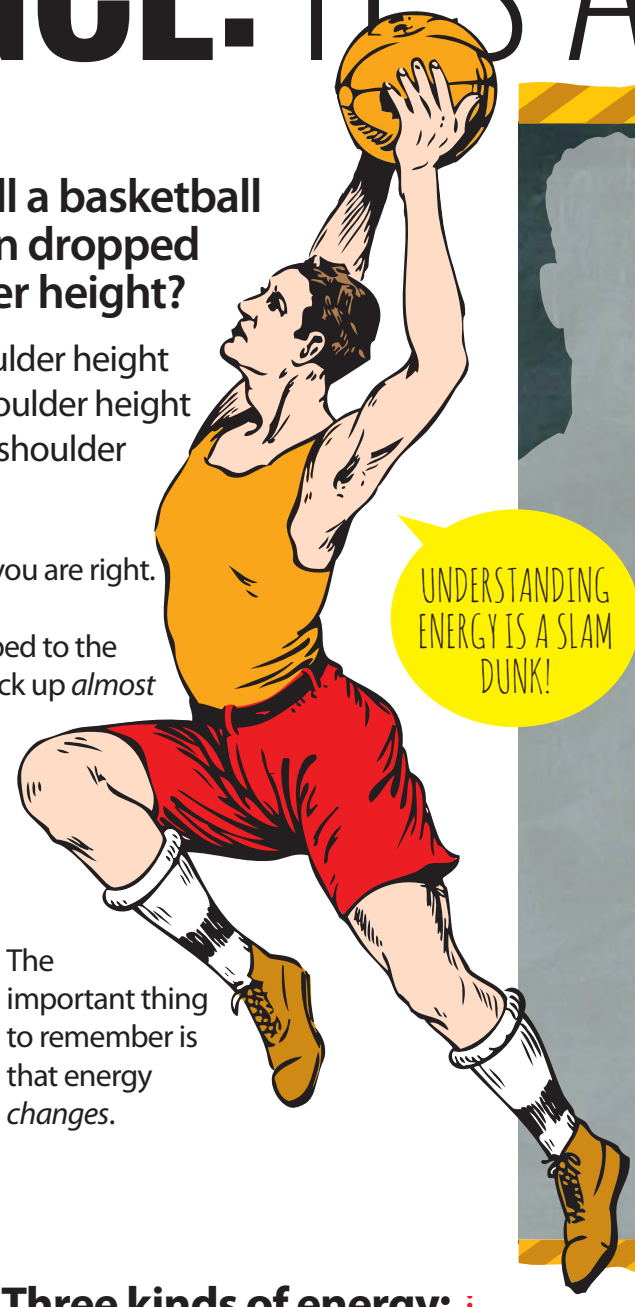
BOUNCE: IT'S ABOUT ENERGY

Q: How high will a basketball bounce when dropped from shoulder height?

a. back to shoulder height
b. less than shoulder height
c. higher than shoulder height

If you answered "b" you are right.

When a ball is dropped to the ground, it comes back up *almost* to the point it was dropped from, but not quite.



The important thing to remember is that energy *changes*.

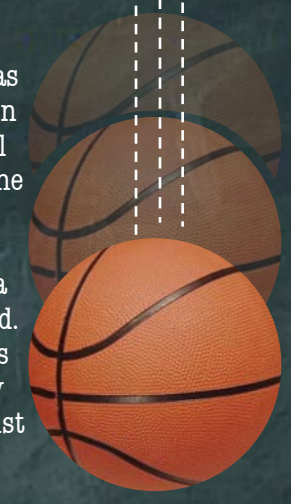
UNDERSTANDING ENERGY IS A SLAM DUNK!

Let's Just Drop It!

When a basketball is held above the ground, it has a lot of **potential energy** and no **kinetic energy**. As it falls, it starts losing its potential energy and gets kinetic energy.

When the ball hits the ground, it has lots of kinetic energy. The friction against the ground slows the ball down, but it also slightly heats the ball. This is **thermal energy**.

The ball bounces back up but to a lower height than where it started. The original potential energy was transformed into thermal energy and kinetic energy. And **that's** just the way the ball bounces.



FUEL FOR THOUGHT

WHAT'S HAPPENING?

Drop a basketball and let it keep bouncing. The bounces get smaller and smaller. The ball appears to be losing energy, but it's not. The energy is being *changed*. When the ball hits the court, the court absorbs some of the energy. Some energy is changed into **thermal energy**.

By using your hand to bounce, or add force to a ball, you replace the energy that was "lost."

Three kinds of energy:

KINETIC ENERGY
The energy of motion. Anything that is moving has kinetic energy, and the faster it is moving, the more kinetic energy.

POTENTIAL ENERGY
An object high above the ground has potential energy because of the work it took to get it there and the work it will do when it falls.

THERMAL ENERGY
Thermal energy is what is called energy that comes from the temperature of matter.

When a ball is dropped, its potential energy is changed into kinetic energy. An important rule is that energy can't be created or destroyed. It can only change into different forms of energy. This is called the **Law of Conservation of Energy.**

THE BOUNCE FACTOR

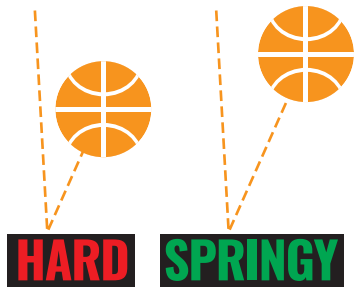
Why does a basketball bounce higher than a bowling ball? Because it is made of different materials. A basketball is inflated with air and made with a rubber covering that has a high bounce factor. Bowling balls are made out of hard materials that don't bounce.

Why is bounce good for a basketball and not so good for a bowling ball? Using a baseball to play basketball or a bowling ball to play tennis doesn't make sense. Different sports require differently designed balls. A lot of scientific research goes into developing the right bounce for the right ball.

Several other factors affect the way a ball bounces:

- the height from which the ball is dropped
- the ball's level of inflation
- temperature
- the surface upon which the ball is bounced

Different Surfaces = Different Bounce



The surface on which a ball is bounced also changes shape when a ball is dropped on it.

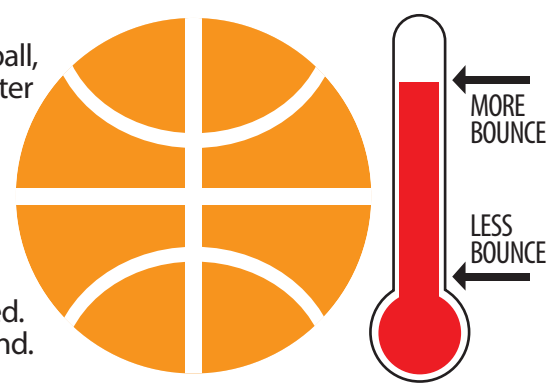
Springier surfaces, such as Styrofoam and cork, change more as a ball hits them and saves the molecules inside the ball from having to do as much flattening. These softer surfaces act like a trampoline, allowing the ball to bounce back higher and faster. Of course, really soft surfaces like cotton would absorb all of the ball's energy and stop the ball from bouncing back.

Higher = More Bounce

The higher the ball is above the ground, the more its potential energy. As the ball is dropped and gravity forces it downward, the ball accelerates and gains speed. As the ball falls through the air, its potential or stored energy is converted into kinetic energy. The longer the fall, the more kinetic energy it gains and when it hits the ground, it bounces higher.

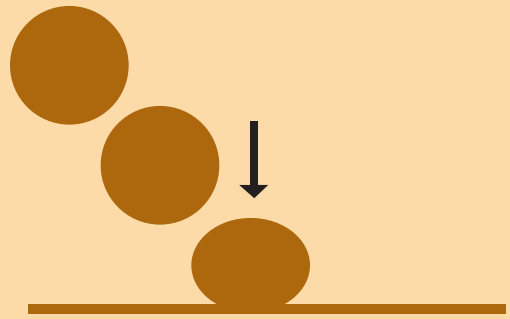
Temperature

As a ball bounces, it warms. An inflated ball, like a basketball, bounces higher and faster when the temperature is warmer. This is because the distance between the air molecules in the ball increases, helping the ball maintain its round shape when it hits the ground. On cooler days, the distance between the air molecules gets smaller, causing the ball to be less inflated. So, it flattens more when it hits the ground.

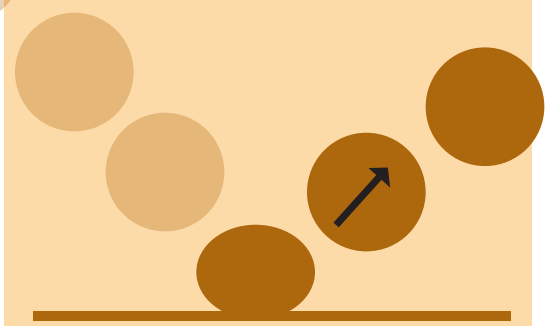


The Physics of a Bouncing Ball

When a basketball hits the floor of the court, it flattens and the shape of the ball changes slightly.



A properly inflated or filled ball is round and the molecules inside the ball quickly rearrange themselves to get back to its round shape. The energy involved in that action causes the ball to bounce.



Swish! It's Geometry

Swish! The lovely sound of a basketball slipping through the net in the hoop, so perfectly centered that the ball doesn't touch the back stop or the rim.

When this happens, a silent swish through the net is the only sound you hear.

And, the ball safely sinks through to score.

If the ball hits the rim of the hoop, the chance of it bouncing out increases. But to sink the basketball through the hoop, swish or not, a player doesn't throw the ball at the hoop. Rather a player uses knowledge of the **parbolic arc** to throw the ball so that it arcs over and up high enough to enter the basket from above.

A **parabola** is a curve, shaped like an arch. It is also called a **parabolic arc**.

PARABOLIC ARC

Scientists can calculate the ideal free-throw angle for players of different heights. It's 13.75 feet from the free-throw line to the center of the basket, and a six-foot player launches the ball from about seven feet above the hardwood. That works out to a shooting angle of 51°.

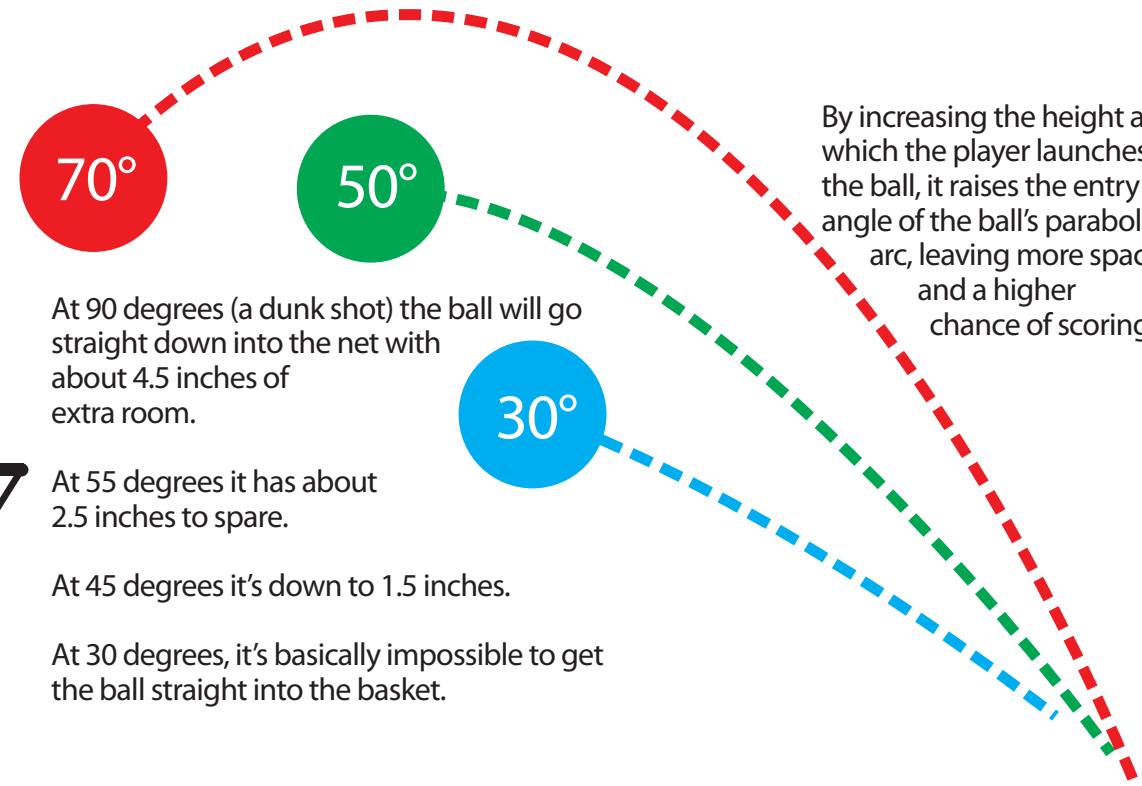
Dunk Directions

The hoop is 18 inches in diameter. A basketball is about 9.4 inches wide.

If a ball is dunked straight down into the hoop from above (a 90 degree angle), there is plenty of room for the ball to sink all the way through the net and score.

But when a player shoots the ball farther away from the hoop, the ball needs to be thrown up at an angle.

Which basketball shot at right most likely to score?



By increasing the height at which the player launches the ball, it raises the entry angle of the ball's parabolic arc, leaving more space and a higher chance of scoring.

At 90 degrees (a dunk shot) the ball will go straight down into the net with about 4.5 inches of extra room.

At 55 degrees it has about 2.5 inches to spare.

At 45 degrees it's down to 1.5 inches.

At 30 degrees, it's basically impossible to get the ball straight into the basket.

SCIENTIST'S NOTEBOOK

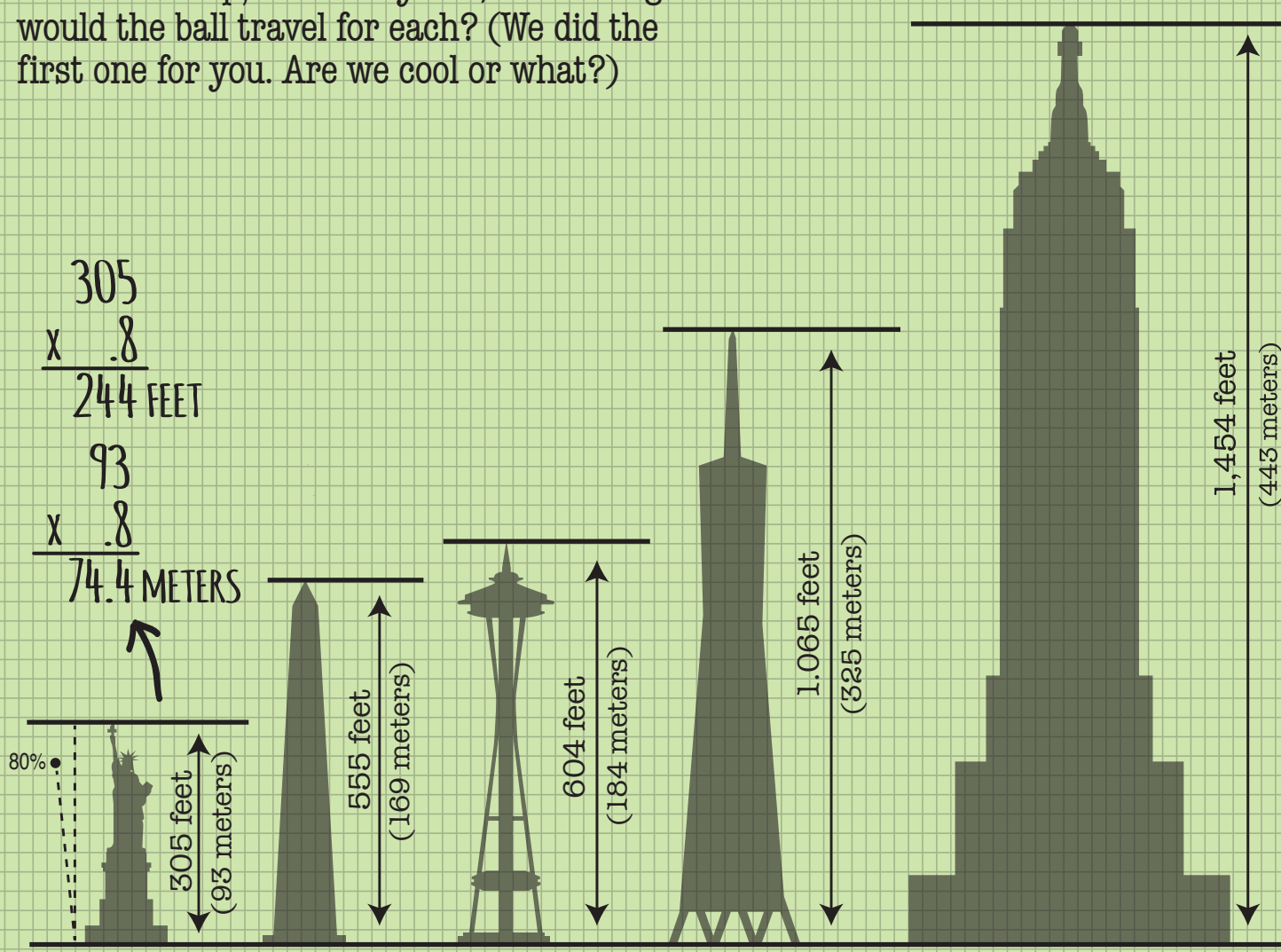
The Big Drop

Imagine dropping a basketball from the top of these famous structures.

If the ball bounces 80% of the way back up toward the top, how many feet/meters high would the ball travel for each? (We did the first one for you. Are we cool or what?)

305
x .8
244 FEET

93
x .8
74.4 METERS



Well, What Do You Know?

1. Thermal energy is energy that comes from the temperature of matter.
   ○ TRUE ○ FALSE
2. A basketball player keeps a ball bouncing by using an elbow.
   ○ TRUE ○ FALSE
3. Basketballs will bounce differently on different surfaces.
   ○ TRUE ○ FALSE
4. Anything moving has kinetic energy.
   ○ TRUE ○ FALSE
5. A 6-foot tall basketball player needs to shoot the ball from the free-throw line at a 75 degree angle for the best chance at making a free throw sink.
   ○ TRUE ○ FALSE

The STEM ZONE

Parabolic Ramp

Explore potential and kinetic energy at the Parbolic Ramp station in the **Chevron STEM Zone**. Discover how to use energy to play a tune!