Name: _____ Teacher: _____ Pd. ___ Date: _____

STAAR Science Tutorial 19
TEK 6.8A: Potential & Kinetic Energy

TEK 6.8A: Compare and contrast potential and kinetic energy.

- Energy is the ability to do work or cause change. Unlike matter, energy does not have mass or take up space. It is visible only through the motion of matter or other changes to matter that it causes.

- Energy is found in six different forms: mechanical energy, chemical energy, thermal energy, electrical energy, radiant (or electromagnetic) energy, and nuclear energy:

    - Mechanical energy is the energy of motion of large objects (masses of particles moving in unison), or the energy stored in large objects because of their position or condition, such as compression or tension. A moving car, ocean wave, compressed spring, stretched rubber band and sound are all examples of mechanical energy.

    - Chemical energy is the energy stored in the bonds between atoms, such as ionic or covalent bonds. The food we eat has chemical energy stored in it, which is transformed into thermal or mechanical energy by our body's digestive process.

    - Thermal energy is the energy of vibrational motion in atoms and molecules. The greater the rate of vibration, the greater the thermal energy, measured as temperature, the particles have. Any atom or molecule above absolute zero (-273°C) has thermal energy.

    - Electrical energy is the energy found in charged particles. If the charges are not moving, we call it static electricity. If the particles (usually electrons) are moving, it is an electrical current.

    - Radiant or electromagnetic energy is the only form of energy that does not need matter to be transmitted. Radio waves and light are types of radiant energy.

    - Nuclear energy is the energy stored in the nucleus of atoms.

- All of the above energy forms can be classified into two broad categories: kinetic and potential energy. Some energy forms can be either kinetic or potential, depending on their motion, while others by their nature can only be in one category.

- **Kinetic energy** is the energy of motion.

    - When the motion is in a larger object, we say that the motion is evidence of **mechanical kinetic energy**. A moving car has kinetic energy. Waves (a rhythmic disturbance that transmits energy) moving through air (sound), rocks

and earth (earthquake or seismic) or water, are also examples of mechanical kinetic energy. The amount of kinetic energy contained in a moving object depends on its speed and its mass.

- If the motion is of electrons moving through a conductor, it is **electrical kinetic energy**.
- If the motion is the random vibration of atoms and molecules, it is **thermal kinetic energy**.
- Electromagnetic waves, which do not require matter to carry energy, are also kinetic energy, because they move and can cause change or work.

- **Potential energy** is stored energy, not presently doing work or causing change.
  - For mechanical potential energy, the energy is stored because of the object's position above the ground (**gravitational potential energy**) or the object's internal stress condition (**elastic potential energy**). Water stored behind a high dam, which must flow downhill because of the pull of gravity, is an example of gravitational potential energy. A stretched rubber band and compressed spring are two examples of elastic potential energy. Deformed rock along a fault line, which when released causes an earthquake, is another example of elastic potential energy.
  - Chemical energy and nuclear energy are both forms of potential energy, because both store energy that is not presently doing work. In chemical energy, it is the bonds between atoms that store the energy. In nuclear energy, it the force that holds the atomic nucleus together that stores the energy. Only when chemical or nuclear energy is transformed into thermal or electromagnetic energy do they become kinetic.
  - If electric charges are not moving (they are "static"), the electrical energy is potential. A capacitor is an electrical device that directly stores electrical charges without converting it into another form.
  - Electromagnetic waves move at a very fast constant speed (the "speed of light"), and thus can only be kinetic, not potential, energy.
- The **law of conservation of energy** states that energy cannot be destroyed, but only transformed into different forms. The motion of objects can result in the conversion of mechanical energy from potential to kinetic, sometimes in a regular cycle. Mechanical energy is usually transformed into thermal energy by friction (a force that opposes motion).
- In a roller coaster, potential energy is first stored in the car when it is pulled to the top of the highest hill of the roller coaster. When the car is released and increases its speed down the track, pulled by gravity, the potential energy is reduced as the car moves lower, but the kinetic energy increases as the car's speed increases. When the car reaches the bottom of the first hill, and begins to climb the second hill, the kinetic energy of the car is transformed back to potential energy, as the car climbs to a higher position but slows due to the pull of gravity. Eventually the car

will come to a stop when all of the mechanical energy is transformed to thermal energy by friction or to mechanical energy in the air by the air resistance on the car.

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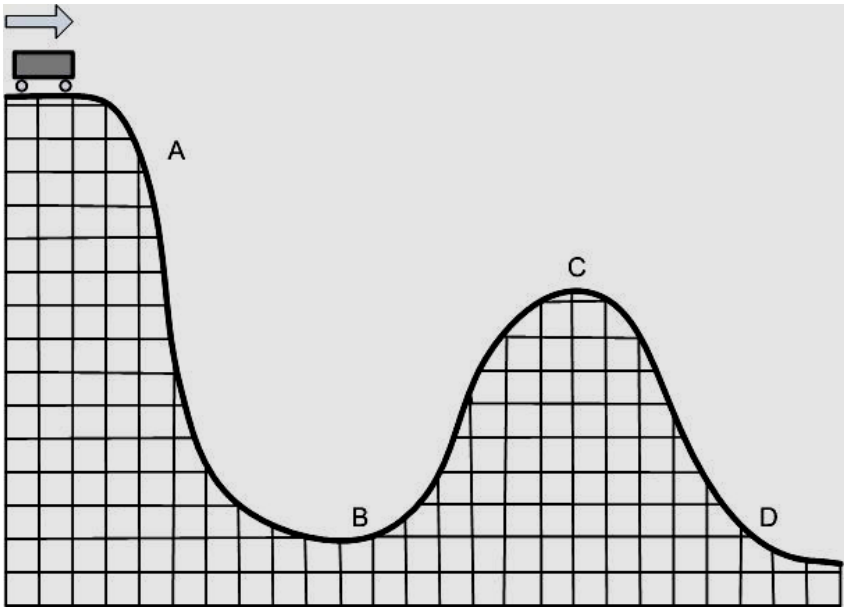
- 

- In the roller coaster diagram above, the car's potential energy will be greatest at the highest point, point A, and the kinetic energy will be the highest at the bottom of the first hill, point B, where the car's speed will be the greatest. As the car travels through the rest of the hills, friction and air resistance will slow the car. Each successive hill must be lower because of the energy that friction converts to thermal energy.

- In a pendulum swinging back and forth, the potential energy is the greatest when the pendulum is at the top of its swing, and the kinetic energy is greatest when it is moving the fastest at the bottom of its swing. At the top of the swing, the kinetic energy is reduced to zero, when the pendulum stops momentarily as it changes its direction of motion.

Practice Questions

1. The ability to do work or cause change is called _____.
2. The two main categories of energy are _____ energy (stored energy) and _____ energy (energy presently doing work or causing change).
3. The form of energy that is found in large moving objects is _____ _____ energy.
4. The form of energy that is stored in large objects because of its position above the ground is _____ _____ energy.

5. The form of energy that is stored in large objects because of its internal condition, such as compression or tension, is called _____ _____ energy.
6. The form of energy stored in the bonds between atoms is _____ energy. This form of energy falls into the _____ energy category.
7. The form of energy stored in the nucleus of atoms is _____ energy, which falls into the _____ energy category.
8. Light and radio are examples of the _____ or _____ energy form, which is _____ because it is always moving.
9. Moving electrons in a conductor are an example of _____ _____ energy.
10. Vibrating molecules and atoms are an example of _____ energy, which falls into the _____ energy category.
11. In a roller coaster, the potential energy is greatest when the car is at the _____ of the _____ hill, and the kinetic energy is greatest when the car is at the _____ of the _____ hill. Both the kinetic and potential energy in the car decreases at each successive hill because of _____ and _____ _____.
12. In a pendulum, the potential energy is greatest when the pendulum is at the _____ of its swing, and the kinetic energy is greatest when the pendulum is at the _____ of its swing.