**Unit 4: Work, Energy, Power**

**Work - Section 1**

Objectives:

* Recognize the difference between the scientific and ordinary definitions of work.
* Define work by relating it to force and displacement.
* Identify where work is being performed in a variety of situations.
* Calculate the net work done with multiple applied forces.
* Identify several forms of energy.
* Calculate kinetic energy for an object.
* Apply the work–kinetic energy theorem to solve problems.
* Distinguish between kinetic and potential energy.
* Classify different types of potential energy.
* Calculate the potential energy associated with an object’s position.
* Identify situations in which conservation of ME is valid.
* Recognize the forms that conserved energy can take.
* Solve problems using conservation of ME.
* Relate the concepts of energy, time, and power.
* Calculate power in two different ways.
* Explain the effect of machines on work and power

Answer the following definitions with your own thoughts and own words:

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| What does the word Work mean to you? | What is the common definition of work? |
|  |  |

Read the PowerPoint and watch the linked videos: <http://my.hrw.com/sh2/sh07_10/student/flash/visual_concepts/70005.htm>

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| Term: | Definition | Equation |
| **Work** |  |  |

Why is work a scalar value?

If the unit of Work is \_\_\_\_\_, and the unit of Force are \_\_\_\_\_\_ , unit of Displacement is \_\_\_\_\_\_\_\_\_\_\_. Then, write a statement that shows the equivalence between work and common SI units:

Work is done only when components of a force are **\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_** to a displacement.

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| **Is work done in the following situations?** | |
| A student holds a heavy chair at arm’s length for several minutes. | A student carries a bucket of water along a horizontal path while walking at constant velocity |

Force may work in the same **\_\_\_\_\_\_\_\_\_\_\_\_\_** or the **\_\_\_\_\_\_\_\_\_\_\_\_\_\_** direction.

Watch the following video, then answer the next two questions. <http://my.hrw.com/sh2/sh07_10/student/flash/visual_concepts/70595.htm>

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| Work is *\_\_\_\_\_\_\_\_\_\_\_\_* when the applied force is in the same  *\_\_\_\_\_\_\_\_\_\_\_\_* as the displacement. | Work is *\_\_\_\_\_\_\_\_\_\_\_\_* when the force is in the opposite  *\_\_\_\_\_\_\_\_\_\_\_\_* of the displacement. |

**Energy - Section 2**

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| Term: | Definition | Example |
| **Energy** |  |  |

Energy have SI units of\_\_\_\_\_\_\_\_\_\_\_\_ which are equivalent to the common units \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

In this section, we will study two types of energy: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ and \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

**Kinetic Energy - The Energy of Motion**

There are many forms of kinetic energy:



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| Term: | Definition | Equation |
| **Kinetic Energy** |  |  |

The standard metric unit of measurement for kinetic energy is the JOULE.

Kinetic energy quantifies the amount of \_\_\_\_\_\_\_\_\_\_\_\_\_ the object could do as a result \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

**If…**

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| --- | --- |
| Wnet of an object is positive than the object \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  The object \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ than the KE \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  Wnet of an object is positive than the KE \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ | Wnet of an object is positive than the object \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  The object \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ than the KE \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_  If the Wnet of an object is positive than the KE \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ |

**Potential Energy - The Energy of Position**

Two different forms of potential energy we will study (two other forms are electric and magnetic).

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| Term: | Description | Equation |
| **Gravitational**  **Potential Energy** |  |  |

Gravitational PE is the energy stored in an object as the result of its \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

The energy is stored as the result of the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ for the object.

There is a direct relation between gravitational potential energy and the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of an object.

There is a direct relation between gravitational potential energy and the MASS AND HEIGHT of an object; therefore to increase PE:



Typically, the \_\_\_\_\_\_\_\_\_\_\_\_\_ is considered to be a position of zero height.

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| Term: | Description | Equation |
| **Elastic**  **Potential**  **Energy** |  |  |

The amount of elastic PE stored in such a device is related to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_

If a spring is not stretched / compressed, then there is no Elastic PE stored in it. The spring is then in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

If a spring is in equilibrium position, then the PEe is equal to \_\_\_\_\_.

**The Work Energy Theorem**

The work done by an external force acting on an object causes a change in the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the object.

Combine the knowledge of Kinematics and Newton's Laws:

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| If only KE is found in the system: | If only PE is found in the system: |
| Two energy forms interact, and work is the change in all energy  Combining the two relationships: | |

It means that if work acts on an object it will undergo a \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ in speed and thus a change in \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

The net \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ done on an object is equal to the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

The work–kinetic energy theorem allows us to think of kinetic energy as the work that an object can do while the object changes speed or as the amount of energy stored in the motion of an object.

Suppose you lift a mass upward at a constant speed, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

* It is known that when an object is lifted above the ground it has \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

If an object is lifted at a constant speed, the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_equals the \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ of the object you are lifting.

Since, \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_are

**Conservation of Mechanical Energy**

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| Term: | Definition |
| **Conservation of Energy** | Total Energy is ALWAYS \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_. |

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| Term: | Definition |
| **Mechanical Energy** |  |

List examples of energy forms that are not considered ME:

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| Term: | Definition (principal) | Equation (3 forms) |
| **Conservation of Mechanical Energy** |  |  |

\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ must be ignored for the equation of Conservation of Mechanical Energy (ME) to be true.

**Power**

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| Term: | Definition | Equation (s) |
| **Power** |  |  |

The unit for Power is: \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_, which is equal to \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_.

Also, 1 horsepower equals \_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_\_ watts.

**Additional Resources for notes and help:**

Song on Mechanical Energy: <https://www.youtube.com/watch?v=-p3msL1P8bw>

Video on brief summary of Work, Energy, and Power: <http://www.bozemanscience.com/energy-work-power>

Equation for Net Work: <http://my.hrw.com/sh2/sh07_10/student/flash/visual_concepts/70106.htm>

Videos with brief summaries on Potential and Kinetic Energy: <http://www.bozemanscience.com/potential-kinetic-energy> and

<http://www.energyeducation.tx.gov/energy/section_1/topics/potential_and_kinetic_energy/index.html>

Equation for Kinetic Energy: <http://my.hrw.com/sh2/sh07_10/student/flash/visual_concepts/70006.htm>

Visual of Kinetic Energy: <http://my.hrw.com/sh2/sh07_10/student/flash/visual_concepts/70318.htm>

Equation for Gravitational Potential Energy: <http://my.hrw.com/sh2/sh07_10/student/flash/visual_concepts/70007.htm>

Visual of Gravitational Potential Energy: <http://my.hrw.com/sh2/sh07_10/student/flash/visual_concepts/70320.htm>

Visual of Elastic Potential Energy: <http://my.hrw.com/sh2/sh07_10/student/flash/visual_concepts/70596.htm>

Visual of Spring Constant: <http://my.hrw.com/sh2/sh07_10/student/flash/visual_concepts/70321.htm>

Equation and explanation of Work – KE theorem: <http://my.hrw.com/sh2/sh07_10/student/flash/visual_concepts/70319.htm>