Energy in Motion: Engineering a Pendulum Basketball Launcher Using the Coefficient of Restitution to Predict the Launch Path

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This project explores the application of physics and calculus to predict and optimize the trajectory of a basketball shot using a pendulum mechanism. First, I calculated the velocity of the pendulum just before it hit the ball using the conservation of energy. An elastic conservation of momentum interaction, combined with the coefficient of restitution, was used to determine the velocity of the ball after impact. I did a video analysis of my basketball bouncing, comparing the height before and after the bounce to calculate the coefficient of restitution. The measured coefficient of restitution was then used to test the launch in the physical world. After controlling as many variables as possible, the basketball made it into the hoop with minimal deviation from the mathematical prediction. Small variations in impact conditions, like slight differences in the launch angle or hoop position, may have contributed to minor discrepancies between the expected and actual results. Regardless, I was able to make six shots in a row. The mathematical framework I developed has potential applications beyond basketball. In aerospace engineering, similar equations can optimize rocket launch trajectories by refining predictions of motion and energy transfer. In materials science, they could improve energy efficiency by analyzing how materials respond to impacts. Additionally, in sports technology, this approach could enhance training tools by creating precision ball launchers that mimic gameplay scenarios.

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