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CIRCUS PHYSICS STUDY GUIDE

Linear Momentum

Platform trapeze requires athleticism, good timing, and a strong understanding of the principle of conservation of linear momentum. An object's momentum is its mass times its velocity. The momentum of a system is the sum of the momenta of all the objects in it. No matter how many times objects collide or change direction, their total momentum must stay the same. Like energy, the momentum of a closed system is always conserved. In this unit you'll learn how platform trapeze artists use this fact to soar beneath the big top.

Watch the Video: Linear Momentum
http://www.pbs.org/opb/circus/classroom/circus-physics/linear-momentum/

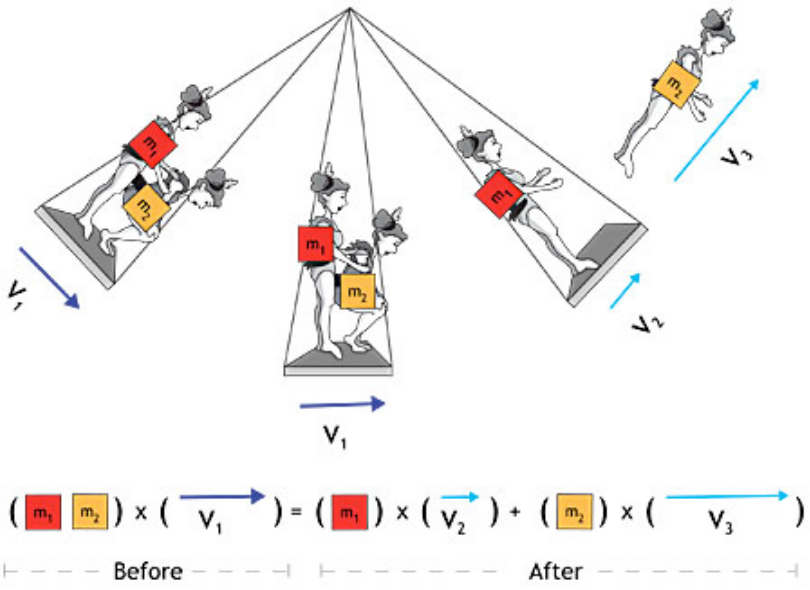
Watch Monica and the other trapeze artist's soar across the ring, thanks in part to the principle of conservation of momentum.

Questions to Consider While Watching the Video

1. How is the jumper able to jump so far?
2. Where does her momentum come from?
3. What happens to the momentum of the person who stays on the platform?

Digging Deeper

Here is a diagram of the swingers on the trapeze platform:



At the beginning of the swing, the momentum of the system, p1, is just the sum of the masses of both people, m1 + m2, multiplied by the velocity, v1.

$$p1 = (m1 + m2)v1$$

A moment after the launch, notice that there are now two separate momentums to consider. First, because the flyer has pushed off of the platform, it's now going the opposite direction, and the momentum of the person still on the platform, p2, is:

$$p2 = m1v2$$

The momentum of the flyer, p3, is then:

$$p3 = m2v3$$

Notice that v3 is much larger than v1, how can that be?

Two things have happened:

1. The mass traveling forward is no longer m1+m2, but just m2, so if all the momentum from before is transferred to the flyer, she now must go faster because her mass is smaller.
2. The platform's velocity has actually switched directions as a result of launching the flyer. Going from moving to stopped is a big change of momentum, but going from moving in one direction to moving in the opposite direction is twice as big. This effectively doubles the momentum transferred to the flyer.

Your Turn

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

Two trapeze artists, each with a mass of 60 kg, are moving on the launch swing at 3 meters/second. At the moment of launch, the person left on the swing momentarily stops, before swinging back. How fast does the flier go, at the moment of launch? For this example, consider the mass of the platform to be zero.

Answer

6 m/s. The momentum before the launch must equal the total momentum after.

Before the launch, the momentum is:

$$(60\ kg + 60\ kg) \times (3\ m/s) = 360\ kg*m/s$$

After the launch, the momentum of the person on the swing is zero, so all of the momentum is carried by the flier, this means her speed, v, must increase:

$$360\ kg*m/s = 60kg \times v$$

Solving for v gives:

$$v = 369\ kg*m/s\ /\ 60\ kg = 6\ m/s)$$

Further Explanation

If you'd like to learn more about conservation of momentum and the trapeze, check out these links:

http://scienceworld.wolfram.com/physics/ConservationofMomentum.html

http://en.wikipedia.org/wiki/Trapeze