



American Heart Association.

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JUMPING ROPE

STEAM Activity

Grades 6-8

The American Heart Association recognizes the importance of building healthy bodies and minds. This STEAM activity is an introduction to science and math concepts particularly in the areas of Physics.

Objective:

Students will be introduced to the concept of rotational motion, which is one of the most important things to understand when you're learning classical physics, and converting a rotational velocity to a linear speed is a key task in many problems.

Materials Needed:



Jump rope



Pencil



Stopwatch



Measuring tape or ruler

The calculation itself is fairly straightforward, but it's complicated if the angular velocity (i.e. the change in angular position per unit time) is expressed in a non-standard form like revolutions per minute (RPM). However, converting RPM to speed is still easy enough after you convert the RPM to a more standard measure of angular velocity.

Vocabulary:

RPM: a measure of the number of complete revolutions in a minute.

Angular velocity: measures this velocity of rotation or revolution.

Linear Speed: the measure of the concrete distance traveled by a moving object. The speed with which an object moves in the linear path is termed linear speed. In other words, it is the distance covered by a linear path in the given time.

Radius: The radius of a circle is defined as a line segment that joins the center to the boundary of a circle. The length of the radius remains the same from the center to any point on the circumference of the circle. The radius is half the length of the diameter.



Calculating Speed

Student Name: _____ Teacher: _____ Date: _____

Activity:

1. With a small group or a partner and a stopwatch, have your partner time you while you jump rope for one minute. As you jump, you should count how many jumps you do. When one minute is up, the person timing you should tell you to stop. If you "mess up" within the minute do not stop, but continue timing, jumping rope and counting the jumps. For example, if after 10 successful jumps, the rope hits your foot and you have to restart, the counter should count the next successful jump as number 11.
2. Write down the number of jumps you got in one minute below after '# of jumps'.
3. Next, lay your jump rope down on the ground to make a circle, as shown. Measure the radius, from the center to the perimeter, of the circle in meters.
4. Now you have everything you need to calculate the speed of your jump rope in miles per hour (mph)! Complete the math in the worksheet.



RPM Formula:

RPM = number of revolutions / time in minutes

$$\text{RPM} = \frac{\text{number of revolutions}}{\text{time in minutes}}$$

of jumps = _____ / 1 minute = ____ RPM



Calculating Speed

Student Name: _____ Teacher: _____ Date: _____

RPMs to Angular Velocity:

Angular Velocity (ω) is the angular change in position of an object per second, measured in radians per second. Most situations in physics will use angular velocity (ω) instead of RPM.

Angular velocity (ω) = RPM / 60 seconds x 2π

First, convert from per minute to per second, then convert the number of revolutions to a value in radians. The formula you need is:

$$\omega = \text{RPM} / 60 \text{ seconds} \times (2 \times \pi) = \text{rad/s} \quad \text{Pi } \pi = 3.14$$

$$\omega = \frac{\text{RPM}}{60 \text{ second/minute}} \times 2\pi \text{ rad/rev}$$

Angular Velocity to Speed:

From this point onward, the conversion from RPM to linear speed is straightforward. The formula you need is:

Speed is $v = \omega r$

Where ω is the angular velocity you calculated in the previous step, and r is the radius of the circular path for the motion, and you multiply these together to find the linear speed.

Radius of your jump rope = _____ cm

100 cm = 1 meter

Radius of your jump rope _____ meters

$V = \text{rad/s} \times \text{meters} = \text{m/second}$

Convert to miles per hour (mph) by using the formula: _____ m/second x 2.23 = _____ mph!