1.2 Strategies for Problem-Solving Success

Problem-solving skills are important in everyday life, in school, and in the workplace. Some problems, like deciding whether to walk or ride your bike, are easier to solve than others. In each case, however, you develop a process to help you make up your mind. In physics, understanding a concept is more important than simply doing the math; hence, the need for creativity and adaptability. As you apply the problem-solving strategies contained in this textbook, remember that your answer to any one question is less important than the reasoning you use.

Figure 1.7 Chess is a game of intricate strategy. Victory belongs to the player who can visualize how the game will progress several moves into the future.

SECTION OUTCOMES

- Select and use appropriate numeric, symbolic, graphical, and linguistic modes of representation to communicate science.
- Analyze and synthesize information in the process of developing problem-solving skills.

KEY TERM

- framing a problem

Framing A Problem

Framing a problem is a way to set parameters (important boundaries) and organize them in a way best suited to a particular problem. There is rarely only one way to frame a problem, and how you do so depends on each situation; you must determine which methods work best for you, and for each problem. Often, simply framing a problem will help the solution to become apparent to you.

Framing a problem, whether it is a physics question or a typical household problem, is a creative and systematic process designed to clarify what is known, what restrictions exist, and what the ultimate goal is. Most people have a preferred method of organizing information. Often the method used to organize information is topic specific rather than personal preference.

Figure 1.9 Framing a problem and developing solution strategies is applicable to all types of problems.

Figure 1.8 Recognizing the modes of organization that you prefer will help you develop your problem-solving strategies.

Example 1: Organizing Data Using Text

You can represent your thinking process in the form of questions.

In this way, you have framed the problem by posing key questions about your available time. Your solution must fit within these parameters.

A Typical Problem

A friend calls you on a Tuesday evening at 6:00 p.m. and asks if you want to join two other friends for two-and-a-half hours of "down time," to play an ongoing game you have all been enjoying. Your friends plan to begin at 7:30 p.m. You know that you have two homework assignments that must be completed before tomorrow. Before you are able to answer, you need to decide if you have enough time to complete your homework and to take time out to play the game. You also need to prioritize your feelings about the benefits of taking time out to play the game.

This scenario has been framed graphically using different strategies. As you examine them, consider their effectiveness. Develop your own strategies for framing problems, and for setting parameters that work best for you.

(a) Written Text

I feel like playing the game. It would be an enjoyable break, but I also have two homework assignments due in the morning. How long do my friends intend to play the game? Two-and-a-half hours. How much time do my assignments require? Physics: thirty minutes. Math: no homework tonight. English: thirty minutes. I should be home by 11:00.

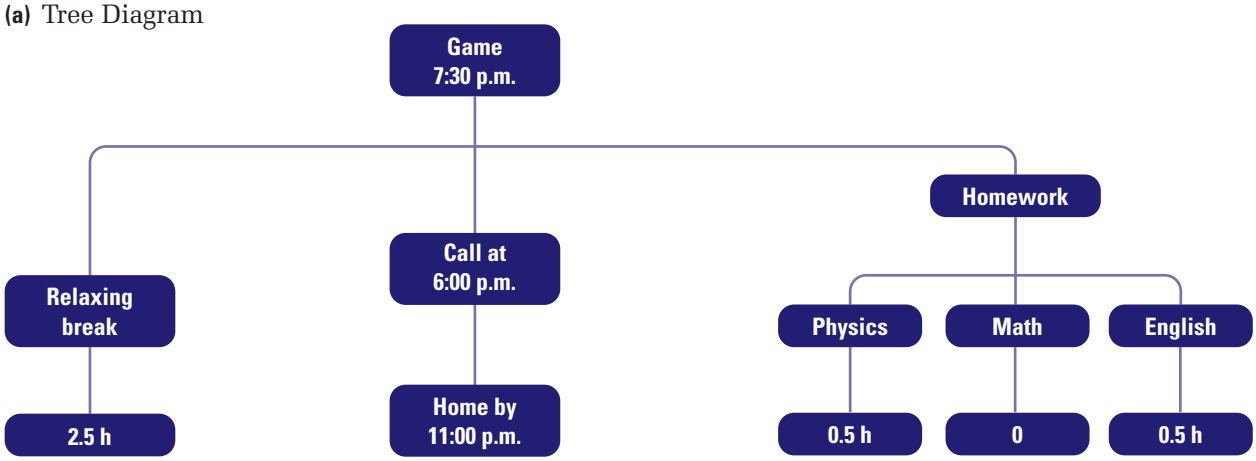
(b) Bulleted List

- Ongoing game
- Fun, and provides a break
- Homework to do
- Thirty minutes of Physics homework
- Thirty minutes of English
- Two-and-a-half hours
- Home by 11:00

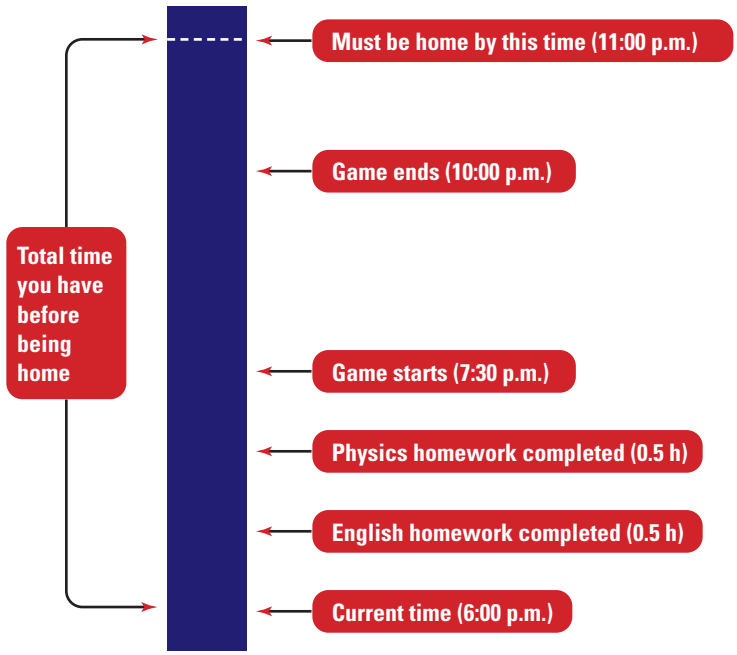
Example 2: Organizing Data Using Diagrams

You have framed the problem by generating diagrams (a) and (b) which outline the parameters. Your solution must fit within these parameters.

(a) Tree Diagram



(b) Temporal Diagram



Model Problems

Throughout this resource, you will find a feature called Model Problem. Each one presents a specific physics problem and its solution. Model Problems follow a step-by-step approach, identical to the one below. Become familiar with these steps, and integrate them into your own bank of problem-solving strategies. Throughout the book, the Model Problems are followed by Practice Problems to help you develop your skills. Answers to these are found at the end of the text.

MODEL PROBLEM

A problem is posed.

Frame the Problem

This section describes the problem and defines the parameters of the solution. Consider statements made in this section very carefully.

PROBLEM TIP

Often you will find problem tips embedded in model problems. The problem tips are designed to highlight strategies to help you successfully navigate a specific type of problem.

Identify the Goal

Narrow your focus and determine the precise goal.

Variables

Known

Lists variables about which information is known or implied.

Unknown

Lists variables that are unknown and must be determined in the solution.

Strategy

A step-by-step description of the mathematical operations involved.

Calculations

Use the data you have accumulated to complete the solution. Simplify the units required in your final answer.

A concluding statement verifies that the goal has been accomplished. The number of significant digits in the solution statement must match those in the question statement.

Validate

This provides an opportunity to clarify the steps used in calculating the solution. Validating the solution helps catch numerical and conceptual errors.

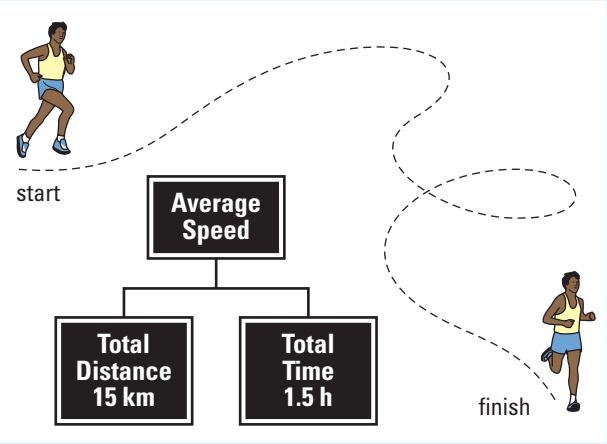
MODEL PROBLEM

Average Speed

A student runs 18 km in 1.5 h. What was the student's average speed?

Frame the Problem

- The student may or may not have stopped for a rest, but the term average implies that only total time and total distance are to be considered.
- Speed has units of distance/time.
- Use the distance/time information to help build a formula for speed (or verify that the one you have memorized is correct).
- Total distance/total time will provide the average speed.



Identify the Goal

The average speed, v_{ave}

Variables and Constants

Known

$\Delta d = 18$ km

$\Delta t = 1.5$ h

Unknown

v_{ave}

PROBLEM TIP

Be sure to identify the number of *significant figures* provided in the question as they will vary from one question to the next. Carry excess significant figures through during calculations, and then round your final answer to the correct number of significant figures. See Skill Set 2 at the back of this textbook for significant digits and rounding information.

Strategy

Use the average speed formula

Substitute in the known values, and solve

Calculations

$$v_{ave} = \frac{\Delta d_{Total}}{\Delta t_{Total}}$$

$$v_{ave} = \frac{(18 \text{ km})}{(1.5 \text{ h})}$$

$$= \frac{12 \text{ km}}{\text{h}}$$

Therefore, the student ran at an average speed of 12 km/h.

Validate

The value for speed is given in distance (km) per time (h) which is correct.

Web Link

This feature directs you to conduct research on the Internet. To help you save time, the Physics Internet site contains links to many useful Web sites.

PROBEWARE

This logo indicates where electronic probes could be used to explore concepts and extend investigations.

Achieving in Physics

The following table identifies four categories of knowledge and skills in science that you can use to assess and evaluate your achievement. The chart is provided to help you in assessing your own learning, and in planning strategies for improvement, with the help of your teacher.

You will find that all written text, problems, investigations, activities, and questions throughout this textbook have been developed to encompass the curriculum outcomes of your course. Questions in the text are encompassed by these general categories: Knowledge/Understanding K/U, Inquiry I, Communication C, and Making Connections MC. Questions in the textbook have been designated under one of these categories to enable you to determine if you are able to achieve well in each category (some questions could easily fall under a different category; we have selected, for each question, the category with which it best complies). In addition, problems that involve calculation have been designated either Practice Problems or, in Chapter and Unit Reviews, Problems for Understanding.

Table 1.1 Charting your Achievement in Physics

Knowledge and Understanding	Inquiry	Communication	Making Connections
■ Understanding of concepts, principles, laws, and theories ■ Knowledge of facts and terms ■ Transfer of concepts to new contexts ■ Understanding of relationships between concepts	■ Application of the skills and strategies of scientific inquiry ■ Application of technical skills and procedures ■ Use of tools, equipment, and materials	■ Communication of information and ideas ■ Use of scientific terminology, symbols, conventions, and standard (SI) units ■ Communication for different audiences and purposes ■ Use of various forms of communication ■ Use of information technology for scientific purposes	■ Understanding of connections among science, technology, society, and the environment ■ Analysis of social and economic issues involving science and technology ■ Assessment of impacts of science and technology on the environment ■ Proposing courses of practical action in relation to science- and technology-based problems

The e-book of this text provides opportunities to extend your learning. At the end of each unit, you will have a chance to tie together the concepts and skills you have learned through the completion of either an investigation, an issue, or a project. Throughout each unit, one of the logos below will remind you of the end-of-unit performance task for that unit. Ideas are provided under each logo to help you prepare and plan for the task.

ELECTRONIC LEARNING PARTNER

The Electronic Learning Partner contains simulations, animations, and video clips to enhance your learning.

UNIT ISSUE PREP

UNIT PROJECT PREP

UNIT INVESTIGATION PREP

The Physics Course Challenges, also on your e-book, will allow you to incorporate concepts and skills learned from every unit of this course. These culminating tasks can be developed during the year, but completed at or near the end of the course. Course Challenge logos exist throughout the text, cueing you to relate specific concepts and skills to these end-of-course tasks. The units in this course may seem to be largely unrelated. By investigating Space-Based Power and Scanning Technology in the Course Challenges, however, you will find some intriguing interactions among many concepts.

COURSE CHALLENGE: SPACE-BASED POWER

1.2 Section Review

1. **C** Explain why problem solving is a creative process. State the importance of framing a problem.
2. **K/U** Reflect on the game scenario. Which framing method most closely matches the thought process you would use to solve the same problem?
3. **I** Develop a different framing technique for the game problem. Share your model with the class.
4. **I** You have been offered a part-time job at the mall on weekends. However, you are determined to pursue a post-secondary education and have been devoting extra time to your studies. Should you accept the job? Frame the problem to help you decide.
5. **I** A friend asks you if warm water freezes faster than cold water. Frame the problem.
6. **I** Another friend tells you that astronauts are weightless when they orbit Earth. You know this to be inaccurate. Frame the problem to help dispel the misconception.