



DEVIL PHYSICS
THE BADDEST CLASS ON CAMPUS

AP PHYSICS

**LSN 6-3: KINETIC ENERGY AND THE
WORK ENERGY PRINCIPLE**

Questions From Reading
Activity?

Big Idea(s):

- The interactions of an object with other objects can be described by forces.
- Interactions between systems can result in changes in those systems.
- Changes that occur as a result of interactions are constrained by ***conservation laws***.

Enduring Understanding(s):

- A force exerted on an object can change the ***kinetic energy*** of the object.
- Interactions with other objects or systems can change the ***total energy*** of a system.

Enduring Understanding(s):

- ***Certain quantities are conserved***, in the sense that the changes of those quantities in a given system are always equal to the transfer of that quantity to or from the system by all possible interactions with other systems.
- The ***energy of a system is conserved***.

Essential Knowledge(s):

- *The change in the kinetic energy of an object depends on the force exerted on the object and on the displacement of the object during the interval that the force is exerted.*
 - *Only the component of the net force exerted on an object parallel or antiparallel to the displacement of the object will increase (parallel) or decrease (antiparallel) the kinetic energy of the object.*

Essential Knowledge(s):

- *The magnitude of the change in the kinetic energy is the product of the magnitude of the displacement and of the magnitude of the component of force parallel or antiparallel to the displacement.*
- *The component of the net force exerted on an object perpendicular to the direction of the displacement of the object can change the direction of the motion of the object without changing the kinetic energy of the object. This should include uniform circular motion and projectile motion.*

Essential Knowledge(s):

- The energy of a system includes its ***kinetic energy, potential energy***, and microscopic internal energy. Examples should include ***gravitational potential energy, elastic potential energy, and kinetic energy***.
- An interaction can be either a force exerted by objects outside the system or the ***transfer of some quantity*** with objects outside the system.

Essential Knowledge(s):

- **Mechanical energy** (the sum of kinetic and potential energy) is transferred into or out of a system when an external force is exerted on a system such that a component of the force is parallel to its displacement. **The process through which the energy is transferred is called work.**

Essential Knowledge(s):

- If the force is constant during a given displacement, then the ***work done is the product of the displacement and the component of the force parallel or antiparallel to the displacement.***
- ***Work (change in energy) can be found from the area under a graph of the magnitude of the force component parallel to the displacement versus displacement.***

Essential Knowledge(s):

- **Energy can be transferred** by an external force exerted on an object or system that moves the object or system through a distance; this energy transfer is **called work**. Energy transfer in mechanical or electrical systems may occur at different rates. **Power is defined as the rate of energy transfer** into, out of, or within a system. [A piston filled with gas getting compressed or expanded is treated in Physics 2 as a part of thermodynamics.]

Learning Objective(s):

- The student is able to make predictions about the **changes in kinetic energy** of an object **based on** considerations of the **direction of the net force** on the object as the object moves.
- The student is able to **use net force and velocity vectors** to determine qualitatively whether kinetic energy of an object would increase, decrease, or remain unchanged.

Learning Objective(s):

- *The student is able to use force and velocity vectors to determine qualitatively or quantitatively the net force exerted on an object and qualitatively whether kinetic energy of that object would increase, decrease, or remain unchanged.*

Learning Objective(s):

- The student is able to ***calculate the total energy of a system*** and ***justify the mathematical routines*** used in the calculation of component types of energy within the system whose sum is the total energy.

Learning Objective(s):

- The student is able to apply mathematical routines to ***determine the change in kinetic energy of an object*** given the forces on the object and the displacement of the object.
- The student is able to ***predict changes in the total energy*** of a system due to ***changes in position and speed*** of objects or ***frictional interactions*** within the system.

Learning Objective(s):

- The student is able to make predictions about the ***changes in the mechanical energy*** of a system when a component of an ***external force acts parallel or antiparallel*** to the direction of the displacement of the center of mass.

Learning Objective(s):

- The student is able to apply the concepts of **Conservation of Energy** and the **Work-Energy theorem** to determine qualitatively and/or quantitatively that **work done** on a two-object system in linear motion will **change the kinetic energy** of the center of mass of the system, **the potential energy** of the systems, **and/or the internal energy** of the system.

Learning Objective(s):

- The student is able to ***design an experiment*** and analyze data to examine how a ***force exerted on an object or system does work*** on the object or system as it moves through a distance.
- The student is able to ***design an experiment*** and ***analyze graphical data*** in which interpretations of the area under a ***force-distance curve*** are needed to determine the work done on or by the object or system.

Learning Objective(s):

- The student is able to ***predict and calculate the energy transfer*** to (i.e., the work done on) an object or system from information about a ***force exerted on the object or system through a distance***.
- The student is able to predict and calculate ***from graphical data*** the energy transfer to or work done on an object or system from information about a force exerted on the object or system through a distance.

Introductory Video:

What is Energy?

So What is Energy?

So What is Energy?

- **The ability to do work**

Name some types of energy

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- **Kinetic**
- **Potential**
- **Thermal**
- **Electrical**
- **Chemical**
- **Nuclear**

What types of energy are involved with the Hoover Dam?



What types of energy are involved with the Hoover Dam?

- Kinetic
- Potential
- Thermal
- Electrical
- ~~Chemical~~
- ~~Nuclear~~



Key: Energy is Conserved.

- Kinetic
- Potential
- Thermal
- Electrical
- Chemical
- Nuclear



Work \mapsto Energy

$$W = (F)(d)$$

$$F = ma$$

$$W = mad$$

$$v_f^2 = v_i^2 + 2ax$$

$$\frac{v_f^2 - v_i^2}{2x} = a$$

Work \mapsto Energy

$$W = m \frac{v_f^2 - v_i^2}{2x} d$$

$$x = d$$

$$W = \frac{1}{2} m v_f^2 - \frac{1}{2} m v_i^2$$

Work \leftrightarrow Energy

- Kinetic Energy (KE)
 $= \frac{1}{2}mv^2$
- Net work is equal to the change in kinetic energy

$$W_{net} = \frac{1}{2}mv_f^2 - \frac{1}{2}mv_i^2$$

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

$$W_{net} = \Delta KE$$

Work \leftrightarrow Energy

- *The work done on an object is equal to the change in its kinetic energy.*
- This is known as the work-energy principle.
- The implication is that work and energy are interchangeable.
- *In nuclear physics, we will show how mass and energy are interchangeable at the nuclear level.*

Work \leftrightarrow Energy

- *Will the same principle apply to other forms of energy?*

Work \leftrightarrow Energy

- *Will the same principle apply to other forms of energy?*
 - *Potential Energy – But that's not until 6-4*

Summary Video:

Kinetic Energy

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QUESTIONS?



Homework

#15-24

