text{ m/s}$ at sign height

$$F = v^2 \cdot A \cdot \alpha$$

$$F = (60.5031025655)^2 (1.5\pi)(.47)$$

$$F = 8107.637 \text{ Newtons}$$



