Energy All Around Us

Grade Level or Special Area: Eighth Grade Science
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Length of Unit: Nine lessons (approximately nine days; one day = 50 minutes)

I. ABSTRACT

In this unit the student will explore energy. They will learn about potential and kinetic energy. They will learn the different forms of energy: mechanical, chemical, electrical, thermal, electromagnetic and nuclear. They will learn about energy conversions and conservation. They will learn all this content through lecture, note taking, laboratory investigations and using mathematical equations for solving problems.

II. OVERVIEW

A. Concept Objectives
   1. Understand that energy is the most important theme to the physical sciences because all physical phenomena and interactions involve energy.

B. Content from the *Core Knowledge Sequence*—Science, 8th Grade, pp. 198 and 199
   1. Physics
      a. Energy
         i. In physics, energy is defined as the ability to do work.
         ii. Energy as distinguished from work
            a) To have energy, a thing does not have to move.
            b) Work is the transfer of energy.
         iii. Two main types of energy: kinetic and potential
            a) Some types of potential energy: gravitational, chemical, elastic
            b) Some types of kinetic energy: moving objects, heat, sound and other waves
         iv. Energy is conserved in a system.
      b. Motion
         i. Velocity and speed
            a) The velocity of an object is the rate of change of its position in a particular direction.
            b) Speed is the magnitude of velocity expressed in distance covered per unit of time.
            c) Changes in velocity can involve changes in speed or direction or both.
         ii. Average speed = total distance traveled divided by the total time elapsed
            a) Formula: Speed = Distance/Time (S = D/T)
            b) Familiar units for measuring speed: miles or kilometers per hour
      c. Forces
         i. The concept of force: force as a push or pull that produces a change in the state of motion of an object
            a) Examples of familiar forces (such as gravity, magnetic force)
            b) A force has both direction and magnitude.
            c) Measuring force: expressed in units of mass, pounds in English system, Newtons in metric system

C. Skill Objectives

1. Students will use a meter stick to measure distance.
2. Students will use a stopwatch to measure time.
3. Students will use a triple beam balance to measure the mass of several objects.
4. Students will use mathematical equations to solve velocity and acceleration problems.
5. Students will use a mathematical equation to solve averages.
6. Students will work in a cooperative group.
7. Students will make observations and collect data.
8. Students will manipulate variables in an experiment.
9. Students will analyze the results from an experiment.
10. Students will make predictions and test them.
11. Students will write a conclusion about what they have learned from the experiment.
12. Students will build a roller coaster and use it to explain the energy conversions that take place during a roller coaster ride.
13. Students will investigate properties of magnets.
14. Students will build electric circuits.
15. Students will carry out a chemical reaction between vinegar and baking soda.
16. Students will take notes on energy.
17. Students will use their notebooks to answer questions on energy in preparation for their formal assessment.
18. Students will demonstrate their knowledge and understanding of the energy unit by taking a formal assessment.

III. BACKGROUND KNOWLEDGE

A. For Teachers

None

B. For Students

None

IV. RESOURCES

None

V. LESSONS

Lesson One: Review of Velocity and Acceleration (50 minutes)

A. *Daily Objectives*

1. Concept Objective(s)
   a. Understand that energy is the most important theme to the physical sciences because all physical phenomena and interactions involve energy.
2. Lesson Content
   a. Motion
      i. Velocity and speed
         a) The velocity of an object is the rate of change of its position in a particular direction.
         b) Speed is the magnitude of velocity expressed in distance covered per unit of time.
         c) Changes in velocity can involve changes in speed or direction or both.

ii. Average speed = total distance traveled divided by the total time elapsed
    a) Formula: Speed = Distance/Time (S = D/T)
    b) Familiar units for measuring speed: miles or kilometers per hour

3. Skill Objective(s)
    a. Students will use a meter stick to measure distance.
    b. Students will use a stopwatch to measure time.
    c. Students will work in a cooperative group.
    d. Students will use mathematical equations to solve velocity and acceleration problems.
    e. Students will make observations and collect data.
    f. Students will manipulate variables in an experiment.
    g. Students will analyze the results from an experiment.

B. *Materials*
1. Copy of Appendices B and C photocopied for students
2. Appendix A transparency for teacher to give as notes to students
3. Overhead projector
4. Science notebook (one for each student)
5. Calculator (one for each student)
6. 25 dominoes (for each group of four students)
7. Meter stick (for each group of four students)
8. Stopwatch (for each group of four students)

C. *Key Vocabulary*
1. Velocity—the rate of change of an object's position in a particular direction
2. Acceleration—the change of velocity over a period of time

D. *Procedures/Activities*
1. Pre-test—Tell the students this: you turn on the radio and hear the tail end of a news story about a hurricane that is approaching land. The storm, traveling at a speed of 20 km/hr, is located 100 km east of your location. Should you be worried?
2. Allow students two minutes to come up with an answer to share with the class.
3. At the end of two minutes discuss how speed alone is not enough to help you decide whether you have to move to a safer area. You must also know the direction of the motion of the hurricane. In other words, you need to know the velocity of the hurricane.
4. Tell the students that velocity includes the speed of an object and the direction of its motion.
5. Ask the students to explain in their own words what the difference between speed and velocity is. Let them share their answers with the class.
6. Put the transparency of Appendix A on the overhead projector.
7. Allow students to write the notes on velocity in their science notebook.
8. Explain that velocity is a measure of how much distance is covered in a certain period of time, and that to calculate velocity all you have to do is take the distance traveled and divide it by the time it took to travel that distance (velocity = distance/time).
9. Pass out a copy of Appendix B (The Domino Derby) to each student.
10. Go over the procedure with the students.
11. Group the students in groups of four.
12. Pass out 25 dominoes, a meter stick and a stopwatch to each group.

13. Allow the students to work on the lab in their groups while you circle around the room. This should take about twenty minutes.
14. Allow the students to answer the two questions at the end of the lab within their group. Then pick up the lab handout to be graded.
15. Tell the students that objects, like a car, train or a person jogging, do not always travel at the same velocity. When velocity of an object changes (that includes a change in speed or direction), we say that the object accelerates.
16. Put the transparency of Appendix A on the overhead projector.
17. Allow students to write the notes on acceleration in their science notebook.
18. Pass out a copy of Appendix C to each student.
19. Allow the students to work individually or in pairs (your choice) to solve the problems. Students may use their calculators if you want them to.
20. After students have had time to work out the problems, solve the first problem on the overhead to make sure the students have done it right, then let them review their answer to the second problem and turn in their paper to you to grade.

E. *Assessment/Evaluation*
   1. Evaluate students' understanding of velocity and acceleration by grading their responses to Appendix B and Appendix C questions.

Lesson Two: Gravity Lab (50 minutes)

A. *Daily Objectives*
   1. Concept Objective(s)
      a. Understand that energy is the most important theme to the physical sciences because all physical phenomena and interactions involve energy.
   2. Lesson Content
      a. Forces
         i. The concept of force: force as a push or pull that produces a change in the state of motion of an object
            a) Examples of familiar forces (such as gravity, magnetic force)
            b) A force has both direction and magnitude.
            c) Measuring force: expressed in units of mass, pounds in English system, Newtons in metric system
   3. Skill Objective(s)
      a. Students will use a triple beam balance to measure the mass of several objects.
      b. Students will work in a cooperative group.
      c. Students will make observations and collect data.
      d. Students will manipulate variables in an experiment.
      e. Students will analyze the results form an experiment.
      f. Students will make predictions and test them.
      g. Students will write a conclusion about what they have learned from the experiment.

B. *Materials*
   1. Copy of Appendix E (Gravity Lab) for each student
   2. Appendix D transparency for teacher to give as notes to students
   3. Overhead projector
   4. Science notebook
   5. One small rock (for each group of four students)
   6. One Styrofoam ball (for each group of four students)

7. One sheet of paper (for each group of four students)
8. One triple beam balance (for each group of four students)

C. *Key Vocabulary*
1. Force—a push or pull that produces a change in the state of motion of an object
2. Gravity—the force of attraction between two objects
3. Mass—a measure of how much matter an object has (measured using a triple-beam balance)

D. *Procedures/Activities*
1. Pre-test—Ask students what a force is. Allow the students to think of the answers and ask for volunteers to share their answers.
2. Ask students what makes things fall. Allow the students to think of answers and ask for volunteers to share their answers.
3. Ask students whether things in space would fall at the same rate that they do on earth. Allow them to think of answers, then let them share their answers.
4. Talk about gravity as a force that pulls on objects.
5. Talk about how gravity depends on the masses of the objects involved and the distance the objects are from each other. For example: if you let go of a pencil, it does not stick to you but falls to the ground. Ask the students why they think that happens. Guide them to the conclusion that the Earth has a lot more mass than you, so it has a stronger gravity than you and the pencil is attracted to it more than it is attracted to you. Then ask the students why they think the moon doesn't just fall on the Earth. Let them come up with answers and discuss their answers with the class. Guide them to the conclusion that the Earth and the moon are far enough from each other that even though they are attracted to each other, the gravity between them is not enough to make the moon fall on the Earth.
6. Put the transparency of Appendix D on the overhead projector.
7. Allow students to write the notes on forces in their science notebook.
8. Pass out a copy of Appendix E (Gravity Lab) to each student.
9. Go over the procedure with the students.
10. Group the students in groups of four.
11. Pass out one Styrofoam ball, one small rock, one sheet of paper, one triple beam balance to each group of four students.
12. Allow the students to work on the lab in their groups while you circle around the room.
13. Allow the students to answer the questions in the lab within their group. Then pick up the lab handout to be graded.

E. *Assessment/Evaluation*
1. Evaluate the students' understanding of gravity by grading their responses to questions in Appendix E (Gravity Lab).

Lesson Three: Energy—Lecture and Notes (50 minutes)

A. *Daily Objectives*
1. Concept Objective(s)
   a. Understand that energy is the most important theme to the physical sciences because all physical phenomena and interactions involve energy.
2. Lesson Content from *Core Knowledge Sequence*—Science, 8th grade, pp. 199
   a. Energy
      i. In physics, energy is defined as the ability to do work.
      ii. Energy as distinguished from work

a) To have energy, a thing does not have to move.
b) Work is the transfer of energy.

iii. Two main types of energy: kinetic and potential
a) Some types of potential energy: gravitational, chemical, elastic
b) Some types of kinetic energy: moving objects, heat, sound and other waves

iv. Energy is conserved in a system.

3. Skill Objective(s)
a. Students will take notes on energy.

B. *Materials*
1. Overhead projector
2. Transparencies of Energy notes, Appendix F (pages 1-5)
3. Science notebook (students')
4. Colored pencils or colored markers (students')
5. Pencil, pen, ruler and eraser (student's supplies needed to take notes with)

C. *Key Vocabulary*
1. Energy—ability to do work
2. Work—transfer of energy
3. Potential energy—stored energy
4. Kinetic energy—energy of motion
5. Joule—metric unit used for energy

D. *Procedures/Activities*
1. Tell the students this: It is Saturday afternoon; you are lazily sitting under a tree in your backyard eating an apple and reading a book. What is allowing you to hold and read the book? What is allowing the tree you are sitting under to grow, and the sun lighting the skies to shine?
2. Allow the students a minute to think of possible answers and then discuss their answers. Try to lead them to the conclusion that energy is needed for them to be able to move and see, for the tree to grow and for the sun to shine.
3. Tell the students that today they will be taking notes on energy.
4. Ask the students to get out their science notebooks, pencil or pen, colored pencils or markers and their ruler and eraser.
5. Tell them that they should try to be as neat as possible in their notebook, so that they may use it later to get the information easily.
6. In order to make it easier to access the information in their notes, the students will be skipping lines wherever there is spacing on the overhead notes, they will be writing their headings in color and they will be putting a box around each vocabulary word in color.
7. Allow the students to get their notebook and supplies ready.
8. Ask them what they think energy is. Talk for a minute or so about what they think, then tell them that energy is the ability to do work or in other words to make things move. Tell them that when you do work on an object, like lifting a ball, that they are transferring some of their energy to that object, in our example the ball. Explain that there are two main types of energy: potential and kinetic.
9. Ask them if they have ever heard a teacher talking about a student who is not very good in school and saying that he or she has a lot of potential. What did the teacher mean by that? Probably that that particular student didn't do much at the moment, but has the ability to do more. That is the same thing with potential energy—it is energy that is not doing much for the moment, but has the potential

to do something. So anything that has stored energy or resting energy has potential energy. Anything that is in motion has kinetic energy.

10. Put the transparency of Appendix F on the overhead.
11. Allow the students to copy the notes. Remind them to use color and skip lines where appropriate.
12. Do the same with the rest of the notes.

E. *Assessment/Evaluation*
   1. Collect and grade science notebook for neatness and completeness.

Lesson Four: Pendulum Lab--Potential and Kinetic Energy (50 minutes)

A. *Daily Objectives*
   1. Concept Objective(s)
      a. Understand that energy is the most important theme to the physical sciences because all physical phenomena and interactions involve energy.
   2. Lesson Content
      a. Energy
         i. In physics, energy is defined as the ability to do work.
         ii. Energy as distinguished from work
            a) To have energy, a thing does not have to move.
            b) Work is the transfer of energy.
         iii. Two main types of energy: kinetic and potential
            a) Some types of potential energy: gravitational, chemical, elastic
            b) Some types of kinetic energy: moving objects, heat, sound and other waves
         iv. Energy is conserved in a system.
   3. Skill Objective(s)
      a. Students will use a triple beam balance to measure the mass of several objects.
      b. Students will work in a cooperative group.
      c. Students will make observations and collect data.
      d. Students will manipulate variables in an experiment.
      e. Students will analyze the results form an experiment.
      f. Students will make predictions and test them.
      g. Students will write a conclusion about what they have learned from the experiment.
      h. Students will use a mathematical equation to solve averages.

B. *Materials*—for each group of four students
   1. One meter length of cord
   2. Four washers
   3. Ring stand
   4. Meter stick
   5. Calculator
   6. Triple beam balance
   7. Copy of Appendix G—Investigating Factors Affecting a Pendulum

C. *Key Vocabulary*
   1. Pendulum—a weight hung from a fixed point so that it is free to swing to and fro

D. *Procedures/Activities*
   1. Ask the students what makes a Grandfather's clock work. Let the students think of answers then discuss the answers with the class. Since this unit is on energy,

hopefully the students' answers with have something to do with energy. If not, guide the students to talk about potential energy and kinetic energy.

2. Pass a copy of Appendix G, Investigating Factors Affecting a Pendulum, to each student.
3. Group the students in groups of four.
4. Pass out one-meter length of cord, four washers, one ring stand, and one triple beam balance to each group of four students.
5. Allow the students to work on the lab in their groups while you circle around the room.
6. Allow the students to answer the questions in the lab within their group. Then pick up the lab handout to be graded.

Enrichment for Gifted students:

1. Give students Appendix G, page 4 (Experimentally finding the acceleration due to gravity!)
2. Tell students that using their experimental results from the pendulum lab, they will use the equation, $T = 2\pi\sqrt{(L/g)}$, to solve for g, which is the gravitational constant on Earth.
3. Tell them they will need to compare their value to the known value of the gravitational acceleration 9.81 m/s^2

E. *Assessment/Evaluation*

1. Evaluate the students' understanding of the factors affecting pendulum motion by grading their responses to questions in Appendix G, pp.1, 2 and 3 (Investigating Factors Affecting a Pendulum).

Lesson Five: Energy Forms, Conversions and Conservation Notes (50 minutes)

A. *Daily Objectives*

1. Concept Objective(s)
   a. Understand that energy is the most important theme to the physical sciences because all physical phenomena and interactions involve energy.
2. Lesson Content from *Core Knowledge Sequence*—Science, 8th grade, pp. 199
   a. Energy
      i. In physics, energy is defined as the ability to do work.
      ii. Energy as distinguished from work
         a) To have energy, a thing does not have to move.
         b) Work is the transfer of energy.
      iii. Two main types of energy: kinetic and potential
         a) Some types of potential energy: gravitational, chemical, elastic
         b) Some types of kinetic energy: moving objects, heat, sound and other waves
      iv. Energy is conserved in a system.
3. Skill Objective(s)
   a. Students will take notes on energy.

B. *Materials*

1. Overhead projector
2. Transparencies of Energy notes, Appendix H, pp. 1 - 5
3. Science notebook (students')
4. Colored pencils or colored markers (students')
5. Pencil, pen, ruler and eraser

C. *Key Vocabulary*
   1. Energy conversion—a change of one form of energy into another
   2. The law of conservation of energy—energy can not be created or destroyed, but may be changed form one form into another

D. *Procedures/Activities*
   1. Tell the students this: they say breakfast is the most important meal of the day; why is that?
   2. Allow the students a minute to think of possible answers and then discuss their answers. Try to lead them to the conclusion that energy is needed for them to be able to move, think, etc. The food they eat provides the energy they need to grow and develop.
   3. Tell the students that today they will be taking notes on energy conversions, which are the changes in energy.
   4. Ask the students to get out their science notebooks, pencil or pen, colored pencils or markers and their ruler and eraser.
   5. Remind them that they should try to be as neat as possible in their notebook, so that they may use it later to get the information easily.
   6. Remind them, that in order to make it easier to access the information in their notes, the students will be skipping lines wherever there is spacing on the overhead notes, they will be writing their headings in color and they will be putting a box around each vocabulary word in color.
   7. Allow the students to get their notebook and supplies ready.
   8. Use transparencies of Appendix H to give the students the notes.
   9. As you put the transparencies on the overhead, talk briefly about what the students are writing.
   10. Allow the students to copy the notes. Remind them to use color and skip lines where appropriate.
   11. Collect and grade the notebooks.

E. *Assessment/Evaluation*
   1. Collect and grade science notebook for neatness and completeness.

Lesson Six: Roller Coaster Lab (50 minutes)

A. *Daily Objectives*
   1. Concept Objective(s)
      a. Understand that energy is the most important theme to the physical sciences because all physical phenomena and interactions involve energy.
   2. Lesson Content from *Core Knowledge Sequence*—Science, 8th grade, pp. 199
      a. Energy
         i. In physics, energy is defined as the ability to do work.
         ii. Energy as distinguished from work
            a) To have energy, a thing does not have to move.
            b) Work is the transfer of energy.
         iii. Two main types of energy: kinetic and potential
            a) Some types of potential energy: gravitational, chemical, elastic
            b) Some types of kinetic energy: moving objects, heat, sound and other waves
         iv. Energy is conserved in a system.
   3. Skill Objective(s)
      a. Students will work in a cooperative group.

b. Students will make observations and collect data.
c. Students will manipulate variables in an experiment.
d. Students will analyze the results form an experiment.
e. Students will make predictions and test them.
f. Students will write a conclusion about what they have learned from the experiment.
g. Students will build a roller coaster and use it to explain the energy conversions that take place during a roller coaster ride.

B. *Materials*
1. One roll of masking tape (for each group of four students)
2. Six meters of pipe insulation tubing (for each group of four students)
3. One marble (for each group of four students)
4. Copies of Appendix I, pp. 1 and 2 (Rollercoaster Lab)

C. *Key Vocabulary*
1. Velocity—the distance covered per unit of time
2. Acceleration—change in velocity per unit of time
3. Potential energy—stored energy
4. Kinetic energy—energy of motion
5. Energy conversion—changes of one form of energy into another
6. Law of conservation of energy—total amount of energy in a system is constant

D. *Procedures/Activities*
1. Tell the students that they have been hired to build a rollercoaster for your amusement park.
2. Ask them what makes a rollercoaster ride exciting. Let them share their answers with the class.
3. Tell them that they will be building a rollercoaster out of tubing and masking tape. They will have to design and build the most fun and safest rollercoaster ride for a marble.
4. Pass out Appendix I (Rollercoaster Lab) to each student.
5. Go over the procedures with the students.
6. Tell them they must use all six meters of tubing provided for the track, and they may use as much masking tape as they think necessary, keeping in mind that more tape means more friction and therefore slower ride.
7. Tell them that they will only get one marble, so they must know where it is at all times.
8. Tell them that the marble must make it safely (that is without leaving the track) from the beginning to the end of the track.
9. Let the students design and build the rollercoaster while you move around the room.
10. When they are done, let the different groups walk around the classroom and check out the other rollercoasters.

E. *Assessment/Evaluation*
1. Evaluate the students' understanding of the energy conversion involved in a rollercoaster ride by grading their responses to questions in Appendix I, pp. 1 and 2 (Rollercoaster Lab).
2. Evaluate students' rollercoaster design and safety by allowing the students to demonstrate their marble's completion of their track from beginning to end without falling off.

Lesson Seven: Energy Forms and Conversions Lab (50 minutes)

A. *Daily Objectives*
   1. Concept Objective(s)
      a. Understand that energy is the most important theme to the physical sciences because all physical phenomena and interactions involve energy.
   2. Lesson Content from *Core Knowledge Sequence*—Science, 8th grade, pp. 199
      a. Energy
         i. In physics, energy is defined as the ability to do work.
         ii. Energy as distinguished from work
            a) To have energy, a thing does not have to move.
            b) Work is the transfer of energy.
         iii. Two main types of energy: kinetic and potential
            a) Some types of potential energy: gravitational, chemical, elastic
            b) Some types of kinetic energy: moving objects, heat, sound and other waves
         iv. Energy is conserved in a system.
   3. Skill Objective(s)
      a. Students will work in a cooperative group.
      b. Students will make observations and collect data.
      c. Students will manipulate variables in an experiment.
      d. Students will analyze the results form an experiment.
      e. Students will make predictions and test them.
      f. Students will write a conclusion about what they have learned from the experiment.
      g. Students will investigate properties of magnets.
      h. Students will build electric circuits.
      i. Students will carry out a chemical reaction between vinegar and baking soda.

B. *Materials* (for each group of four students)
   1. Two bar magnets
   2. Two tea spoons of iron filings in a sealed Petri dish (seal with masking tape)
   3. One D battery
   4. One small light bulb
   5. Four 15 cm pieces of bell wire, with alligator clips attached to both ends of each wire
   6. One small motor
   7. One table spoon of baking soda
   8. One coffee filter paper
   9. 50 ml of vinegar
   10. One 250-ml flask with stopper
   11. One radiometer
   12. One lamp
   13. Copies of Appendix J (Energy Forms and Conversions Lab) for each student

C. *Key Vocabulary*
   1. Energy—ability to do work
   2. Chemical energy—energy stored in the bonds between atoms
   3. Thermal energy—heat energy
   4. Mechanical energy—energy associated with motion of objects
   5. Electrical energy—energy associated with motion of electrons

6. Electromagnetic energy—energy associated with the motion of waves
7. Nuclear energy—energy stored in the nucleus of an atom
8. Energy conversion—changes of one form of energy into another

D. *Procedures/Activities*

1. Ask the students where they think the energy they use to cook their food comes from. Let the students think of answers then discuss the answers with the class. Guide the students to talk about the changes in energy that occurs to make it possible for them to cook food—Energy from the sun allows plants to grow. Over millions of years the plants are fossilized and turn to coal which we burn to change water into steam which turns a turbine and makes electricity that we use to heat our food.
2. Pass a copy of Appendix J, Energy Forms and Conversions Lab, to each student.
3. Group the students in groups of four.
4. Pass out a tray containing the materials listed in the materials section above to each group of four students.
5. Allow the students to work on the lab in their groups while you circle around the room.
6. Allow the students to answer the questions in the lab within their group. Then pick up the lab handout to be graded.

E. *Assessment/Evaluation*

1. Evaluated students' understanding of energy forms and conversions by grading Appendix J (Energy Forms and Conversions Lab)

Lesson Eight: Energy Unit Review (50 minutes)

A. *Daily Objectives*

1. Concept Objective(s)
   a. Understand that energy is the most important theme to the physical sciences because all physical phenomena and interactions involve energy.
2. Lesson Content from *Core Knowledge Sequence*—Science, 8th grade, pp. 199
   a. Energy
      i. In physics, energy is defined as the ability to do work.
      ii. Energy as distinguished from work
         a) To have energy, a thing does not have to move.
         b) Work is the transfer of energy.
      iii. Two main types of energy: kinetic and potential
         a) Some types of potential energy: gravitational, chemical, elastic
         b) Some types of kinetic energy: moving objects, heat, sound and other waves
      iv. Energy is conserved in a system.
3. Skill Objective(s)
   a. Students will use their notebooks to answer questions on energy in preparation for their formal assessment.

B. *Materials*

1. Copy of Appendix K, pp. 1-5 (Energy Unit Review) for each student

C. *Key Vocabulary*

All vocabulary used in Lessons One through Seven

D. *Procedures/Activities*

1. Tell the students that tomorrow they are going to take a written test on all the material they covered in the energy unit.

2. Tell them that in order to prepare them for the test, you have prepared a review for them. They will be able to use their notes to answer the questions in the review, but they will not be able to use their notes on the real test.
3. Tell them that they should try to do the review without the use of their notebook first and that if they get stuck then they should find the answers in their notebook—this way they will know how much studying they need to do.
4. Allow the students time to answer the questions on the review. Let the students keep the review to turn in before the test tomorrow.

E. *Assessment/Evaluation*
1. Grade the energy review.

Lesson Nine: Unit Test on Energy (50 minutes)

A. *Daily Objectives*
1. Concept Objective(s)
   a. Understand that energy is the most important theme to the physical sciences because all physical phenomena and interactions involve energy.
2. Lesson Content from *Core Knowledge Sequence*—Science, 8th grade, pp. 199
   a. Energy
      i. In physics, energy is defined as the ability to do work.
      ii. Energy as distinguished from work
         a) To have energy, a thing does not have to move.
         b) Work is the transfer of energy.
      iii. Two main types of energy: kinetic and potential
         a) Some types of potential energy: gravitational, chemical, elastic
         b) Some types of kinetic energy: moving objects, heat, sound and other waves
      iv. Energy is conserved in a system.
3. Skill Objective(s)
   a. Students will demonstrate their knowledge and understanding of the energy unit by taking a formal assessment.

B. *Materials*
1. Copies of Appendix L, pp. 1 and 2 (Energy Unit Test) for each student

C. *Key Vocabulary*
None

D. *Procedures/Activities*
1. Ask students if they have any last minute questions on energy. If they do, then answer the questions for them.
2. Let students sharpen pencils if they need to.
3. Tell the students that they may not leave their seats while others are still working on the test.
4. Pass out copies of Appendix L to each student.
5. Allow the students to work on the test while you monitor.

E. *Assessment/Evaluation*
1. Grade the test to evaluate student's understanding of the energy unit.

VI. CULMINATING ACTIVITY

A. Appendix J—Performance Assessment on energy unit (Energy Forms and Conversions Lab)
B. Appendix L—Formal Assessment on energy unit (Energy Unit Test)

VII. HANDOUTS/WORKSHEETS

A. Appendix A: Review Notes on Velocity and Acceleration
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C. Appendix C: Calculating Acceleration Problems
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Appendix A
(Lesson One)

Review Notes on Velocity and Acceleration

Velocity is the distance covered in a period of time.

V = d/ t units of meter/ second (m/s)

where V = velocity, d= distance traveled and t = time

Most things do not move at constant velocity. When velocity changes, an object is said to have accelerated. Acceleration is the change of Velocity over a period of time.

a = ΔV/t unit of meter/ seconds^2 (m/s^2)

where a = acceleration, ΔV = change in velocity = (final velocity – initial velocity), t = time

Appendix B
(Lesson One)

The Domino Derby

Speed is the rate at which an object moves. In this activity, you will determine the factors that affect the speed of falling dominoes.

Procedure

1. Set up 25 dominoes in a straight line. Try to keep equal spacing between the dominoes.

2. Using a meter stick, measure the total length of your row of dominoes, and write it down.

3. Using the stopwatch, time how long it takes for the entire row of dominoes to fall. Record this measurement.

4. Repeat steps 2 and 3 several times, using distances between the dominoes that are smaller and larger than the distance used in your first setup.

Analysis

1. Calculate the average speed for each trial by dividing the total distance (length of the domino row) by the time taken to fall.

   $$\textit{Velocity} = \frac{\textit{Distance}}{\text{Time}} =$$

2. How did the spacing between dominoes affect the average speed? Is this result what you expected? If not, explain.

(adapted from *Forces, Motion and Energy* by Holt, Rinehart and Winston)

Calculating Acceleration

Use the equation for Acceleration ($a = \Delta V/t$) to do the following problems. Be sure to express your answer in units of m/s^2.

1. A plane passes over Point A with a velocity of 8,000 m/s north. Forty seconds later it passes over Point B at a velocity of 10,000 m/s north. What is the plane's acceleration from A to B?

2. A coconut falls from the top of a tree and reaches a velocity of 19.6 m/s when it hits the ground. It takes 2 seconds to reach the ground. What is the coconut's acceleration?

(adapted from *Forces, Motion and Energy* by Holt, Rinehart and Winston)

Calculating Acceleration—Answer Key

Use the equation for Acceleration ($a = \Delta V/t$) to do the following problems. Be sure to express your answer in units of m/s^2.

1. A plane passes over Point A with a velocity of 8,000 m/s north. Forty seconds later it passes over Point B at a velocity of 10,000 m/s north. What is the plane's acceleration from A to B?

   Acceleration = change in velocity /time

   $$a = \frac{\Delta V}{t} = \frac{\text{(final velocity – initial velocity)}}{\text{time}}$$

   $$= \frac{\text{(10,000 m/s – 8000 m/s)}}{\text{40 s}}$$

   $$= \frac{\text{2,000 m/s}}{\text{40 s}} = \text{50 m/s}^2 \text{ north}$$

2. A coconut falls from the top of a tree and reaches a velocity of 19.6 m/s when it hits the ground. It takes 2 seconds to reach the ground. What is the coconut's acceleration?

   $$a = \frac{\Delta V}{t} = \frac{\text{(final velocity – initial velocity)}}{\text{time}}$$

   $$= \frac{\text{(19.6 m/s – 0 m/s)}}{\text{2 s}} = \frac{\text{19.6 m/s}}{\text{2 s}}$$

   = 9.8 m/s^2 downward
   (some students may recognize this as the acceleration due to gravity which will be next lesson's topic)

(adapted from *Forces, Motion and Energy* by Holt, Rinehart and Winston)

Appendix D
(Lesson Two)

Review Notes on Forces

Force is a push or a pull

*F = m a units of kilogram * meter/ second^2 (kg m/s^2), equivalent to a Newton (N)*

where F = force, m = mass and a = acceleration

Gravity is a force of attraction between two objects

F_g = m g units of Newton (N)

where Fg = the force due to gravity, m is the mass of the object and g is the gravitational acceleration which is equal to 9.82 m/s^2

Gravity depends on the mass of the objects involved and the distance between them:

a. The farther away the objects are from each other, the weaker the gravitational force between them.

b. The more mass an object has, the greater its gravitational force.

GRAVITY LAB

INTRODUCTION

Legend has it that in the late 1500s, the famous Italian scientist Galileo dropped two cannonballs at exactly the same time from the top of the leaning Tower of Pisa in Italy. One cannonball had ten times the mass of the other cannonball. According to the scientific theories of that day, the more massive ball should have landed first. But Galileo felt that this was not correct. He believed that the cannonballs would land at the same time. Who had the correct hypothesis—the people who believed the heavier ball would land first- or Galileo?

What is your hypothesis?

PROBLEM: Does an object's mass affect its rate of fall?

MATERIALS

One small rock
One Styrofoam ball
One sheet of paper
One triple beam balance

PROCEDURE

1. Use the triple beam balance to determine the masses of the rock, Styrofoam ball and paper. Record each mass to the nearest 0.1 gram in Data Table 1.
2. Hold the rock and the Styrofoam ball horizontally at arm's length. The largest surface area of each object should be parallel to the ground.
3. Release both rock and Styrofoam ball at the same time. Observe if they land at the same time or if one hits the ground before the other. Record your observations under Trial 1 in Data Table 2.
4. Repeat step 3. Record results under Trial 2 in Data Table 2.
5. Repeat steps 2 to 4 for the Styrofoam ball and the flat piece of paper.
6. Repeat steps 2 to 4 for the rock and the flat piece of paper.
7. Crumple that paper into a tight ball.
8. Compare the falling rates of the crumpled paper and the Styrofoam ball. Record your results.
9. Compare the falling rates of the crumpled paper and the rock. Record your results.

DATA AND OBSERVATIONS

Data Table 1

Object	Mass (g)
Styrofoam ball	
Rock	
Flat piece of paper	
Crumples piece of paper	

Data Table 2

Objects released at the same time and from the same distance	Trial 1 Rate of fall-- same/different	Trial 2 Rate of fall-- same/different
Rock and Styrofoam ball		
Styrofoam ball and flat paper		
Rock and flat paper		
Styrofoam ball and crumpled paper		
Rock and crumpled paper		

1. Which reaches the ground first, the rock or the piece of Styrofoam?
   Are the results the same in each trial?

2. Which reaches the ground first, the piece of Styrofoam or the flat piece of paper?
   Are the results the same in each trial?

3. Which reaches the ground first, the rock or the flat piece of paper?
   Are the results the same in each trial?

4. Which reaches the ground first, the piece of Styrofoam or the crumpled paper?
   Are the results the same in each trial?

5. Which reaches the ground first, the rock or the crumpled paper?
   Are the results the same in each trial?

ANALYSIS AND CONCLUSIONS

1. Galileo stated that two bodies with different masses fall at the same rate. Do your observations verify his hypothesis?
   Explain your answer.

2. What object you worked with did not verify Galileo's hypothesis?
   Why do you think this is?

3. Did crumpling the paper have any effect on its falling rate?
   Why or why not?

4. Why do you think the flat piece of paper did not fall at the same rate as the piece of Styrofoam, rock or crumpled piece of paper?

5. When you first think about two objects falling to the ground, it seems as if the heavier object would hit the ground before the lighter object. We have proved that this is not so – for example a heavy rock and a light rock would hit the ground at the same time. Why do you think this is true?

6. What do you think gravity is?

7. List at least two conclusions that you have come up with during this lab.

(adapted from a lesson written by Kris Kilburn, Hodgkins Middle School)

Energy Notes

Energy is all around you. You can hear it as sound, you can see it as light, and you can feel it as wind.

All living things need energy for growth and movement.

- ***Energy*** -- the ability to do work!
- ***Work***--the transfer of energy
- When you do work on something, you transfer energy to it.
- Work is expressed as the product of a force and distance covered.
- Work = Force * Distance

Types of Energy

- **Potential energy**—stored energy
- **Kinetic energy**—energy of motion

Potential Energy

- Potential energy—*the energy an object has because of its position, shape or composition.*

- Mathematically, it is generally expressed as:

PE = Weight * Height

Sometimes when you transfer energy to an object you change its position or shape. This energy is stored and held in readiness. This kind of energy is Potential energy, P.E.—it has the potential to do work.

Elastic Potential Energy—*the P.E. associated with objects that can be stretched or compressed (rubber band, bow and arrow, spring, etc)*

Gravitational Potential Energy—*the P.E. that is dependent on height (A rock resting at the top of a hill contains gravitational potential energy. Hydropower, such as water in a reservoir behind a dam, is an example of gravitational potential energy)*

Kinetic Energy

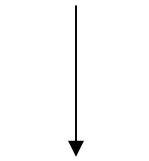
- **Kinetic energy**—*the energy of motion*
- Mathematically, it is generally expressed as:

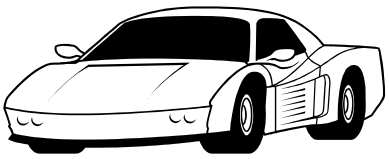
$$KE = \frac{1}{2} * mass * Velocity^2$$

The Kinetic energy (K.E) of an object depends on both its mass and its velocity.

Example 1:

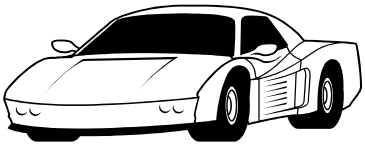
Soccer ball





New Car

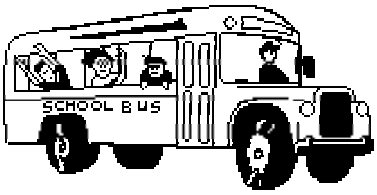
Bowling ball



New Car

Which ball would you rather hit your new car?
Which ball has more mass?
Which ball has more energy?

Example 2:



School bus moving at 5 km/hr

bike moving at 5 km/hr

Will the bus or the bike cause more damage? Which one has more energy?

The more mass an object has, the more energy it has, and the more work it can do.

As mass increases, KE increases

Example 3:

Car 1 moving at 5 km/hr

Car 2 moving at 20 km/hr

Which car is moving faster?
Which car can do more work?
Which car has more energy?

The faster an object moves, the more KE it has.

As velocity increases, KE increases

Investigating Factors Affecting a Pendulum

Background Information

A pendulum demonstrates many of the laws of physics. Several related factors affect the behavior of the pendulum. These factors include the length of the arc, the length of the pendulum, the mass, and the number of swings per minute. In this investigation you will study the behavior of a pendulum as several factors are changed.

Problem

How do various factors affect the behavior of a pendulum?

Materials

1-meter length of cord
Four washers (the bigger sizes are better to use)
Ring stand
Meter stick

Procedure

1. Use a triple beam balance to measure the mass of four washers and one washer. Record your measurements in Data Table 1.

2. Tie a cord at least 1 meter in length to a ring stand so that it can swing freely. Attach four washers securely at the end of the cord.

3. Start the mass swinging by releasing it from a measured height of 50 cm above its lowest point. Count the number of swings in 10 seconds and multiply by 6 to obtain the number of swings in 1 minute. Record your answer in the Data Table 2. Repeat twice more and take an average for the number of swings per minute (you get the average by adding the three trials and dividing by three).

4. Raise the pendulum to a height of 25 cm above the lowest point. Release the mass. Again count the number of swings in 10 seconds and multiply by 6 to obtain the number of swings in 1 min. Repeat twice more and take an average for the number of swings in minutes.

5. Reduce the length of the cord by one half. Repeat steps 3 and 4 using the half cord length.

6. Remove the four washers and replace them with 1 washer. Repeat steps 2 through 5 using the one washer.

Appendix G, page 2
(Lesson Four)

Observations

Data Table 1

Objects	Mass (g)
4 washers	
1 washer	

Data Table 2

	Swings per minute Trial 1	Swings per minute Trial 2	Swings per minute Trial 3	Swings per minute Average
4 washers, full length of cord, raised to 50 cm				
4 washers, full length of cord, raised to 25 cm				
4 washers, half length of cord, raised to 25 cm				
1 washer, full length of cord, raised to 50 cm				
1 washer, full length of cord, raised to 25 cm				
1 washer, half length of cord, raised to 25 cm				

Average number of Swings per minute $= \frac{(\text{Trial 1} + \text{Trial 2} + \text{Trial 3})}{3}$

Analysis and Conclusion

1. By changing the height from which the mass is released in step 4, you change the length of the swing. How does the length of the swing affect the number of swings in 1 minute?

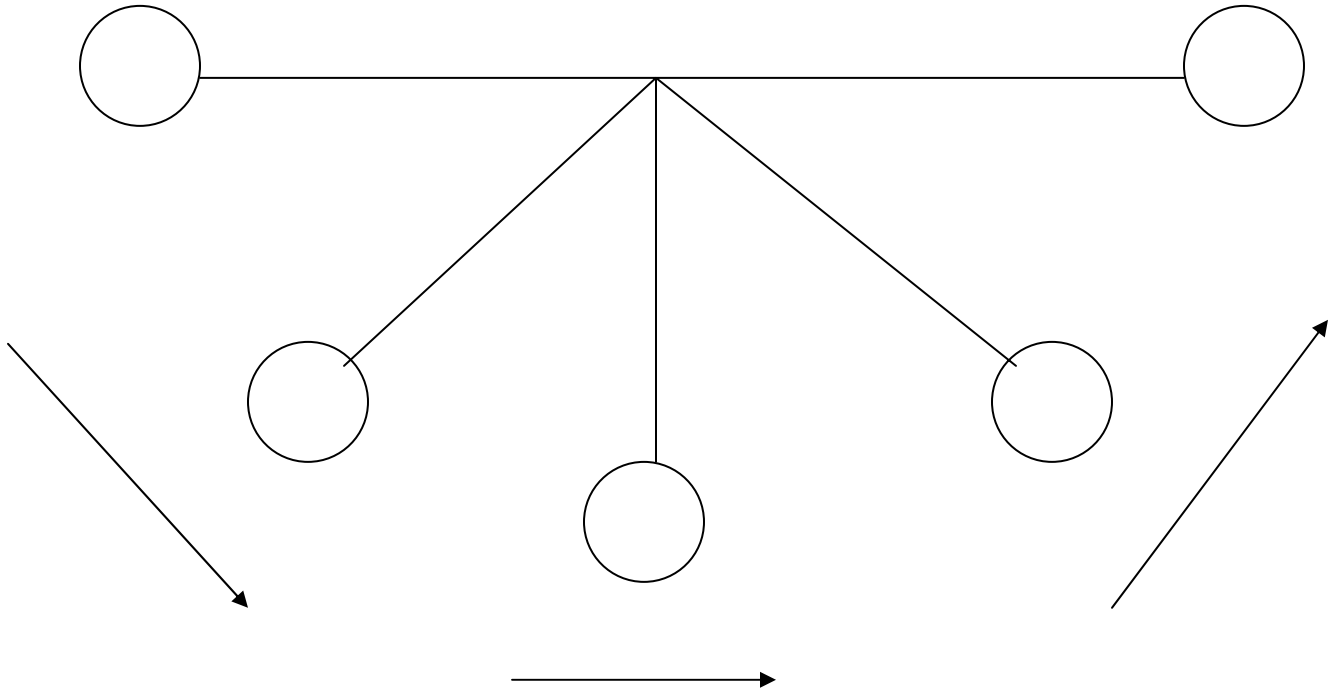
2. How does the mass of the pendulum affect the number of swings in 1 minute?

3. How does the length of the cord affect the number of swings in 1 minute?

Appendix G, page 3
(Lesson Four)

Critical Thinking

1. Based on what you know about free fall, why does the mass of a pendulum not affect the number of swings per minute?



Put P on the diagram, where there is maximum PE
Put K on the diagram, where there is maximum KE
Put I on the diagram, where KE increases and PE decreases
Put D on the diagram, where KE decreases and PE increases

(adapted from *Forces, Motion and Energy* by Holt, Rinehart and Winston)

Enrichment Activity for Gifted Students

Experimentally finding the acceleration due to gravity!

Here is a challenge for you! Use your results from the pendulum lab and a basic physics equation to estimate the acceleration due to gravity. Compare the results to the known value of 9.81 m/s^2

Equation to use to calculate gravity:

$T = 2\pi \sqrt{(L/g)}$

Where $\sqrt{(L/g)}$ means to take the square root of (L/g), T = period of a swing (the time required for the pendulum mass to make one cycle—i.e. a full swing), L = the length of the pendulum string, g = gravity, $\pi = 3.14$.

(adapted from a lab written by Matt Krugman, Colorado School of Mines)

Energy Conversion and Conservation Notes

Total Energy

- Total energy must be conserved
- Energy $_{total}$ = KE + PE

Energy Conversion and Conservation

Any form of energy can be converted into other forms of energy.

Energy Conversion—a change from one form of energy into another form of energy

The Law of Conservation of Energy—states that energy cannot be created or destroyed, but may change from one form to another

The total amount of energy before and after any process is the same (i.e. the total amount of energy in the universe is constant).

Albert Einstein added a small change to the law of conservation of energy. He added that matter and energy may be converted into one another using the following equation:

$$E = m c^2$$

where E = energy, m = mass and c= the speed of light.

Forms of Energy

Both KE and PE have different forms.

There are six major forms of energy:

1. Mechanical
2. Thermal (heat)
3. Chemical
4. Electrical
5. Electromagnetic
6. Nuclear

I. Mechanical Energy—energy associated with the motion of an object.

Ex: school bus ride, flying bird, wind, sound, leaping frog, and heart pumping

II. Thermal Energy—energy associated with the motion of atoms and molecules.

Ex: melting ice, heat from the sun

III. Chemical Energy—energy stored in chemical bonds that hold compounds together.

Ex: an apple, charcoal, rocket fuel and gasoline

IV. Electrical Energy—energy associated with the motion of electrons

Ex: TV, computer, iron and toaster

V. Electromagnetic Energy—energy associated with wave movement

Ex: visible light, UV radiation, microwaves, IR radiation

VI. Nuclear Energy—PE that is stored in the core or nucleus of an atom

Nuclear Fission—occurs when a nucleus of an atom splits

Nuclear Fusion—occurs when two nuclei fuse together

Ex: nuclear power plant, nuclear bomb, the sun and other stars

Roller Coasters

You and your partners have been hired by the Peterson Amusement Park to design an exciting roller coaster.

What makes an exciting roller coaster?

When you design your roller coaster, you will want to make sure it is safe for the riders. The rider in this case will be a marble. Design your roller coaster so that it would be an adventure (but safe) for the marble.

Project Rules

1. Your first hill may not be higher than 2 meters in height.
2. Your vehicle must complete the entire track without stopping or falling off. Once you have placed your vehicle on top of the first hill, you cannot add any energy to the system to help your vehicle complete its route.
3. Before you begin building your roller coaster, make a sketch of your basic track.
4. You must be able to apply key terms such as kinetic energy, potential energy, acceleration, and velocity to the description of your roller coaster.

Draw your first design:

Appendix I, page 2
(Lesson Six)

Construct your roller coaster using the tubing and tape. Try it by releasing the marble at the beginning of the ride. Change your design until you have a successful, safe and exciting roller coaster.

Draw your final design below. Label points that show: the point of maximum potential energy, the point of maximum kinetic energy, the distances between hills, the height of each hill, where the marble's velocity increases (marble accelerates), where the marble's velocity decreases.

Questions

1. A student plans to build a roller coaster in which his second hill is taller than his first hill. Would it be possible for his vehicle to complete the track? Why or why not?

2. A student plans to build a roller coaster in which his first and second hills are of equal height. Would be possible for his vehicle to complete the track? Why or why not?

3. A student plans to build a roller coaster in which his third hill is taller than his second hill. Would it be possible for his vehicle to complete the track? Why or why not?

Write a five-sentence paragraph summary of your experience as a marble.

(adapted from a lab written by Amy Nichols)

Appendix J, page 1
(Lesson Seven)

Energy Forms and Conversions Lab

Objectives:

1. To identify different types of energy
2. To discover how energy can be converted from one form to another

Materials:

A tray containing the following:

Two bar magnets
Two tea spoons of iron filings in a sealed Petri dish
One D battery
One small light bulb
Four 15 cm pieces of bell wire, with alligator clips attached to both ends of each wire
One small motor
One table spoon of baking soda
One coffee filter paper
50 ml of vinegar
One 250-ml flask with stopper
One radiometer
One lamp

Section One—Magnets

1. Take out your bar magnets. What generalizations can you make about the reaction between "like" poles?

2. What generalizations can you make about the reaction between "unlike" poles?

3. Move the south end of your magnet across the top of the container with the iron filings. What happens?

4. Move the north end you magnet across the top of the container with the iron filings. What happens?

5. What forms of energy did you observe in this section?

Appendix J, page 2
(Lesson Seven)

Section Two—Electricity

1. Take out the small light bulb, the D battery, and two wires with the attached alligator clips.
2. Connect one end of each wire to the battery.
3. Connect the other end of each wire to the small light bulb.
4. What happens?

5. Take out the small motor.
6. Replace the small bulb with the motor.
7. What happens?

8. What forms of energy did you observe in this section?

9. What energy conversions took place in this section?

Section Four—Chemical Energy

1. Fill your coffee filter paper with the table spoon of sodium bicarbonate.
2. Place you filter paper filled with sodium bicarbonate into the flask containing acetic acid.
3. Immediately place e stopper on the flask.
4. Step back and watch.
5. What happens?

6. What forms of energy did you observe in this section?

7. What energy conversions took place in this section?

Section Five—Thermal Energy

1. Take out your radiometer and lamp.

2. Turn on the lamp

3. Place the radiometer in front of the lamp so that the light shines on it.

4. What happens?

5. What forms of energy takes place in this section?

6. What energy conversions took place in this section?

ENERGY REVIEW

1. What is energy?

POTENTIAL AND KINETIC

1. What is potential energy?
2. What is kinetic energy?

True or False

____ Kinetic energy is another word for stored up energy.
____ A moving truck has kinetic energy.
____ If you climb up a ladder your potential energy increases.
____ A battery which is not attached to anything demonstrates that it has kinetic energy.
____ As an airplane picks up speed, its kinetic energy increases.

Fill in the blank that best completes each statement.

1. Energy is the ability to do _____.
2. Energy of motion is known as _____energy.
3. Work is said to be going on whenever something is made to _____.
4. When a bow and arrow is held, just before it is released, are looking at an example of _____ energy.
5. Potential energy is a name for _____ energy.
6. As a roller coaster climbs the first hill, its potential energy _____.
7. Suppose you decide to dive into a swimming pool. From the peak of your dive until you hit the water, your _____ energy increases.
8. Your beating heart is an example of _____ energy.
9. The greater the number of volts in a battery, the greater its _____ energy.
10. An unlit match has _____ energy.

For each of the following situations, state whether the potential energy and kinetic energy increase, decrease, or stay the same.

An elevator descends from the 10th floor to the 3rd floor at a constant rate.
PE _____ KE _____

A rocket ship blasts off for outer space with an increasing speed.
PE _____ KE _____

A train moves along a track at a steady speed of 150 km/hr.
PE _____ KE _____

A roller coaster comes down its first hill.
PE _____ KE _____

FORMS OF ENERGY

Match the form of energy with the correct definition.

1. Energy that occurs when the temperature changes.
2. Energy that occurs when one kind of matter changes into another kind of matter.
3. Energy related to the flow of electrons.
4. Energy related to changes in the nucleus of an atom.
5. Energy related to movement.
6. Radiant energy.

_____ Chemical energy
_____ Nuclear energy
_____ Electrical energy
_____ Electromagnetic energy
_____ Thermal energy
_____ Mechanical energy

How do each of these forms of energy relate to potential and kinetic energy?

a. They can all exist in the potential energy state or the kinetic energy state.
b. They don't relate.
c. They can only exist in the potential energy state.
d. They can only exist in the kinetic energy state.

Each of the following items is a particular form of energy. Write the energy form of each item in the blank.

The rusting of an iron fence. _____

A hydrogen bomb._____

A star twinkles at night. _____

The spark seen as you walk across a carpet and touch someone.

_____

The music you hear when you're listening to your radio. _____

The change in temperature you feel when you rub your hands together.

_____

ENERGY CONVERSIONS

What is energy conversion?

Write in the form of energy that best completes the statement.

1. When you listen to your radio, _____ energy is converted into _____ energy.
2. To make food for itself, a plant must convert _____ energy into _____ energy.
3. When you push a button in an elevator it starts moving. You've changed electrical energy into _____ energy.
4. A nuclear powered submarine is propelled through the water with the help of a nuclear fuel. In this case, nuclear energy is converted into _____ energy.
5. When there is an electrical storm, with thunder and lightening, besides electrical energy, you are probably most aware of _____ energy and _____energy.

Short Answers

A battery is used to light a light bulb. What is the energy conversion taking place in this situation?

A battery is used to run a small motor. What types of energy conversions are taking place here?

You are brushing your hair. Suddenly your hair begins to stand straight up in the air. What is the energy conversion taking place here?

What is the law of conservation of energy?

How are work and energy related?

ENERGY REVIEW—ANSWER KEY

1. What is energy? **The ability to do work**

POTENTIAL AND KINETIC

1. What is potential energy? **Stored energy**
2. What is kinetic energy? **Energy of motion**

True or False

_F__ Kinetic energy is another word for stored up energy.
_T__ A moving truck has kinetic energy.
_T__ If you climb up a ladder your potential energy increases.
_F__ A battery which is not attached to anything demonstrates that it has kinetic energy.
_T__ As an airplane picks up speed, its kinetic energy increases.

Fill in the blank that best completes each statement.

1. Energy is the ability to do **_work_____**.
2. Energy of motion is known as **_kinetic____**energy.
3. Work is said to be going on whenever something is made to **____move____**.
4. When a bow and arrow is held, just before it is released, are looking at an example of **__elastic potential_** energy.
5. Potential energy is a name for **__stored_____** energy.
6. As a roller coaster climbs the first hill, its potential energy **__increases____**.
7. Suppose you decide to dive into a swimming pool. From the peak of your dive until you hit the water, your **_kinetic___** energy increases.
8. Your beating heart is an example of **__kinetic__** energy.
9. The greater the number of volts in a battery, the greater its **_potential_____** energy.
10. An unlit match has **__potential_** energy.

For each of the following situations, state whether the potential energy and kinetic energy increase, decrease, or stay the same.

An elevator descends from the 10th floor to the 3rd floor at a constant rate.
PE __**decreases**_____ KE __**stays the same**__

A rocket ship blasts off for outer space with an increasing speed.
PE __**decreases**_____ KE __**increases**_____

A train moves along a track at a steady speed of 150 km/hr.
PE __**decreases**_____ KE __**stays the same**__

A roller coaster comes down its first hill.
PE ___**decreases**___ KE __**increases**___

FORMS OF ENERGY

Match the form of energy with the correct definition.

1. Energy that occurs when the temperature changes.
2. Energy that occurs when one kind of matter changes into another kind of matter.
2. Energy related to the flow of electrons.
3. Energy related to changes in the nucleus of an atom.
4. Energy related to movement.
5. Radiant energy.

___**2**____ Chemical energy
___**4**____ Nuclear energy
___**3**____ Electrical energy
___**6**____ Electromagnetic energy
___**1**____ Thermal energy
___**5**____ Mechanical energy

How do each of these forms of energy relate to potential and kinetic energy?

a. They can all exist in the potential energy state or the kinetic energy state.
b. They don't relate.
c. They can only exist in the potential energy state.
d. They can only exist in the kinetic energy state.

Each of the following items is a particular form of energy. Write the energy form of each item in the blank.

The rusting of an iron fence. __**chemical**____
A hydrogen bomb.___**nuclear**____
A star twinkles at night. ____**electromagnetic**__
The spark seen as you walk across a carpet and touch someone. __**electrical**__
The music you hear when you're listening to your radio. _**mechanical**____
The change in temperature you feel when you rub your hands together.
__**thermal**____

ENERGY CONVERSIONS

What is energy conversion?

A change of one form of energy into another

Write in the form of energy that best completes the statement.

1. When you listen to your radio, _**electrical**___ energy is converted into __**mechanical**__ energy.
2. To make food for itself, a plant must convert _**electromagnetic**_ energy into __**chemical**____ energy.
3. When you push a button in an elevator it starts moving. You've changed electrical energy into __**mechanical**_____ energy.
4. A nuclear powered submarine is propelled through the water with the help of a nuclear fuel. In this case, nuclear energy is converted into _**mechanical**_____ energy.
5. When there is an electrical storm, with thunder and lightening, besides electrical energy, you are probably most aware of ___**electromagnetic**____ energy and _**mechanical**_____energy.

Short Answers

A battery is used to light a light bulb. What is the energy conversion taking place in this situation?

Chemical energy is changing to electrical and thermal energy. Electrical energy changing electromagnetic and thermal energy.

A battery is used to run a small motor. What types of energy conversions are taking place here?

Chemical energy is changing to electrical and thermal energy. Electrical energy is changing to mechanical and thermal energy.

You are brushing your hair. Suddenly your hair begins to stand straight up in the air. What is the energy conversion taking place here?

Chemical energy is changing to mechanical and thermal energy. Mechanical energy is changing to electrical energy.

What is the law of conservation of energy?

Energy cannot be created or destroyed, but may be changed from one form into another.

How are work and energy related?

Energy is the ability to do work and work is the transfer of energy.

ENERGY: FORMS AND CHANGES—UNIT TEST

MULTIPLE CHOICE: Choose the letter of the answer that best completes each statement.

1. _____Potential energy is (a) energy of motion (b) energy in chemical bonds (c) energy involved in the internal motion of the atoms (d) stored energy.
2. _____Energy is measured in units of (a) watt (b) Newton (c) electron (d) joule.
3. _____When you stretch rubber band you give it (a) nuclear energy (b) kinetic energy (c) electromagnetic energy (d) potential energy.
4. _____Microwaves and radio waves are forms of (a) mechanical energy (b) electromagnetic energy (c) chemical energy (d) nuclear energy.
5. _____Energy associated with moving electric charges is (a) electrical energy (b) potential energy (c) heat energy (d) chemical energy.
6. _____Gravitational potential energy is dependent on (a) speed and height (b) acceleration and kinetic energy (c) time and weight (d) weight and height.
7. _____The food you eat stores (a) chemical energy (b) electromagnetic energy (c) mechanical energy (d) kinetic energy.
8. _____Diesel and rocket fuel store (a) electromagnetic energy (b) mechanical energy (c) gravitational potential energy (d) chemical energy.
9. _____Energy is the ability to do (a) work (b) motion (c) acceleration (d) power.
10. _____Energy of motion is (a) potential energy (b) nuclear energy (c) electromagnetic energy (d) kinetic energy.
11. _____According to Einstein, matter is another form of (a) light (b) time (c) energy (d) mass.

FILL IN THE BLANK: Fill in the blanks with the word(s) that best complete each statement.

1. The faster an object moves, the more _____ energy it has.
2. Changes in the forms of energy are called _____ _____.
3. The faster the particles of matter move, the _____thermal energy is produced.
4. Sound is a form of _____ energy.
5. Light is _____ energy.
6. Energy that is produced by the fusion of hydrogen nuclei in the sun is _____ energy.
7. Energy stored in an object due to its position (height) is called _____ _____ energy.

DIRECTIONS: For each of the following statements, state whether the potential energy and kinetic energy increase, decrease, or stay the same.

1. A roller coaster goes up a hill
   KE _____ PE _____

2. A roller coaster goes down a hill
   KE _____ PE _____

3. A stretched rubber band is released
   KE _____ PE _____

Appendix L, page 2
(Lesson Nine)

MATCHING: Match the form of energy with the correct definition.

1. Energy that is stored in the nucleus of an atom.
2. Energy that is stored in chemical bonds that hold the compounds together.
3. Energy that is associated with wave movement.
4. Energy that is associated with the motion of an object.
5. Energy that is associated with the movement of electrons.
6. Energy that is associated with the motion of atoms and molecules.

_____ Mechanical
_____ Thermal
_____ Chemical
_____ Electrical
_____ Electromagnetic
_____ Nuclear

TRUE OR FALSE: If the statement is true, write true. If the statement is false, change the underlined word or words to make the statement true.

_____ 1. Work is the transfer of energy
_____ 2. Potential energy that depends on height is kinetic potential energy.
_____ 3. A pendulum has maximum potential energy at the bottom of its swing.
_____ 4. The law of conservation of energy states that when one form of energy is converted to another, some energy is destroyed.
_____ 5. Plants convert nuclear energy to chemical energy.

SHORT ANSWERS: Use complete sentences to answer the following questions.

A battery is used to power a radio. What is the energy conversion taking place in this situation?

Sandra bikes 7 miles to school. What is the energy conversion taking place here?

How are work and energy related?

State the law of conservation of energy.

Extra Credit
Explain the energy conversions that take place when the sun causes plants to grow.

ENERGY: FORMS AND CHANGES—UNIT TEST—ANSWER KEY

MULTIPLE CHOICE: Choose the letter of the answer that best completes each statement.

1. __D__Potential energy is (a) energy of motion (b) energy in chemical bonds (c) energy involved in the internal motion of the atoms (d) stored energy.
2. __D__Energy is measured in units of (a) watt (b) Newton (c) electron (d) joule.
3. __D__When you stretch a rubber band you give it (a) nuclear energy (b) kinetic energy (c) electromagnetic energy (d) potential energy.
4. __B___Microwaves and radio waves are forms of (a) mechanical energy (b) electromagnetic energy (c) chemical energy (d) nuclear energy.
5. __A___Energy associated with moving electric charges is (a) electrical energy (b) potential energy (c) heat energy (d) chemical energy.
6. __D___Gravitational potential energy is dependent on (a) speed and height (b) acceleration and kinetic energy (c) time and weight (d) weight and height.
7. __A__The food you eat stores (a) chemical energy (b) electromagnetic energy (c) mechanical energy (d) kinetic energy.
8. __D__Diesel and rocket fuel store (a) electromagnetic energy (b) mechanical energy (c) gravitational potential energy (d) chemical energy.
9. __A__Energy is the ability to do (a) work (b) motion (c) acceleration (d) power.
10. __D___Energy of motion is (a) potential energy (b) nuclear energy (c) electromagnetic energy (d) kinetic energy.
11. __C__According to Einstein, matter is another form of (a) light (b) time (c) energy (d) mass.

FILL IN THE BLANK: Fill in the blanks with the word(s) that best complete each statement.

1. The faster an object moves, the more _KINETIC_____ energy it has.
1. Changes in the forms of energy are called ___ENERGY__ ____CONVERSIONS____.
2. The faster the particles of matter move, the ___MORE_____thermal energy is produced.
3. Sound is a form of ____MECHANICAL____ energy.
4. Light is ___ELECTROMAGNETIC___ energy.
5. Energy that is produced by the fusion of hydrogen nuclei in the sun is _NUCLEAR_ energy.
6. Energy stored in an object due to its position (height) is called _GRAVITATIONAL POTENTIAL__ energy.

DIRECTIONS: For each of the following statements, state whether the potential energy and kinetic energy increase, decrease, or stay the same.

1. A roller coaster goes up a hill
   KE _DECREASES___ PE __INCREASES__
2. A roller coaster goes down a hill
   KE ___INCREASES__ PE DECREASES___
3. A stretched rubber band is released
   KE __INCREASES __ PE __ DECREASES ___

MATCHING: Match the form of energy with the correct definition.

1. Energy that is stored in the nucleus of an atom.
2. Energy that is stored in chemical bonds that hold the compounds together.
3. Energy that is associated with wave movement.
4. Energy that is associated with the motion of an object.
5. Energy that is associated with the movement of electrons.
6. Energy that is associated with the motion of atoms and molecules.

__**4**__ Mechanical
__**6**__ Thermal
__**2**__ Chemical
__**5**__ Electrical
__**3**__ Electromagnetic
__**1**__ Nuclear

TRUE OR FALSE: If the statement is true, write true. If the statement is false, change the underlined word or words to make the statement true.

_____**True**_____ 1. Work is the transfer of energy
__**Gravitational**__ 2. Potential energy that depends on height is kinetic potential energy.
_____**Top**_____ 3. A pendulum has maximum potential energy at the bottom of its swing.
_____**No**_____ 4. The law of conservation of energy states that when one form of energy is converted to another, some energy is destroyed.
**Electromagnetic** 5. Plants convert nuclear energy to chemical energy.

SHORT ANSWERS: Use complete sentences to answer the following questions.

A battery is used to power a radio. What is the energy conversion taking place in this situation?
Chemical energy in the battery changes to electrical energy in the radio, which then changes into thermal energy as heat and mechanical energy as sound

Sandra bikes 7 miles to school. What is the energy conversion taking place here?
Chemical energy in the food she eats changes to mechanical energy and thermal energy when she bikes

How are work and energy related?
Energy is the ability to do work and work is the transfer of energy.

State the law of conservation of energy.
Energy cannot be created or destroyed, but may be changed from one form into another.

EXTRA CREDIT

Explain the energy conversions that take place when the sun causes plants to grow.

Nuclear energy from the sun changes to electromagnetic energy (light) and thermal energy (heat). The electromagnetic energy is changed into chemical energy by the plants (glucose made by plants) and thermal energy (the heat you feel when you go out in the sun). The chemical energy (glucose) is changed into mechanical energy (growth and development of the plant)