GET VERTICAL!

What is needed to make an explosive jump?

More than in many other sports, jumping is essential in basketball.

HERE'S WHAT YOU'LL NEED:

- **Plastic playing cards**
- **Scissors**
- **Hole punch**
- **Crayons or marker**
- **Paper clips**
- **Rubber bands, several thicknesses and lengths**
- **Strong packing tape**
- **Tape**
- **Measuring Tape**
- **Journal**
- **Pencil**
- **Large sheets of paper or roll of craft paper**
- **Cooperation of friends and an adult**

WARMUPS

Have you ever dreamed of flying high above the defender and slam dunking for the buzzer-beating win? Or maybe having the ability to jump so high you grab every rebound and win every jump ball. Some athletes seem to soar to the rim or get up amazingly high to spectacularly block shots.

Let's compare jumps to see if we can find what scientific principles are found in the most successful vertical jumps.

1. Attach a large sheet paper high on a wall. You may need an adult's help to mount it high enough that it is difficult for your friends to reach unless they are jumping.
2. Select eight friends to volunteer. Have each person stand on the scale and record their weight in your journal.
3. Next, measure (in centimeters) from the floor to the highest point each person can reach with their dominant hand. Knowing this "reach height" will allow you to figure the distance of their vertical jump.
4. To measure the approximate jump height, each student should stand next to the paper on the wall holding a crayon or marker in the same hand as before and mark the paper as high as they can reach at the peak of their jump. After each jump, measure the height of the mark from the floor.

Pro tip: If time allows, each student could jump 3 times, and use the distance of the highest jump. This will help ensure that the measurement used represents their maximum power.

5. Figure everyone's jump distance by subtracting their reach height from jump height.

Highest Jump - Reach Height = Vertical Jump Distance

6. Design a table to record your results for each person.
7. After everyone has jumped and vertical jump heights have been calculated, compare the results and look for any patterns

How did height and weight affect jumping ability, if at all? What other observations can you make?

Jumping requires power. In this case, is equal to force multiplied by velocity, or

$$P = F \times V$$

Muscle strength, particularly in our legs, provides some of the force for jumping. The more weight we can lift with our legs, the more force available to use.

Velocity refers to how quickly we jump up.

Based on your observations, how does power affect the height of a jump?

GAME TIME

In addition to power, flexibility is very important for jumping. If you cannot stretch properly, your range of motion will be limited. In this activity we will construct a jumping gadget to explore flexibility.

1. Stack one playing card on top of another so that all edges line up. Tape together thoroughly so that they look like one thick card. Repeat this process with two more cards. You should now have two sets of taped cards that have the appearance of being two thick cards.

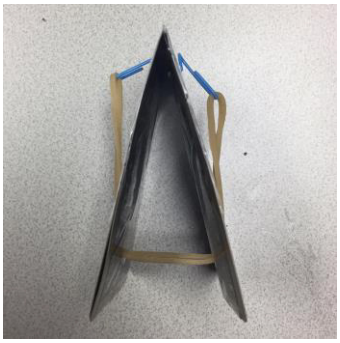
2. On each set of cards, measure in 1cm from one end of the card. Make a mark along the center of the card, but 1cm from the end. Punch a hole here. Repeat this process on the second set of cards.

3. Tape the two cards together at the opposite end from where you punched the holes. It should look like this:

4. Open two paper clips slightly and tape them so that they are only a couple of millimeters in from the taped middle on each card. It should like this:

5. Pick a rubber band and hook it on the open end of the paper clip. With the rubber band attached at one end to the paper clip, run the other end through both holes.

Finally, hook the end of the rubber band to the other paper clip. If the rubber band is very short or not elastic enough, it may snap or bend the cards. You may have to try several rubber bands until you find one that seems to work well for this purpose. Your construction may look like this:



Now let's test it out.

1. Fold over the gadget so the paper clips are on the inside and the rubber band is stretched along the center of the outside.
2. Place your fingertip on the center of the edge of the end of the cards beyond where the rubber band went through the holes.

3. Quickly remove your finger and observe what happens. Practice letting go of the edge of the cards quickly. Watch the apparatus spring into the air, reset it by folding it over and do it again. Repeat this activity several times and record your observations in your journal.

ANALYZE THE REPLAY
What happened?

Compare the actions of your gadget to the actions you observed of your friends jumping.

- What part(s) of the gadget supplied it with force or strength?
- What action(s) provided the velocity that allowed the gadget to spring the air?
- What part(s) of the gadget was critical for its flexibility?
- What part(s) of the gadget would you identify as its body weight?

All of these examples help us to understand what can contribute to a great jump. One part of the gadget also provided potential energy that was converted to kinetic energy when you released the card.

Potential energy results from an object storing energy due to its position. Imagine a wrecking ball held high in the air. It isn't moving, but it has a lot of potential for movement.

When the wrecking ball is released and it starts to move, the potential energy (stored energy) is converted to **kinetic energy,** the energy of motion.

This example of potential energy is called **gravitational potential energy** because the energy is provided by the gravitational pull on the object.

There is another type of potential energy called **elastic potential energy**. This type of energy is the result of an elastic material being stretched or compressed causing energy to be stored within the object. Imagine a bow being drawn back with an arrow in place. If the bowstring was released, the arrow would be pushed by the string a travel through the air.

- What part of your gadget supplied it with potential energy?
- Does this gadget benefit from gravitational potential energy or elastic potential energy?
- Identify the gadget's kinetic energy.

OVERTIME
Let's take it further

In the Game Time activity, you selected a rubber band that seemed to work best for the gadget that you were creating. You may have found that one rubber band didn't have enough elasticity. It may have snapped or bent the cards in a way that was not advantageous to the creation of the gadget. Are there other things that you could change to allow different rubber bands to work?

Look at the different parts that make up the gadget. You could change the number of cards on each side, use different paper clips, or even a longer rubber band! How would the flexibility change which each of these? What about the weight of the gadget? How would increasing or decreasing the weight impact its "jumping" ability?

What changes could you make to other parts of the gadget to allow you to use thicker or shorter rubber bands? Would there be benefits to doing this? What would the benefits be?

Experiment with your gadget, adding or substituting variables to create something that jumps higher or springs into the air faster.

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

Jumping is quite difficult to explain. There are several factors and many different forces that come into play. For example, you can assist motion by swinging arms as you jump. We simplified what elements of the jump we were investigating in this activity to focus on key concepts like power and energy.

DO YOU WANT TO LEARN MORE?

Research: Work, Energy, Potential Energy, Kinetic Energy, Force, Velocity, Gravity

OKLAHOMA ACADEMIC STANDARDS: MATHEMATICS

STANDARD	4TH GRADE	5th Grade	6th Grade
PS3 -1 Energy	●		
PS3-3 Energy	●		
PS1-3 Matter and Interactions		●	
PS2-1 Motion and Stability		●	
MS-PS3-1 Energy			●
MS-PS3-2 Energy			●
MS-PS3-3 Energy			●