Kinetic Energy and Rowing

Many sports fundamentally depend on scientific principles. The study of energy and motion, for example, is integral to the sport of rowing.

Objects in motion, like these rowers, have kinetic energy.

Rowing requires athletes to propel a boat down a waterway using oars. Science can describe movement in terms of energy. There are many types of energy. The energy of an object in motion is called kinetic energy. The word "kinetic" comes from the Greek word *kinetos*, which literally means “moving.” When rowers propel their boat, kinetic energy is evident. Their bodies exert kinetic energy as they move back and forth in the rowing motion. The oars utilize kinetic energy as they move through the water. The boat applies kinetic energy as it speeds down the river. Even the water itself possesses kinetic energy as it flows across the land.

The kinetic energy of any object in motion depends on two things: its mass and its speed. Using these two values to find an object’s kinetic energy can be displayed in a formula. The formula determines that the kinetic energy is equal to one-half of an object’s mass multiplied by the square of its speed (or velocity). This can be written as:

$$KE = \frac{1}{2} mv^2$$

Scientists and athletes can use this formula to calculate the kinetic energy of a boat being rowed. A single-person boat, for example, is made of a very lightweight material. It has a mass of only 15 kilograms. If a rower’s mass is 45 kilograms, the combined mass of the rower and the boat is 60 kilograms. If the rower can propel the boat at a speed of 3 m/s, those numbers can be plugged into the formula to find the kinetic energy:

$$KE = \frac{1}{2} (60 \text{ kg})(2 \text{ m/s})^2 = 120 \text{ kg} \cdot \text{m}^2/\text{s}^2$$

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The standard unit of energy is a joule (J). One joule is equal to 1 kg•m^2/s^2, so the kinetic energy of the single-person boat carrying a rower with a mass of 45 kilograms is 120 J.

Kinetic energy can change drastically when either of its two factors changes. For example, there are several Olympic rowing events. Some races require lightweight boats, while others use heavier boats. Some races have two or four crew members, while others have eight. All of these differences can affect the mass and velocity of a boat. If either value increases, then the kinetic energy increases. The same is true if either mass or velocity decreases: Kinetic energy will also decrease. As an example of how much a change in mass affects kinetic energy, compare the kinetic energy of a single-person boat and its rower with that of a two-member rowing team. Two-person boats have a mass of about 30 kilograms, and two rowers would add 90 kilograms, for a total of 120 kilograms. If the two rowers propelled their boat at the same speed as the single rower, the kinetic energy would be:

With large mass and a fast speed, an eight-person rowing team has a lot of kinetic energy.

$$KE = \frac{1}{2} (120 \text{ kg})(2 \text{ m/s})^2 = 240 \text{ J}$$

When the mass doubled, the kinetic energy also doubled. Remember, though, that kinetic energy is the energy of motion. Changing how fast the boat moves has an even bigger impact on the amount of kinetic energy. If the single-person boat increases its speed to an Olympic level, the kinetic energy at play likewise increases. An Olympic speed is closer to 4 m/s.

$$KE = \frac{1}{2} (60 \text{ kg})(4 \text{ m/s})^2 = 480 \text{ J}$$

As velocity doubles, kinetic energy is quadrupled, or multiplied by four. So you can see that changing the velocity of an object has an even greater impact than changing the mass. This is because kinetic energy is proportional to the square of the object's speed. This kind of mathematical relationship is called "exponential."

Kinetic energy can be found everywhere. Everything that is in motion possesses kinetic energy. Understanding what kinetic

energy is and how it is calculated is very useful. The fact that velocity affects kinetic energy more than mass does applies to many sports, including rowing. Therefore, science is both fundamental and essential to sports and the athletes involved.