

Chapter 7 Answers

7.1 Section Review

- Sample answers: (a) Yes, the apple has energy. I know because if I take a bite of the apple, I get some food energy (or chemical energy) from eating it. Also, if I drop the apple on my foot, it might hurt! The force of the apple hitting my foot indicates that it has kinetic energy. (b) You could increase the apple's potential energy by putting it on a high shelf. (c) You could increase the apple's kinetic energy by throwing or dropping it.
- Yes, a stretched spring has one form of potential energy because it can exert a force or move something attached to the spring when it is released. A box on a high shelf has gravitational potential energy. The box can exert a force on a floor if it falls and converts its potential energy to kinetic energy.
- $E_p = 20 \text{ J}$
 $20 \text{ J} = (2 \text{ m})(9.8 \text{ m/s}^2)(\text{mass of the book})$
 $1 \text{ kg} = \text{mass of the book}$
- $E_k = 8 \text{ J}$
 $8 \text{ J} = 1/2(1 \text{ kg})(\text{speed of ball})^2$
 $\sqrt{(16 \text{ J}/1 \text{ kg})}$
 $= 4 \text{ m/s}$
 $4 \text{ m/s} = \text{speed of ball}$
- If the speed increased from 1 m/s to 4 m/s, the kinetic energy of the ball would increase 16 times (4^2).
- Graph A.
- Kinetic and potential energy are forms of mechanical energy.
- A rubber band has more elastic energy when it is stretched.
- Light energy is part of the electromagnetic spectrum.

Challenge

Because Venus is closer to the Sun, it should be warmer than Earth and it is. The average temperature on Venus is 461.85°C and it is constant both day and night. Venus has a thick atmosphere which helps keep it so hot day and night and a desert-like surface.

Solve It!

- About half a calorie.
- 1 calorie

7.2 Section Review

- When I rub my hands together I am converting chemical energy in my body to kinetic energy. This kinetic energy becomes heat due to the friction between my hands.
- The four energy units from largest to smallest: b. kWh (largest), d. Calorie, c. Btu, a. joule (smallest).
- The chemical energy from the food is transformed into kinetic energy as Martha rides her bike. As she moves uphill, some of her kinetic energy is changed into potential energy. Some of her kinetic energy is also changed into electrical energy by the generator and then into light energy by the light bulb.

Challenge

This problem is solved using the formula for potential energy: mass \times gravity \times height.

$$1,000,000 \text{ joules} = (54 \text{ kg} + \text{mass of bicycle}) \times 9.8 \text{ m/s}^2 \times 1,600 \text{ m}$$

$$10 \text{ kg} = \text{mass of the bicycle}$$

7.3 Section Review

- Saying energy is conserved means that the total amount of energy stays the same. Energy isn't created or destroyed, just converted from one form to another or given from one object to another.
- Sample answer: Running out of energy just means that we are running out of certain forms of energy. Once we use fossil fuels for transportation by car or plane, for example, that fuel is "used up" because it has been converted to motion and heat. However, it has not been destroyed, just converted to forms that not longer give us the form of energy we need to keep our cars and planes moving.
- As a ball falls, its potential energy is transformed into kinetic energy. The amount of kinetic energy the ball gains is equal to the amount of potential energy it loses, so the total amount of energy is constant.
- Sample answer: Some of the car's fuel energy is converted to kinetic energy or electrical energy to keep the car's engine functioning. Because a car is not 100% efficient, some of the energy is "lost" as heat energy. This is why a car's engine and other mechanical devices get hot when they are working.
- The ball has a kinetic energy of 2.25 J, so it will have a potential energy of 2.25 J when it stops. It must therefore have a height of 0.459 m.

6. Sample answer: Energy is like “nature’s money” because you need energy to complete a task the way you need money to buy something. You cannot accomplish a task without energy. And sometimes you need to save or accumulate energy in order to be able to accomplish something. For example, if I wanted to run a marathon, I would need to make sure that my body has enough chemical energy to accomplish the task. Similarly, I would need to fill my car with gas in order to drive it. After I have “spent” my gas energy it is gone in the sense that it has been converted to heat or motion energy. I need to buy more gas to fill up my car!
7. The abnormal events could only happen if you added energy to the system. For example, you could use fuel energy to run a motor to push a ball up hill or you could use your own energy to pick up the apple. Also, you would have to use your own energy to stretch a rubber band, it would never stretch on its own! Systems only go from high to low energy normally. This is why a ball rolls downhill, an apple falls to the ground not up into the sky, and why a rubber band snaps back after it has been stretched.

Challenge

Student answers will vary. (1) Students may find information by typing the name of their city and “energy conservation” into any web browser. Most cities and local energy companies have programs (including incentive programs) to help people conserve energy. (2) One million joules equals 0.278 kWh. Often electric companies charge according to how many kWh have been used. To answer this challenge, students need to know the rate for their electric company. For example the rate might be \$0.15/kWh.

Connection

- Rechargeable batteries could reduce the battery weight that soldiers carry by 50 percent. They could virtually eliminate costly and dangerous battery resupply missions.
- Scientists and engineers from around the country have pooled resources and ideas to rapidly advance solar cell efficiency.
- Answers will vary. Sample answers include: Computers (from World War II decoding machines), the Internet and email, global positioning systems and other satellite technology, weather system simulation software, and many others.

Chapter 7 Assessment

Vocabulary

Section 7.1

- potential energy
- kinetic energy
- joule
- chemical energy
- mechanical energy
- radiant energy;
nuclear energy

Section 7.2

- Calorie

Section 7.3

- law of conservation of energy

Concepts

Section 7.1

- Energy gives objects the ability to change themselves or other objects.
- Answers: (a) The wave has energy because it has enough force to move the sand of the sand castle. (b) The houseplant grows better in the sunlight because the plant uses the Sun’s energy to make food. Changes take place in the plant when it is exposed to sunlight. (c) When you eat, your body works and changes to digest the food and convert it to energy for you to use. Your body feels bad and you don’t have much energy when you don’t eat. (d) The plate has potential energy before it is dropped since it is off the ground. Then, the plate gains kinetic energy when it is dropped. When it hits the floor, the kinetic energy is converted to energy and forces that result in the plate breaking. (e) Electricity is produced in our cities and towns by burning fossil fuels. This energy source is then used to work the motors of appliances like hair dryers so that we can move air around and cause water to evaporate off of our hair.
- There is pressure energy in a blown-up balloon.
- The Sun is the source of energy for Earth.
- Work is the transfer of energy that occurs when a force is applied to an object over a distance.
- Potential energy is stored energy and it can be related to the position or height of an object. It is related to Earth’s gravity. Kinetic energy is related to the motion of objects. Potential energy can be converted to kinetic energy.

7. Answers:

| | Potential energy | Kinetic energy |
|--|-------------------|-------------------|
| Formula | mgh | $1/2mv^2$ |
| What happens to energy when the mass of an object increases? | PE increases | KE increases |
| What happens when the object is lifted to a higher height (without a change in speed)? | PE increases | KE stays constant |
| What happens when the speed of an object increases (without a change in height)? | PE stays constant | KE increases |

8. The answer is (b).

Section 7.2

9. Sample answer: A form of fossil fuel is used by the electric company to provide electrical energy for my town. I use this energy to run my computer. Inside my computer, some of this electrical energy is used to run a fan so that it has kinetic energy. The purpose of the fan is to cool down the computer which gets hot due to the conversion of some of the electrical energy into heat energy.
10. Sample answer: At the top of the hill, the sled has potential energy. When the sled moves down the hill, the potential energy is converted to kinetic energy. At the bottom of the hill, the sled goes straight through the snow but eventually slows down. This is because the kinetic energy is converted to energy to move the snow. On the hill, the snow actually reduces friction between the sled and the ground, but at the bottom of the hill, the sled's energy is not enough to push the snow out of the way.

Section 7.3

11. Answers are:
- The first hill is the largest so that the car has the most potential energy at the beginning of the roller coaster ride. This energy is then used to get the car moving all along the track.
 - To create all the stored energy of the car on the top of the first hill, a motor is needed to pull the car up the hill. Once the car has potential

energy in this position, a motor is no longer needed. The potential energy is then converted to kinetic energy to move along the track.

- Toward the bottom of hills, most of the potential energy is converted to kinetic energy and the car is moving really fast. When the car then goes up a hill, the kinetic energy is re-converted into potential energy.
12. Answers:
- The book has potential energy and zero kinetic energy.
 - Half of the book's potential energy has been converted to kinetic energy.
 - Most of the book's potential energy has been converted to kinetic energy.
13. A limited resource, like oil or gas, is used up and not easily or quickly replaced. In fact, it would take millions of years to replenish the oil and gas we used. A resource that is not limited is actually renewable because its availability is continuous. Examples of renewable resources are solar energy, wind energy, and water energy.

Problems

Section 7.1

- 4,000 joules
- You push the object for 4 meters.
- $E_p = (0.1 \text{ kg})(9.8 \text{ m/s}^2)(5 \text{ m}) = 4.9 \text{ joules}$
- $E_p = 3 \text{ joules} = (0.1 \text{ kg})(9.8 \text{ m/s}^2)(? \text{ m})$
The bird is 3 meters off the ground.
- $E_k = (1/2)(2,000 \text{ kg})(10 \text{ m/s})^2 = 100,000 \text{ joules}$

Section 7.2

6. Answers: 21.6 kWh, 7.8×10^7 joules, 0.6 gallons of gas

Section 7.3

7. Answers:
- $E_k = (1/2)(2 \text{ kg})(10 \text{ m/s})^2 = 100 \text{ J}$
 - $E_p = 100 \text{ J}$
 - $100 \text{ J} = (2 \text{ kg})(9.8 \text{ m/s}^2)(? \text{ m})$
The hill was 5.1 meters tall.
8. Answers:
- $E_p = (80 \text{ kg})(9.8 \text{ m/s}^2)(30 \text{ m}) = 23,520 \text{ joules}$
 - $E_p = (80 \text{ kg})(9.8 \text{ m/s}^2)(10 \text{ m}) = 7,840 \text{ joules}$
 - $E_k = (1/2)(80 \text{ kg})(19.6 \text{ m/s})^2 = 15,366 \text{ joules}$

- d. The total kinetic + potential energy must add to 23,520 joules, so the potential energy must be 8,154 joules.

Applying Your Knowledge

Section 7.1

- Solar energy is energy obtained from radiant energy. Photovoltaic cells can be used to convert this energy into electrical energy. Alternatively, radiant energy can be used to heat liquid so that steam is produced to turn a turbine and run a generator. Resources to research: U.S. Department of Energy (www.energy.gov), Energy Information Administration (www.eia.doe.gov), and American Solar Energy Society (www.ases.org). An excellent cover article on solar energy's potential for the future is in *Scientific American*, January 2008, Volume 298, Number 1.

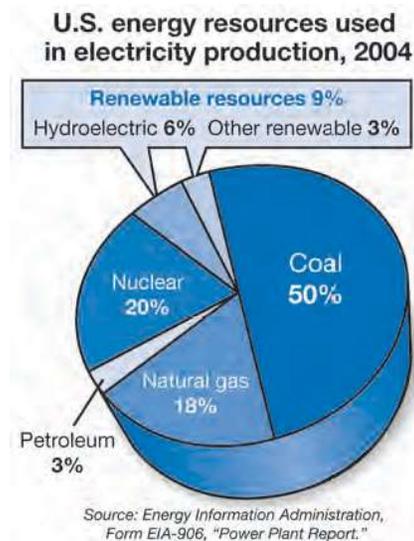
Hydroelectric energy is energy obtained from water that is falling. The kinetic energy from the falling water is converted to electricity.

Resources: U.S. Department of Energy (www.energy.gov) and the Energy Information Administration (www.eia.doe.gov).

A table of the "Net Generation from Hydroelectric (Conventional) Power by State by Sector, Year-to-Date through September 2007 and 2006" is at <http://www.eia.doe.gov/cneaf/solar.renewables/page/hydroelec/hydroelec.html>

- Forms of renewable resources: solar, hydroelectric, wind energy, geothermal, and bioenergy. Renewable energy sources made up 9% of the energy used in electricity production in the U.S. in 2004.
- Sample answer: Pros to using nuclear energy: Nuclear energy is one energy source that does not produce pollution or emissions that contribute to global warming. Nuclear energy is a non-polluting, large-scale producer of hydrogen fuel from water for cars should the country move toward this cleaner (less greenhouse gases emitted) fuel for cars and other forms of transportation.

Cons to using nuclear energy: Nuclear energy production by nuclear plants



does need water to cool down. Sometimes the heated water affects neighboring ecosystems. But, the main issue with nuclear energy is the fact that nuclear waste is produced that does not go away for thousands to millions of years. Nuclear waste is radioactive and very harmful to people.

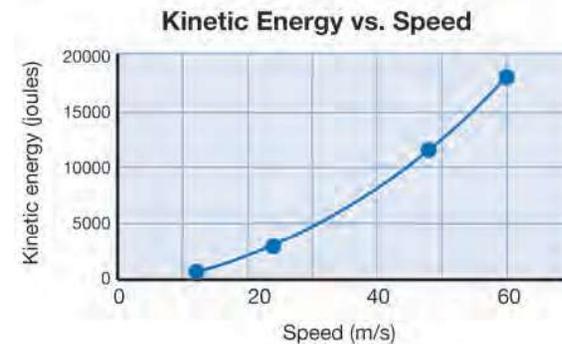
Resource: American Nuclear Society (www.ans.org)

Section 7.2

- Answers: (a) 3; (b) 2; (c) 1

Section 7.3

- The graph and answers:



- The mass of the object is 10 kilograms.
- Graph: The kinetic energy of the object is 4,500 joules.
- Graph A (the one that shows the real relationship for kinetic energy and speed) is exponential. Graph B is linear.