

SECTION 1

Identifying and Classifying: What Is a Sport?

Section Overview

In this section, students identify the meaning of the term “sport.” They begin by brainstorming a list of words and phrases that describe a sport. Then they discuss each suggested characteristic of a sport with their group members and make a final list of attributes that apply to all sports. Eventually, students come to an agreement among their group members about the characteristics and the definition of the term “sport” and write that definition in their *Active Physics* logs. They also learn through the *Physics Talk* that all sports follow the laws of physics, and the laws of physics are based on universal and invariable observations.

Background Information

Being receptive and respecting the thoughts of others is central to the process outlined for students to arrive at a definition of “sport” in this section.

It can be expected that some students will have a rather narrow sense of what is or is not a sport, and those students also may have low tolerance for different meanings of the term held by others. The most likely point of contention will probably focus on the desire for some to limit the meaning of the term to athletic contests and for others to attach broader meaning to include activities such as fishing.

The “right” definition is, of course, the definition on which the group or the entire class agrees, and would seem reasonable to be included in a proposal to NASA for sports on the Moon. The main rule of the brainstorming process to be used for the activity is that, initially, no idea should be evaluated or thrown out. An unwritten extension of that rule is that tolerance and kindness to others should be exhibited when lists of ideas that have been brainstormed are being reduced and refined through discussion.

Crucial Physics

- Sports contain physical activity.
- The laws of physics are universal; that is, they are the same throughout the universe.

| Learning Outcomes | Location in the Section | Evidence of Understanding |
|---|-------------------------------------|---|
| Apply brainstorming as a process for generating ideas. | <i>Investigate</i> Steps 1 and 2 | Students brainstorm a list of words or phrases that describe a sport. |
| Develop a working definition of the term “sport.” | <i>Investigate</i> Step 4 | From a list of attributes that define a sport, students construct a written definition of the term sport, and compare their definition with the definition developed by other members of their group. |

Meeting the Needs of All Students

Differentiated Instruction: Augmentation and Accommodations

| Learning Issue | Reference | Augmentation and Accommodations |
|------------------------------|--|--|
| Vocabulary | <i>Investigate</i> Step 1 | <p>Augmentation</p> <ul style="list-style-type: none"> Students may not know the meaning of the word “attribute.” Ask the group what the word “attribute” means. Then ask the class to generate a list of the attributes of vehicles, animals, or something else that they would be familiar with. This will help students understand the word “attribute” and will help them be better prepared for the <i>Investigate</i>. |
| Generating a list | <i>Investigate</i> Steps 1 and 2 <i>Physics to Go</i> Questions 3 and 4 | <p>Augmentation</p> <ul style="list-style-type: none"> Generating a list of attributes is a difficult task for students with any kind of expressive language struggles. Students have a difficult time using language to describe the world around them. For these students, it may help to allow them to list the sports first because that task only requires students to identify rather than describe. Then students can use their list of sports to start thinking about descriptions that define those sports. Visual aids often help students with expressive language difficulties. Provide sports magazines or Web sites for students to view while they are generating their list of attributes. Strategically set up groups to include students who have stronger expressive language skills with those who struggle with expressive language. Give students a couple of minutes to silently record their ideas as individuals before the group brainstorm begins. This wait time is useful for students who need extra time to collect their thoughts before participating in a conversation. <p>Accommodation</p> <ul style="list-style-type: none"> For the students who are really struggling to develop a list of attributes, provide a list of attributes of sports and ask students to sort them into two categories; “Shared by many sports” and “Shared by all sports.” |
| Writing their own definition | <i>Investigate</i> Step 4 | <p>Augmentation</p> <ul style="list-style-type: none"> Writing a good definition will help students with the remainder of <i>Section 1</i> and the <i>Chapter Challenge</i>. Allow students to share their definitions with the class for feedback and questions. The definition may seem perfect to the creators, but they may be forgetting a key point that makes the definition confusing or inaccurate for others. <p>Accommodation</p> <ul style="list-style-type: none"> If time is an issue and some students are taking a long time to write a definition, provide a list of definitions of the word “sport” that is either teacher-developed or developed by past students. Then ask students to choose the best definition or write their own definitions with the material you have provided. |

Strategies for Students with Limited English-Language Proficiency

| Learning Issue | Reference | Augmentation |
|--|------------------------------------|---|
| Vocabulary comprehension | <i>Investigate</i> Step 1 | ELL students may need support with comprehension because of rapid speech patterns that occur in brainstorming activities. To slow down the pace of student responses, have students explain each word or phrase they propose. This will help all students improve their communication skills and allow ELL students more time for internalizing the meanings of the words and phrases on the list. Make sure students understand that during brainstorming, the explanations should not evolve into a discussion. |
| Vocabulary comprehension | <i>Investigate</i> Step 2 | The names of sports may be different in other parts of the world. The most notable example is soccer, which is called football in most of the world. FIFA, which stands for Fédération Internationale de Football Association, is the governing organization for this sport. |
| Higher-order thinking | <i>Physics Talk</i> | Understanding the way scientists look at the world is crucial to understanding science itself. To help students understand, start a class discussion about the laws of physics. Be sure students comprehend that the laws are our best description of how nature works, and the laws change not because nature changes, but rather because our understanding improves as new experiments lead to a deeper understanding of phenomena. |
| Vocabulary comprehension Understanding concepts | <i>Active Physics Plus</i> | ELL students may not know the English names of some extreme sports, such as skydiving, hang gliding, "air surfing," and motocross. Perhaps the best and easiest way of teaching these names would be to show photos of the activities. Sports magazines and library books are good sources of such photos, and you may also find short videos for students to watch on the Internet. Engage students with these visuals by challenging them to identify physics concepts that apply to the activities. |
| Vocabulary comprehension | <i>Active Physics Plus</i> | Help students understand the meaning of "lexicon." They may not be able to decode the word from context alone. |
| Understanding prefixes | <i>Active Physics Plus</i> | The prefix "ultra," meaning "extra" or "above," is relatively common in physics. Challenge ELL students to determine the meaning of "ultra-high energy," "ultra-cold," and "ultra-strong" through context. |
| Higher-order thinking Vocabulary comprehension | <i>Physics to Go</i> Question 3 | Challenge students to explain why air in tanks on the Moon is compressed (to fit more air in the tank, allowing for longer intervals between refilling). Help students decipher the meaning of "malfunction" by telling them that "mal" means "bad" or "abnormal." To help solidify their understanding, bring words they may know with this prefix, such as "malnutrition," "malignant," and "malevolent." |
| Vocabulary comprehension | <i>Physics to Go</i> Question 7 | ELL students may not be familiar with the names of some of the activities listed here. You may wish to show pictures of these activities, as you did for the extreme sports mentioned in <i>Active Physics Plus</i> . |
| Appreciating cultural diversity | <i>Inquiring Further</i> | If any of your ELL students are from countries in which people play sports not found in the United States, encourage them to choose one such sport as the subject of their report. These students will likely appreciate the opportunity to share their culture, and their classmates will benefit from the glimpse into their friend's life. You might also arrange for a physical education teacher to allow an ELL student to teach the activity to classmates during gym class. |

SECTION 1

Teaching Suggestions and Sample Answers

What Do You See?

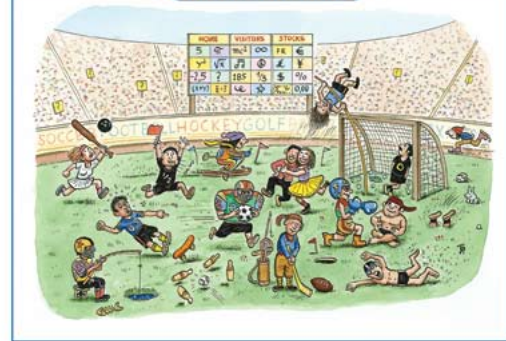
There are many sports and players depicted in this illustration that students will most likely comment on the events happening on the field. To streamline the discussion that ensues, you might want to ask students why the artist would choose to depict so many different sports in one place. Why is a man trying to swim in grass? Why is the girl skiing on the grass? These and other questions will undoubtedly stir students' interest and provide opportunity for further discussion. Using an overhead of the illustration would be useful in highlighting different aspects of the visual. Encourage students to find clues in the title that might explain what the illustration is trying to convey.



Section 1

Identifying and Classifying: What Is a Sport?

What Do You See?



Learning Outcomes

In this section, you will

- Apply brainstorming as a process for generating ideas.
- Develop a working definition of the term "sport."

What Do You Think?

A friend comes by and asks if you want to watch some sports on TV. You turn on the set and your friend says, "That's a movie." You try another station and your friend complains, "That's a soap opera." You try a third time and your friend says, "Stop, there's some sports."

- How did your friend know what type of program was on after seeing the TV for only a few seconds?
- What did your friend observe on the screen that indicated that a sport was on TV?

Record your ideas about these questions in your *Active Physics* log. Be prepared to discuss your responses with your small group and the class.

Investigate

1. Brainstorm a list of at least 10 words or phrases that identify attributes, or characteristics, of activities known as sports. (Example: team involved, individual involved, and/or score kept.)

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Students' Prior Conceptions

This section provides students with the creative opportunity to define a sport and to begin thinking about how their identified sport or sports would play out on the Moon. You may wish to keep the following prior conceptions in mind when guiding students through the brainstorming process to help them define the rules for their sport on the Moon and to explain the physics involved.

When students explain changes, they tend to postulate a cause that produces a linear chain of effects one after another. Students may need to be mindful of events pursuant upon those that precede them, but they also need to become cognizant of events that may occur randomly and are dependent upon the conditions of a specific location or event sequence. Encourage students to expand their thinking to include multiple paths that diverge from one thing.

For instance, the players may determine the path taken and the potential for subsequent consequences for the sport or a specific game, or the path taken may be dependent upon other factors not under the players' control. It is helpful for you to encourage students to explore the effect that randomness may have on a sport, and even for you to mention chaos theory where things that appear random actually generate predictable, statistical patterns. For example, in a baseball game, after a player hits a single, the role of a dice may determine if the single becomes a home run or an out. Students may think it is exciting to develop a "chaotic" sport to be played on the Moon, for example, one that seems to have random events but the analysis of these events generates a predictable statistical pattern of behavior. Although the outcome of any one action may not be predictable, the odds of a certain result may be determined.

Remind them that they will have other opportunities during the course of this section to review their initial impressions.

What Do You Think?

Students will come up with a wide range of responses to these questions and most will be fairly accurate. The purpose of these questions is not to elicit a “right” or “wrong” answer but to draw students’ attention toward which activities would qualify for a sport. Ask students to write their responses in their *Active Physics* logs. After an initial discussion, ask them to share their answers with each other and also write questions that come to mind about sports. Assure students that their work will not be evaluated at this stage, but will only serve as a building block of inquiry that will guide them toward the right answers.

What Do You Think?

A Physicist’s Response

A key word found in dictionary definitions of “sport” is the word “diversion.” Sports provide enjoyable diversion from other, less enjoyable forms of human activity, such as household tasks and career activities.

Usually, “diversions of the field” such as hunting and fishing are included with athletic games under the umbrella term “sport.” Competition usually is not involved in the former and usually is involved in the latter sports.

Investigate

1.

Answers will vary from group to group. See *Background Information* for suggestions on how to encourage a variety of opinions.

Concentrating on the inputs and outputs of a system often requires a different, time-independent view, which students may not take to be an explanation. This prior conception correlates with the first one and again it is optimal for you to advance the thinking of students so that they move away from completely concrete, linear situations in their brainstorming to encompass various probabilities and unique playing situations that may occur within the format of their sport. It is helpful for you to persuade students to examine these two notions throughout the chapter and especially when they are forming inputs for evaluation in their design process.

Physics Talk

This *Physics Talk* affirms that laws of physics are universal. Students learn that defining the attributes that make an activity a sport is in general a difficult task and that their discussions in the *Investigate* were to bring about the realization that all sports require physical action. After students have finished reading the *Physics Talk*, ask them how they would describe a law of physics. Ask students to share their descriptions with their group and have a group member record the essential features of a physics law. Students could then prepare a poster of their ideas that describe a physics law and also give examples of sports that can be explained using Newton's laws. Consider asking students why the results might be complicated when action in a sport is described using physics laws.

Checking Up

1.

The laws of physics cannot be broken because they are not laws like you think of in a legal sense. These laws describe the way you see nature interacting, and if it is discovered that nature acts differently in some situations, the laws are immediately amended to take the new events into account.

2.

Because gravity on the Moon is very different from gravity on Earth, generally all sports that are strongly affected by gravity will be affected. For example, people trying to jump on the Moon will



Physics Talk

THE LAWS OF PHYSICS

Everybody seems to recognize a sporting event when they pass by a field or see it on television. Defining the attributes of a sport can be a bit more difficult. In your group discussions on the nature of sports, you perhaps had disagreements as to which activities are sports. Is ballroom dancing a sport? Is ultimate disk throwing a sport? Is chess a sport? You have been asked to invent a sport that can be played on the Moon. Your discussion of sports from this section will aid you in developing that sport.

Trying to come up with a definition of a sport might have proven difficult, but most people would agree that a sport requires physical action. If a sport requires physical action, then it can be described by the appropriate physics – what scientists sometimes call the **laws of physics**.

The laws of physics are generalizations about relationships in the physical world based on universal and invariable observations. That means that if everywhere the observations of many people about the same event are always the same, scientists can use the observations to develop a law. Laws of physics are universal. They are true anywhere in the universe. They are also parsimonious, meaning that they are clear and concise, and they are no more complex than necessary. They follow “the simpler, the better,” principle. You have already investigated a number of laws of physics. Newton's laws of motion are three well-known laws of physics you have studied. The law of conservation of energy is also a law with which you are familiar. The activities you see in sports can be explained using these and other laws of physics.

The laws of physics are not laws in the sense you usually think of them. They need no one to enforce them, since nature does the enforcing. If it is found that some event does not obey the laws of physics, the law of physics is amended so that the new law can explain that event as well as all the other events.

When a scientist tries to describe the action in a sport according to the laws of physics, the results may often be very complicated. A curve ball thrown by a pitcher in a baseball game, the spins, twists and turns of a diver, or the trajectory of a forward pass in football will all require complex physics to describe them adequately.



Physics Words

Laws of physics: universal and invariable observations and relations of the physical world. The laws of physics may, however, be disproved if new facts or evidence contradict them.

Checking Up

1. Explain why the laws of physics cannot be broken.
2. List two factors that would be radically different for an athlete playing a sport outdoors on the Moon when compared to Earth.

find that they can jump much higher than on Earth, and thrown objects will take much longer to fall, meaning they will go much further. There are many more examples such as these that may be cited, and are equally correct.

Active Physics

| +Math | +Depth | +Concepts | +Exploration |
|-------|--------|-----------|--------------|
| | • | • | • |

Plus

Do Extreme Sports Require Extreme Physics?

Extreme sports take many forms, such as skydiving, hang gliding, and even “air surfing,” where participants jump out of an airplane with a snowboard strapped to their feet. Similar to hang gliding, but with a smaller wing, these “air surfers” use a snowboard to control their descent to the ground.

The physics needed to explain sports of this nature is the same physics that is investigated in *Physics in Action*. For extreme sports like air surfing, scientists looking to explain just what is occurring must look deeply into these phenomena.

Equations for air resistance, or drag, like the one below, are used to help explain the motion of these falling air surfers.

$$D = \frac{1}{2} \rho A C_D v^2$$

This expression may appear extreme to you now, but you will soon learn more about drag in *Section 9* of this chapter, which will help give you a greater understanding of physics.

Motocross, another extreme sport, where people do stunts in midair while riding “dirt” motorcycles, requires understanding the physics of conservation of angular momentum, moment of inertia, and the gyroscopic principle.



All these concepts are part of the basic vocabulary of physics. They describe the real world and are only slightly more complex than the material you are studying in this book. In the future, you will continue to learn about physics and gain a better understanding about these marvelous sports.

To a physicist, physics occurs in even more extreme ways, like ultra-high energy particles, ultra-cold temperatures, and the ultra-strong gravity of black holes. All these exciting areas of study use even more complex and fascinating areas of physics.

1. Choose an extreme sport. Research one physics concept related to the sport that you have not learned about in class. For example, if you choose snowboarding, you may wish to find out what makes snow slippery. Be prepared to present your research to the class.

Active Physics Plus

Students read how physics is able to describe what is occurring even in extreme sports. Although the physics may also look “extreme” to students, it is part of the basic lexicon of science and only slightly more complex than the physics they study in the text. Students research an extreme sport and choose one physics concept related to the sport.

1.

Students’ answers will vary depending upon the sport they choose. If students choose to answer why snow is slippery, their answers may include the ability of ice crystals to slide over one another due to lack of cohesive forces between them, and the generation of heat due to friction when objects move through the snow. If the heat is sufficient to melt the snow, a thin film of water can build up, lubricating the slip. This is probably why the slipperiest snow is snow near the melting point of water, rather than “cold” snow that is at a much lower temperature.

What Do You Think Now?

Ask students to review previous answers and update them according to what they now understand by the meaning of the term “sport.” The questions that are presented in this section are open-ended and will most likely have a range of correct answers. Students should be able to come up with a definition for a sport that identifies different activities that might be included in a sport. This is also a good time for students to revisit the *What Do You See?* illustration and realize how their understanding of a sport has grown. You may want to provide them with *A Physicist’s Response* for further insight and discussion.



What Do You Think Now?

At the beginning of the section, you were asked the following:

- How did your friend know what type of program was on after seeing the TV for only a few seconds?
- What did your friend observe on the screen that indicated that a sport was on TV?

After your investigation of what makes a sport, is it possible to come up with a definition for a sport that includes all of the activities people would identify as requirements to be a sport? Explain your answer.

Physics

Essential Questions

What does it mean?

What does brainstorming reveal about the definition of a sport?

How do you know?

What convinced you that your definition of a sport was a good one?

Why do you believe?

| Connects with Other Physics Content | Fits with Big Ideas in Science | Meets Physics Requirements |
|-------------------------------------|--------------------------------|---|
| Forces and motion | Well-defined terms | * Agreement on the meaning of terminology and definitions |

* Many groups considered the question of what is a sport. What convinced you that people agree or disagree on the definition of a sport?

Why should you care?

How will you convince NASA that the activity proposed by your group fits the definition of a sport?

Reflecting on the Section and the Challenge

The first item that you must address in your proposal to NASA is how your chosen sport for Moon dwellers meets the basic requirements for a sport. In order for you to convince NASA that you know what the requirements for a sport are, it seems necessary for you to include a fundamental definition of a sport as a basis of your proposal. You may wish to refine your definition later. The list of sports generated by your group during this activity is a good starting place for considering which sports could be adapted to the Moon. However, you probably need more information about the differences between Earth and the Moon before you can make a good decision about the particular sport to include in your proposal.

Physics Essential Questions

What does it mean?

Many sports do not have all the identical properties of other sports. Many sports share specific attributes.

How do you know?

All of the sports fit within the definition of sport with no exceptions.

Why do you believe?

Some activities that were considered a sport by some groups were not considered a sport by other groups.

Why should you care?

Having a definition of “sport” allows you to test your invented sport against the definition.

Physics to Go

1.

Student's response should recognize the need to define terms because, lacking definitions of important terms, different people often attach different meanings to terms.

2.

Webster's New Collegiate Dictionary, first two meanings:

1. That which diverts, and makes mirth; pastime; diversion.

2. A diversion of the field, as hunting, fishing, racing, games, especially athletic games, and so on. Also, any of various similar games usually played under cover, as bowling, rackets, basketball, and so on.

The second definition will probably more closely align with students' definitions of a sport. In addition, students might put more emphasis upon keeping score and the use of organized teams with uniforms.

3.

Students should realize that pressurized suits add a great deal of weight to the astronauts, and restrict movement to a certain degree. In addition, the lack of mobility will restrict vision and reflexes needed for some sports. The danger associated with a tear in the pressurized suit would limit the sports that could be played. Contact sports where the players strike one another would not be allowed, as would any sport where there is equipment involved that could damage the suit.

4.

Some sports that could safely be played on the Moon would include golf, many track and field sports (such as running, throwing or jumping), weight lifting, shuffleboard, ice skating, badminton, tennis and bowling. Any sport that does not present a significant danger of an object striking the suit and causing a rip would be an acceptable answer.

5.

Many of the same sports played on Earth indoors in a stadium could be played on the Moon when the differences in gravity are accommodated. Sports such as baseball, football, soccer, softball, basketball, and so on, would all be possible.

6.a)

Answers will vary depending on which sports students like to play the most.

6.b)

Answers will vary depending on which sports students like to watch the most. It is unlikely that students will have very much knowledge of how sports would be affected on the Moon, including, for example, inability to walk or run normally on the Moon.

7.a)

Student's answers will depend upon how they view the physical activity associated with the various sports. Ballroom dancing might be controversial.

7.b)

Chess should be eliminated due to lack of physical activity.

7.c)

Students probably will accept skateboarding as a sport.

7.d)

Students probably will accept white-water canoeing with little disagreement.

7.e)

Students probably will accept beach volleyball as a sport.

7.f)

Students probably will accept weight lifting with little disagreement.

8.

Preparing for the Chapter Challenge

Because one team is "on the bench" during each half inning, air tanks could be refilled. If a batter or runner on base needs air, prior to refilling, a rule change might be to allow a substitute player, or a change in the batting order until the batter has refilled their air tank. Any other rule change that accommodates the need for air refills at regular intervals is acceptable.

Inquiring Further

Some highly recommended resources might include "Football Physics" with Dr. Tim Gay of the University of Nebraska and "The Physics of Baseball" by Robert Adair. Numerous other excellent resources are also available.

Section 1 Identifying and Classifying: What Is a Sport?

Physics to Go

1. You learned from this section that the term “sport” means different things to different people. Write a brief paragraph describing an occasion when someone asked you for the definition or the meaning of a term used in a conversation with you. (Example: A parent saying, “Don’t get home too late.”)
2. Look up the definition of “sport” in a dictionary. What do you think of the definition? Explain your answer. How did this definition of sport compare with the one you and your team proposed?
3. Outdoors on the Moon, astronauts must carry compressed air tanks for breathing (there is no air on the Moon). Astronauts must also wear pressurized suits. If the pressurized suit rips or the air tank malfunctions, the astronaut could die. How will this affect participation in sports played on the Moon?
4. List three sports that could be played outdoors on the Moon, taking into account the safety concerns listed in *Question 3*.
5. List three sports that could be played indoors in a stadium on the Moon.
6. Based only on what you know about the Moon so far, how would conditions on the Moon affect
 - a) the sport you like playing the most?
 - b) the sport that you like watching the most?
7. Do the following meet your definition of a sport? Explain.

| | |
|---------------------|-------------------------|
| a) ballroom dancing | b) chess |
| c) skateboarding | d) white-water canoeing |
| e) beach volleyball | f) weightlifting |
8. *Preparing for the Chapter Challenge*



Part of the excitement of playing sports is having spectators. If the sport on the Moon is to be played on the surface, everyone (athletes and spectators) will require compressed air and pressurized suits. If a normal compressed air bottle holds enough air for 45 minutes, suggest a rules change for a softball game, since the game often lasts several hours.

Inquiring Further

Research the physics of a sport

Many books have been written about the physics of sports, and the Internet has dozens of sites devoted to the explanation of how physics describes a particular sport. Choose a sport that interests you and do an Internet search to find a site that deals with that sport. Summarize what the site says about the sport and the related physics, and give a brief report to the class.

SECTION 1 QUIZ**9-1a****Blackline Master**

1. The laws of physics are said to be “parsimonious.” Which statement below best explains this principle?
 - a) The laws of physics must explain everything.
 - b) The laws of physics are as complex as necessary, but not more so.
 - c) The laws of physics must be made simple.
 - d) The laws of physics should be complicated to a non-scientist.
2. When a scientist says the laws of physics are universal, she means that
 - a) the laws of physics are the same everywhere in the universe.
 - b) scientists can make any situation fit into the laws already known.
 - c) only the laws of physics are possible in the universe.
 - d) no situation is possible that is not covered by the laws already known.
3. Which of the following statements best describe all sports?
 - a) A sport must be played outdoors.
 - b) A sport must be played only between teams.
 - c) A sport must have crowds watching.
 - d) A sport must have physical action.
4. Which of the following would not be considered one of the laws of physics?
 - a) The law of conservation of energy
 - b) Newton’s laws of motion
 - c) Murphy’s law
 - d) The law of conservation of charge
5. The laws of physics are enforced by
 - a) physicists.
 - b) nature.
 - c) the science law council.
 - d) all of the above.

SECTION 1 QUIZ ANSWERS

- 1 b) When something is parsimonious, it is made as simple as possible to explain things, but no simpler than that.
- 2 a) The laws of physics are true everywhere in the universe as best science can determine.
- 3 d) Most people would agree that a sport requires physical action. Activities that require only mental agility are generally be considered games, but not sports.
- 4 c) Murphy's law is generally quoted as "Anything that can go wrong, will." This may be true, but it is not a law of physics.
- 5 b) There is no enforcement agency for the laws of physics, because they are enforced by nature.