Flipping Physics Lecture Notes:

Calculating the Force of Impact when Stepping off a Wall

Example: A 73 kg mr.p steps off a 73.2 cm high wall. If mr.p bends his knees such that he stops his downward motion and the time during the collision is 0.28 seconds, what is the force of impact caused by the ground on mr.p?

With the exception of the mass, m = 73 kg, the known values for this problem need to be split into two parts.

Part 1 – Free Fall: $v_{1iy} = 0; h_{1i} = 73.2cm \times \frac{1m}{100cm} = 0.732m$

Part 2 – Collision: $v_{1fy} = 0; \Delta t_2 = 0.28\text{sec}$

We are solving for the Force of Impact during part two, therefore we can use the Force of Impact equation $\sum \vec{F} = \frac{\Delta \vec{p}}{\Delta t}$ during part two.

Part 2: $\sum \vec{F}_2 = \frac{\Delta \vec{p}_2}{\Delta t_2} = \frac{\vec{p}_{2f} - \vec{p}_{2i}}{\Delta t_2} = \frac{m\vec{v}_{2f} - m\vec{v}_{2i}}{\Delta t_2} = \frac{(73)(0) - (73)(\vec{v}_{2i})}{0.28}$

Therefore, we need the velocity for part 2 initial. Because the beginning of part 2 is the same as the end of part 1, $\vec{v}_{1f} = \vec{v}_{2i}$, therefore, we need to find the final velocity for part 1.

Part 1 – Conservation of Energy: Zero line at the ground, initial point at the start of part 1, final point at the end of part 1.

$$ME_{1i} = ME_{1f} \Rightarrow PE_{g1i} = KE_{1f} \Rightarrow mgh_{1i} = \frac{1}{2}m(v_{1f})^2 \Rightarrow gh_{1i} = \frac{1}{2}(v_{1f})^2 \Rightarrow v_{1f} = \sqrt{2gh_{1i}}$$

$$\Rightarrow v_{1f} = \sqrt{(2)(9.81)(0.732)} = \pm 3.7897 = -3.7897\frac{m}{s} = v_{2i}$$

And now back to part 2: $\sum \vec{F}_2 = \frac{m\vec{v}_{2f} - m\vec{v}_{2i}}{\Delta t_2} = \frac{(73)(0) - (73)(-3.7897)}{0.28} = 988.03 \approx \boxed{990N}$

$$\sum \vec{F}_2 = 988.03N \times \frac{1lb}{4.448N} = 222.13 \approx \boxed{220lb}$$