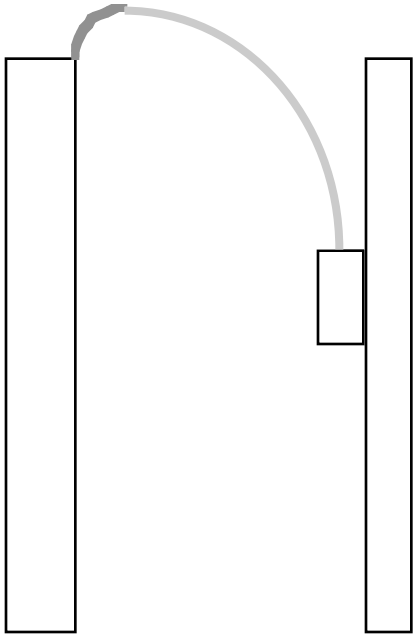
rumble_in_the_bronx

In the movie “Rumble in the Bronx” Jackie Chan jumps from the top of a parking garage across an alley and lands in the balcony of an apartment



Kind of like that. Rent the movie, or better yet, rent “Supercop.”

Now, if the alley is 10 m wide and the difference in height between where he jumps and where he lands is 6.0 m, how fast would he need to be running if he leaps

(a) Staight out with no vertical velocity.

(b) At an anngle of 30° above horizontal.

Solution:

In part (a) he would fall at a rate of 9.8 m/s^2 and since he has no initial vertical velocity, the time it takes him to fall is the same as the time it takes anything to fall 6.0 m

or simply $\sqrt{\frac{2h}{g}} = \sqrt{\frac{2 \cdot 6m}{9.8 \, m/s^2}}$ *or 1.1 s*

Thus he needs to running at a speed of $v = \frac{d}{t} = \frac{10m}{1.1} = 9.1 \, m/s$

Which is about 20 mi/h or world class speed. so he needs to jump at an angle of say 30°

(b) In this case we have two equations in two unknowns. The two unknowns are

velocity and time

But we have one equation for vertical motion (equation 1)

$$h = h_o + v_o \sin\theta \cdot t - \tfrac{1}{2} g t^2$$

and one for horizontal motion (equation 2)

$$Range = v_o \cos\theta \cdot t$$

or for our case

$$0 = 6 + v_o \sin(30) - 4.9t^2$$
$$0 = 6 + v_o \cdot 0.5 \cdot t - 4.9t^2$$

equation 2 is

$$10 = v_o \cos\theta \cdot t$$
$$10 = v_o 0.87 \cdot t$$

For equation 1. take the 6 and -1/2gt^2 to the other side

$4.9t^2 - 6 = v_o \cdot 0.5t$ *and multiply through by 0.87 (the coefficient of the v_o term in equation 2)*

$$(0.87) \cdot 4.9t^2 - 6 \cdot (0.87) = 0.5(0.87) v_o \cdot t$$
$$4.263t^2 - 5.22 = 0.435 v_o \cdot t$$

for equation 2 multiply through by 0.5 (the coefficient of the v_o term in equation 1)

$$10(0.5) = v_o (0.87)(0.5) t$$
$$5 = v_o (0.435) t$$

Notice that that the right side of each equation is equal. Combining the two equations we get

$$4.263t^2 - 5.22 = 5$$
$$4.263t^2 = 10.22$$
$$t^2 = \frac{10.22}{4.263}$$
$$t = \sqrt{2.40}$$
$$t = 1.54\,s$$

Even though the question never asks for time explicitly, we still need to solve for it.

Now we can use our value of time to solve for "v_o"

Using equation 2 we get

$$5 = v_o(0.435)t$$
$$5 = v_o(0.435)\cdot 1.54$$
$$\backslash \frac{5}{0.6699} = v_o$$
$$v_o = 7.46\,{}^{m}\!/_{s}$$