

Warm-Up

Kinetic Energy



Lesson Question

How are kinetic energy and work related?

Lesson Goals

Define kinetic energy and identify situations in which it is present.

Calculate kinetic energy, mass, or velocity given the other two quantities.

Describe the

work-
energy

theorem and use it to solve problems.



Words to Know

Write the letter of the definition next to the matching word as you work through the lesson. You may use the glossary to help you.

 B work-energy theorem

A. the energy an object or particle has due to its motion

 C work

B. the theorem that states that the change in kinetic energy of an object is equal to the work done on the object

 D joule

C. the use of force to move an object

 A kinetic energy

D. the SI unit of work

**Forces**

- Pedaling harder
- Braking
- Riding against the **wind**
- Going **downhill**

Review of Work

- Work is the use of force to move an object.
- In order for work to be done on an object, the object has to **move**.

$$W = Fd$$

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Kinetic Energy

- Kinetic energy exists as a result of a mass **moving**.

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Kinetic Energy Equation

- Kinetic energy is equal to one half the mass multiplied by the **velocity** squared.

- m = mass measured in kg
- v = velocity measured in m/s
- KE = kinetic energy measured in **joules** (J)
- $J = \text{kg} \cdot \frac{\text{m}^2}{\text{s}^2}$

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

Kinetic Energy

EXAMPLE

- An 80 kg bicyclist is moving at a velocity of 3 m/s. What is his kinetic energy?

- Given:

- $m = 80 \text{ kg}$
- $v = 3 \text{ m/s}$

- Unknown: KE

- Formula: $KE = \frac{1}{2}mv^2$

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

$$KE = \frac{1}{2} \mathbf{(80 \text{ kg})} \mathbf{(3 \text{ m/s})}^2$$

$$KE = (40 \text{ kg})(9 \text{ m}^2/\text{s}^2)$$

$$KE = \mathbf{360 \text{ J}}$$

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How Mass Affects Kinetic Energy

- Kinetic energy is directly proportional to mass.
- $KE = \frac{1}{2}mv^2$



$$\frac{1}{2}(0.6 \text{ kg})(2 \text{ m/s})^2 = \boxed{1.2 \text{ J}}$$



$$\frac{1}{2}(5 \text{ kg})(2 \text{ m/s})^2 = \boxed{10 \text{ J}}$$

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Kinetic Energy, Mass, and Velocity

- When kinetic energy and mass are known, velocity can be found.

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

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

$$v^2 = \frac{2KE}{m}$$

$$\sqrt{v^2} = \boxed{\sqrt{\frac{2KE}{m}}}$$

$$v = \sqrt{\frac{2KE}{m}}$$

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- A 1,200 kg car has 15,000 J of kinetic energy. What is its velocity?

- Given:

- $m = 1,200 \text{ kg}$

- $KE = 15,000 \text{ J}$

- Unknown: v

- Formula: $v = \sqrt{\frac{2KE}{m}}$

$$v = \sqrt{\frac{2KE}{m}}$$

$$v = \sqrt{\frac{2(15,000 \text{ J})}{1,200 \text{ kg}}}$$

$$v = \sqrt{\frac{30,000 \text{ J}}{1,200 \text{ kg}}}$$

$$v = \sqrt{25}$$

$$v = 5 \text{ m/s}$$

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Work-Energy Theorem

- When **work** is either added to or taken away from a system, it forces the kinetic energy to change.
- The **work-energy theorem** states that the change in **kinetic** energy of an object is equal to the work done on the object.
- When the **velocity** of a system changes, the kinetic energy of the system also changes.

$$W = \Delta KE = \frac{1}{2}m(v_f^2 - v_i^2)$$

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Positive and Negative Work

- The environment can work on an object or an object can work on the environment.
 - Energy can flow both ways.
 - When work is positive, the environment did work on the object.
The energy of the system **increases**.
 - When work is negative, the object did work on the environment.
The energy of the system **decreases**.

Summary

Kinetic Energy

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Lesson Question

How are kinetic energy and work related?

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Answer

(Sample answer) Work is required to change the kinetic energy of an object.

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Review: Key Concepts

Term	Description	Formula	Unit (abbreviation)
Kinetic energy	The energy of motion	$KE = \frac{1}{2}mv^2$	joule (J)
Work	The use of force to move an object	$W = \Delta KE$ $\Delta KE = \frac{1}{2}m(v_f^2 - v_i^2)$	joule (J)



Summary

Kinetic Energy

Use this space to write any questions or thoughts about this lesson.