ENERGY
GRADE 7

ASSESSMENT PACKET

All the different forms of energy (like heat, electrical, nuclear, sound, etc.) can be broken down into just two categories: potential and kinetic energy. You'll construct a working steam boat, design and build an external combustion engine from soda cans, make a fire water balloon, use a gum wrapper as a bi-metallic thermostat, launch projectiles, race coasters, calculate the energy inside of a peanut, and more.

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This curriculum is aligned with the National State Standards and STEM for Science.

Educational Goals

All the different forms of energy (heat, electrical, nuclear, sound etc.) can be broken down into two categories: potential and kinetic energy.

Think of potential energy the "could" energy. The battery "could" power the flashlight. The light "could" turn on. I "could" make a sound. That ball "could" fall off the wall. That candy bar "could" give me energy. Potential energy is the energy that something has that can be released. For example, the battery has the potential energy to light the bulb of the flashlight if the flashlight is turned on and the energy is released from the battery. Your legs have the potential energy to make you hop up and down if you want to release that energy (like you do whenever it's time to do science!). The fuel in a gas tank has the potential energy to make the car move.

Kinetic energy is the energy of motion. Kinetic energy is an expression of the fact that a moving object can do work on anything it hits; it describes the amount of work the object could do as a result of its motion. Whether something is zooming, racing, spinning, rotating, speeding, flying, or diving… if it's moving, it has kinetic energy. How much energy it has depends on two important things: how fast it's going and how much it weighs. A bowling ball cruising at 100 mph has a *lot* more kinetic energy than a cotton ball moving at the same speed.

Temperature is a measure of how much kinetic energy the particles in a substance has. Temperature is measuring thermal energy which is how fast the molecules in something are vibrating and moving. The higher the temperature something has, the faster the molecules are moving. Water at 34°F has molecules moving much more slowly than water at 150°F. Temperature is really a molecular speedometer. When something feels hot to you, the molecules in that something are moving very fast. When something feels cool to you, the molecules in that object aren't moving quite so fast.

If you put an ice cube in a glass of lemonade, the ice cube melts. The thermal energy from your lemonade moves to the ice cube. Increasing the temperature of the ice cube and decreasing the temperature of your lemonade. The movement of thermal energy is called heat. The ice cube receives heat from your lemonade. Your lemonade gives heat to the ice cube. Heat can only move from an object of higher temperature to an object of lower temperature. We're going to learn about temperature, heat energy, atoms, matter, phase changes, and more in our unit on Thermodynamics.

Believe it or not, the concept of heat is really a bit tricky. What we call heat in common language, is really not what heat is as far as physics goes. Heat, in a way, doesn't exist. Nothing has heat. Things can have a temperature. They can have a thermal energy but they can't have heat. Heat is really the transfer of thermal energy. Or, in other words, the movement of thermal energy from one object to another.

Here are the scientific concepts:

- Kinetic energy is energy of motion. The faster something is moving and/or the more massive it is the more kinetic energy it has. $KE=1/2\ mv^2$
- Potential Energy is the amount of energy something can use to do work.
- Gravitational potential energy is the amount of energy something has due to its height above the ground. The higher it is and more mass it has the more gravitational potential energy it has. PE=mgh
- Energy can be transferred, in other words it can be changed from one form to another and from one object to another.
- Conservation of energy means that in a closed system energy can neither be created or destroyed.
- Energy efficiency is how much energy in a system is transferred to useless energy. The most common forms of useless energy are sound energy and heat energy.
- The amount of energy transfer needed to change temperature of matter depends on the size and properties of the substance.
- When two objects interact, each exerts a force on the other than can cause energy to be transferred.
- Energy is the ability to do work. Work is moving something against a force over a distance. Mathematically, work = force x distance. Work can be measured in Joules or calories. Power measures how quickly work can be done.
- Mathematically, power is work divided by time. Power can be measured in horsepower or Watts.
- Temperature is a measure of average kinetic energy of matter particles.
- The terms hot, cold, warm etc. describe what physicists call thermal energy. Thermal energy is how much the molecules are moving inside an object. The faster molecules move, the more thermal energy that object has.
- Temperature is basically a speedometer for molecules. The faster they are wiggling and jiggling, the higher the temperature and the higher the thermal energy that object has.
- Heat is the movement of thermal energy from one object to another.
- Heat can only flow from an object of a higher temperature to an object of a lower temperature.
- Heat can be transferred from one object to another through conduction, convection and radiation.
- Heat is movement of thermal energy from one object to another.
- When an object absorbs heat it does not necessarily change temperature.
- Heat capacity is how much heat an object can absorb before its temperature increases.
- Specific heat is how much heat energy a mass of a material must absorb before it increases 1°C. Each material has its own specific heat. The higher a material's specific heat is, the more heat it must absorb before its temperature increases.

By the end of the labs in this unit, students will be able to:

- Build a working steam boat that uses thermal energy to move through water.
- Design and build a real working external combustion Stirling engine from soda cans.
- Learn how a Hero engine works and why it's not very popular today.
- Build your own thermostat by using heat expansion properties of bi-metallic strips.
- Construct and interpret data that relate kinetic energy to the speed and mass of an object.
- Design and build an experiment that shows what happens when the arrangement of object interacting at a distances changes, and different amounts of potential energy are stored in the system.
- Show how thermal energy is transferred in an experiment while measuring mass, particle kinetic energy (temperature), and other thermal properties and how they relate to each other.
- Differentiate observation from inference (interpretation) and know scientists' explanations come partly from what they observe and partly from how they interpret their observations.
- Measure and estimate the weight, length and volume of objects.
- Formulate and justify predictions based on cause-and-effect relationships.
- Conduct multiple trials to test a prediction and draw conclusions about the relationships between predictions and results.
- Construct and interpret graphs from measurements.
- Follow a set of written instructions for a scientific investigation.

Energy Evaluation

Teacher Section

Overview: Kids will demonstrate how well they understand important key concepts from this section.

Suggested Time: 45-60 minutes

Objectives: Students will be tested on the key concepts:

- Demonstrate their knowledge of potential and kinetic energy
- Show they can identify work, power, and force in a system
- Explain their understanding of thermal energy, heat, and the laws of thermodynamics

Students will also demonstrate these principles:

1. Collecting and interpreting data from an experiment
2. Making valid observations based on their actions in lab

Materials Set 1 (one set for entire class for the lab practical)

- string
- scissors
- tape
- pencil
- pulley with 6 feet of rope
- yardstick
- wood block
- tennis ball
- large washer or hexnut

Material Set 2 (one set for each student)

- 2 marshmallows
- 3 index cards
- 2 paper drinking cups
- roll of masking tape
- 5 drinking straws
- 6 rubber bands
- 10 feet of string
- 2 paper clips
- 7 popsicle sticks
- 3 marbles
- 1 toilet paper tube

Lab Preparation

1. Print out copies of the student worksheets, lab practical, and quiz.
2. Have a tub of the materials in front of you at your desk. Kids will come up when called and demonstrate their knowledge using these materials.

Lesson

The students are taking two tests today: the quiz and the lab practical. The quiz takes about 20 minutes, and you'll find the answer key to make it easy to grade.

Energy Grade 7 Evaluation

Student Worksheet

Overview: Today you're going to take two different tests: the quiz and the lab practical. You're going to take the written quiz first, and the lab practical at the end of this lab. The lab practical isn't a paper test – it's where you get to show your teacher that you know how to do something.

Lab Test & Homework

1. Your teacher will call you up so you can share how much you understand about energy and how it works. Since science is so much more than just reading a book or circling the right answer, this is an important part of the test to find out what you really understand.
2. While you are waiting for your turn to show your teacher how much of this stuff you already know, you get to get started on your homework assignment. The assignment is due TODAY, and half the credit is for creativity and the other half is for content, so really let your imagination fly as you work through it. You will have 20 minutes to complete one of the following challenges. You may use any or all of the materials provided:

- 2 marshmallows
- 3 index cards
- 2 paper drinking cups
- roll of masking tape
- 5 drinking straws
- 6 rubber bands
- 10 feet of string
- 2 paper clips
- 7 popsicle sticks
- 3 marbles
- 1 toilet paper tube

Choose one:

a. Marshmallow Launcher Invent a device that launches a marshmallow into the air at least 6 feet high and 4 feet away from starting position.
b. Water Shift Move a cup of water across a 6 ft. by 10 ft. area without spilling any water. (You may not carry it – the water in the cup must make it across the distance on its own.)
c. Marble Run Create a free standing marble run where the marble must travel at least 10 feet and end in a cup.

Energy Grade 7 Quiz

Teacher's Answer Key

1. Temperature is measuring _____energy, which is how fast the _____ in something are vibrating and moving.(thermal, molecules or particles)
2. _____ energy is the energy of motion. (kinetic)
3. Jar lids, spiral staircases, key rings and light bulb bases are all examples of _____ that wind around themselves. (inclined planes)
4. A lever has three parts: the load, the effort and the _____ (fulcrum)
5. Potential energy is the _____ that something has that can be released. (energy)
6. Hydraulic systems use _____ under pressure to move, lift, and support loads.(fluid)
7. A _____ is a wheel with a grooved rim around which a cord passes, and it acts to change the direction of a force applied to the cord, and us used to raise heavy loads. (pulley)
8. Springs and rubber bands can store elastic _____ energy.(potential)
9. A _____ is the metric unit of work or energy, and is found using the equation: **F· d**.(Joule)
10. Power is the _____that work is done over _____.(rate, time)
11. _____ is a measure of how much kinetic energy the particles in a substance has. (temperature)
12. Energy can be transferred, but never _____ or destroyed.(created)
13. Heat flows from an object of _____ temperature to an object of _____ temperature. (higher, lower)
14. Gravitational potential energy is the amount of energy something has due to its _____ above the ground.(height)
15. When a ball is released from a height, it has a lot of _____ but not very much _____. (potential, kinetic).
16. Just before a ball hits the ground, it has more _____ energy than _____ energy. (kinetic, potential)
17. Heat _____ is how much heat an object can absorb before its temperature increases.(capacity)
18. _____ is the transfer of thermal energy.(heat)
19. Pendulums have high _____ energy at the base of the arc of its swing. (kinetic)
20. Water droplets _____ on the outside of a cold glass of lemonade on a hot day.(condense)
21. _____ is the transfer of heat caused by the movement in a fluid when a hotter and less dense material rises, and colder, denser material sinks due to gravity.(convection)
22. A pan on the stove heats up by _____ when in direct contact with an electric burner.(conduction)
23. The energy from the sun reaches us through the vacuum of space by travelling through electromagnetic waves, called _____.(radiation)
24. A force is a _____ or pull. (push)
25. The first law of thermodynamics is:
    _____.(Energy is conserved).
26. The second law of thermodynamics is:
    _____.(Heat flows from hot to cold)

BONUS QUSETION:

The six different kinds of simple machines are: _____, _____, _____, _____, _____, _____.(inclined plane, lever, wedge, wheel & axle, screw, pulley)

Energy Grade 7 Quiz

Student Quiz Sheet

Name_____

Fill in the blank:

1. Temperature is measuring _____energy, which is how fast the _____ in something are vibrating and moving.

2. _____ energy is the energy of motion.

3. Jar lids, spiral staircases, key rings and light bulb bases are all examples of _____ that wind around themselves.

4. A lever has three parts: the load, the effort and the _____.

5. Potential energy is the _____ that something has that can be released.

6. Hydraulic systems use _____ under pressure to move, lift, and support loads.

7. A _____ is a wheel with a grooved rim around which a cord passes, and it acts to change the direction of a force applied to the cord, and us used to raise heavy loads.

8. Springs and rubber bands can store elastic _____ energy.

9. A _____ is the metric unit of work or energy, and is found using the equation: **F· d**

10. Power is the _____that work is done over _____.

11. _____ is a measure of how much kinetic energy the particles in a substance has.

12. Energy can be transferred, but never _____ or destroyed.

13. Heat flows from an object of _____ temperature to an object of _____ temperature.

14. Gravitational potential energy is the amount of energy something has due to its _____ above the ground.

15. When a ball is released from a height, it has a lot of _____ but not very much _____.

16. Just before a ball hits the ground, it has more _____ energy than _____ energy.

17. Heat _____ is how much heat an object can absorb before its temperature increases.

18. _____ is the transfer of thermal energy.

19. Pendulums have high _____ energy at the base of the arc of its swing.

20. Water droplets _____ on the outside of a cold glass of lemonade on a hot day.

21. _____ is the transfer of heat caused by the movement in a fluid when a hotter and less dense material rises, and colder, denser material sinks due to gravity.

22. A pan on the stove heats up by _____ when in direct contact with an electric burner.

23. The energy from the sun reaches us through the vacuum of space by travelling through electromagnetic waves, called _____.

24. A force is a _____ or pull.

25. The first law of thermodynamics is:

_____

_____

26. The second law of thermodynamics is:

_____

_____

BONUS QUSETION:

The six different kinds of simple machines are:

_____

_____

_____

_____

_____

_____

Energy Grade 7 Lab Practical

Teacher's Answer Key

This is your chance to see how well your students have picked up on important key concepts, and if there are any holes. Your students also will be working on their homework assignment as you do this test individually with the students.

Materials:

- string
- scissors
- tape
- pencil
- pulley with 6 feet of rope
- yardstick
- wood block
- tennis ball
- large washer or hexnut

Lab Practical: Ask the student *Note: Answers given in italics!*

You will demonstrate two of the following:

1. Design an experiment that demonstrates the first law of thermodynamics.
    a. *Refer to "First Law of Thermodynamics" for ideas. Basically you are looking for them to show you how energy is always conserved, and then have them show you how energy is the ability to do work, and work is moving something against a force over a distance. Pushing a block, lifting an object, etc) are all examples of this.*
2. Design an experiment that demonstrates the second law of thermodynamics.
    a. *Refer to "Second Law of Thermodynamics" for ideas. Essentially you want to see that they can explain to you that heat only flows from a warmer object to a cooler object.*
3. Make a simple pendulum (only one bob) and identify points where the kinetic and potential energies are both highest and lowest for each.
    a. *Highest kinetic energy/lowest potential energy is at the base of the arc of the swing, and highest potential energy/lowest potential energy is at either end of the arc when the pendulum changes direction.*

Energy Grade 7 Lab Practical

Student Exam

This is your chance to see how well your students have picked up on important key concepts, and if there are any holes. Your students also will be working on their homework assignment as you do this test individually with the students.

Materials:

- string
- scissors
- tape
- pencil
- pulley with 6 feet of rope
- yardstick
- wood block
- tennis ball
- large washer or hexnut

Lab Practical:

You will demonstrate two of the following using the materials provided:

1. Design an experiment that demonstrates the first law of thermodynamics.

2. Design an experiment that demonstrates the second law of thermodynamics.

3. Make a simple pendulum and identify points where the kinetic and potential energies are both highest and lowest for each.