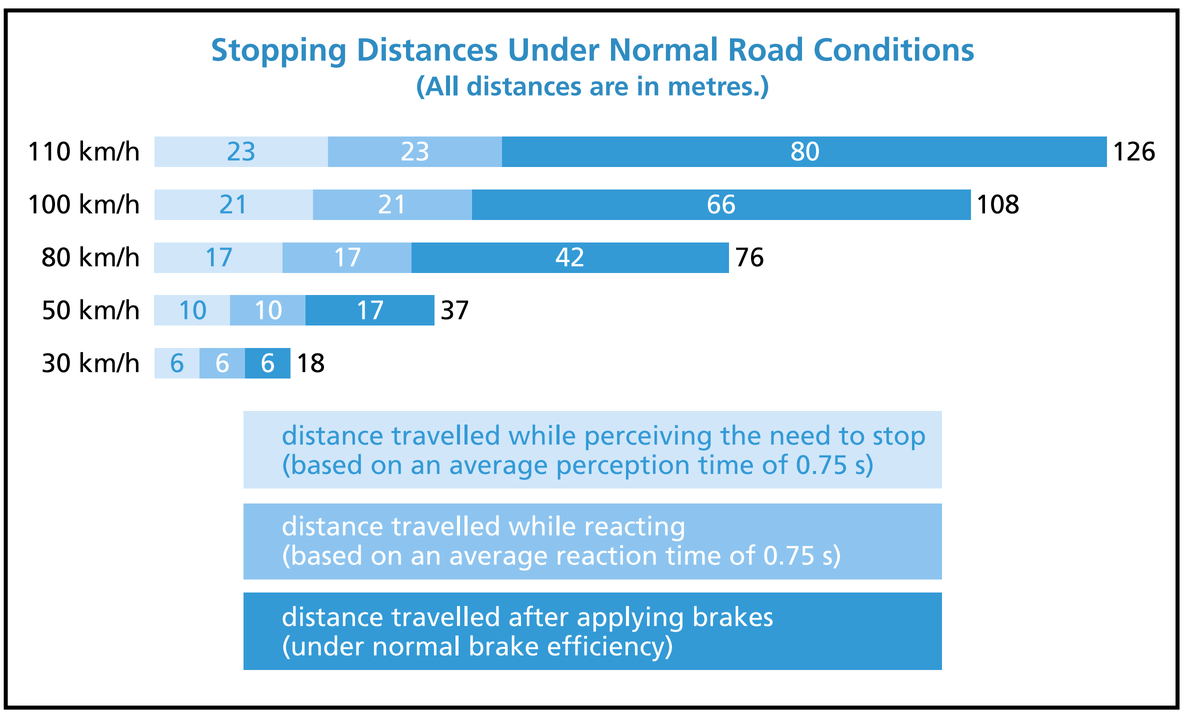
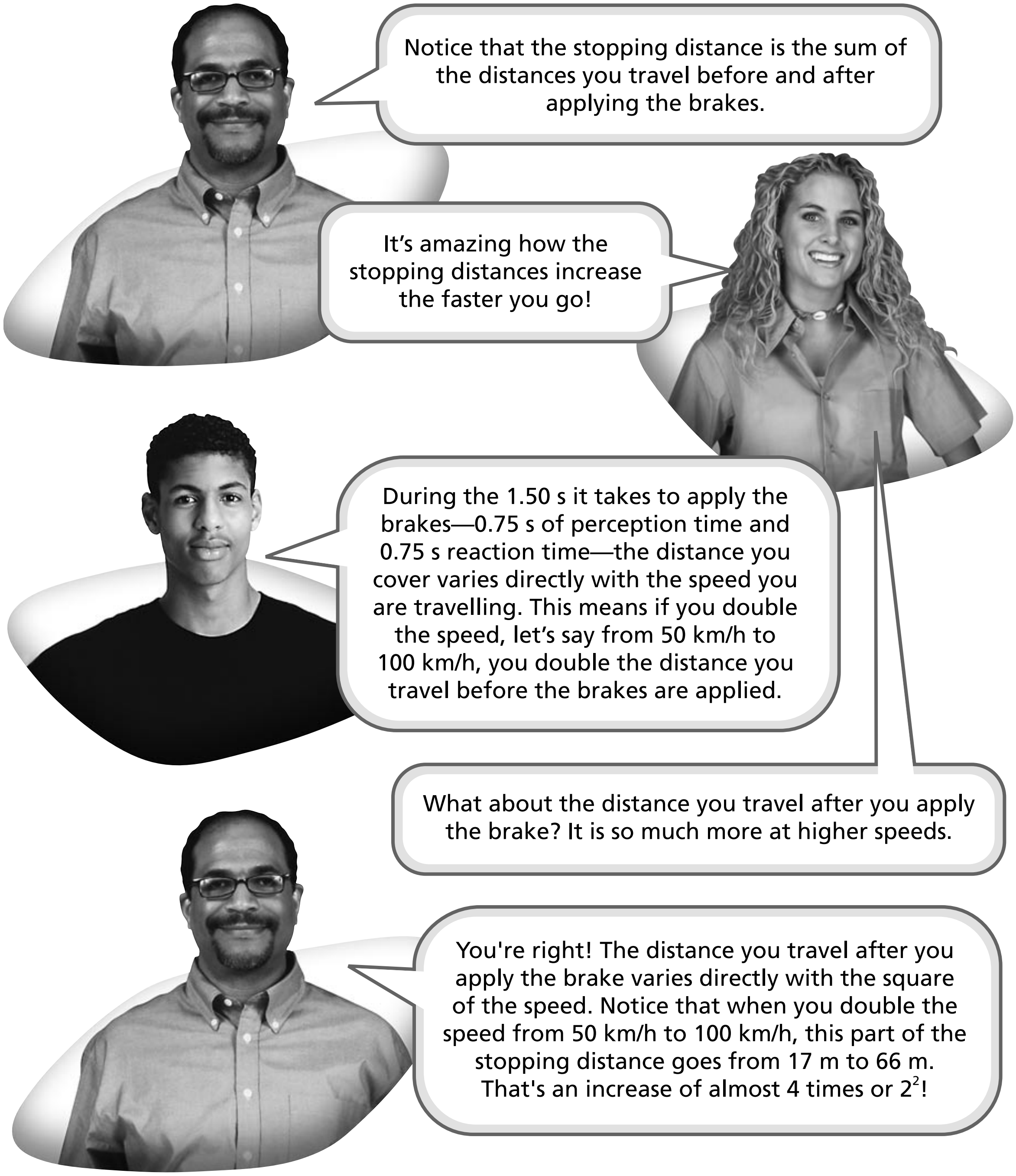
Lesson 19

Kinetic Energy and Motion

Have you studied the Driver's Handbook recently? If so, you would have seen a graph like this, showing stopping distances for various speeds.



Information from the Basic Driver's Handbook provided by Alberta Infrastructure and Transportation. This handbook can be downloaded at **http://www.trans.gov.ab.ca/DriversInfo/Handbooks.asp**.



The relationship between the distance travelled after applying the brakes and speed is similar to another relation—the relation between the kinetic energy of an object and its speed.

Turn to page 179 of the textbook and read "*info*BIT." The information indicates that the kinetic energy of a snowball varies directly with the square of its speed and varies directly with its mass.

Now, read "Kinetic Energy and Motion" on pages 179 and 181. Work through the Example Problems B2.3, B2.4, and B2.5 carefully.

1. Answer questions 4 and 5 of "Practice Problems" on page 179 of the textbook.

2. Answer question 6 of "Practice Problems" on page 181 of the textbook.

Check Check your answers with those on pages 86 and 87.

Did You Know?

On January 29, 2005, the largest snowball fight ever recorded occurred in Wauconda, Illinois (a suburb of Chicago). The snowball fight consisted of a whopping 3027 participants! This beat the previous record of 2473 snowballers set in a small town in Switzerland in 2003.

Inquiry Lab

Kinetic Energy and Motion

Read the entire activity on pages 180 and 181 of the textbook.

If you have access to a supervised laboratory, do **Part A**. If you do not have access to a supervised laboratory, do **Part B**.

Part A

Follow the steps outlined in the procedure to complete this activity.

3. Copy and complete the table given at the bottom of page 180 by following steps 1 to 3 of "Analyzing and Interpreting" on page 181.

4. Answer question 4 of "Analyzing and Interpreting" on page 181 of the textbook.

Check Check your answers with those on pages 87 and 88.

Part B

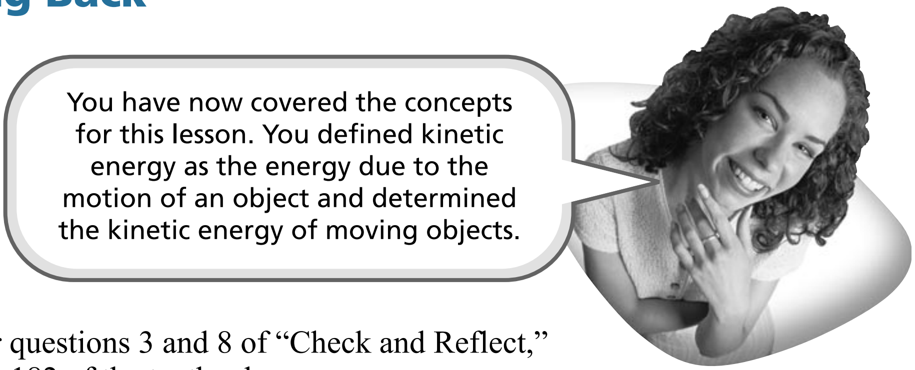
Insert the Science 10 Multimedia CD into your computer, and view the segment "Kinetic Energy and Motion." Use the information from this segment to answer the following questions.

5. Copy and complete the table given at the bottom of page 180 of the textbook.

6. Answer question 4 of "Analyzing and Interpreting" on page 181 of the textbook.

Check Check your answers with those on page 88.

Looking Back



7. Answer questions 3 and 8 of "Check and Reflect," on page 182 of the textbook.

Check your answers with those on page 88.

Go to pages 5 to 7 of Assignment Booklet 2B and answer questions 10 to 15.

Suggested Answers

1. **Textbook questions 4 and 5 of "Practice Problems," p. 179**

    4. $$\begin{aligned} E_{\text{k}} &= \frac{1}{2}mv^2 \\ &= \frac{1}{2}(9.11\times10^{-31}\text{ kg})(2.00\times10^{5}\text{ m/s})^2 \\ &= 1.82\times10^{-20}\text{ J} \end{aligned}$$

    The kinetic energy of the electron is 1.82×10^{-20} J.

5. $E_k = \frac{1}{2}mv^2$

$$2E_k = mv^2$$

$$m = \frac{2E_k}{v^2}$$

$$= \frac{2(18\ \text{J})}{(2.2\ \text{m/s})^2}$$

$$= 7.4\ \text{kg}$$

$$\frac{\text{J}}{(\text{m/s})^2} = \frac{\text{kg}\cdot\cancel{\text{m}^2/\text{s}^2}}{\cancel{\text{m}^2/\text{s}^2}} = \text{kg}$$

The mass of the toy is 7.4 kg.

2. **Textbook question 6 of "Practice Problems," p. 181**

6. $E_k = \frac{1}{2}mv^2$

$$2E_k = mv^2$$

$$v^2 = \frac{2E_k}{m}$$

$$v = \sqrt{\frac{2E_k}{m}}$$

$$= \sqrt{\frac{2(304\ \text{J})}{0.300\ \text{kg}}}$$

$$= 45.0\ \text{m/s}$$

$$\sqrt{\frac{\text{J}}{\text{kg}}} = \sqrt{\frac{\cancel{\text{kg}}\cdot\text{m}^2/\text{s}^2}{\cancel{\text{kg}}}} = \sqrt{\text{m}^2/\text{s}^2} = \text{m/s}$$

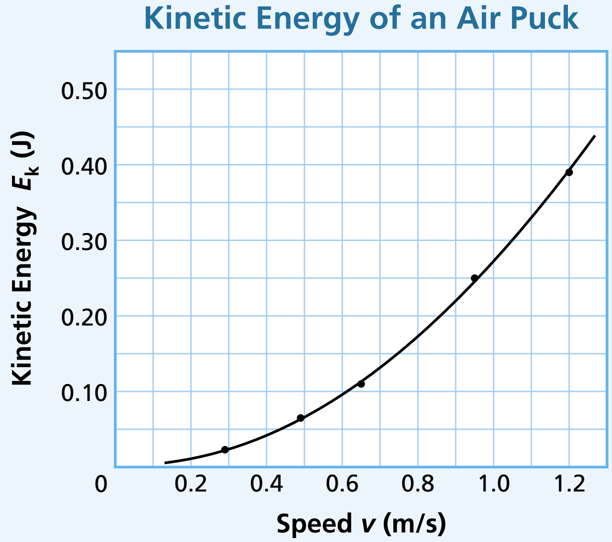
The speed of the baseball is 45.0 m/s.

3. Answers will vary. Sample data is given.

Trial	Mass of the Air Puck m (kg)	Time Interval of the Generated Sparks Δt (s)	Average Distance Travelled During Each Time Interval Δd (m)	Average Speed of the Air Puck v (m/s)	Kinetic Energy of the Air Puck E_k (J)
1	0.543	0.10	0.029	0.29	0.023
2	0.543	0.10	0.049	0.49	0.065
3	0.543	0.10	0.065	0.65	0.11
4	0.543	0.10	0.095	0.95	0.25
5	0.543	0.10	0.118	1.2	0.39

4. **Textbook question 4 of "Analyzing and Interpreting," p. 181**

   4. Answers will vary. A sample graph of the puck's kinetic energy as function of speed is given.



5. Refer to the answer to question 3.

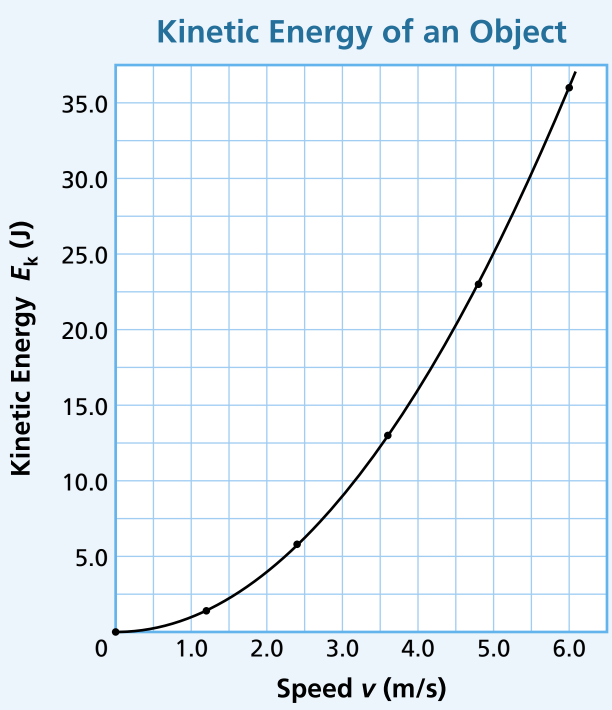
6. Refer to the answer to question 4.

7. **Textbook questions 3 and 8 of "Check and Reflect," p. 182**

   3. $$\begin{aligned}1\text{ J} &= 1\text{ N}\bullet\text{m}\\ &= 1\text{ (kg}\bullet\text{m/s}^2)\bullet\text{m}\\ &= 1\text{ kg}\bullet\text{m}^2/\text{s}^2\end{aligned}$$

      Therefore, 1 J is equal to 1 kg•m^2/s^2.

   8. a.



      b. The graph shows that kinetic energy varies directly with the square of the speed.

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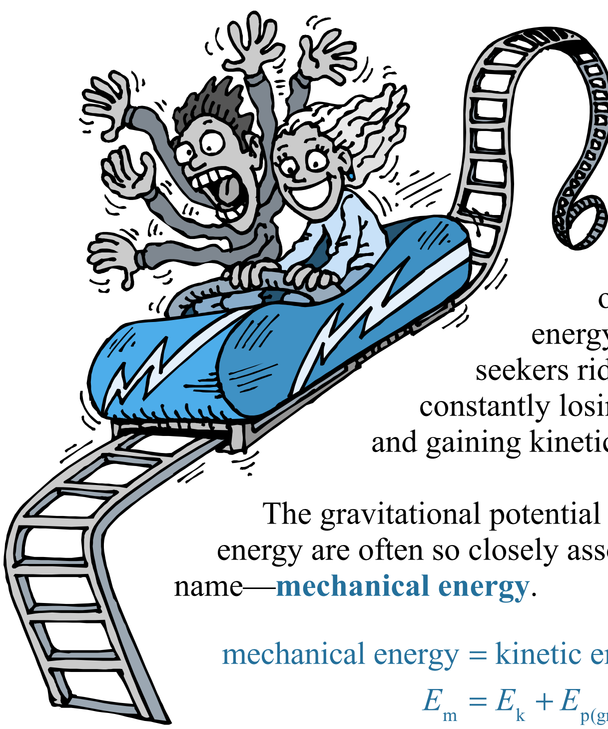
Lesson 20

Mechanical Energy



A roller coaster is a great example of the conversion of potential energy into kinetic energy. As the thrill seekers ride the roller coaster, they are constantly losing gravitational potential energy and gaining kinetic energy and vice versa.

The gravitational potential energy of an object and its kinetic energy are often so closely associated that their sum has a special name—**mechanical energy**.

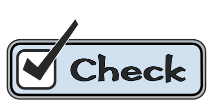
mechanical energy: energy due to the motion and position of an object

mechanical energy = kinetic energy + gravitational potential energy

$$E_m = E_k + E_{p(grav)}$$

Turn to page 183 of the textbook and read the introductory paragraphs of "Mechanical Energy." Work through the Example Problem B2.6 carefully.

1. Answer question 10 of "Practice Problems" on page 183 of the textbook.



Check your answer with the one on page 94.