21-P-WE-AG-025

The post office stores all incoming packages in a large warehouse. To get the packages from the warehouse to their customers, they need to load the packages into delivery trucks. They have designed a system where the packages, weighing approximately W kilograms, start out at the top of a slide with a minimum velocity of $v_A = V\ \frac{m}{s}$, and then are launched from the bottom of the slide into the delivery truck. If $h_A = A\ m$, $h_B = B\ m$, and the height of the truck is $C\ m$, then what is the maximum distance the truck can park away from the edge of the slide so that packages still make it inside?

ANSWER:

First, we need to find the velocity of the package at point B when it leaves the slide by writing down the work-energy equation.

$$\frac{1}{2}mv_A^2 + mgh_a = \frac{1}{2}mv_B^2 \rightarrow v_B = \sqrt{v_A^2 + 2gh_a} = \sqrt{V^2 + 2gA}$$

Then, we determine how long it would take the package to fall from the bottom of the slide to the top edge of the truck.

$${v_{y,f}}^2 = {v_{y,i}}^2 + 2ad \rightarrow v_{y,f} = \sqrt{2g(B - C)}$$

$$v_{y,f} = v_{y,i} + at \rightarrow t = \frac{v_{y,f}}{g}$$

Then, we use that time to determine how far the package would travel horizontally, which is equal to our maximum distance.

$$d_x = v_x t = v_B t = \sqrt{\frac{(v_A^2 + 2gh_a)(C\ m - B\ m)}{-19.62\ \frac{m}{s^2}}}$$