CIRCUS PHYSICS: NEWTON'S LAWS OF MOTION

The Pound Puppies dog show looks like chaos in the ring, but the commotion can be explained by Newton's three laws of motion: objects in motion tend to stay in motion, force equals mass times acceleration, and for every action, there is an equal and opposite reaction. In this unit, students will learn how these three laws—Newton's Laws of Motion—can help make sense out of the outrageous antics of the dog show

Watch the Video: Newton's Laws of Motion

http://www.pbs.org/opb/circus/classroom/circus-physics/newtons-laws/

In the video, watch Luciano and his canine companions jump, slide, and wrestle according to Newton's Laws of Motion.

Questions to ask while watching the video

1. What forces do you see in action?
2. Why does the dog slide down the slide?
3. What is happening when the dog jumps off of the man?
4. What force does the dog feel?
5. What force does the man feel?

Questions to Kick-Start Class Discussion After the Video

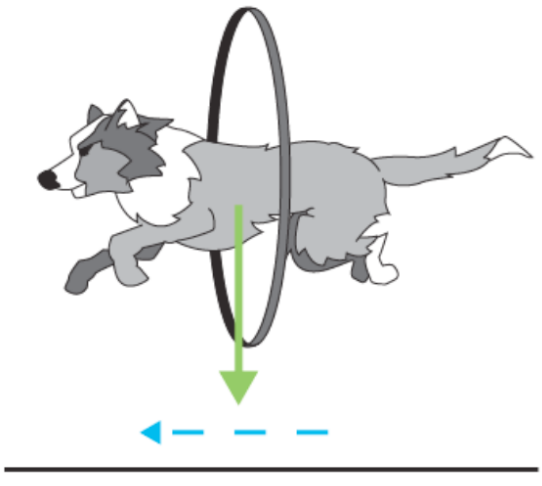
6. Do unbalanced forces feel different than balanced? Give an example.

Digging Deeper

Newton's 1st Law says that an object in motion will stay in motion, continuing in a straight line, unless acted upon by an unbalanced force. Objects at rest will likewise tend to stay at rest. This concept is also called *inertia*.

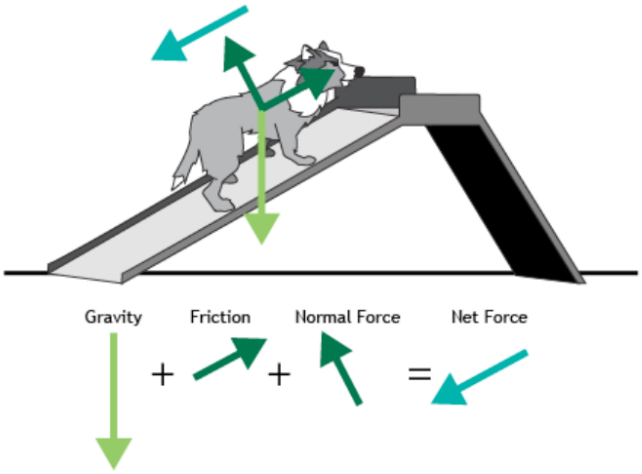
When a dog jumps through a hoop, it momentarily leaves contact with the ground. How does it keep going forward?

Once in the air, the only force acting on the dog is gravity, pulling it down. In the horizontal direction there are no other forces, so the dog keeps moving horizontally at the speed he had when he jumped. Gravity keeps pulling the dog down until he lands on the ground where the ground's force, also known as the *normal* force, balances out gravity and the dog stops falling.



Newton's 2nd Law tells us how to find an object's acceleration if we know its mass and the total force acting on it.

The dog on the slide feels a number of different forces, all acting in different directions. Gravity pulls straight down while the slide pushes back up with a normal force, but at an angle. Friction pushes against whichever way the dog is sliding. In this case the dog is sliding down the ramp, so friction pushes up along the ramp perpendicular to the normal force. To find out how fast the dog will slide, we need one other piece of information, his mass.



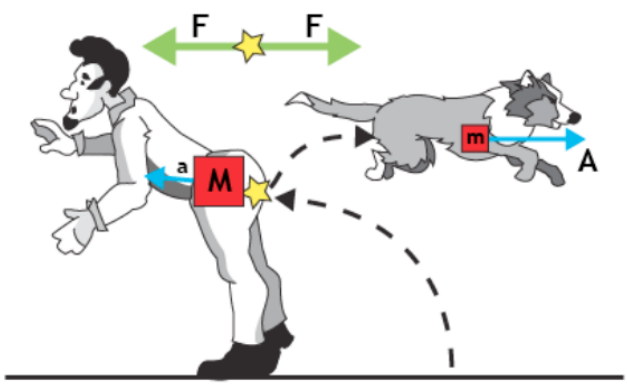
To find the dog's acceleration, we can use Newton's 2nd Law:

Net Force = Mass x Acceleration

This is more commonly known simply as "F = ma".

Newton's 3rd Law states that for every action, there is an equal and opposite reaction.

When the dog jumps off of Luciano, the force of the jump propels the dog to the right. Luciano, however, feels the same force, pushing in the opposite direction. Why does the dog get pushed so far, while Luciano only moves a little?



Mass.

Both Luciano and the dog feel an equal force—green arrows—but because Luciano's mass, *M*, is so much larger, his acceleration, *a*, must be smaller. If Luciano were standing on ice or some frictionless surface, he would slide very slowly in reaction to the dog's jump. Likewise, the dog has a small mass, *m*, so it feels a greater acceleration, *A*. Because he is air-borne and feels very little friction, he goes flying away.

Your Turn: Use the concepts and formulas from this unit to figure out the following:

7. **Lucky the dog jumps off of Luciano, causing Lucky to momentarily accelerate horizontally at 2.45 meters/second/second. If the dog has a mass of 15 kgs and Luciano has a mass of 80 kgs, what horizontal acceleration does Luciano feel?**