INSTRUCTOR'S SOLUTIONS MANUAL

COMPUTER MATH

Problem Solving *for* Information Technology

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Contents

Chapter 1: Problem Solving

Introductory Problem

This chapter's introductory problem requires a team of two persons.

String Handcuffs

- Each person needs to make a set of "handcuffs" from a piece of string about 3 feet long. Tie slipknots at each end of the string. (If you don't know how, ask your instructor.)
- The first person puts the handcuffs on by placing a slipknot around each wrist and drawing it snug, but not tight. Notice the handcuffs complete an unbroken "ring" that includes the shoulders and both arms.
- The next person puts the handcuffs on by putting one hand in a slipknot and passing the other slipknot through the partner's "ring" before putting it on the remaining wrist. Again, pull both slipknots close over the wrist, but not tight.

Each team member is connected to the other by an unbroken "ring" formed by arm, body, arm, and string. The ring of one person is interlocked with that of the other. It's somewhat like those brass rings that magicians so mysteriously snap apart.

To solve the problem you must separate the two "rings" so you and your partner are no longer connected. Do this without breaking the string or removing any slipknot from around any wrist. Random trial and error is a good way to begin. But at some point it will be helpful to carefully think about your situation and try to examine things systematically. You may break the rules to gain insight. But your final solution you must follow the rules.

From time to time, as you try to solve the problem, your instructor may give you hints.

After You Have Solved the Problem

Write a detailed set of instructions telling how to solve the problem. Then have another team carry out your instructions. Correct and refine your instructions if some parts are incorrect or unclear.

Answer the following questions:

- What insight let you discover the solution?
- What was slightly misleading about the wording of the problem?

After Your Written Solution Has Been Tested

At the end, your instructor will present you with a formal solution to compare with your own.

Instructions to Separate the String Handcuffs

1. Identify the team members as person A and person B.

2. Place a section of person A's string over person B's wrist, just on the elbow side of the slipknot.

3. Reach under person B's slipknot and pull a loop of person A's string through, toward the fingers of person B.

4. Without twisting it, pass the loop completely over person B's hand.

5. Now the string can be pulled free and the partners can separate.

Note: The five steps above are diagramed in figure 1.1 on the following page.

What insight led you to this solution?

Different insights are likely. Here are some possibilities:

- The string, arm, and body forms what at first seemed to be an unbroken ring.
- Without a break in this ring separation is not possible.
- The only possible break in the ring is at the slipknot. Examine that point closely.
- Because the string is flexible it can be passed around the hand.
- This can be clearly seen by removing the slipknot from the hand A to a position just away from the fingertips. Although this violates the rules, it does allow you see how B's string can be passed over A's hand to allow separation.

What part of the problem statement led you to the final insight above?

The statement: "You may break the rules to gain insight."

What was slightly misleading about the wording of the problem?

The statement: "It's somewhat like the brass rings that magicians snap apart."

The five steps needed to separate the string handcuffs are shown below.

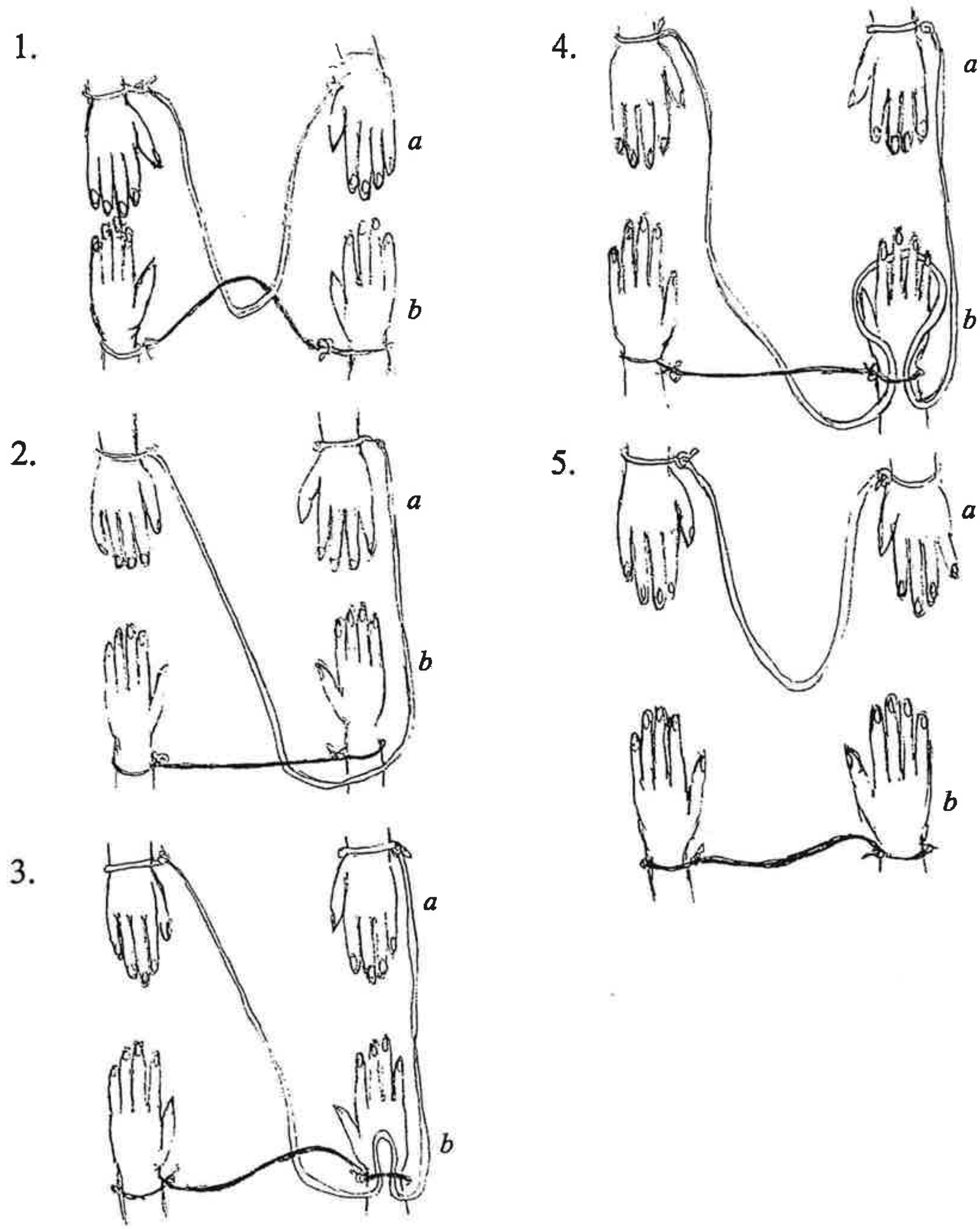

Figure 1.1 Separating String Handcuffs
Illustration by Emily Reeder

Practice Problems

Section 1-2

Introductory Problems

For the following problems, merely identify the data, condition, and unknown (Polya's components). Every problem need not have a condition, but if it does, it will often be preceded by the word *if*. For now there is no need to develop a plan or carry out the solution. You will have an opportunity to do that later.

1-2.1 A computer-generated report includes inventory information for 200 items. The information for each item is given on a separate line. If 50 lines will fit on a page of printer paper, how many pages of printer paper will it take print the report?

Answer:	Data:	The report contains information for 200 items. Information for each item takes one line.
	Condition:	50 lines will fit on a page of printer paper.
	Unknown:	The number of pages in the report is unknown.

1-2.2 A box contains 30 cookies. If each cookie weighs 1/2 ounce, what is the weight of the cookies?

Answer:	Data:	A box contains 30 cookies.
	Condition:	Each cookie weighs 1/2 ounce.
	Unknown:	The weight of the cookies is unknown.

1-2.3 A box contains 30 cookies. If the empty box weighs 2 ounces and each cookie weighs 1/2 ounce, what is the weight of the box full of cookies?

Answer:	Data:	The box contains 30 cookies.
	Condition:	The empty box weighs 2 ounces. Each cookie weighs 1/2 ounce.
	Unknown:	The weight of the full box of cookies is unknown.

Intermediate Problems

1-2.4 A box of cookies contained 30 cookies when purchased. The empty box weighs 2 ounces and each cookie weighs 1/2 ounce. If one third of the cookies have been eaten, what is the combined weight of the box and the remaining cookies?

Answer:	Data:	A box contains 30 cookies. The empty box weighs 2 ounces. Each cookie weighs 1/2 ounce.
	Condition:	One third of the cookies have been eaten.
	Unknown:	The weight of the box and the remaining cookies is unknown.

1-2.5 A computer-generated report includes inventory information for 220 items. The information for each item is given on a separate line. If 50 lines will fit on a page, how many pages will it take to print the report?

Answer:	Data:	Report contains information for 220 items.
		Information for each item takes one line.
	Condition:	50 lines will fit on a page of printer paper.
	Unknown:	The number of pages in the report is unknown.

1-2.6 A report generated by a computer includes information for 1000 customers. There are two types of customers, regular and preferred. The information for each regular customer takes one line on the report. The information for each preferred customer takes two lines on the report. Each page can contain up to 50 lines. If the number of regular customers is three times the number of preferred customers, how many pages will the report require?

Answer:	Data:	The report contains 1000 customers.
		There are two types of customers: regular and preferred.
		Information for each regular customer takes one line.
		Information for each preferred customer takes two lines.
		Each page of the report can contain 50 lines.
	Condition:	The number of regular customers is three times the number of preferred customers.
	Unknown:	The number of pages in the report is the unknown.

1-2.7 Students in the CIS department can receive internship credit for work experience in a position related to information technology. At the beginning of the term, each student with an approved internship position enrolls for a specified number of credits. At the end of the term each student submits a time sheet showing the number of hours worked. Credit is awarded at the rate of one credit for each 30 hours worked. Credits are rounded to the nearest half credit. (For example, values in the range 1.75 and up to but not including 2.25 will round to 2.0. Values in the range 2.25 and up to but not including 2.75 will round to 2.5.) The credits awarded can never exceed the credits enrolled, regardless of the number of hours worked. Compute the number of credits awarded to each student from the following enrollment data:

Name	*Credits Enrolled*	*Hours worked*
Adams, Jane	1	30
Beck, Carl	2	15
Jones, Michael	2	90
Smith, Mary	2	50
Walker, William	5	75

Answer:	Data:	Each student enrolls for a specified number of credits.
		Each student submits time sheet showing hours worked.
		Each student earns one credit for each 30 hours worked.
		Credits earned are rounded to the nearest 1/2 credit.
	Condition:	Credits awarded can not exceed credits enrolled.
	Unknown:	The number of credits earned by each student is unknown.

Brainstorming Problems

Try solving these problems with careful reasoning. Your instructor has the solutions.

1-2.8 A bear goes for a walk. He walks 3 miles south, then 3 miles east, and finally 3 miles north. At the end of this walk the bear has arrived back where he started. What color is the bear?

Answer: The only point on earth that a walk of three miles south, three miles east and three miles north will return to the starting point is at the North Pole. The only type of bear that will be found at the North Pole is a polar bear. **Therefore, the bear must be white.**

We will ignore the issue of whether polar bears come as far north as the pole or if they are more likely to be found farther south near the edge of the ice cap where access to food is easier. Just consider that this a stray bear and the problem works very nicely.

1-2.9 You are a driving a bus on the Main Street line. At the start of the run down Main Street the bus is empty. At First Avenue three passengers get on. At Second Avenue two more passengers get on. At Fifth Avenue four passengers get on and two get off. At Seventh Avenue one passenger gets off and two get on. How old is the bus driver?

Answer: The age of the driver will be the same as your age since *you* are driving. The rest of the information is superfluous.

1-2.10 A 10-pound solid iron ball is dropped from 5 feet above the surface of a lake that is 50 feet deep. The time for the ball to disappear is measured with a stopwatch. This measurement is made under two different conditions as follows:

Condition 1: It is noon on a bright sunny day with the wind from the north at 4 mph. The temperature of the lake at the surface is 40 degrees Fahrenheit. The lake is crystal clear with visibility downward 25 feet.

Condition 2: It is 2:00 PM on a cloudy day with the wind from the south at 10 mph. The temperature of the lake at the surface is 20 degrees Fahrenheit. Visibility downward is less than a few inches below the surface.

Under which condition will the ball take the longest time to disappear? Explain.

Answer: **The ball takes the longest time to disappear under condition 2.**
Of all the information given, the temperature makes the biggest difference in this problem. Since the freezing point of fresh water is 32 degrees Fahrenheit, the lake surface will be frozen solid at a temperature of 20 degrees Fahrenheit. Thus, the ball will fall 5 feet to the surface and after a few bounces will to come to rest and stay put.

1-2.11 Three lamps (labeled 1, 2, and 3) are sitting on a table in a room. In an adjacent room out of sight of the lamps, are three switches (labeled A, B, and C). Each switch controls one of the lamps. The wiring is out of sight and there is no way to see which switch is connected to which lamp. What is the fewest number of trips from the switch room to the lamp room that will allow you to match each switch with its lamp?

Answer: Only one trip to the lamp room is required to match each lamp with its switch. Here is how to do it:

- In the switch room turn on two lamps.
- After a few minutes, turn off one of these.
- Then go to the lamp room.
- The lamp that is on matches the switch you left on.
- The lamp that is off but has a warm bulb, matches the switch you turned on then off.
- The remaining lamp matches the remaining switch.

1-2.12 Four men want to cross a bridge at night so they can proceed on to the town on the other side. All begin on the side opposite the town. They need a flashlight to cross the bridge, and they have only one flashlight among them. Also, a maximum of only two men can cross the bridge at one time, and whoever crosses must share the flashlight. They can cross two at a time but someone must return the flashlight to the starting side so the next two can cross. Each man walks at a different speed and any pair crossing at the same time must walk at the slower man's pace. Here are their walking rates:

Man #1 takes 1 minute to cross the bridge.
Man #2 takes 2 minutes to cross the bridge.
Man #3 takes 5 minutes to cross the bridge.
Man #4 takes 10 minutes to cross the bridge.

Can you find a strategy that will get all four men together on the other side of the bridge (under the above constraints) in only 17 minutes?

Answer: Man #1 and 2 cross together (takes 2 minutes).
Man #1 goes back alone (takes 1 more minute).
Man #3 and 4 cross together (takes 10 minutes).
Man #2 takes flashlight back (takes 2 minutes).
Man #1 and 2 cross together again (takes 2 minutes).
Now all four have crossed and it took 2+1+10+2+2 = 17 minutes!

Key ideas: Let the two slowest men to go together so their times don't add up, and let the two fastest men do the shuttling of the flashlight.

1-2.13 Ten stacks of gold coins have ten coins each. Nine of the stacks have coins made of pure gold, and one stack has coins made of an alloy that looks exactly like gold. Each pure gold coin weighs 10 grams and each alloy coin weighs 9 grams. You have an electronic scale that can display the weight of any pile of coins with 99.99 percent accuracy. What is the fewest number of weighings needed to determine which stack contains the alloy coins.

Answer: One weighing is sufficient. Weigh a pile of 55 coins made up of one coin from the first stack, two coins from the second, three from the third and so on. If all coins weighed 10 grams, the total weight would be 550 grams. Because some of the coins are alloy, the pile will weigh less. (Between 549 and 540.) The number of grams under 550 corresponds to the stack number of the alloy coins.

Section 1-4

Practice using the IPO method to plan, execute, and check the solution of the following problems. These problems should be solved using **only simple arithmetic and careful reasoning**.

Solution to Practice Problem 1-4.1

Problem	How many 150-foot laps must you swim in a 75-foot pool in order to swim a mile?	
Output	Number of 150-foot laps required to swim one mile	
Input	Length of pool is 75 feet. Each lap is 150 feet.	
Process	Notation	None needed.
	Additional Information	A mile is 5280 feet. A lap is two lengths of the pool.
	Diagram	None needed.
	Approach	To find the number of laps in a mile divide the number of feet in a mile by the number of feet in a lap.
Solution	Number of laps = 5280/150 = 35.2 laps **Number of Laps = 35.2**	
Check	Work problem in reverse: 35.2 laps each 150 feet long give 35.2 * 150 feet = 5280 feet 5280 feet is one mile, the solution checks.	

Solution to Practice Problem 1-4.2

Problem	A box contains 30 cookies. If each cookie weighs 1/2 ounce, what is the net weight of the box when it is full? Net weight is the weight of the contents and excludes the weight of the container.	
Output	The net weight of the box when it is full	
Input	A box contains 30 cookies. Each cookie weighs 1/2 ounce. Net weight is the weight of the contents and excludes the weight of the box.	
Process	Notation	w = net weight
	Additional Information	None needed.
	Diagram	None needed.
	Approach	Compute the net weight (weight of the contents) by multiplying the number of cookies by the weight per cookie.
Solution	w (ounce) = 30 (cookies) * 1/2 (ounce/cookie) = 15 ounces **w = 15 ounces**	
Check	Work problem in reverse: Net weight is 15 oz. There are 2 cookies for each ounce: x (cookies) = 15 (ounces) * 2 (cookies/ounce) Thus the box contains 30 cookies. The solution checks.	

Solution to Practice Problem 1-4.3

Problem	A computer-generated report includes inventory information for 200 items. The information for each item is given on a separate line. Up to 50 lines will fit on a page. The pages are numbered. The first page is number 1. What is the final page number?	
Output	The final page number, counting from 1	
Input	A computer-generated report includes inventory information for 200 items. The information for each item is given on a separate line. Up to 50 lines will fit on a page. The pages are numbered. The first page is number 1.	
Process	Notation	None needed.
	Additional Information	None needed.
	Diagram	None needed.
	Approach	Divide the total items by 50 to get the number of pages. If there is a remainder, these lines will be on an additional page.
Solution	200 items / 50 lines per page = **4 pages exactly**. There is no remainder, so an additional page is not needed.	
Check	The 1st page contains 50 lines. The total lines so far are 50. The 2nd page contains 50 lines. The total lines so far are 100. The 3rd page contains 50 lines. The total lines so far are 150. The 4th page contains 50 lines. The total lines so far are 200. All 200 lines will fit on 4 pages exactly.	

Solution to Practice Problem 1-4.4

Problem	Compute the floor area (in square feet) of a computer laboratory that is a rectangular room 40 feet in length and 30 feet in width using the formula: area = length * width.	
Output	The area of the floor in the computer lab (in square feet)	
Input	The computer laboratory is a rectangular room. The room is 40 ft. in length and 30 ft. in width. Use the given formula for area: area = length * width.	
Process	Notation	a = area l = length w = width
	Additional Information	$a = l * w$
	Diagram	Draw a rectangle and label the length and width.
	Approach	Substitute the length and width given into the formula for the area of a rectangle.
Solution	$a = l * w$ a = 40 (feet) * 30 (feet) ***a* = 1200 square feet.**	
Check	Work the problem backwards: 1200 square foot rectangle with a 40-foot length Has a width of 1200 / 40 = 30 feet The solution checks.	

Solution to Practice Problem 1-4.5

Problem		When a thermometer measures a temperature of 90 degrees on the Fahrenheit scale, what is the equivalent temperature on the Celsius scale? The formula that converts degrees Fahrenheit (F) to degrees Celsius (C) is: $C = (5/9) * (F - 32)$
Output		The equivalent temperature on the Celsius scale of 90 degrees Fahrenheit.
Input		The formula that converts degrees Fahrenheit (F) to degrees Celsius (C) is: C = (5/9) * (F – 32)
Process	Notation	F = Degrees Fahrenheit C = Degrees Celsius The ° symbol signifies one degree in either scale.
	Additional Information	None needed since formula is given.
	Diagram	None needed. A diagram will be used for the check.
	Approach	Substitute the 90 for F in the formula and compute C.
Solution		C = (5/9) * (F – 32) C = (5/9) * (90 –32) C = (5/9) * 58 C = 32.2 degrees on the Celsius scale **C = 32.2°C**
Check		An alternative approach uses the boiling and freezing point of water in both scales. You may have to consult a reference book to find these temperatures. Draw the two scales side by side. On the diagram mark the freezing point of water at 32° F and also at 0° C. On the diagram mark the boiling point of water at 212° F and also at 100° C. On the Celsius scale there are 100 degrees between 0° C and 100° C. On the Fahrenheit scale there are 180 degrees between 212° F and 32° F. Therefore, 100 degrees C are equal to 180° F. Note that 90° F is about 1/3 the way from 32° to 212° on the F scale. More precisely it is 58/180 the distance between 0° and 100° on the C scale. Thus, the corresponding point on the C scale is 100 * 58/180 = 32.2°. The solution checks.

Solution to Practice Problem 1-4.6

Problem	A box contains 30 cookies. If the empty box weighs 2 ounces and each cookie weighs 1/2 ounce, what is the total weight of the box full of cookies?	
Output	The total weight of the box full of cookies	
Input	A box contains 30 cookies. The empty box weighs 2 ounces. Each cookie weighs 1/2 ounce.	
Process	Notation	None needed.
	Additional Information	None needed.
	Diagram	None needed.
	Approach	Compute the weight of 30 cookies. Add the weight of the empty box.
Solution	Weight of the cookies = 30 * (1/2) = 15 ounces Weight of the box = 2 ounces Weight of the box full of cookies = 15 + 2 = **17 ounces**	
Check	Work the problem in reverse to get the weight of one cookie: The box full of cookies weighs 17 ounces. Remove the weight of the box: 17 – 2 = 15 ounces. If 30 cookies weigh 15 ounces, how much does one cookie weigh? 15 / 30 = 1/2 ounce for each cookie. Thus, the weight of one cookie checks with the weight given. The solution checks.	

Solution to Practice Problem 1-4.7

Problem	A box of cookies contained 30 cookies when it was bought. The empty box weighs 2 ounces and each cookie weighs 1/2 ounce. If one-third of the cookies have been eaten, what is the weight of the box and the remaining cookies?	
Output	The weight of the box and the remaining cookies	
Input	A box of cookies contained 30 cookies when it was bought. The empty box weighs 2 ounces and each cookie weighs 1/2 ounce. One-third of the cookies have been eaten.	
Process	Notation	None needed.
	Additional Information	None needed.
	Diagram	None needed.
	Approach	Compute the weight of the cookies in the full box. Add the weight of the empty box. Subtract the weight of the cookies eaten.
Solution	Weight of 30 cookies = 30 * 1/2 = 15 ounces Weight of empty box is 2 ounces Weight of box full of cookies = 15 + 2 = 17 ounces Weight of cookies eaten = 30 * (1/3) * (1/2) = 5 ounces Weight of box and remaining cookies = 17 – 5 = **12 ounces**	
Check	Cookies remaining = 30 * (2/3) * (1/2) = 10 ounces Empty box = 2 ounces Box and remaining cookies = 10 + 2 = 12 ounces The solution checks.	

Solution to Practice Problem 1-4.8

<table>
<tr><td>Problem</td><td colspan="2">A computer-generated report includes inventory information for 220 items. The information for each item is given on a separate line. Up to 45 lines will fit on a page. The pages are numbered. The first page is number 1. What is the final page number?</td></tr>
<tr><td>Output</td><td colspan="2">The final page number of the report</td></tr>
<tr><td>Input</td><td colspan="2">A computer-generated report includes inventory information for 220 items.
The information for each item is given on a separate line.
A maximum of 45 lines will fit on a page.
Each page is numbered starting from 1.</td></tr>
<tr><td rowspan="4">Process</td><td>Notation</td><td>None needed.</td></tr>
<tr><td>Additional Information</td><td>None Needed.</td></tr>
<tr><td>Diagram</td><td>None needed.</td></tr>
<tr><td>Approach</td><td>The report requires 220 lines, one line per item.

Divide the number of items by the number of lines that will fit on a page.

The result will be a whole number and a decimal part.

If the decimal part is greater than zero, add one to the whole number to account for the partially filled last page.

The whole number (with one added if necessary) will be the total number of pages required.</td></tr>
<tr><td>Solution</td><td colspan="2">Divide 220 by 45 to get 4.89.
The whole number is 4 and the decimal part is 0.89.
Since the decimal part is greater than zero, add one to 4 to get 5.

Counting the final partial page, the final page number is 5.</td></tr>
<tr><td>Check</td><td colspan="2">5 pages can contain up to 225 items.
4 pages contain up to 180 items.
Thus 220 items will require 4 full pages holding 180 items, plus an additional page for the remaining 40 items.
The final page number is 5. The solution checks.</td></tr>
</table>

Solution to Practice Problem 1-4.9

Problem	The volume of a sphere is given by the formula: $v = \frac{4}{3}\pi r^3$. In the formula, *v* represents volume, *r* represents the radius of the sphere, and π is a constant with an approximate value of 3.14159. Compute the volume of a sphere with a radius of 2 feet. Round your answer to two decimal places.	
Output	The volume of a sphere with a radius of 2 feet	
Input	The volume of a sphere is given by the formula $v = \frac{4}{3}\pi r^3$, where *v* represents volume, *r* represents the radius of the sphere, and π is a constant with an approximate value of 3.14159. The radius of the sphere is 2 feet.	
Process	Notation	v = volume of sphere r = radius of sphere $\pi = 3.14159$ $v = \frac{4}{3}\pi r^3$
	Additional Information	r^3 represents $r * r * r$
	Diagram	None needed.
	Approach	Substitute the values given for radius and π into the formula and compute the volume.
Solution	$v = \frac{4}{3}\,\pi r^3$ $v = \frac{4}{3} * 3.14159 * (2)^3$ $v = 4 * 3.14159 * (2 * 2 * 2) / 3$ **v = 33.51 cubic feet**	
Check	Work in reverse to find π: 33.51 cubic feet / (2 * 2* 2) = 4.18875 4.18875 / $\frac{4}{3}$ = 3 * 4.18875 / 4 = 3.14156 Which is π, correct to 4 decimal places. Thus, the solution checks.	

Solution to Practice Problem 1-4.10

Problem	Students in the CIS department can receive internship credit for work experience in a position related to information technology. At the beginning of the term, each student with an approved internship position enrolls for a specified number of credits. At the end of the term each student submits a time sheet showing the number of hours worked. Credit is awarded at the rate of one credit for each 30 hours worked. Credits are rounded to the nearest half credit. (For example, values in the range 1.75 and up to but not including 2.25 will round to 2.0. Values in the range 2.25 and up to but not including 2.75 will round to 2.5.) The credits awarded can never exceed the credits enrolled, regardless of the number of hours worked. Compute the number of credits awarded to each student the following enrollment data: *Name* / *Credits Enrolled* / *Hours worked* Adams, Jane / 1 / 30 Beck, Carl / 2 / 15 Jones, Michael / 2 / 90 Smith, Mary / 2 / 50 Walker, William / 5 / 75	
Output	The number of credits awarded to each student	
Input	The rules:	Students enroll for internship credit. Students work during the term. One credit is earned for each 30 hours worked. The credits earned are rounded to the nearest 1/2 credit. If the credits earned exceed the credits enrolled, then the credits earned are reduced to the credits enrolled.
Process	Notation	CEN = credits enrolled, CER = credits earned
	Additional Information	None needed.
	Diagram	None needed.
	Approach	For each student: Compute the credits earned (CER) by: dividing hours worked by 30. Round result to nearest 1/2 credit. If credits earned (CER) exceeds credits enrolled (CEN), then reduce result to credits enrolled (CEN).
Check	Carefully work again and compare results.	

Solution:

Name	CEN	Hours / 30	Rounded Credits	CER
Adams	1	30 / 30 = 1.0	1.0 (does not exceed 1)	**1.0**
Beck	2	15 / 30 = 0.5	0.5 (does not exceed 2)	**0.5**
Jones	2	90 / 30 = 3.0	3.0 (exceeds 2, reduce to 2)	**2.0**
Smith	2	50 / 30 = 1.67	1.5 (does not exceed 2, rnd.)	**1.5**
Walker	5	75 / 30 = 2.5	2.5 (does not exceed 5)	**2.5**