HANGING THE VERTICAL!

Exploring vertical jump heights.

HERE'S WHAT YOU'LL NEED:

- Long sheets of paper
- Tape measure or meter stick
- Tape
- Pencil
- Small cup of water with a few drops of food coloring
- A notebook for recording data
- An area for testing with a flat open floor and a smooth vertical wall

Tape a long sheet of paper to the vertical wall of the test area so that the top of the paper is at least 3 meters above the ground.

WARM-UPS

Start by finding initial reach height.

Stand next to the wall. Dip the tips of fingers into the colored water. Lift your arm up as high as you can while keeping your feet flat on the ground and touch the paper. Using the pencil, mark the highest spot your fingertips reached with the letter R.

Use the tape measure or meter stick to measure the distance from the floor to the letter R. This is your initial reach height. Record it in your notebook.

Now try it with a jump. Dip your fingers into the water, crouch down and spring up and touch the wall as high as you can. Mark the highest spot your fingertips touched with the letter J. Measure the distance between point R and point J. This is your vertical jump height. Record it in your notebook. Repeat the jump at least three times. Calculate the vertical jump height for each one.

Compare your vertical jump height numbers with those of your friends or classmates. How do yours compare?

GAME TIME

What are some possible causes for a difference in the numbers?

Let's focus on two specific movements that are often used in a vertical jump and investigate what kind of impact they have on your jump height.

The first is swinging or pumping arms, and the second is a quick bending of the knees before pushing off of the floor.

Design three different experiments to test vertical jump performance:

1. only arm swings
2. only knee bends
3. a combination of both.

You will need a control to compare it to. The control for this experiment is jumping without swinging or knee bent. Why would this be a good baseline control to compare your performance to see if it is better or worse?

Before starting your tests, think about what you've observed from your warmups and from watching others play basketball. Make a claim as to which movement(s) will produce the best vertical jump height.

Create a data table to record types of jumps and resulting heights.

Based on your experiments, does your data support your claim? What evidence do you have?

OVERTIME
Let's take it a step further

Looking at your data, what other factors might affect vertical jump?

Do you think how tall a person is plays a role in vertical jump height? Measure your height. Collect data from five other people, who are not the same height, and create a graph of height vs the warmup vertical jump distances. Does the graph support your claim? What evidence do you have?

Jumping is a major component in the physics behind basketball. When a basketball player jumps in the air to make a shot, he can appear to be suspended in mid-air during the high point of the jump. Hang-time is the amount of time that a jump is in the air.

Would the highest jump result in the longest "hang-time" in the air? How could you find out?

ANALYZE THE REPLAY
What happened?

Once you've finished collecting your data, take time to review all of the information.

What surprised you the most about your results?

What difficulties did you have collecting your data? How did you overcome them?

How does your data help you determine the best way to jump with a ball in your hands?

Check out these websites for more information and cool videos:

The Science Behind Your Vertical Leap
http://www.usab.com/youth/news/2012/08/the-science-behind-your-vertical-leap.aspx

FSN Sport Science. Episode 1 - Skywalker - Chris Lowery
https://www.youtube.com/watch?v=z1cnxwGHdfY

FSN Sport Science. Episode 1 - Hang Time - Jordan Farmar
https://www.youtube.com/watch?v=vZqVq5LrdQQ

COACH'S CORNER
Additional information and explanations for parents and educators

There are many factors that contribute to a large vertical jump height. When you jump, you have to overcome body weight and gravity. The jumper applies a downward force against the surface, which, in turn, pushes the jumper up. The more force down, the more force up. Newton's third law helps to explain this. For every action there is an equal reaction in magnitude and opposite reaction in direction. There are different movements that can increase the downward force applied, including swinging arms or bending legs. Gravity will always be a force acting against a jump, and there are limits to how high a person can jump. This is why athletes train their muscles and their body movements to maximize the force available to temporarily overcome gravity.

As you add different movements, you increase potential energy that will be converted to kinetic once the jump begins.

HANG-TIME (ADVANCED)

Hang-time is how much time you are in the air from when your feet leave the ground to when they land. When your feet first leave the ground, your upward speed is immediately slowed down by gravity. At the highest point you reach, your body stops moving then starts going back down. Gravity works with you this time, and your acceleration increases on the way down until you land with a "thud!"

At the very top of your leap, your upward acceleration has to slow to zero, then you start coming down. Your time jumping up is the same as your time falling down. Knowing this, you can calculate your air hang-time, which is the sum of your time up and time down.

Using your vertical jump height and a little bit of math, you can compute your "hang-time." Because the speed at the top of your jump is 0, the equation below can be used to find the time it takes for you to jump up to the highest point, half of your "hang-time"

$$t = \sqrt{\frac{2d}{a}}$$

t = time from floor to highest point
d = vertical jump distance (jump height – reach height)
a = acceleration of gravity, which is a constant rate = 9.8m/s2

Since your time jumping up is the same as your time falling down, your total in-air "hang-time" will be twice this number.

Hang-time = $2 \times t$

Oklahoma Academic Standards for Science	
GRADE	STANDARD
4th	PS3-1 Energy
5th	PS2-1 Motion
6th	PS2-5 Motion
	PS3-1 Energy