

Example: Mythbusters – Does toast always land buttered side down?

After buttering your toast (assumed to be a uniform rigid square with side length l) one morning and holding it in a horizontal position with buttered side up, you accidentally drop it from a height H above a counter, which itself is a height h above the ground. The toast is oriented parallel to the counter's surface, and as it falls, one edge barely hits the counter causing the toast to spin. The moment of inertia for a square is $\frac{1}{12}ml^2$.

- What is the velocity of the toast just before it hits the counter after falling through a height H having been released from rest?
- What is the change in angular momentum of the toast as it collides with the counter?
- If the collision is elastic, total kinetic energy is conserved. What is the expression for conservation of total kinetic energy during the collision?
- What are the translational and rotational speeds after the collision?
- How long does it take the toast to fall through h and through what angle does the toast rotate if it started butter side up and goes butter side down?
- What value of H (in terms of h and l) will make the toast land buttered side down? Evaluate H for a counter height of $1m$ and toast $100cm^2$.

“If toast always lands butter-side down, and cats always land on their feet, what happens if you strap toast on the back of a cat and drop it?”

Steven Wright