Kinetic Energy

Ck12 Science

Say Thanks to the Authors
Click http://www.ck12.org/saythanks
(No sign in required)

AUTHOR
Ck12 Science

To access a customizable version of this book, as well as other interactive content, visit www.ck12.org

CK-12 Foundation is a non-profit organization with a mission to reduce the cost of textbook materials for the K-12 market both in the U.S. and worldwide. Using an open-content, web-based collaborative model termed the **FlexBook®**, CK-12 intends to pioneer the generation and distribution of high-quality educational content that will serve both as core text as well as provide an adaptive environment for learning, powered through the **FlexBook Platform®**.

Printed: March 24, 2014

flexbook
next generation textbooks

CHAPTER 1 Kinetic Energy

- Define energy.
- Define kinetic energy.
- Given the mass and speed of an object, calculate its kinetic energy.
- Solve problems involving kinetic energy.

This military jet, like all jets, requires a large amount of work to get into the air; unlike most jets, this one is taking off from the deck of aircraft carrier. This requires careful coordination of the plane's engines and the ship's catapults and harnesses to accelerate the jet to about 270 km per hour in just two seconds. This incredible feat requires huge energy conversions.

Kinetic Energy

Energy is the capacity of an object to do work, and like work, energy's unit is the joule (J). Energy exists in many different forms, but the one we think of most often when we think of energy is **kinetic energy**. Kinetic energy is often thought of as the energy of motion because it is used to describe objects that are moving. Remember, though, that energy is the ability of an object to do work. Any moving object has the capacity to cause another object to move if they collide. This ability is what we mean when we refer to an object's kinetic energy: the ability to change another object's motion or position simply by colliding with it. The equation of an object's kinetic energy depends on its mass and velocity:

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

The kinetic energy of a moving object is directly proportional to its mass and directly proportional to the square of its velocity. This means that an object with twice the mass and equal speed will have twice the kinetic energy while an object with equal mass and twice the speed will have quadruple the kinetic energy.

The kinetic energy of an object can be changed by doing work on the object. The work done on an object equals the kinetic energy gain or loss by the object. This relationship is expressed in the work-energy theorem $W_{\text{NET}} = \Delta KE$.

Example Problem: A farmer heaves a 7.56 kg bale of hay with a final velocity of 4.75 m/s.

(a) What is the kinetic energy of the bale?

(b) The bale was originally at rest. How much work was done on the bale to give it this kinetic energy?

Solution:

(a) $KE = \frac{1}{2}\,mv^2 = \left(\frac{1}{2}\right)(7.56\text{ kg})(4.75)^2 = 85.3\text{ Joules}$

(b) Work done $= \Delta KE = 85.3$ Joules

Example Problem: What is the kinetic energy of a 750. kg car moving at 50.0 km/h?

Solution: $\left(\frac{50.0\ \mathbf{km}}{\mathbf{h}}\right)\left(\frac{1000\ \mathbf{m}}{\mathbf{km}}\right)\left(\frac{1\ \mathbf{h}}{3600\ \mathbf{s}}\right) = 13.9\ \mathbf{m/s}$

$KE = \frac{1}{2}\,mv^2 = \left(\frac{1}{2}\right)(750.\text{ kg})(13.9\text{ m/s})^2 = 72,300\text{ Joules}$

Example Problem: How much work must be done on a 750. kg car to slow it from 100. km/h to 50.0 km/h?

Solution: From the previous example problem, we know that the KE of this car when it is moving at 50.0 km/h is 72,300 Joules. If the same car is going twice as fast, its KE will be four times as great because KE is proportional to the square of the velocity. Therefore, when this same car is moving at 100. km/h, its KE is 289,200 Joules. Therefore, the work done to slow the car from 100. km/h to 50.0 km/h is $(289,200\text{ Joules}) - (72,300\text{ Joules}) = 217,000$ Joules.

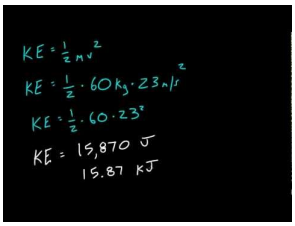
Summary

- Energy is the ability to change an object's motion or position.
- The energy of motion is called kinetic energy.
- The formula for kinetic energy is $KE = \frac{1}{2}\,mv^2$.
- The work done on an object equals the kinetic energy gain or loss by the object, $W_{\text{NET}} = \Delta KE$.

Practice

The following video discusses kinetic energy. Use this resource to answer the questions that follow.

http://www.youtube.com/watch?v=g157qwT1918



MEDIA

Click image to the left for more content.

1. Potential energy is present in objects that are _____.
2. Kinetic energy is present in objects that are _____.
3. What formula is given for kinetic energy?

Practice problems involving kinetic energy:

http://www.physicsclassroom.com/Class/energy/u5l1c.cfm

Review

1. A comet with a mass of 7.85×10^{11} kg is moving with a velocity of 25,000 m/s. Calculate its kinetic energy.
2. A rifle can shoot a 4.00 g bullet at a speed of 998 m/s.
   (a) Find the kinetic energy of the bullet.
   (b) What work is done on the bullet if it starts from rest?
   (c) If the work is done over a distance of 0.75 m, what is the average force on the bullet?
   (d) If the bullet comes to rest after penetrating 1.50 cm into a piece of metal, what is the magnitude of the force bringing it to rest?

- **energy:** An indirectly observed quantity that is often understood as the ability of a physical system to do work.
- **kinetic energy:** The energy an object has due to its motion.

References

1. Courtesy of Mass Communication Specialist 3rd Class Torrey W. Lee, U.S. Navy. Jet Takeoff . Public Domain