

Pendulums

Overview: This is a very simple yet powerful demonstration that shows how potential energy and kinetic energy transfer from one to the other and back again, over and over.

What to Learn: Where does the energy go? You should know by now how kinetic and potential energy are related, but this experiment should help us remember well.

Materials

- some string
- a bit of tape
- a washer or a weight of some kind
- set of magnets (at least 6, but more is better)
- metal sheet

Lab Time

1. Make the string into a 2-foot or so length.
2. Tie the string to the washer, or weight.
3. Tape the other end of the string to a table.
4. Lift the weight and let go, causing the weight to swing back and forth at the end of the pendulum.
5. Now stop and go ahead to answer the questions about the pendulum. Record your observations about how the pendulum moves in lab today.
6. Attach a magnet where the nut or weight was attached.
7. Suspend your pendulum above the metal sheet.
8. Place the rest of the magnets in a circle around the space below the hanging pendulum. Make sure they all face the same direction.
9. Play with the arrangement of the magnets to try and get it to move around. If you do this right, you can get the pendulum to swing pretty much forever! How is this possible? Adjust the height of the pendulum by shortening the string and attaching it with masking tape if you need to.

Pendulum Observations:

1. Watch the pendulum for a bit and describe what it's doing as far as energy goes. Where is the potential energy greatest? Where is the kinetic energy greatest? Where is potential energy lowest? Where is kinetic energy lowest? Where is KE increasing, and PE is decreasing? Where is PE increasing and KE decreasing? Where did the energy come from in the first place? Draw a picture of the pendulum and label each part.
2. Lastly, where did the energy come from in the first place? It came from you. You added energy (increased PE) when you lifted the weight. (By the way, you did work on the weight by lifting it the distance you lifted it. You put a certain amount of Joules of energy into the pendulum system. Where did you get that energy?
3. What does this tell us about the energy that gets used by us, by machines, and by pretty much anything in the universe?

Reading

This two-part experiment helps us understand the dynamics of kinetic and potential energy. The large nut from our last experiment can be used again for this experiment, coincidentally.

The chaos pendulum is more of a curiosity than a lesson in kinetic energy. You can use the pendulum to explain the conservation of energy, and in fact that a "perpetual motion machine" is impossible to build. You don't need to get into the complexities of magnetic fields and electromagnetism.

A pendulum is an easy way to see how energy changes forms between kinetic and potential energy. If we look at a swinging pendulum, where is the energy different in this system? Think back to our past experiments with motion.

Remember, potential energy is highest where the weight is the highest. Kinetic energy is highest where the weight is moving the fastest. So potential energy is highest at the ends of the swings. Here's a coincidence: That's also where kinetic energy is the lowest since the weight is moving the least. Where's potential energy the lowest? At the middle or lowest part of the swing.

Exercises Answer the questions below:

1. Why can we never make a machine that powers itself over and over again?
 - a. Energy is mostly lost to heat.
 - b. Energy is completely used up.
 - c. Energy is unlimited, but is absorbed by neighboring air molecules.
 - d. None of these
2. In the pendulum, as kinetic energy increases, potential energy _____.
 - a. Increases
 - b. Decreases
3. As potential energy decreases, kinetic energy _____.
 - a. Increases
 - b. Decreases

Answers to Exercises: Pendulums

1. Why can we never make a machine that powers itself over and over again? (Because energy is conserved and lost to heat or other forms of energy that aren't kinetic.)
2. In the pendulum, as kinetic energy increases, potential energy _____. (decreases)
3. As potential energy decreases, kinetic energy _____. (increases)