Riding A Roller Coaster

You and a friend to go to Six Flags Magic Mountain in California to ride the Viper roller coaster, which has a vertical drop of 173 ft. Your friend, knowing that you are a pro at physics, wants to know what the speed will be at the bottom of the drop. Assume that the speed of the roller coaster cars at the top of the drop is 4.0 m/s and that you can neglect friction and all other external nonconservative forces.

1. Convert the length of the drop to meters.

$$173\ ft\ x\frac{1\ m}{3.28\ ft} = 52.74\ m$$

2. What is the work done by external nonconservative forces?

$W_{nc} = 0\ J$ because we are neglecting friction and all other external nonconservative forces.

3. What is the speed at the bottom of the drop?

$$E_f = E_i$$

$$\frac{1}{2}mv_f^2 + mgh_f = \frac{1}{2}mv_i^2 + mgh_i$$

$$\frac{1}{2}v_f^2 + gh_f = \frac{1}{2}v_i^2 + gh_i$$

$$v_f^2 + 2gh_f = v_i^2 + 2gh_i$$

$$v_f^2 = v_i^2 + 2gh_i - 2gh_f$$

$$v_f = \sqrt{v_i^2 + 2g(h_i - h_f)}$$

$$v_f = \sqrt{(4.0\ m/s)^2 + 2(9.80\ m/s^2)(52.74\ m)} = 32.4\ m/s$$

4. The Viper's maximum speed is 73 mph. Convert this to m/s.

$$\frac{73\ miles}{1\ hr}x\frac{1.6\ km}{1\ mile}x\frac{1{,}000\ m}{1\ km}x\frac{1\ hr}{60\ \text{min}}x\frac{1\ \text{min}}{60\ s} = 32.4\ m/s$$

5. How does the Viper's maximum speed compare with the speed at the bottom of the drop?

They are the same!