Answer on Question#46962 - Physics - Mechanics - Kinematics - Dynamics

Your opponent, in a desperate attempt to return your wicked serve, makes a high lob of the tennis ball that causes it to land out of bounds on the asphalt course behind you. It then bounces so that it just barely clears a $h_1 = 3.52\text{m}$ wall that is $l_1 = 2.22\text{m}$ from where the ball hit the asphalt and that is separating your court from the next. In the adjacent court play is suddenly interrupted by the ball leaving your court and bouncing $h_2 = 1.82\text{m}$ up into the action. How far horizontally, in meters, does the ball travel in this second bounce? Hint: Use the trajectory of the first bounce to get the horizontal speed, and assume that it remains unchanged between bounces.

Solution:

The time needed for the ball to reach height h_1 after first bounce is

$$t_1 = \sqrt{\frac{2h_1}{g}}$$

Since the ball horizontally overcame the distance l_1 during time t_1, its horizontal speed should be

$$v = \frac{l_1}{t_1} = l_1\sqrt{\frac{g}{2h_1}}$$

Before the 3rd bounce and after the 2nd it spent some time t_2 flying. This time could be calculated in the same manner as time t_1 was:

$$t_2 = 2\sqrt{\frac{2h_2}{g}}$$

(The ball first rose and then fell. That's why there is coefficient 2 in this formula)

So now we can easily calculate the distance between 2nd and 3rd bounces

$$l_{23} = v \cdot t_2 = l_1\sqrt{\frac{g}{2h_1}}2\sqrt{\frac{2h_2}{g}} = 2l_1\sqrt{\frac{h_2}{h_1}} = 2 \cdot 2.22\text{m}\sqrt{\frac{1.82\text{m}}{3.52\text{m}}} = 3.19\text{m}$$

Answer: $l_{23} = 2l_1\sqrt{\frac{h_2}{h_1}} = 3.19\text{m}.$