20-P-MOM-PT-004

September 11, 2020 3:26 PM

A toboggan of mass 10.0 kilogram starts from rest at point A.
There are two people on the toboggan.
The person in front wearing green has a mass of 40.0 kilograms and the person in back wearing blue has a mass of 45.0 kilograms.

a) The toboggan slides down the perfectly slippery hill and reaches point B at the bottom.
They are travelling horizontally at point B.
Ignoring all friction and other resistive or non-conservative forces, what is the speed of the toboggan at point B?

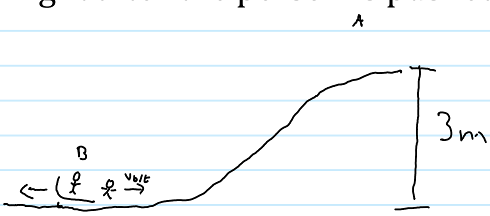
$T_1 + V_1 = T_2 + V_2$ $\quad T_1 = 0 = V_2 \quad V_1 = m_{total}\, g h$

$m_{total} \cdot g \cdot h = \frac{1}{2} m_{total} v_t^2 \qquad T_2 = \frac{1}{2} m_{total} v_t^2$

$v_t = \sqrt{2gh} = \sqrt{2 \cdot 9.81\ 3}$

$\boxed{v_t = 7.67 \ m/s}$

b) At the instant they reach point B, the person at the back who is wearing blue is pushed off from the back with a horizontal velocity of v b/t = 2.00 meters per second measured relative to the toboggan. The push is an internal force. What is the velocity of the toboggan right after the person is pushed off?



$m_{total} v_t = m_b v_b + m_{g+t} \cdot v_{g+t}$

$m_{total} = 10 + 40 + 45 = 95 kg$

$m_b = 45 kg$

$m_{g+t} = 50 kg$

$v_t = 7.67 m/s$

$v_b = v_{g+t} + v_{b/t} = v_{g+t} - 2.00$

$m_{total} v_t = m_b \cdot v_{g+t} - m_b v_{b/t} + m_{g+t} \cdot v_{g+t}$

$v_{g+t} = \dfrac{m_{total} \cdot v_t - m_b \cdot v_{b/t}}{m_{g+t}}$

$v_{g+t} = \dfrac{95 \cdot 7.67 + 45\ \ 2}{50 + 45}$

$\boxed{v_{g+t} = 8.617 \ m/s}$