



Ramp & Cup Collisions

Mission: A bowling alley designer asks: does a heavier ball or a faster ball knock pins harder? Roll balls of different masses down ramps of different heights into a cup and measure how far the cup slides.

Big question: How do mass and speed affect kinetic energy?

★ Warm-up: Rank it

Rank from least to most damage in a crash. Explain.

A bike at 5 mph, a truck at 5 mph, a truck at 30 mph ✓ **Bike 5, truck 5, truck 30.**

Why do trucks need longer to stop than cars? ✓ **More mass means more kinetic energy.**

Key vocabulary

Kinetic energy	The energy of a moving object: $KE = \frac{1}{2} \times \text{mass} \times \text{speed}^2$.
Mass	How much matter an object has.
Independent variable	The one thing you change on purpose.
Dependent variable	The thing you measure (cup distance).

1 Box 1

Predict

PREDICTION If you double the ball's mass (2 kg), the cup will move...

☐ about twice as far ☐ about four times as far ☐ the same distance

Mass trials

Record the cup distance.

Ball mass	Cup moved (cm)
1 kg	from simulator
2 kg	from simulator
4 kg	from simulator

2 Box 2

Mass pattern

You predicted: _____. What happens to KE when mass doubles?

☐ KE doubles ☐ KE stays the same ☐ KE is cut in half

✓ **KE doubles**

3 Box 3

Height trials

Record the cup distance.

Ramp height	Speed (m/s)	Cup moved (cm)
0.5 m	2.6	from simulator
2 m	5.3	from simulator

4 Box 4

Speed matters

Which change gave the ball more kinetic energy?

☐ Both doubling the mass and a higher ramp increased KE; a 4× higher ramp gave 4× the KE with only 2× the speed

☐ Only mass matters ☐ Only height matters

✓ Both doubling the mass and a higher ramp increased KE; a 4× higher ramp gave 4× the KE with only 2× the speed

5 Box 5

Legend: calculate KE Legend only

KE = $\frac{1}{2} \times m \times v^2$. What is the KE of a 2 kg ball moving 3 m/s?

Answer: _____ J ✓ 9

Show your thinking:

6 Box 6

Advice for the bowling alley (CER)

How do mass and speed affect kinetic energy?

Claim

Look for: Names mass; Names speed; at least 8 words

Evidence

Look for: Uses distance data; a number from the simulator; at least 12 words

Reasoning

Look for: Connects distance to energy; at least 10 words

Exit ticket: answer the big question in your own words

How do mass and speed affect kinetic energy?

Look for: Kinetic energy depends on both mass and speed. Doubling the mass doubles the kinetic energy. A higher ramp gives more speed, and speed has a bigger effect because KE depends on speed × speed.

Completion codes

Students see a code like **ABC-I3** when they finish. The first part must match below. The letter is the level (E = Explorer, I = Investigator, L = Legend), and the number at the end is how many stars they earned.

Level	Code starts with
 Explorer	RC5-E

 Investigator

1D2-I

 Legend

1RH-L

 Watch for these misconceptions

- "Cold moves into things." Heat moves; objects feel cold because heat leaves your hand.
- "Only moving things have energy." Stored (potential) energy counts too.
- "Radiation needs air to travel." Radiation crosses empty space, which is how sunlight reaches Earth.