## Shattering \& Splashing

WHERE DISCOVERIES BEGIN

## Shattering \& Splashing

Instead of bouncing whole an object may shatter or splash, throwing separate pieces into the air.


From Joseph Gilland's Elemental Magic

## Shattering Impact

For a brick split into pieces, the impact needs to be sharp and sudden.

Brick Drop<br>Speed: 120 frames per second Size: Brick - $71 / 2 \times 31 / 2 \times 2$ inches

www.AnimationPhysics.com

## Shatter Fragments

Regardless of their size or speed, shatter fragments that have a lower apex height hit the ground first.

The time in the air, both going up and coming back down, only depends on the apex height.
$\leftarrow$ This piece hits the ground first

## Splashing

Splashing of a liquid is similar to the shattered bouncing of a solid.

Granular materials, like sand and flour, also splash as grains bounce on impact with the ground.

## Sack Drop Pop-Up

The granular material in a flour sack is too inelastic to bounce the sack but there is still a noticeable pop-up.

## Twinning

## Twinning is unrealistically synchronized motion in an animation.



In shattering and splashing the pieces break and move randomly, with smaller pieces typically flying off the fastest.

## Perception of Patterns

Humans, being predators, are good at perceiving patterns in randomness.


## Twinning in Character Animation

Twinning is also distracting and undesirable in character animation.


If the motion of a character's arms is too symmetric then it resembles cheerleading.

## Splash Height

Drop a bucket of water from a certain height.
Can drops from the splash go higher than the height from which the bucket is dropped?

## Yes!

And the same for the fragments of a shattered object.


## Splash Height



## Splash Height

Many drops fly several feet above my head.


## Two-Ball Drop



## Two-Ball Drop



## Multi-Ball Drop



## Summary

- Instead of bouncing a solid object may shatter into fragments; a liquid splashes droplets.
- The time in the air for the fragments and droplets only depends on their apex heights.
- Shattering and splashing should be irregular to avoid unnatural twinning.
- The height reached by a few of the fragments or droplets may exceed the original height.

