SECTION 1

Accidents

Section Overview

The section begins by having students assess their knowledge of risks involved with vehicles. Students answer questions designed to deal with common misconceptions about automobile safety. A list of common safety features found in automobiles today is provided. Students use this list to consider how safety features have changed over time. They apply their knowledge of safety features by identifying safety features in various modes of transportation, describing what type of collision they protect passengers from, and how they protect passengers. Students then record new ideas in their logs for designing their prototype of safety features to protect passengers during a collision.

Background Information

Accidents occur whenever a vehicle collides with another object. The major factors that influence accidents are slowed reaction times and road hazards, such as snow, potholes, or animals. The physics involved in accidents is the same. The fundamental concepts of conservation of energy and conservation of momentum determine how severe the accident is or how much damage is done to the objects and passengers involved in the collision. The more energy and momentum transferred, the greater the damage. Safety features are designed to avoid collisions and to assist in absorbing and dispersing energy and momentum during a collision.

There are two main categories of safety features: active and passive. Active safety features use information from the vehicle's external environment to change and improve the response of the vehicle before and during a collision. The ultimate goal of an active safety feature is to avoid a collision. Examples of active safety features include the following:

- Intelligent speed adaptation—uses global positioning satellites and an electronic throttle to control the speed of a vehicle, not allowing the vehicle to go over the speed limit.
- Turn signals and brake lights—allow other drivers to determine how the vehicle is changing its motion.
- Dynamic steering response and variable-assist power steering—change how much force is needed to turn the steering wheel, requiring less force when driving at slow speeds and more force when driving at higher speeds. They reduce overcompensation when drivers try to avoid collisions at high speeds.
- Traction control—prevents wheels from spinning and operates the brakes or the throttle to restore traction.
- Four-wheel drive—allows each wheel to have the power to rotate. This feature reduces sliding and over and under-compensation of turning.
- Reverse backup sensors—alert drivers to items behind their vehicle when driving in reverse.
- Electronic stability control—monitors an automobile's stability; can decrease power, apply brakes, and adjust steering compensation if the automobile seems to be going out of control.
- Lateral support—alerts drivers when they leave their lane.
- Mirrors—provide visibility.
- Low center-of-gravity—provides better handling.
- Anti-lock braking assist, brake-assist systems, dynamic brake control, etc. —braking systems that reduce skidding and sliding.
- Driver-state sensor—monitors a driver's eyelid movement.

Passive safety features are designed to help minimize injury during a collision. Some examples of passive safety features include the following:

- Seat belts—absorb some of the energy and limit the forward motion of an occupant, keeping the occupant from being ejected from the vehicle. Shoulder harnesses restrain the upper body, absorb energy, and prevent a secondary collision with items in the vehicle.
- Air bags—restrain motion and absorb some of the energy during a collision.
- Crumple zone—absorbs the energy of a collision, diverting it from the occupant compartment.
- Side-impact bars—reduce deformation of the side of a vehicle during impact.
- Collapsible steering column—reduces impact between driver and steering wheel.
- Fuel pump shut-off—turns off the fuel pump during a collision.
- Car seats—reduce energy of impact for children.
- There are also features that protect pedestrians involved in accidents:
  - bumpers are soft;
  - no sharp edges on the exterior of the vehicle;
  - and the shape of vehicles prevent the hit pedestrian from hitting other parts of the vehicle.

Crucial Physics

- Identify and describe factors that affect safety while driving.
- Compare and contrast safety features designed to protect passengers during collisions.

Learning Outcomes	Location in the Section	Evidence of Understanding
Evaluate your understanding of safety.	***Investigate*** Steps 1-3	Students take a test about safety.
Identify and evaluate safety features in selected automobiles.	***Investigate*** Step 3 ***Physics Talk*** ***Physics Essential Questions*** ***Physics to Go*** Questions 1, 6 ***Inquiring Further*** Question 1	Students consider a list of common safety features and describe the conditions under which they protect passengers and how they protect passengers. Students identify and/or evaluate safety features of new vehicles.
Compare and contrast the safety features in selected automobiles.	***Investigate*** Step 3 ***Physics Talk*** ***Inquiring Further*** Question 2	Students compare and contrast common safety features in automobiles.
Identify safety features required for other modes of transportation (in-line skates, skateboards, bicycles).	***Physics to Go*** Questions 2-4 ***Inquiring Further*** Question 1	Students identify safety features that would reduce the risk of injury during a collision for other modes of transportation, such as in-line skates, skateboards, and bicycles.

CHAPTER 3

NOTES

Section 1 Materials, Preparation, and Safety

Materials and Equipment

No materials or equipment are needed for this section.

Time Requirement

Approximately 30 minutes are required for this investigation.

Teacher Preparation

- This section is centered primarily on reading and answering the questions in the *Investigate*. After the students have answered the questions, there should be a class discussion to investigate the understanding students now have about accidents, and to help the students open their minds to the seriousness of accidents. As the majority of students are entering a very dangerous time of their lives, in terms of learning to drive and statistically being prone to accidents, the discussion should be serious. Allow more time if a film and a discussion are added. A review of early automobile safety problems would provide additional background. An Internet search for Ralph Nader and vehicle safety should provide much information.

Safety Requirements

- No safety precautions are necessary for this section. A review of early automobile safety problems would provide background information.

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Meeting the Needs of All Students

Differentiated Instruction: Augmentation and Accommodations

Learning Issue	Reference	Augmentation and Accommodations
Understanding the purpose of a section	***Learning Outcomes***	**Augmentation** • Students often complete sections as discrete items that are not connected to a common goal. This makes it much more difficult to analyze results, draw conclusions, and establish meaning from new learning. Explicitly review the *Learning Outcomes* at the beginning of each section to set a purpose and make students aware of the big picture.
Creating a table from a model	***Investigate*** Step 3	**Augmentation** • Copying tables is a tedious and time-consuming task for students with visual-motor, graphomotor, and focus difficulties. Ask students to hold their papers in portrait format. Then students should divide their papers into four columns—three skinny columns and a wider one—to record an explanation. Next, students can mark rows using single lines on the paper, mark rows for every two lines, or mark the rows as they complete the explanations. Ask students to label the columns and rows using the table in the book. • Point out the photographs as a reference tool for filling in the table. **Accommodation** • Provide students with a blank chart to fill in and tape into their logs.
Reading comprehension	***Physics Talk*** ***Checking Up***	**Augmentation** • Many students are able to read and decode words, but they really struggle to understand the meaning of a text. Instruct students to read the *Checking Up* questions to provide a purpose for the reading and to guide understanding.

Strategies for Students with Limited English-Language Proficiency

Point out new vocabulary words in context and practice using the words as much as possible throughout the section.

anticipation
attributed to
beneficial
casualty
chrome
restraint
dashboard
steering column
designation
submerged
manufacturing
minimizing
overcompensate
pedestrian
hazard
collision
compile
fatality
statistics
transportation

After students have finished the *Inquiring Further* in which they review advertising brochures and research auto safety, have them write and illustrate a one-page brochure of their own. (Not all students will have collected brochures during the *Inquiring Further,* therefore, you may need to help students understand that a brochure is a small publication giving product information or advertising a product. Showing them a few sample brochures may be helpful.) Let them choose one of the following two scenarios:

- You sell automobiles. Write and illustrate a one-page brochure advertising a vehicle you sell. Be sure to tell possible buyers why it is the safest vehicle they can buy. Use at least five vocabulary words from the list in your brochure.

- You work for the National Highway Traffic Safety Administration (NHTSA). Write and illustrate a one-page brochure that tells people why they should always wear their seat belts. Use at least five vocabulary words from the list in your brochure.

Instruct students to write in complete sentences. You may wish to have students work in pairs. Review and correct the students' work. Rapid feedback about students' sentences is essential, because the sentences and errors will be fresh in their minds. A quick and powerful method for providing this feedback is to prepare a list of examples of sentences containing errors from the students' work. Divide examples into the following categories: incorrect science, incorrect usage of vocabulary, incorrect sentence structure, and incorrect grammar. Choose several examples from the collected work to use in each category and edit the sentences until they contain only one or two obvious errors. At the beginning of class the next day, provide each student with a page containing a double-spaced, typed list of the incorrect sentences, with headings for the four categories. Allow students 10 minutes to silently make corrections to the sentences. Then place a copy of the list on the overhead projector and ask students to suggest ideas for how to correct the sentences. During the exercise, guide students toward correct science and correct English usage.

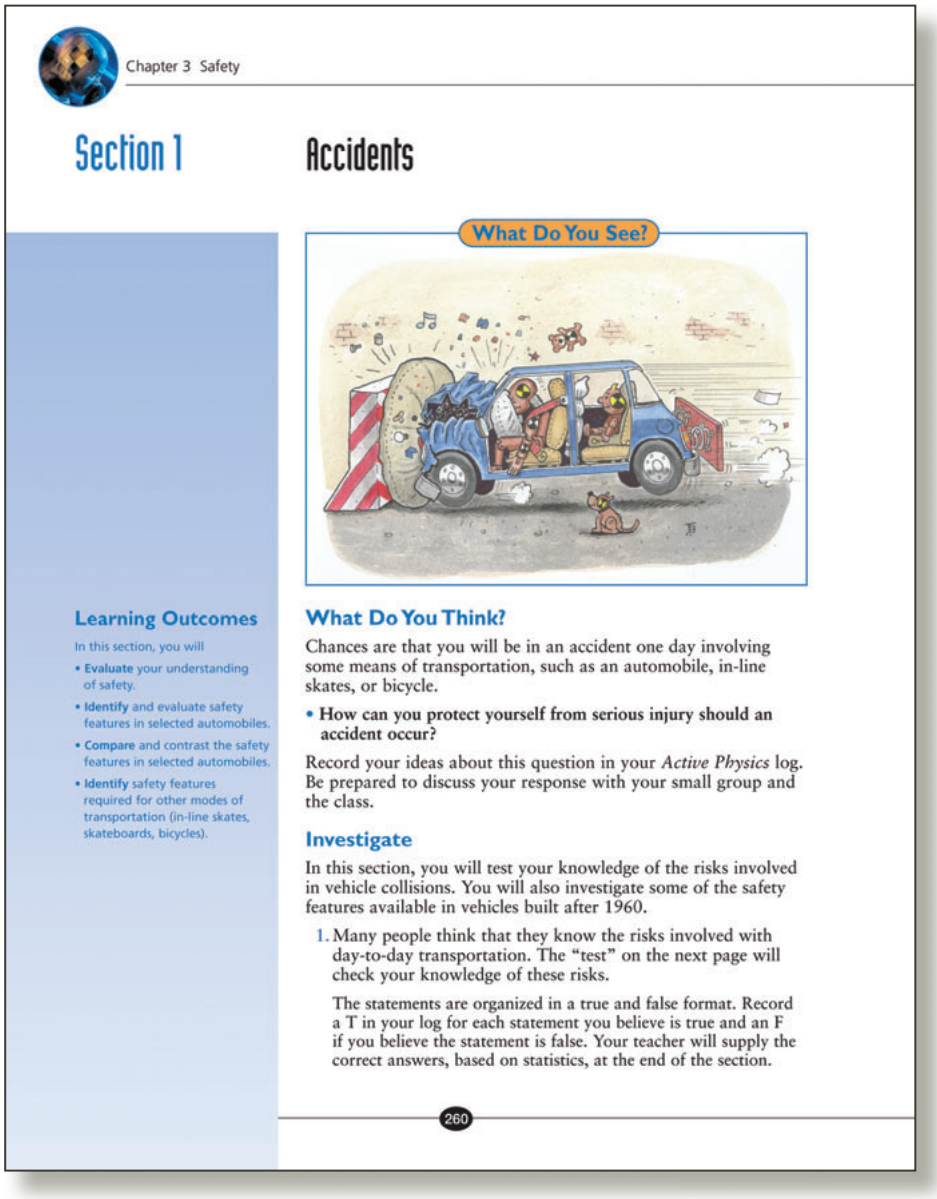
NOTES

SECTION 1

Teaching Suggestions and Sample Answers

What Do You See?

The *What Do You See?* illustration provides an interesting way to introduce students to the physics concepts being developed. Have a class discussion of the illustration. Consider using an overhead of the illustration as a focal point for the discussion. Elicit students' initial impressions of what they see, what dangerous features of a collision are portrayed, what safety features are shown, and why it is significant in the context of this section. You are likely to get many different responses. Focus on the responses that provide an opportunity for you to get the students engaged in the physics concepts presented in this section. For example, if students mention some of the safety features illustrated, you might ask how they provide protection against


Chapter 3 Safety

Section 1 Accidents

What Do You See?

Learning Outcomes

In this section, you will

- **Evaluate** your understanding of safety.
- **Identify** and evaluate safety features in selected automobiles.
- **Compare** and contrast the safety features in selected automobiles.
- **Identify** safety features required for other modes of transportation (in-line skates, skateboards, bicycles).

What Do You Think?

Chances are that you will be in an accident one day involving some means of transportation, such as an automobile, in-line skates, or bicycle.

- **How can you protect yourself from serious injury should an accident occur?**

Record your ideas about this question in your *Active Physics* log. Be prepared to discuss your response with your small group and the class.

Investigate

In this section, you will test your knowledge of the risks involved in vehicle collisions. You will also investigate some of the safety features available in vehicles built after 1960.

1. Many people think that they know the risks involved with day-to-day transportation. The "test" on the next page will check your knowledge of these risks.

   The statements are organized in a true and false format. Record a T in your log for each statement you believe is true and an F if you believe the statement is false. Your teacher will supply the correct answers, based on statistics, at the end of the section.

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Students' Prior Conceptions

This section gives students the opportunity to articulate their understanding of what actually happens during a vehicle collision. They identify and evaluate prior knowledge continuously, as they progress through the phases of their evaluation of safety features.

1. **Students believe that collision severity is the same for both automobiles in a head-on collision.** Giving students opportunities to investigate what happens to passengers during collisions with and without seat belts provides them with cognitive and mathematical tools needed to explore the impact of forces involved in collisions. Modeling what happens to a passenger and to the automobiles during the same impact will show students that the severity of a collision can be high to the automobile but at the same time minimal to the passenger wearing a seat belt. The mechanical devices employed for safety reduce the impact of the collision to the passenger and/or the automobile. Modeling what happens between colliding automobiles should lead students to explore the nature of the mass and the velocity of automobiles involved in accidents. Examining what happens during each of the three collisions in every accident should reinforce correct student thinking.

injury or what physics concepts they think are involved with the safety features they described.

What Do You Think?

Ask students to use the illustration and their own experiences to help them answer the *What Do You Think?* question. Emphasize to students that there is no correct or incorrect response, but rather, opinions and ideas are being elicited. Remind students to record their ideas in their log. Have a class discussion, eliciting and recording students' ideas. Encourage students to ask classmates questions during the discussion. Students might discuss front air bags, seat belts, and child seats. Ask them what they think these features do to help reduce injury, and have them describe their ideas as best they can in terms of physics concepts. Reassure students that as they go through the chapter, they will investigate the physics involved with collisions and safety features.

What Do You Think?

A Physicist's Response

Accidents occur when two objects collide. The severity of the accident depends on how much energy is transferred to the objects, and the structural design of the objects. The greater the energy exchanged and the more localized it is during a collision, the greater the damage. Protecting yourself from injury during an accident requires the use of safety features. Some safety features are designed to aid in the prevention of a collision (such as mirrors and directional signals), and some are designed to reduce the energy transferred to a passenger or a localized area of a vehicle during a collision (such as seat belts and air bags). Objects with more mass or moving faster tend to cause greater damage during a collision.

Investigate

Decide how you wish students to take the safety quiz. The quiz can be given individually, or students could work in groups of two to three and discuss each question.

After all students have completed the quiz, create a bar graph on the board, listing the questions by letter with some key words. Have each student or team bring up a small sticky note for each question to create a bar graph that represents the class's responses.

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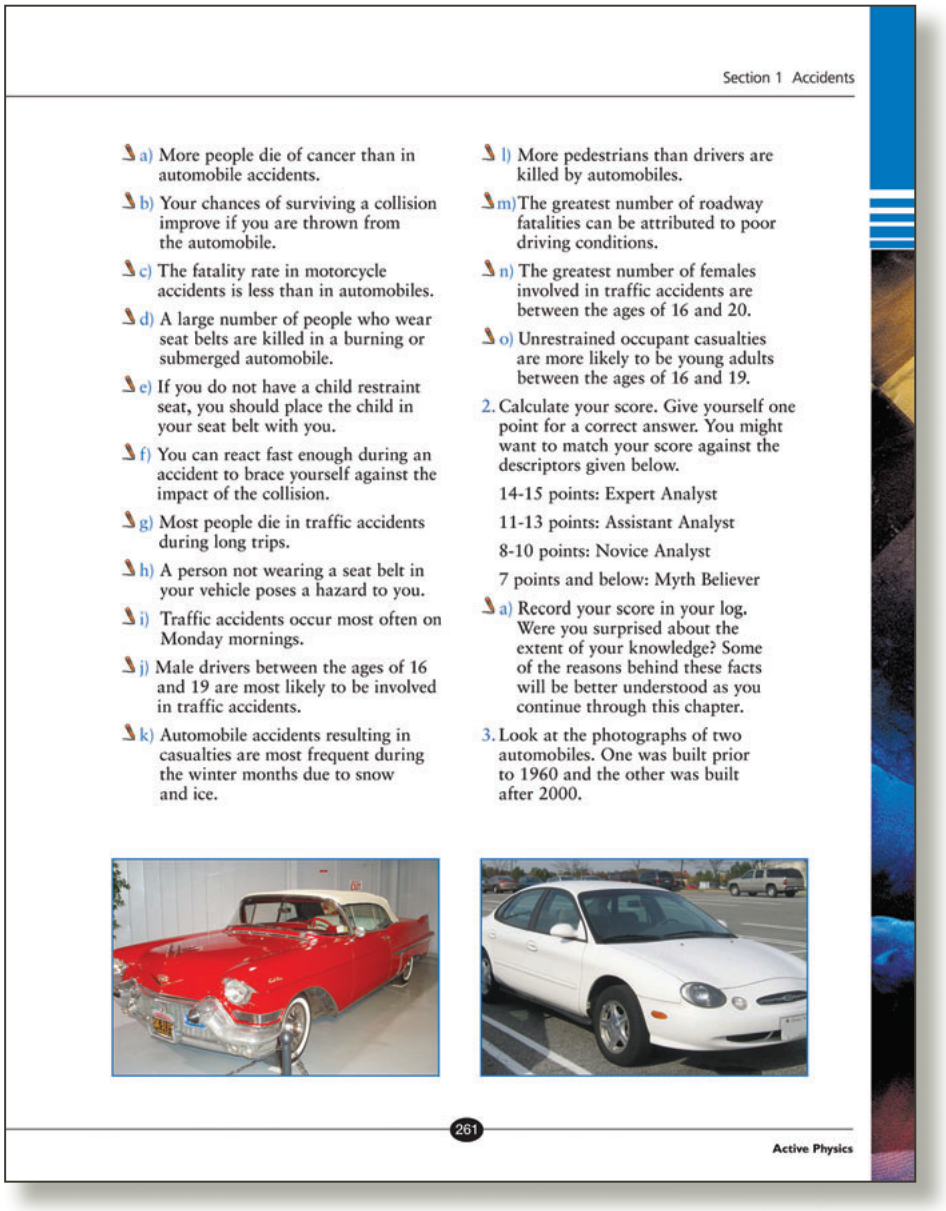
Section 1 Accidents

a) More people die of cancer than in automobile accidents.

b) Your chances of surviving a collision improve if you are thrown from the automobile.

c) The fatality rate in motorcycle accidents is less than in automobiles.

d) A large number of people who wear seat belts are killed in a burning or submerged automobile.

e) If you do not have a child restraint seat, you should place the child in your seat belt with you.

f) You can react fast enough during an accident to brace yourself against the impact of the collision.

g) Most people die in traffic accidents during long trips.

h) A person not wearing a seat belt in your vehicle poses a hazard to you.

i) Traffic accidents occur most often on Monday mornings.

j) Male drivers between the ages of 16 and 19 are most likely to be involved in traffic accidents.

k) Automobile accidents resulting in casualties are most frequent during the winter months due to snow and ice.

l) More pedestrians than drivers are killed by automobiles.

m) The greatest number of roadway fatalities can be attributed to poor driving conditions.

n) The greatest number of females involved in traffic accidents are between the ages of 16 and 20.

o) Unrestrained occupant casualties are more likely to be young adults between the ages of 16 and 19.

2. Calculate your score. Give yourself one point for a correct answer. You might want to match your score against the descriptors given below.

14-15 points: Expert Analyst

11-13 points: Assistant Analyst

8-10 points: Novice Analyst

7 points and below: Myth Believer

a) Record your score in your log. Were you surprised about the extent of your knowledge? Some of the reasons behind these facts will be better understood as you continue through this chapter.

3. Look at the photographs of two automobiles. One was built prior to 1960 and the other was built after 2000.

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Teaching Tip

Students may get into a lively discussion of the relative safety of various ages of drivers. Acknowledge that young drivers are often very safe drivers, but point out that statistically younger drivers are involved in more accidents than older drivers.

1.a)

True. According to the Statistical Abstract of the United States, in 2005, there were less than one and a half times as many deaths from respiratory cancer as from motor-vehicle accidents. When all forms of cancer are considered, this figure is nearly five times higher than for motor-vehicle accidents.

Deaths in 2005 (in units of deaths/100,000 population) were because of the following:

Motor vehicle accidents—39.7 (leading cause of death by accidents)

Major cardiovascular disease—288.8 (leading cause of death listed)

Respiratory cancer—53.7

All forms of cancer—188.7

1.b)

False. Thirty percent of the people involved in automobile accidents die from being thrown from the vehicle during the collision. One report indicates that at least 50% of these fatalities need not have occurred. In 2005 just over 4% of reported motor-vehicle accidents resulted in a death, according to the Statistical Abstract of the United States.

1.c)

False. Motorcycles are less common, but they are much more dangerous.

1.d)

False. Few people are killed because of burning or drowning. One study indicates that it is less than 0.1%.

1.e)

False. The child can be sandwiched by your mass. The abdomens of small children are particularly vulnerable to impact.

1.f)

False. You do not have enough time to react even at 50 km/h (about 31 mi/h).

1.g)

False. Most people die within 40 kilometers of their home (about 25 miles).

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1.h)

True. The person becomes a projectile once the car stops.

1.i)

False. Most traffic accidents occur during Friday afternoon or evening traffic.

1.j)

True. That accounts for the higher insurance rates.

1.k)

False. The months of May, June, and August have the greatest number of casualty collisions.

1.l)

False. Pedestrians only account for 6.1% of traffic fatalities.

1.m)

False. More accidents take place when road conditions are dry.

1.n)

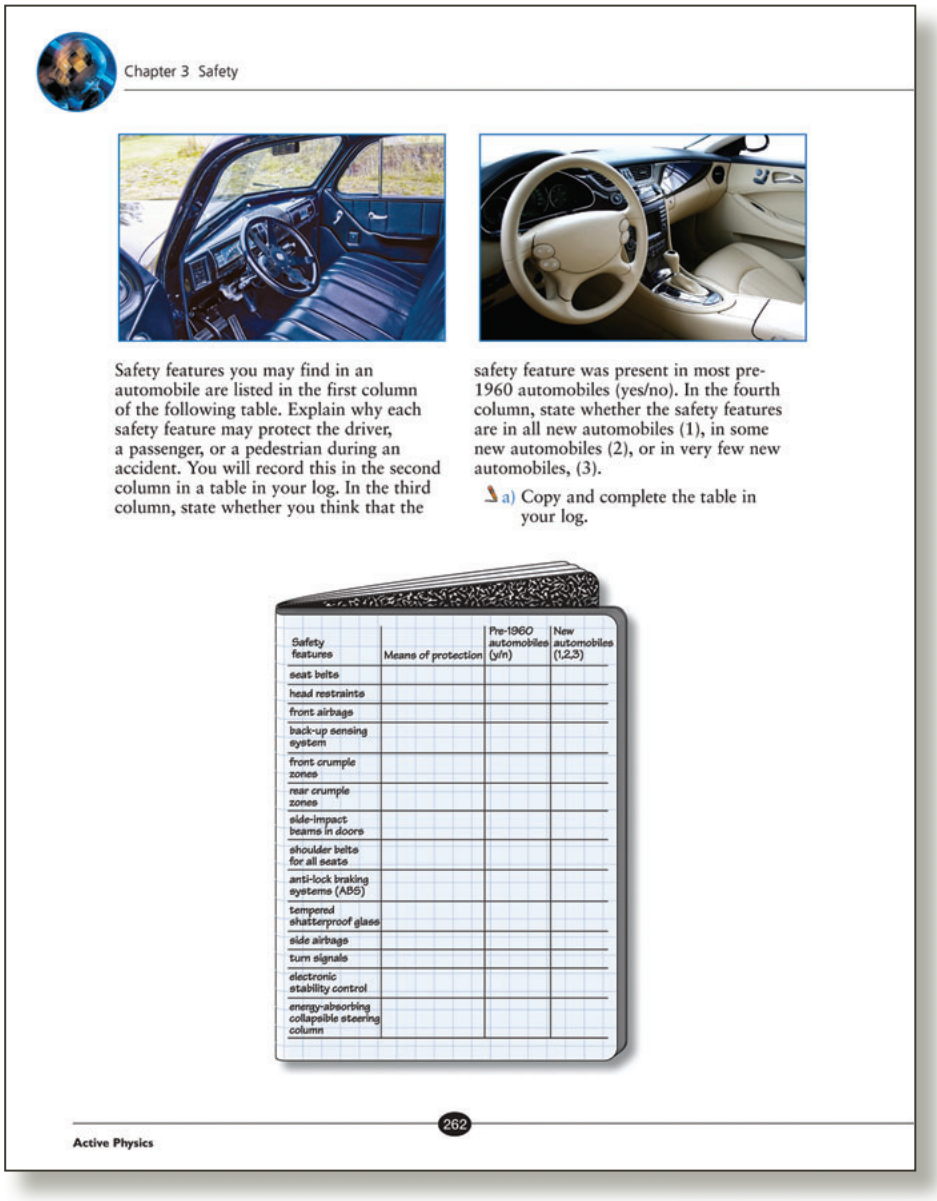
True. Young female drivers, like their male counterparts, are responsible for the greatest number of accidents. Inexperience may be the major contributing factor.

1.o)

True.

2.a)

Students should calculate their scores after the class has made a graph of their responses. Using the bar graph created with sticky notes, discuss the class's overall responses. If a question generally had incorrect responses, ask them how surprised they were to find out the answer. A short discussion should follow with the expectation that the students will be able to better understand the physics of the accidents after the next few sections. Then have them complete *Step 3*.



Chapter 3 Safety

Safety features you may find in an automobile are listed in the first column of the following table. Explain why each safety feature may protect the driver, a passenger, or a pedestrian during an accident. You will record this in the second column in a table in your log. In the third column, state whether you think that the safety feature was present in most pre-1960 automobiles (yes/no). In the fourth column, state whether the safety features are in all new automobiles (1), in some new automobiles (2), or in very few new automobiles, (3).

a) Copy and complete the table in your log.

Safety features	Means of protection	Pre-1960 automobiles (y/n)	New automobiles (1,2,3)
seat belts			
head restraints			
front airbags			
back-up sensing system			
front crumple zones			
rear crumple zones			
side-impact beams in doors			
shoulder belts for all seats			
anti-lock braking systems (ABS)			
tempered shatterproof glass			
side airbags			
turn signals			
electronic stability control			
energy-absorbing collapsible steering column			

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Active Physics

3.a)

Students should record the table and their responses in their *Active Physics* logs. Compare students' initial ideas with the correct responses on the following page.

Teaching Tip

Students may not be familiar with safety features that were available in automobiles prior to 1960. You may want to update this to prior to 1990 or even 2000. If you choose 2000, point out that passenger-side air bags did not become common until around 2000, side-curtain airbags until after 2000, and electronic stability control and backup-sensing systems were not available in most automobiles until 2007.

3-1a Blackline Master

Safety feature	Means of protection	Pre-1960 automobiles (y/n)	New automobiles (1, 2, 3)
seat belts	keeps driver and passengers inside of car	n	1, all
head restraints	prevents whiplash	n	1, all
front air bags	cushions during a collision	n	1, all (driver's side)
back-up sensing system	allows to see in blind spots while backing up	n	3, few
front crumple zones	increase collision distance reducing impact	n	1, 2, all, some
rear crumple zones	increase collision distance reducing impact	n	2, some
side impact beams in doors	resists side penetration	n	2, some
shoulder belts for all seats	keeps passengers in seats during collision	n	1, all
anti-lock braking systems (ABS)	helps maintain control/ prevents skids	n	2, some
tempered shatterproof glass	helps prevent cuts	y	1, all
side air bags	protects head/torso in side collisions	n	2, some
turn signals	warns other drivers of actions	y	1, all
electronic stability control	helps resist rollovers	n	2, 3, some, few
energy absorbing collapsible steering column	prevents chest trauma	n	1, all

NOTES

Section 1 Accidents

Physics Talk

VEHICLE SAFETY

Nobody expects to be in an automobile accident. But accidents do occur. You may have already studied ways to avoid being involved in automobile accidents. In this chapter, you will investigate the systems in vehicles that are designed to keep you safe in case of a collision.

Governments and manufacturers of automobiles can work together to make vehicles safer. If you are in an accident in a safer vehicle, the chances of injury will be limited. People in vehicles are not the only ones in danger. A pedestrian can get hit by an automobile. Engineers can try to build the automobile so that pedestrians may be safer if they are hit by an automobile.

Safety was not always a major consideration in automotive manufacturing. A turning point in the history of automobile safety occurred when Ralph Nader, an American attorney and political activist, wrote the book *Unsafe at Any Speed* in 1965. This book highlighted the problems of not having seat belts in vehicles, having hard chrome dashboards, and solid steering columns. Since then, all automobile manufacturers have improved the safety of their vehicles.

An interesting Australian study of four-wheel drive (4WD) vehicles found that the incidence of fatal 4WD crashes increased by 85 percent between 1990 and 1998 (up 28 percent between 1994 and 1998). By comparison, the incidence of all fatal crashes decreased by 25 percent between 1990 and 1998 (down 10 percent between 1994 and 1998). There are two competing explanations for this. This increase in fatal 4WD crashes could be due to the growing number of kilometers traveled by 4WDs. It could also be due to the tendency of some drivers to increase speed under the impression that the safety features will protect them. Automobiles with anti-lock brakes and four-wheel drive should be safer than automobiles without these features. Some drivers may overcompensate for these added features and end up in accidents that could have been avoided if they had just slowed down.

Checking Up

1. List three ways that manufacturers have made vehicles safer since the 1960s.
2. What are two explanations for the increase in fatal 4WD crashes?

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Checking Up

1.

Some possible safety features are seat belts, air bags, padded dashboards, four-wheel drive, anti-lock brakes, energy-absorbing collapsible steering columns, and so on.

2.

Fatal 4WD crashes may be due to the fact that drivers of 4WD vehicles have a greater tendency to increase speed and may drive less cautiously because they think they have safety features that will protect them from accidents and minimize injury. Another factor that may have affected the number of fatalities involved with 4WD vehicles is that the 4WD vehicles in the study were driving greater distances.

Physics Talk

The *Physics Talk* discusses some of the issues and history of vehicle safety. It also presents a study conducted on four-wheel drive vehicles that provides an example of competing theories. This provides a good opportunity to discuss how scientists may have competing theories and the need for evidence to ascertain which theory, if any, is correct.

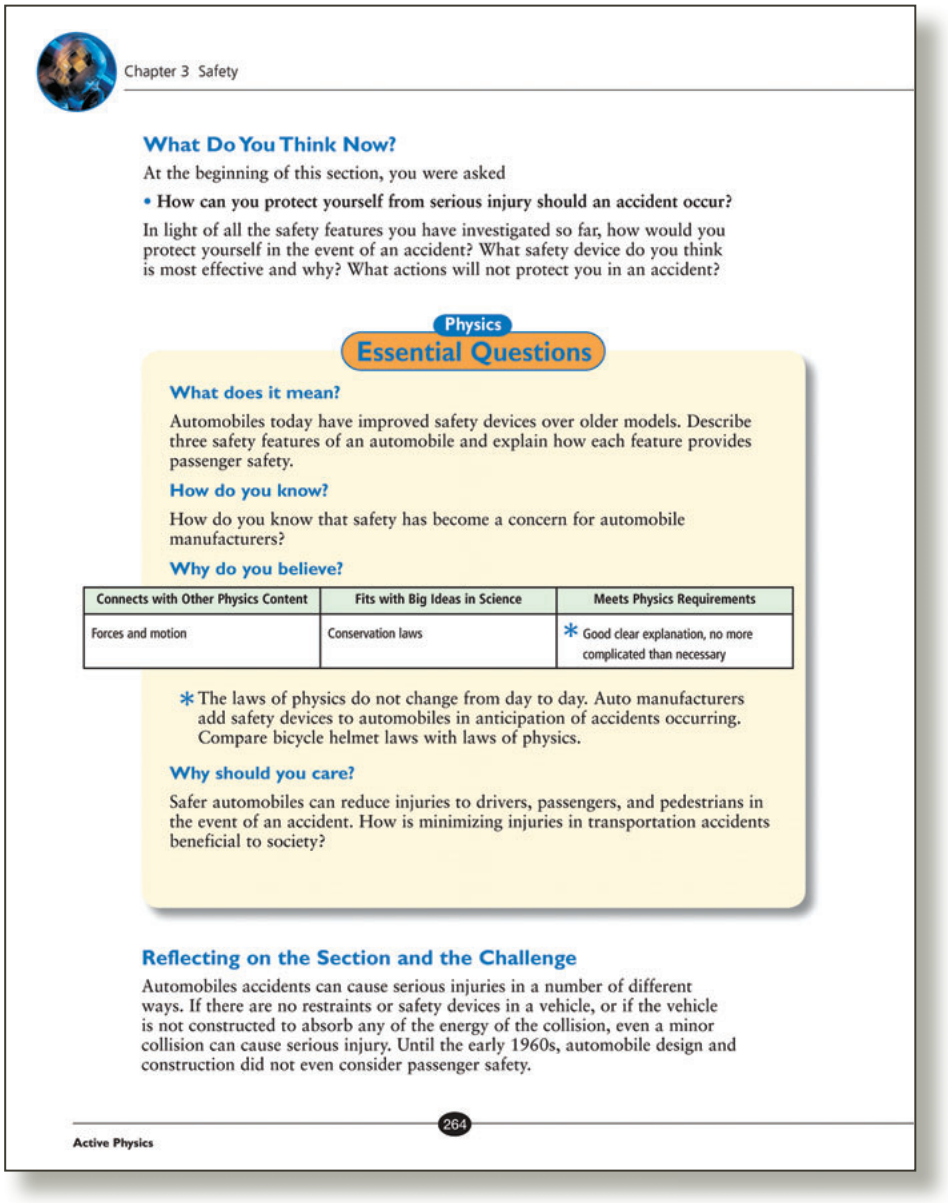
Oftentimes when there are competing theories, part of each theory may be correct.

Consider asking students what factors or variables might affect the results provided and record their responses. Then ask students what ideas they have to reduce the number of accidents that occur with four-wheel drive vehicles and how they could minimize passenger injuries.

CHAPTER 3

What Do You Think Now?

Have students revisit the *What Do You See?* illustration and ask students if they can identify any other safety features they did not already list that are shown in the illustration. Discuss how safety features can reduce the number of injuries and revisit the *What Do You Think?* question, asking students what other ideas they have. Consider sharing the information in *A Physicist's Response* and elicit students' opinions on it. Students should apply ideas from the *Investigate*.



Physics Essential Questions

What does it mean?

Seat belts prevent you from being ejected from your seat. Air bags protect you in an accident. A padded dashboard protects your head if it collides into it.

How do you know?

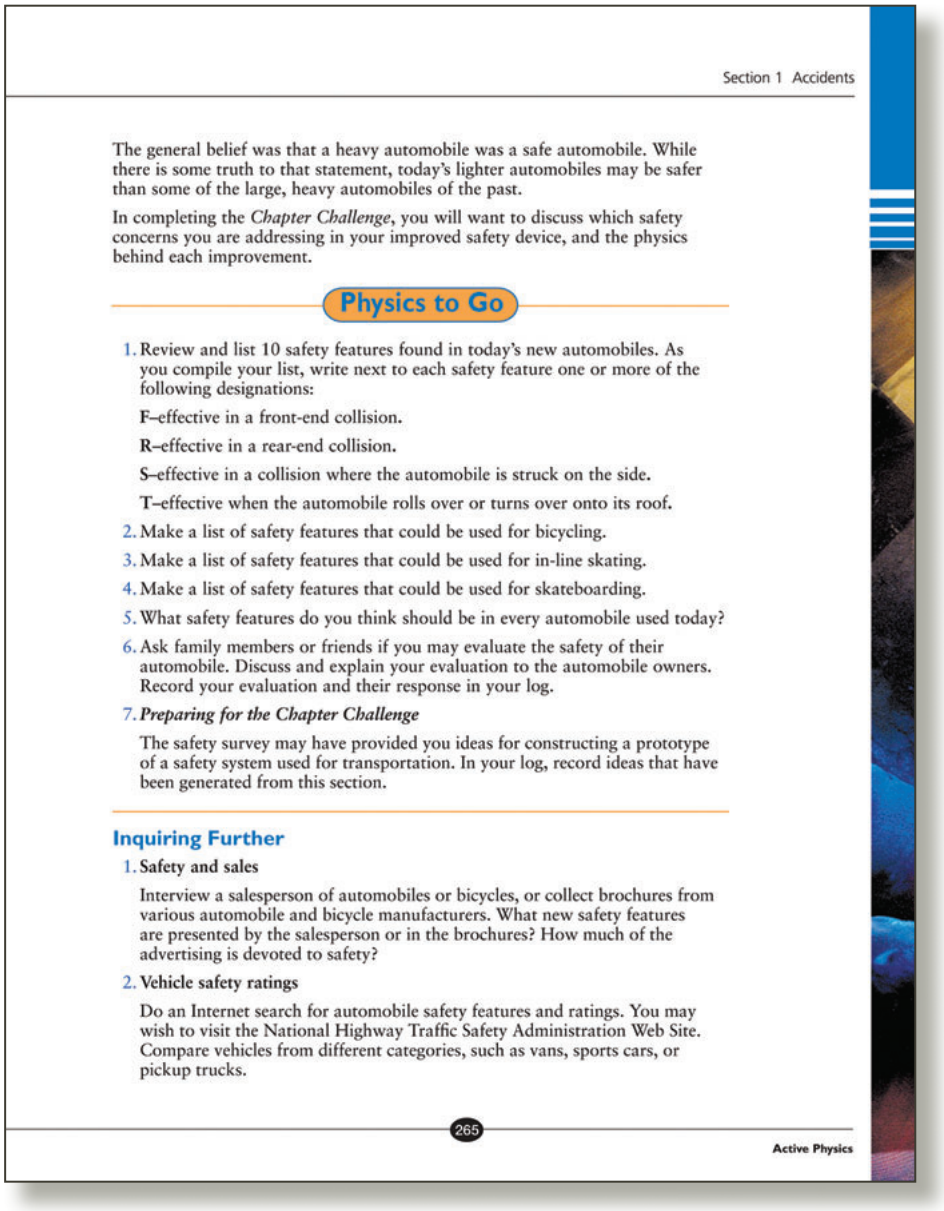
There are many safety features, such as seat belts, that are mandated for vehicles.

Why do you believe?

A bicycle helmet law is passed by legislature. A law of physics is not changed by a vote of the public.

Why should you care?

If there are fewer accidents, there will be fewer hospitalizations, which will save money.



Section 1 Accidents

The general belief was that a heavy automobile was a safe automobile. While there is some truth to that statement, today's lighter automobiles may be safer than some of the large, heavy automobiles of the past.

In completing the *Chapter Challenge*, you will want to discuss which safety concerns you are addressing in your improved safety device, and the physics behind each improvement.

Physics to Go

1. Review and list 10 safety features found in today's new automobiles. As you compile your list, write next to each safety feature one or more of the following designations:

   F–effective in a front-end collision.

   R–effective in a rear-end collision.

   S–effective in a collision where the automobile is struck on the side.

   T–effective when the automobile rolls over or turns over onto its roof.
2. Make a list of safety features that could be used for bicycling.
3. Make a list of safety features that could be used for in-line skating.
4. Make a list of safety features that could be used for skateboarding.
5. What safety features do you think should be in every automobile used today?
6. Ask family members or friends if you may evaluate the safety of their automobile. Discuss and explain your evaluation to the automobile owners. Record your evaluation and their response in your log.
7. ***Preparing for the Chapter Challenge***

   The safety survey may have provided you ideas for constructing a prototype of a safety system used for transportation. In your log, record ideas that have been generated from this section.

Inquiring Further

1. **Safety and sales**

   Interview a salesperson of automobiles or bicycles, or collect brochures from various automobile and bicycle manufacturers. What new safety features are presented by the salesperson or in the brochures? How much of the advertising is devoted to safety?
2. **Vehicle safety ratings**

   Do an Internet search for automobile safety features and ratings. You may wish to visit the National Highway Traffic Safety Administration Web Site. Compare vehicles from different categories, such as vans, sports cars, or pickup trucks.

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Active Physics

Reflecting on the Section and the Challenge

Read as a class the three paragraphs in *Reflecting on the Section and the Challenge*, or have students read them to themselves. Have a discussion based on the student text. Ask students why it might be true that a heavier automobile is a safer automobile. Then ask why they think new automobiles are safer now, even though they are much lighter. Ask students what types of safety features they are considering for their prototype and why. Then emphasize that when they complete the *Chapter Challenge* they will need to clearly state the safety issue they are addressing, the improvements they have made, and the physics concepts behind each improvement.

Physics to Go

1.

Students should describe at least ten safety features and the type of collision that each safety feature focuses on. Students may use the following chart in the *Investigate*.

Safety Feature	Collision Type
side-impact beams in door	S
shoulder belts	F, R, S, T
anti-lock brakes	F, R, S
side air bags	S
collapsible steering column	F, R
rear crumple zones	R
front crumple zones	F
head restraints	F, R, S
back-up sensing systems	R
mirrors	R, S
side air bags	S
front air bags	F, R, S
knee air bags	F, R, S
padded front seats	F, R
padded roof frame	T
head rests	F, R
padded console	F, R, S, T
padded sun visor	F, S, T
padded doors and arm rests	S
padded steering wheel	F
padded gear level	F, S
padded door pillars	S, T

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2.

The students' lists should describe how each safety feature reduces collisions and/or injuries. For example, students might describe mirrors on helmets or handlebars that help avoid collisions, or padded handlebars that absorb energy during a collision, reflectors and/or lights for visibility, better braking systems, knee pads, elbow pads, and helmets.

3.

Students' responses should describe how each safety feature reduces collisions and/or injuries. For example, students might describe mirrors on helmets that help drivers avoid collisions; knee pads and elbow pads that absorb energy during a collision; reflectors or lighting on clothing to increase visibility; or helmets.

4.

Students' lists should describe how each safety feature reduces collisions and/or injuries. For example, students might describe mirrors on helmets that help drivers avoid collisions; or helmets, knee pads, and elbow pads that absorb energy during a collision. Lighting or reflectors on clothing increase visibility.

5.

Student suggestions will vary, and will probably include seat belts, anti-lock brakes, various types of air bags and other items from the list preceeding the *Physics Talk*. Students may not realize that items such as a dashboard and ceiling padding would be safety items so they may not include them. Newer features such as traction control may also be suggested. Many students may also suggest four-wheel drive. If this is suggested it may be worthwhile to probe the students as to why they believe this is a safety item. Many students are under the false impression that four-wheel drive allows them to drive safely faster in the snow. Point out that more will be learned about this later in the chapter.

6.

Students should record their responses in their log, as well as the responses of the vehicle owner. Students should describe the safety features, the types of collisions it is constructed for, and how it helps drivers avoid a collision or reduce injury.

7.

Preparing for the Chapter Challenge

Students should record ideas in their logs for safety features of their prototype that were generated from this section.

Inquiring Further

1. Safety and sales

Have students describe the vehicles they are writing about, the safety features in the vehicles, and how much advertising is devoted to safety in the selling of an automobile. Consider asking students what the amount of safety advertising implies.

2. Vehicle safety ratings

Students should compare and contrast safety features and ratings of several new vehicles.

NOTES

SECTION 1 QUIZ

3-1b Blackline Master

1. Which of the following would not be considered a safety device in an automobile?

   a) seat belt
   b) speedometer
   c) turn signals
   d) tempered glass

2. Which of the following safety devices will make it less likely for an automobile to get into a crash with another vehicle?

   a) turn signals
   b) seat belts
   c) tempered glass
   d) head restraints

3. The age group most likely to be involved in an automobile accident is

   a) 16-20.
   b) 20-30.
   c) 40-50.
   d) 50-60.

4. Which of the following safety devices will protect the driver of an automobile during a collision?

   a) electronic stability control
   b) back-up sensing system
   c) anti-lock brake system
   d) shoulder belts

5. Four-wheel drive vehicles should be safer than two-wheel drive vehicles on snowy roads. Which of the following is a possible cause of why the driver of a four-wheel drive vehicle might be more likely to have a crash than the driver of a two-wheel drive vehicle in the snow?

   a) Four-wheel drive vehicles are larger than two-wheel drive vehicles.
   b) Drivers of four-wheel drive vehicles are older than drivers of two-wheel drive vehicles.
   c) The drivers of four-wheel drive vehicles are less cautious on snowy roads than are the drivers of two-wheel drive vehicles.
   d) Four-wheel drive vehicles have fewer safety features than two-wheel drive vehicles.

SECTION 1 QUIZ ANSWERS

1. b) speedometer
2. a) turn signals
3. a) 16-20.
4. d) shoulder belts
5. c) The drivers of four-wheel drive vehicles are less cautious on snowy roads than are the drivers of two-wheel drive vehicles.

NOTES