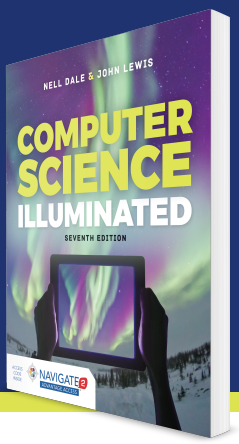

CHAPTER 7
EXERCISES AND ANSWERS

Computer Science Illuminated, Seventh Edition

Nell Dale, PhD; John Lewis, PhD

Answers are in blue.

For Exercises 1–6, match the problem-solving strategy with the definition or example.

A. Ask questions
B. Look for familiar things
C. Divide and conquer

1. The first strategy to use when given a problem
   A
2. Don't reinvent the wheel.
   B
3. Strategy used in the binary search algorithms
   C
4. Is a solution to a previous problem appropriate for the current one?
   B
5. Strategy used in the Quicksort algorithm
   C
6. There is an apparent contradiction in the problem statement.
   A

For Exercises 7–10, match the following phase with its output.

A. Analysis and specification phase
B. Algorithm development phase
C. Implementation phase
D. Maintenance phase

7. Working program
   C
8. None
   D
9. Problem statement
   A
10. General solution
    B

For Exercises 11–15, match the term with the definition.

A. Information hiding
B. Abstraction
C. Data abstraction
D. Procedural abstraction
E. Control abstraction

11. The practice of hiding the details of a module with the goal of controlling access to the details of the module
    A
12. A model of a complex system that includes only the details essential to the viewer
    B
13. The separation of the logical view of an action from its implementation
    D
14. The separation of the logical view of a control structure from its implementation
    E
15. The separation of the logical view of data from its implementation
    C

For Exercises 16–36, mark the answers true or false as follows:

A. True
B. False

16. Count-controlled loops repeat a specific number of times.
    A
17. Event-controlled loops repeat a specific number of times.
    B
18. Count-controlled loops are controlled by a counter.
    A
19. Event-controlled loops are controlled by an event.
    A
20. An infinite loop is a loop that never terminates.
    A
21. Loops can be nested, but selection structures cannot.
    B
22. Selection structures can be nested, but loops cannot.
    B
23. All control structures can be nested.
    A
24. The square root algorithm used a count-controlled loop.
    B
25. An array is a homogeneous structure, but a record is not.
    A

26. A record is a heterogeneous structure, but an array is not.
    A
27. A record is a homogeneous structure; an array is a heterogeneous structure.
    B
28. The bubble sort algorithm involves finding the smallest item in the unsorted portion of the array and swapping it with the first unsorted item.
    B
29. Quicksort is not always quick.
    A
30. A binary search can be applied to both a sorted and unsorted array.
    B
31. A binary search is always faster than a linear search.
    B
32. A selection sort puts one more item into its permanent place at each iteration.
    A
33. An insertion sort puts one more item into its place with respect to the already sorted portion.
    A
34. Recursion is another name for iteration.
    B
35. Recursive algorithms use `IF` statements.
    A
36. Iterative algorithms use `WHILE` statements.
    A

Exercises 37–67 are short-answer questions.

37. List the four steps in Polya's "How to Solve It" List.
    Understanding the problem
    Devising a plan
    Carrying out the plan
    Looking back
38. Describe the four steps listed in Exercise 37 in your own words.
    Each student's answer is unique.
39. List the problem-solving strategies discussed in this chapter.
    Ask questions.
    Look for familiar things.
    Divide and conquer.
40. Apply the problem-solving strategies to the following situations.
    Solutions are not unique.
    A. Buying a toy for your four-year-old cousin.
    Ask questions:
    What do four-year-olds like?
    Is he or she into sports?
    What stores sell toys?
    Where is a particular store located?
    What toys does the cousin already have?
    Look for things that are familiar:
    I liked Lincoln Logs; would my cousin?
    I liked my red wagon; would my cousin?
    My cousin is like his (or her) mother; what did she play with as a child?
    Divide and conquer:
    Go to store.
    Go to toy aisle.
    Find girl's (or boy's) toys.
    Choose one.

    B. Organizing an awards banquet four your soccer team.
    Ask questions:
    Where will it be?
    When will it be?
    How many will be there?
    How many trophies will be awarded?
    Look for things that are familiar:
    I organized one last year.
    I organized a fundraiser.
    I was a scout leader.
    I play soccer.
    Divide and conquer:
    Have Jane decide on day and time.
    Have Jim choose menu.
    Have Mary buy trophies.
    Have Jeremy call people.

    C. Buying a dress or suit for an awards banquet at which you are being honored.
    Ask questions:
    What time of day is the banquet?
    Where is the banquet being held?
    What will others be wearing?
    What is my best color?
    Look for things that are familiar:
    Last year the award winner wore a blue dress (suit).
    Last year I wore a green suit.
    I wore a suit when I was honored last year.
    Divide and conquer:
    Choose the store.
    Go to the store.
    Choose possibles from racks.
    Choose one.
41. Examine the solutions in Exercise 40 and determine three things they have in common.
    Each solution includes data objects: toy, food, dress, suit.
    Each solution involves choices or decisions.
    Each solution involves a container for objects: toy store, restaurant, clothing store.
42. What is an algorithm?
    An algorithm is a set of instructions for solving a problem in a finite amount of time using a finite amount of data.
43. Write an algorithm for the following tasks.
    Solutions are not unique.
    A. Making a peanut butter and jelly sandwich.
    Get bread
    Get peanut butter
    Get jelly
    Get knife
    Spread peanut butter on one slice of bread

Spread jelly on one slice of bread
Combine slices of bread, peanut butter facing jelly

B. Getting up in the morning.
Alarm goes off
Hit sleep button
Alarm goes off
Hit sleep button
Alarm goes off
Turn off alarm
Move dog
Throw back covers
Put feet over side of the bed
Stand up

C. Doing your homework
Turn off TV
Turn off CD
Get backpack
Sit at desk
Open backpack
Pet cat
Open book
Open assignment
WHILE (more to do)
    Solve problem
    Pet cat

D. Driving home in the afternoon
Find car
Open car door
Get into car
Fasten seat belt
Start engine
Turn on radio
WHILE (not yet home)
    Keep going
Turn off engine
Open car door
Get out of car
Close car door

44. List the three phases of the computer problem-solving model.
Algorithm development phase
Implementation phase
Maintenance phase

45. How does the computer problem-solving model differ from Polya's?
In Polya's list, the human executes the plan and evaluates the results. In a computer solution, a program is written that expresses the plan in a language that the computer can execute. The human then takes the computer output and evaluates the results.

46. Describe the steps in the algorithm development phase.
The algorithm development phase includes analysis (understanding the problem), proposed solution (logical sequence of solution steps), and testing (following algorithm).

47. Describe the steps in the implementation phase.
The implementation phase includes coding (translating the algorithm into a computer language) and testing (compiling and running the program).

48. Describe the steps in the maintenance phase.
The maintenance phase involves using the program and modifying the program to add functionality or correct errors.

49. Look up a recipe for chocolate brownies in a cookbook and answer the following questions.

A. Is the recipe an algorithm? Justify your answer.
(One author's solution.)
Yes, the recipe is an algorithm. If the steps are followed exactly, brownies are produced.

B. Organize the recipe as an algorithm, using pseudo-code.
Preheat oven to 375°
Put 2 oz unsweetened chocolate in double boiler
Add 1/2 cup butter to chocolate in double boiler
Put double boiler over moderate flame
Melt contents of double boiler
Remove double boiler from flame
Get a cup of sugar
Put 2 eggs in bowl
WHILE (more sugar)
    Beat eggs
    Add sugar gradually
Put contents of cooled double boiler in bowl
Mix contents of bowl
Sift 1/2 cup flour and dash of salt
Stir in flour mixture into bowl
Add 1 teaspoon vanilla to bowl
Add 1/2 cup chopped nuts to bowl
Mix contents of bowl
Grease 9-inch square pan
Pour contents of bowl into pan
Set minutes to 20
Put pan in oven
WHILE (minutes not 0)
    Set minutes to minutes – 1
Remove pan from oven
Cut into 1-1/2" squares
Eat

C. List the words that have meaning in computing.
WHILE is the only computing word. It means repetition.

D. List the words that have meaning in cooking.
Words with meaning in cooking include preheat, add, double boiler, melt, moderate flame, beat, gradually, mix, shift, dash, chopped, and grease.

E. Make the cookies and take them to your professor.

50. We said that following a recipe is easier than developing one. Go to the supermarket and buy a vegetable that you have not cooked (or eaten) before. Take it home and develop a recipe. Write up your recipe and your critique of the process. (If it is good, send it to the authors.)
This is an activity. No answer expected.

51. Describe the top-down design process.
The top-down design process is characterized by successive layers of refinement. The top-level tasks are listed. At each succeeding level, the tasks from the previous one are further developed.

52. Differentiate between a concrete step and an abstract step.
An abstract step is one in which further development is needed. A concrete step is one in which all the steps are fully specified.

53. Write a top-down design for the following tasks.
Solutions are not unique.

A. Buying a toy for your four-year-old cousin.

```
Go to store
    Choose toy
    Buy toy
Go to store
    Choose store
    Find location
    Take bus
Choose toy
    Walk up and down aisles
    Panic at choices
    Grab nearest large stuffed animal
Buy toy
    Go to clerk
    Give stuffed animal to clerk
    Give credit card to clerk
    Sign credit card slip
```

B. Organizing an awards banquet four your soccer team.

```
Rent banquet room
    Send invitations
    Choose menu
    Buy trophies
Rent banquet room
    Find what is available
    Visit possible choices
    Choose one
    Make reservation
Send invitations
    Get list of people to invite
    Buy invitations
    Address invitations
    Mail invitations
Buy trophies
    Find out how many to buy
    Find store that carries trophies
    Order trophies over the phone
    Pick up trophies
```

C. Buying a dress or suit for an awards banquet at which you are being honored.

```
Go to favorite store
    Choose dress or suit that suits you
    Pay for choice
    Go home
Go to favorite store
    Get in car
    Drive to favorite store
    Get out of car
    Walk in to store
Choose dress or suit for occasion
    Make an initial selection of several
    Try each one on
    Choose best
Pay for choice
    Take purchase to cashier
    Hand the cashier your credit card
    Sign receipt
Go home
    Walk to car
    Get in
    Find keys
    Start car
    Drive home
```

54. Write a top-down design for the following tasks.
Solutions are not unique.

A. Calculating the average of ten test scores.

```
Set count to 0
Set sum to 0
WHILE (count < 10)
        Get score
        Set sum to sum plus score
        Set count to count plus 1
Set average to sum divided by 10
```

B. Calculating the average of an unknown number of test scores.

```
Set count to 0
Set sum to 0
WHILE (there are more scores)
        Get score
        Set sum to sum plus score
        Set count to count plus 1
Set average to sum divided by count
```

C. Describe the differences in the two designs.
The loop in the first design operates exactly 10 times. The loop in the second design operates as long as there were more scores.

55. Write a top-down design for the following tasks.
Solutions are not unique.

A. Finding a telephone number in the phone book.
Find the right page
Find the right column
Search the column for name

```
Find the right page
Open to approximate part of book
WHILE (page not found)
    Compare name with name on top of right page
    IF (name on top is less)
        Turn page forward
    ELSE
        Compare name with name on top of left page
        IF (name on top is greater)
            Turn page backward
        ELSE
            Page is found
Find right column
Current column is leftmost one
WHILE (column not found)
    IF (name on bottom of current column is greater)
        Column is found
    ELSE
        Set current column to one at right of current column
Search the column for name
Set found to false
WHILE (more to look at and not found)
```

```
    Get next name
    IF (name is the one you want)
        Get phone number
        Set found to trueIF (found is false)
    Number not in book
```

B. Finding a telephone number on the Internet.

```
Log on to Internet
Go to favorite search engine
Type in "Find phone number"
Go to first response
Get phone number
Log off
```

C. Finding a telephone number on a scrap of paper that you have lost.

Search purses (wallets) for scrap of paper
Search wastepaper baskets for scrap of paper
Search trash can for scrap of paper

```
Search purses (wallets)
WHILE (paper not found and there are more purses or wallets)
    Get next one
    IF (paper is there)
        paper is found
Search wastepaper baskets
WHILE (paper not found and there are more wastepaper baskets)
    Get next one
    IF (paper is there)
        paper is found
```

D. Describe the similarities and differences among these designs.

The first and third both have a process repeated a number of times; the second does not. The first and third are processes that most of us have done physically many times. The first and third involve a linear search through a container of data: columns in a book, purses (wallets), and wastepaper baskets.

56. Distinguish between information and data.

Information is any knowledge that can be communicated. When information is in the form that a computer can use, it is called *data*. Thus, data is any knowledge that can be communicated in a form that a computer can process.

57. Write a top-down design for sorting a list of names into alphabetical order.

```
WHILE (more names)
    Scan list for name closest to beginning of the alphabet (smallest)
    Copy name to new list
    Cross name off original list
Copy names back onto original list
```

58. A. Why is information hiding important?

Information hiding defers details until the level where the details are important. This process keeps an algorithm from being dependent on the implementation details, which may change.

B. Name three examples of information hiding that you encounter every day.

Talking on the telephone.
Driving a car.
Turning on the television.

59. An airplane is a complex system.

Solutions are not unique.

A. Give an abstraction of an airplane from the view of a pilot.

A pilot can view the airplane as a car that he or she drives on a highway of air.

B. Give an abstraction of an airplane from the view of a passenger.

A passenger can view the airplane as the inside of a limousine that is carrying the passenger from one place to another.

C. Give an abstraction of an airplane from the view of the cabin crew.

The cabin crew can view an airplane as a dining room.

D. Give an abstraction of an airplane from the view of a maintenance mechanic.

A maintenance mechanic can view an airplane as a collection of parts and wires put together according to his or her maintenance diagrams.

E. Give an abstraction of an airplane from the view of the airline's corporate office.

From the view of the boardroom, the airplane can be viewed as an expensive object used in the process of making money.

60. List the identifiers and whether they named data or actions for the designs in Exercise 53.

A. Actions: *go, choose, buy, find, give, sign*
Data: *store, toy, clerk, credit card*

B. Actions: *rent, send, choose, buy, find, visit, make, get, address, mail, order, pick up*
Data: *banquet room, invitations, menu, trophies, reservation, list of people, phone*

C. Actions: *go, choose, pay*
Data: *store, dress, suit, choice, home*

61. List the identifiers and whether they named data or actions for the designs in Exercise 54.

A. Actions: *set, get*
Data: *count, sum, score, average*

B. Actions: *set, get*
Data: *count, sum, score, average*

62. List the identifiers and whether they named data or actions for the designs in Exercise 55.

A. Actions: *find, search, open, compare, turn, set*
Data: *page, column, name, book, right page, left page*

B. Actions: *log on, go, type, get*
Data: *Internet, search engine, first response, phone number*

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Exercises 63–65 use the following array of values.

Length	*list*	[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
11		23	41	66	20	2	90	9	34	19	40	99

63. Show the state of the list when `firstUnsorted` is first set equal to the 4th item in the selection sort. Array when `firstUnsorted` is first set to 4th item.

[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
2	9	19	20	23	90	41	34	66	40	99

64. Show the state of the list when `firstUnsorted` is first set equal to the 5th item in the bubble sort algorithm. Array when `firstUnsorted` is first set equal to the 5th item.

[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
2	9	19	20	23	41	66	34	40	90	99

65. Show the state of the list when the first recursive call is made in *Quicksort* using `list[0]` as split value.
Array when first recursive call is made.

[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
2	19	9	20	23	90	66	34	41	40	99

Exercises 66–67 use the following array of values.

Length	*list*	[0]	[1]	[2]	[3]	[4]	[5]	[6]	[7]	[8]	[9]	[10]
11		5	7	20	33	44	46	48	49	101	102	105

66. How many comparisons does it take using a sequential search to find the following values or determine that the item is not in the list?
    A. 4
    11
    B. 44
    5
    C. 45
    11
    D. 105
    11
    E. 10
    11

67. How many comparisons does it take using a binary search to find the following values or determine that the item is not in the list?
    A. 4
    4
    B. 44
    4
    C. 46
    1
    D. 105
    4
    E. 106
    4