Loop Activity: Conservation of Energy

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1 Memory Bank

1. $KE = \frac{1}{2}mv^2$ ... Definition of kinetic energy
2. $PE_G = mgh$ ... Definition of gravitational potential energy
3. $KE_{rot} = \frac{1}{2}I\omega^2$ ... Definition of kinetic energy for system rotating with ω.
4. $I = \frac{2}{5}mr^2$ ... *Moment of inertia* for a solid sphere with radius r.
5. $a_C = mv^2/r$ ... Centripetal acceleration.

2 Fixing the Loop the Loop Experiment

1. Start with energy conservation, and assume y is the initial marble height and that R is the loop radius. (a) If the initial marble height is y, and it has mass m, what is the initial PE_G of the system? (b) Write the general expression for the KE of the marble with speed v, and add to it the PE_G the marble has when it is at the top of the loop (height of $2R$). (c) Set the results from (a) and (b) equal to each other. This is **energy conservation**.

2. Note that the marble is moving in a circle, meaning it has centripetal acceleration a_C. (a) Show that the normal force on the marble at the top of the loop is $N + mg = mv^2/R$. (b) For $N = 0$, derive an expression for v, representing the minimum velocity necessary to proceed through the loop.

3. Substitute v into the equation for **energy conservation** from (1), and solve for y/R (the result should be a unitless fraction).

3 Bonus Round: Adding angular kinetic energy

1. Repeat the entire process, but adding KE_{rot} from the memory bank to the kinetic energy. How does this affect the result for y/R?