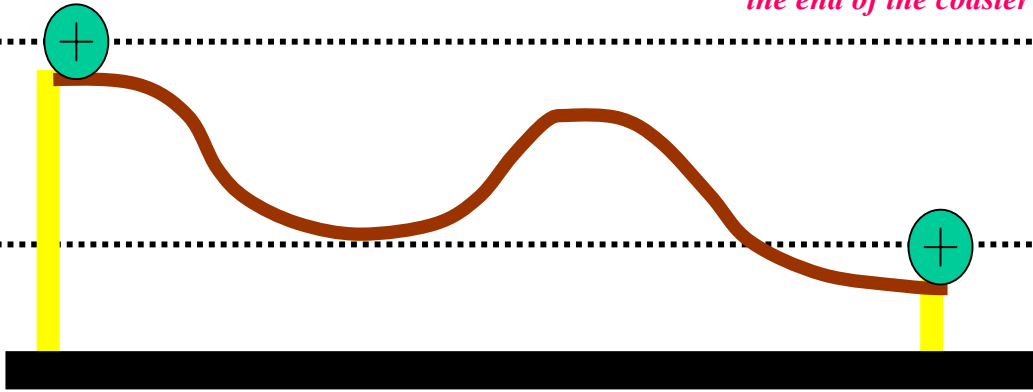


ROLLER COASTER “ENERGY CONSERVATION” LAB CONTINUED (i.e. CPO LAB 5.2)

Question: Why didn't the Velocity measured at the end of the coaster equal = $\text{SQRT}[(2.0)(g)(25.5 \text{ cm})]$ or $\sim 224 \text{ cm/s}$ - which is what one would have calculated if all the Potential Energy (at the maximum height of the coaster) were converted into translational Kinetic Energy at the end of the coaster ??



Answer: It involves topics you won't cover until your next Physics course and has to do with “Rotational Kinetic Energy”. The expression $KE = (1/2)mV^2$ represents translational KE (i.e. kinetic energy due entirely to linear vice rotational velocity). If the ball slid down the coaster then only translational kinetic energy would apply and we should have measured about 224 cm/s – which none of us did. Why? Because the ball did not slide down the coaster – it rolled.

When the ball starts to roll down the plane – friction causes this – it picks up a “rotational” Kinetic Energy component which equals $(1/2)I\omega^2$, where I = the moment of inertia for the ball & ω = the angular velocity of the ball. As such the initially available potential energy of the ball $[(m)(g)(\Delta h)]$ is converted in its entirety to the sum of its translational and rotational kinetic energies – not just to kinetic.

Symbolically:

$$[(m)(g)(\Delta h)] = (1/2)mV^2 + (1/2)I\omega^2$$

Where for a solid ball of mass “m” and radius “r”, $I = (2/5)(m)(r^2)$ => the rotational equivalent of translational mass and $\omega = V/r$.

Solving for V we get:

$$V = \text{SQRT} [(10/7)(g)(\Delta h)]$$

Recall that on 02-15-07 the SOC problem showed that there was a maximum of about 710,000 Ergs of energy available (via the ball) in our roller coaster due the maximum change in height (Δh) from the highest to the lowest points on our coaster. Remember, “g” in the CGS system is 981 cm/s^2 . This was based on a Δh of 25.5 cm. Solving for V we get:

$$V = \sim 189.04 \text{ cm/s}$$

Which is far closer to most of our readings taken when we did this lab. NOTE: This solution notwithstanding – for problems involving Potential to Kinetic Energy transformations and vice – versa, you may assume (unless other wise stated) that objects slide (vice roll) and as such the “Rotational” component of kinetic energy may be ignored.