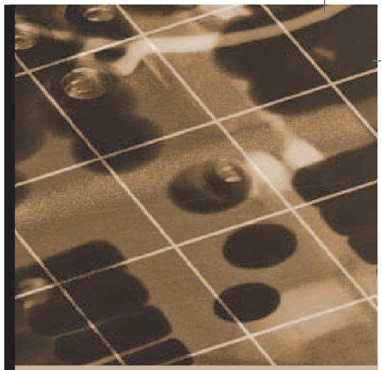


PART III

ADVANCED DESIGN AND IMPLEMENTATION

Business Vignette

Using Queries to Score Runs

Today, we take for granted the ability to comb through vast amounts of data to find one item that meets a slew of requirements or to find several items that share common features. When we go to the library, retrieve bank account records, call Information to get a phone number, or search for a movie review or restaurant online, we are interacting with databases that did not exist 40 years ago. The impact of the information revolution is very apparent in our daily lives. What is less apparent is how this revolution is slowly changing society by determining who wins and who loses in school, in business, and even in sports.

In the old days, money was the major factor in establishing which teams went to the World Series. The rich teams could hunt for and buy the best players. As a result, the Yankees have dominated the event, playing in and winning many more championships than any other team in the Major League. Today, databases are being used to even the playing field.

In the late 1990s, the Yankees hired E Solutions, a Tampa-based IT company, to complete a customized software project to analyze scouting reports. E Solutions saw the potential and developed ScoutAdvisor, a program that runs queries on data on baseball players collected from many sources. Such sources include the Major League Baseball Scouting Bureau, which provides psychological profile data on players, while SportsTicker supplies game reports, and STATS provides game statistics such as where balls land in the field after being hit or types of pitches.

The ScoutAdvisor database stores information on prospective and current players, such as running speed, fielding ability, hitting ability, and plate discipline. Team managers can run queries to find a pitcher with high arm strength, arm accuracy, and pitch speed. They can check for injuries or discipline problems. They can run queries to determine if a player's performance justifies his cost. The database also stores automatic daily player updates. Managers can run queries to determine whether a pitcher's fastball speed is increasing or whether a hitter's tendency to swing at the first pitch is declining. ScoutAdvisor is customizable, so managers can also design their own queries.

The result is that more and more baseball teams are signing contracts with E Solutions as it becomes increasingly apparent that managing information is becoming as important to team success as managing money or players.

SEVEN

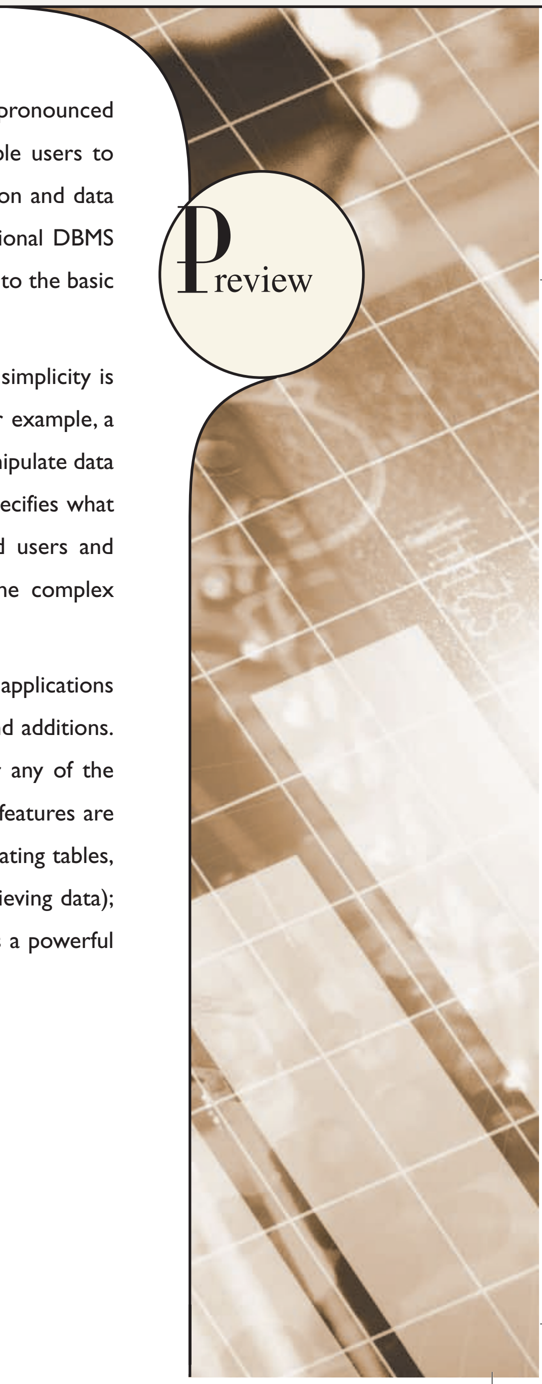
7

Introduction to Structured Query Language (SQL)

In this chapter, you will learn:

- The basic commands and functions of SQL
- How to use SQL for data administration (to create tables, indexes, and views)
- How to use SQL for data manipulation (to add, modify, delete, and retrieve data)
- How to use SQL to query a database for useful information

Preview



In this chapter, you learn the basics of Structured Query Language (SQL). SQL, pronounced S-Q-L by some and "sequel" by others, is composed of commands that enable users to create database and table structures, perform various types of data manipulation and data administration, and query the database to extract useful information. All relational DBMS software supports SQL, and many software vendors have developed extensions to the basic SQL command set.

Because SQL's vocabulary is simple, the language is relatively easy to learn. Its simplicity is enhanced by the fact that much of its work takes place behind the scenes. For example, a single command creates the complex table structures required to store and manipulate data successfully. Furthermore, SQL is a nonprocedural language; that is, the user specifies what must be done, but not how it is to be done. To issue SQL commands, end users and programmers do not need to know the physical data storage format or the complex activities that take place when a SQL command is executed.

Although quite useful and powerful, SQL is not meant to stand alone in the applications arena. Data entry with SQL is possible but awkward, as are data corrections and additions. SQL itself does not create menus, special report forms, overlays, pop-ups, or any of the other utilities and screen devices that end users usually expect. Instead, those features are available as vendor-supplied enhancements. SQL focuses on data definition (creating tables, indexes, and views) and data manipulation (adding, modifying, deleting, and retrieving data); we cover these basic functions in this chapter. In spite of its limitations, SQL is a powerful tool for extracting information and managing data.

7.1 INTRODUCTION TO SQL

Ideally, a database language allows you to create database and table structures, to perform basic data management chores (add, delete, and modify), and to perform complex queries designed to transform the raw data into useful information. Moreover, a database language must perform such basic functions with minimal user effort, and its command structure and syntax must be easy to learn. Finally, it must be portable; that is, it must conform to some basic standard so that an individual does not have to relearn the basics when moving from one RDBMS to another. SQL meets those ideal database language requirements well.

SQL functions fit into two broad categories:

- It is a *data definition language (DDL)*: SQL includes commands to create database objects such as tables, indexes, and views, as well as commands to define access rights to those database objects. The data definition commands you learn in this chapter are listed in Table 7.1.
- It is a *data manipulation language (DML)*: SQL includes commands to insert, update, delete, and retrieve data within the database tables. The data manipulation commands you learn in this chapter are listed in Table 7.2.

TABLE 7.1 SQL Data Definition Commands

COMMAND OR OPTION	DESCRIPTION
CREATE SCHEMA AUTHORIZATION	Creates a database schema
CREATE TABLE	Creates a new table in the user's database schema
NOT NULL	Ensures that a column will not have null values
UNIQUE	Ensures that a column will not have duplicate values
PRIMARY KEY	Defines a primary key for a table
FOREIGN KEY	Defines a foreign key for a table
DEFAULT	Defines a default value for a column (when no value is given)
CHECK	Validates data in an attribute
CREATE INDEX	Creates an index for a table
CREATE VIEW	Creates a dynamic subset of rows/columns from one or more tables
ALTER TABLE	Modifies a tables definition (adds, modifies, or deletes attributes or constraints)
CREATE TABLE AS	Creates a new table based on a query in the user's database schema
DROP TABLE	Permanently deletes a table (and its data)
DROP INDEX	Permanently deletes an index
DROP VIEW	Permanently deletes a view

TABLE 7.2 SQL Data Manipulation Commands

COMMAND OR OPTION	DESCRIPTION
INSERT	Inserts row(s) into a table
SELECT	Selects attributes from rows in one or more tables or views
WHERE	Restricts the selection of rows based on a conditional expression
GROUP BY	Groups the selected rows based on one or more attributes
HAVING	Restricts the selection of grouped rows based on a condition
ORDER BY	Orders the selected rows based on one or more attributes
UPDATE	Modifies an attribute's values in one or more table's rows
DELETE	Deletes one or more rows from a table
COMMIT	Permanently saves data changes
ROLLBACK	Restores data to their original values

TABLE 7.2 SQL Data Manipulation Commands (continued)

COMMAND OR OPTION	DESCRIPTION
COMPARISON OPERATORS	
=, <, >, <=, >=, <>	Used in conditional expressions
LOGICAL OPERATORS	
AND/OR/NOT	Used in conditional expressions
SPECIAL OPERATORS	Used in conditional expressions
BETWEEN	Checks whether an attribute value is within a range
IS NULL	Checks whether an attribute value is null
LIKE	Checks whether an attribute value matches a given string pattern
IN	Checks whether an attribute value matches any value within a value list
EXISTS	Checks whether a subquery returns any rows
DISTINCT	Limits values to unique values
AGGREGATE FUNCTIONS	Used with SELECT to return mathematical summaries on columns
COUNT	Returns the number of rows with non-null values for a given column
MIN	Returns the minimum attribute value found in a given column
MAX	Returns the maximum attribute value found in a given column
SUM	Returns the sum of all values for a given column
AVG	Returns the average of all values for a given column

You will be happy to know that SQL is relatively easy to learn. Its basic command set has a vocabulary of fewer than 100 words. Better yet, SQL is a nonprocedural language: you merely command *what* is to be done; you don't have to worry about *how* it is to be done. The American National Standards Institute (ANSI) prescribes a standard SQL—the current version is known as SQL-99 or SQL3. The ANSI SQL standards are also accepted by the International Organization for Standardization (ISO), a consortium composed of national standards bodies of more than 150 countries. Although adherence to the ANSI/ISO SQL standard is usually required in commercial and government contract database specifications, many RDBMS vendors add their own special enhancements. Consequently, it is seldom possible to move a SQL-based application from one RDBMS to another without making some changes.

However, even though there are several different SQL "dialects," the differences among them are minor. Whether you use Oracle, Microsoft SQL Server, MySQL, IBM's DB2, Microsoft Access, or any other well-established RDBMS, a software manual should be sufficient to get you up to speed if you know the material presented in this chapter.

At the heart of SQL is the query. In Chapter 1, Database Systems, you learned that a query is a spur-of-the-moment question. Actually, in the SQL environment, the word *query* covers both questions and actions. Most SQL queries are used to answer questions such as these: "What products currently held in inventory are priced over $100, and what is the quantity on hand for each of those products?" "How many employees have been hired since January 1, 2006 by each of the company's departments?" However, many SQL queries are used to perform actions such as adding or deleting table rows or changing attribute values within tables. Still other SQL queries create new tables or indexes. In short, for a DBMS, a query is simply a SQL statement that must be executed. But before you can use SQL to query a database, you must define the database environment for SQL with its data definition commands.

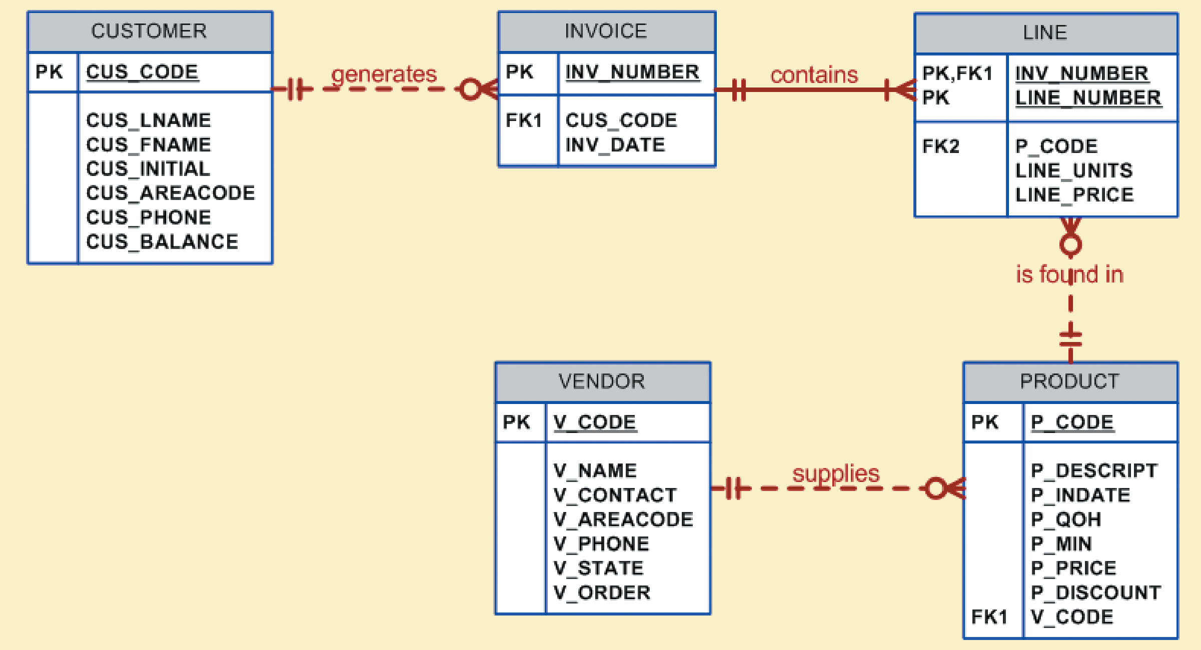
7.2 DATA DEFINITION COMMANDS

Before examining the SQL syntax for creating and defining tables and other elements, let's first examine the simple database model and the database tables that will form the basis for the many SQL examples you'll explore in this chapter.

7.2.1 The Database Model

A simple database composed of the following tables is used to illustrate the SQL commands in this chapter: CUSTOMER, INVOICE, LINE, PRODUCT, and VENDOR. This database model is shown in Figure 7.1.

FIGURE 7.1 The database model



The database model in Figure 7.1 reflects the following business rules:

- A customer may generate many invoices. Each invoice is generated by one customer.
- An invoice contains one or more invoice lines. Each invoice line is associated with one invoice.
- Each invoice line references one product. A product may be found in many invoice lines. (You can sell more than one hammer to more than one customer.)
- A vendor *may* supply many products. Some vendors do not (yet?) supply products. (For example, a vendor list may include *potential* vendors.)
- If a product is vendor-supplied, that product is supplied by only a single vendor.
- Some products are not supplied by a vendor. (For example, some products may be produced in-house or bought on the open market.)

As you can see in Figure 7.1, the database model contains many tables. However, to illustrate the initial set of data definition commands, the focus of attention will be the PRODUCT and VENDOR tables. You will have the opportunity to use the remaining tables later in this chapter and in the problem section.

So that you have a point of reference for understanding the effect of the SQL queries, the contents of the PRODUCT and VENDOR tables are listed in Figure 7.2.

Online Content

The database model in Figure 7.1 is implemented in the Microsoft Access **Ch07_SaleCo** database located in the Student Online Companion. (This database contains a few additional tables that are not reflected in Figure 7.1. These tables are used for discussion purposes only.) If you use MS Access, you can use the database supplied online. However, it is strongly suggested that you create your own database structures so you can practice the SQL commands illustrated in this chapter.

SQL script files for creating the tables and loading the data in Oracle and MS SQL Server are also located in the Student Online Companion. How you connect to your database depends on how the software was installed on your computer. Follow the instructions provided by your instructor or school.

FIGURE 7.2 **The VENDOR and PRODUCT tables**

Table name: VENDOR **Database name: Ch07_SaleCo**

V_CODE	V_NAME	V_CONTACT	V_AREACODE	V_PHONE	V_STATE	V_ORDER
21225	Bryson, Inc.	Smithson	615	223-3234	TN	Y
21226	SuperLoo, Inc.	Flushing	904	215-8995	FL	N
21231	D&E Supply	Singh	615	228-3245	TN	Y
21344	Gomez Bros.	Ortega	615	889-2546	KY	N
22567	Dome Supply	Smith	901	678-1419	GA	N
23119	Randsets Ltd.	Anderson	901	678-3998	GA	Y
24004	Brackman Bros.	Browning	615	228-1410	TN	N
24288	ORDVA, Inc.	Hakford	615	898-1234	TN	Y
25443	B&K, Inc.	Smith	904	227-0093	FL	N
25501	Damal Supplies	Smythe	615	890-3529	TN	N
25595	Rubicon Systems	Orton	904	456-0092	FL	Y

Table name: PRODUCT

P_CODE	P_DESCRIPT	P_INDATE	P_QOH	P_MIN	P_PRICE	P_DISCOUNT	V_CODE
11QER/31	Power painter, 15 psi., 3-nozzle	03-Nov-07	8	5	109.99	0.00	25595
13-Q2/P2	7.25-in. pwr. saw blade	13-Dec-07	32	15	14.99	0.05	21344
14-Q1/L3	9.00-in. pwr. saw blade	13-Nov-07	18	12	17.49	0.00	21344
1546-QQ2	Hrd. cloth, 1/4-in., 2x50	15-Jan-08	15	8	39.95	0.00	23119
1558-QW1	Hrd. cloth, 1/2-in., 3x50	15-Jan-08	23	5	43.99	0.00	23119
2232/QTY	B&D jigsaw, 12-in. blade	30-Dec-07	8	5	109.92	0.05	24288
2232/QWE	B&D jigsaw, 8-in. blade	24-Dec-07	6	5	99.87	0.05	24288
2238/QPD	B&D cordless drill, 1/2-in.	20-Jan-08	12	5	38.95	0.05	25595
23109-HB	Claw hammer	20-Jan-08	23	10	9.95	0.10	21225
23114-AA	Sledge hammer, 12 lb.	02-Jan-08	8	5	14.40	0.05	
54778-2T	Rat-tail file, 1/8-in. fine	15-Dec-07	43	20	4.99	0.00	21344
89-WRE-Q	Hicut chain saw, 16 in.	07-Feb-08	11	5	256.99	0.05	24288
PVC23DRT	PVC pipe, 3.5-in., 8-ft	20-Feb-08	188	75	5.87	0.00	
SM-18277	1.25-in. metal screw, 25	01-Mar-08	172	75	6.99	0.00	21225
SW-23116	2.5-in. wd. screw, 50	24-Feb-08	237	100	8.45	0.00	21231
WR3/TT3	Steel matting, 4'x8'x1/6", .5" mesh	17-Jan-08	18	5	119.95	0.10	25595

Note the following about these tables. (The features correspond to the business rules reflected in the ERD shown in Figure 7.1.)

- The VENDOR table contains vendors who are not referenced in the PRODUCT table. Database designers note that possibility by saying that PRODUCT is *optional* to VENDOR; a vendor may exist without a reference to a product. You examined such optional relationships in detail in Chapter 4, Entity Relationship (ER) Modeling.

- Existing V_CODE values in the PRODUCT table must (and do) have a match in the VENDOR table to ensure referential integrity.
- A few products are supplied factory-direct, a few are made in-house, and a few may have been bought in a warehouse sale. In other words, a product is not necessarily supplied by a vendor. Therefore, VENDOR is optional to PRODUCT.

A few of the conditions just described were made for the sake of illustrating specific SQL features. For example, null V_CODE values were used in the PRODUCT table to illustrate (later) how you can track such nulls using SQL.

7.2.2 Creating the Database

Before you can use a new RDBMS, you must complete two tasks: first, create the database structure, and second, create the tables that will hold the end-user data. To complete the first task, the RDBMS creates the physical files that will hold the database. When you create a new database, the RDBMS automatically creates the data dictionary tables to store the metadata and creates a default database administrator. Creating the physical files that will hold the database means interacting with the operating system and the file systems supported by the operating system. Therefore, creating the database structure is the one feature that tends to differ substantially from one RDBMS to another. The good news is that it is relatively easy to create a database structure, regardless of which RDBMS you use.

If you use Microsoft Access, creating the database is simple: start Access, select **File/New/Blank Database**, specify the folder in which you want to store the database, and then name the database. However, if you work in a database environment typically used by larger organizations, you will probably use an enterprise RDBMS such as Oracle, SQL Server, MySQL or DB2. Given their security requirements and greater complexity, those database products require a more elaborate database creation process. (You will learn how to create and manage an Oracle database structure in Chapter 15, Database Administration and Security.)

You will be relieved to discover that, *with the exception of the database creation process*, most RDBMS vendors use SQL that deviates little from the ANSI standard SQL. For example, most RDBMSs require that each SQL command ends with a semicolon. However, some SQL implementations do not use a semicolon. Important syntax differences among implementations will be highlighted in Note boxes.

If you are using an enterprise RDBMS, before you can start creating tables you must be authenticated by the RDBMS. **Authentication** is the process through which the DBMS verifies that only registered users may access the database. To be authenticated, you must log on to the RDBMS using a user ID and a password created by the database administrator. In an enterprise RDBMS, every user ID is associated with a database schema.

7.2.3 The Database Schema

In the SQL environment, a **schema** is a group of database objects—such as tables and indexes—that are related to each other. Usually, the schema belongs to a single user or application. A single database can hold multiple schemas belonging to different users or applications. Think of a schema as a logical grouping of database objects, such as tables, indexes, and views. Schemas are useful in that they group tables by owner (or function) and enforce a first level of security by allowing each user to see only the tables that belong to that user.

ANSI SQL standards define a command to create a database schema:

```
CREATE SCHEMA AUTHORIZATION {creator};
```

Therefore, if the creator is JONES, use the command:

```
CREATE SCHEMA AUTHORIZATION JONES;
```

Most enterprise RDBMSs support that command. However, the command is seldom used directly—that is, from the command line. (When a user is created, the DBMS automatically assigns a schema to that user.) When the DBMS *is* used, the CREATE SCHEMA AUTHORIZATION command must be issued by the user who owns the schema. That is, if you log on as JONES, you can use only CREATE SCHEMA AUTHORIZATION JONES.

For most RDBMSs, the CREATE SCHEMA AUTHORIZATION is optional. That is why this chapter focuses on the ANSI SQL commands required to create and manipulate tables.

7.2.4 Data Types

After the database schema has been created, you are ready to define the PRODUCT and VENDOR table structures within the database. The table-creating SQL commands used in the example are based on the data dictionary shown in Table 7.3.

In the data dictionary in Table 7.3, note particularly the data types selected. Keep in mind that data type selection is usually dictated by the nature of the data and by the intended use. For example:

- P_PRICE clearly requires some kind of numeric data type; defining it as a character field is not acceptable.
- Just as clearly, a vendor name is an obvious candidate for a character data type. For example, VARCHAR2(35) fits well because vendor names are "variable-length" character strings, and in this case, such strings may be up to 35 characters long.
- U.S. state abbreviations are always two characters, so CHAR(2) is a logical choice.
- Selecting P_INDATE to be a (Julian) DATE field rather than a character field is desirable because the Julian dates allow you to make simple date comparisons and to perform date arithmetic. For instance, if you have used DATE fields, you can determine how many days are between them.

If you use DATE fields, you can also determine what the date will be in say, 60 days from a given P_INDATE by using P_INDATE + 60. Or you can use the RDBMS's system date—SYSDATE in Oracle, GETDATE() in MS SQL Server, and Date() in Access—to determine the answer to questions such as, "What will be the date 60 days from today?" For example, you might use SYSDATE + 60 (in Oracle); GETDATE() + 60 (in MS SQL Server) or Date() + 60 (in Access).

Date arithmetic capability is particularly useful in billing. Perhaps you want your system to start charging interest on a customer balance 60 days after the invoice is generated. Such simple date arithmetic would be impossible if you used a character data type.

Data type selection sometimes requires professional judgment. For example, you must make a decision about the V_CODE's data type as follows:

- If you want the computer to generate new vendor codes by adding 1 to the largest recorded vendor code, you must classify V_CODE as a numeric attribute. (You cannot perform mathematical procedures on character data.) The designation INTEGER will ensure that only the counting numbers (integers) can be used. Most SQL implementations also permit the use of SMALLINT for integer values up to six digits.
- If you do not want to perform mathematical procedures based on V_CODE, you should classify it as a character attribute, even though it is composed entirely of numbers. Character data are "quicker" to process in queries. Therefore, when there is no need to perform mathematical procedures on the attribute, store it as a character attribute.

The first option is used to demonstrate the SQL procedures in this chapter.

TABLE 7.3 Data Dictionary for the CH07_SALECO Database

TABLE NAME	ATTRIBUTE NAME	CONTENTS	TYPE	FORMAT	RANGE*	REQUIRED	PK OR FK	FK REFERENCED TABLE
PRODUCT	P_CODE	Product code	CHAR(10)	XXXXXXXXXX	NA	Y	PK	
	P_DESCRIPT	Product description	VARCHAR(35)	Xxxxxxxxxxxx	NA	Y		
	P_INDATE	Stocking date	DATE	DD-MON-YYYY	NA	Y		
	P_QOH	Units available	SMALLINT	####	0-9999	Y		
	P_MIN	Minimum units	SMALLINT	####	0-9999	Y		
	P_PRICE	Product price	NUMBER(8,2)	####.##	0.00-9999.00	Y		
	P_DISCOUNT	Discount rate	NUMBER(5,2)	0.##	0.00-0.20	Y		
	V_CODE	Vendor code	INTEGER	###	100-999		FK	VENDOR
VENDOR	V_CODE	Vendor code	INTEGER	#####	1000-9999	Y	PK	
	V_NAME	Vendor name	CHAR(35)	Xxxxxxxxxxxxxx	NA	Y		
	V_CONTACT	Contact person	CHAR(25)	Xxxxxxxxxxxxxx	NA	Y		
	V_AREACODE	Area code	CHAR(3)	999	NA	Y		
	V_PHONE	Phone number	CHAR(8)	999-9999	NA	Y		
	V_STATE	State	CHAR(2)	XX	NA	Y		
	V_ORDER	Previous order	CHAR(1)	X	Y or N	Y		

FK	= Foreign key
PK	= Primary key
CHAR	= Fixed character length data, 1 to 255 characters
VARCHAR	= Variable character length data, 1 to 2,000 characters. VARCHAR is automatically converted to VARCHAR2 in Oracle
NUMBER	= Numeric data. NUMBER(9,2) is used to specify numbers with two decimal places and up to nine digits long, including the decimal places. Some RDBMSs permit the use of a MONEY or a CURRENCY data type.
INT	= Integer values only
SMALLINT	= Small integer values only

DATE formats vary. Commonly accepted formats are: 'DD-MON-YYYY', 'DD-MON-YY', 'MM/DD/YYYY' or 'MM/DD/YY'

* Not all the ranges shown here will be illustrated in this chapter. However, you can use these constraints to practice writing your own constraints.

When you define the attribute's data type, you must pay close attention to the expected use of the attributes for sorting and data retrieval purposes. For example, in a real estate application, an attribute that represents the numbers of bathrooms in a home (H_BATH_NUM) could be assigned the CHAR(3) data type because it is highly unlikely the application will do any addition, multiplication, or division with the number of bathrooms. Based on the CHAR(3) data type definition, valid H_BATH_NUM values would be '2','1','2.5','10'. However, this data type decision creates potential problems. For example, if an application sorts the homes by number of bathrooms, a query would "see" the value '10' as less than '2', which is clearly incorrect. So you must give some thought to the expected use of the data in order to properly define the attribute data type.

The data dictionary in Table 7.3 contains only a few of the data types supported by SQL. For teaching purposes, the selection of data types is limited to ensure that almost any RDBMS can be used to implement the examples. If your RDBMS is fully compliant with ANSI SQL, it will support many more data types than the ones shown in Table 7.4. And many RDBMSs support data types beyond the ones specified in ANSI SQL.

TABLE 7.4 Some Common SQL Data Types

DATA TYPE	FORMAT	COMMENTS
Numeric	NUMBER(L,D)	The declaration NUMBER(7,2) indicates numbers that will be stored with two decimal places and may be up to seven digits long, including the sign and the decimal place. Examples: 12.32, −134.99.
	INTEGER	May be abbreviated as INT. Integers are (whole) counting numbers, so they cannot be used if you want to store numbers that require decimal places.
	SMALLINT	Like INTEGER, but limited to integer values up to six digits. If your integer values are relatively small, use SMALLINT instead of INT.
	DECIMAL(L,D)	Like the NUMBER specification, but the storage length is a *minimum* specification. That is, greater lengths are acceptable, but smaller ones are not. DECIMAL(9,2), DECIMAL(9), and DECIMAL are all acceptable.
Character	CHAR(L)	Fixed-length character data for up to 255 characters. If you store strings that are not as long as the CHAR parameter value, the remaining spaces are left unused. Therefore, if you specify CHAR(25), strings such as Smith and Katzenjammer are each stored as 25 characters. However, a U.S. area code is always three digits long, so CHAR(3) would be appropriate if you wanted to store such codes.
	VARCHAR(L) or VARCHAR2(L)	Variable-length character data. The designation VARCHAR2(25) will let you store characters up to 25 characters long. However, VARCHAR will not leave unused spaces. Oracle automatically converts VARCHAR to VARCHAR2.
Date	DATE	Stores dates in the Julian date format.

In addition to the data types shown in Table 7.4, SQL supports several other data types, including TIME, TIMESTAMP, REAL, DOUBLE, FLOAT, and intervals such as INTERVAL DAY TO HOUR. Many RDBMSs also have expanded the list to include other types of data, such as LOGICAL, CURRENCY, AutoNumber (Access), and sequence (Oracle). However, because this chapter is designed to introduce the SQL basics, the discussion is limited to the data types summarized in Table 7.4.

7.2.5 Creating Table Structures

Now you are ready to implement the PRODUCT and VENDOR table structures with the help of SQL, using the **CREATE TABLE** syntax shown next.

```
CREATE TABLE tablename (
          column1          data type      [constraint] [,
          column2          data type      [constraint] ] [,
          PRIMARY KEY      (column1       [, column2]) ] [,
          FOREIGN KEY      (column1       [, column2]) REFERENCES tablename] [,
          CONSTRAINT       constraint ] );
```

ONLINE CONTENT

All the SQL commands you will see in this chapter are located in script files in the Student Online Companion for this book. You can copy and paste the SQL commands into your SQL program. Script files are provided for Oracle and SQL Server users.

To make the SQL code more readable, most SQL programmers use one line per column (attribute) definition. In addition, spaces are used to line up the attribute characteristics and constraints. Finally, both table and attribute names are fully capitalized. Those conventions are used in the following examples that create VENDOR and PRODUCT tables and throughout the book.

NOTE

SQL SYNTAX
Syntax notation for SQL commands used in this book:

CAPITALS	Required SQL command keywords
italics	An end-user-provided parameter (generally required)
{a | b | ..}	A mandatory parameter; use one option from the list separated by |
[......]	An optional parameter—anything inside square brackets is optional
Tablename	The name of a table
Column	The name of an attribute in a table
data type	A valid data type definition
constraint	A valid constraint definition
condition	A valid conditional expression (evaluates to true or false)
columnlist	One or more column names or expressions separated by commas
tablelist	One or more table names separated by commas
conditionlist	One or more conditional expressions separated by logical operators
expression	A simple value (such as 76 or Married) or a formula (such as P_PRICE − 10)

```
CREATE TABLE VENDOR (
V_CODE              INTEGER             NOT NULL   UNIQUE,
V_NAME              VARCHAR(35)         NOT NULL,
V_CONTACT           VARCHAR(15)         NOT NULL,
V_AREACODE          CHAR(3)             NOT NULL,
V_PHONE             CHAR(8)             NOT NULL,
V_STATE             CHAR(2)             NOT NULL,
V_ORDER             CHAR(1)             NOT NULL,
PRIMARY KEY (V_CODE));
```

NOTE

- Because the PRODUCT table contains a foreign key that references the VENDOR table, create the VENDOR table first. (In fact, the M side of a relationship always references the 1 side. Therefore, in a 1:M relationship, you must *always* create the table for the 1 side first.)
- If your RDBMS does not support the VARCHAR2 and FCHAR format, use CHAR.
- Oracle accepts the VARCHAR data type and automatically converts it to VARCHAR2.
- If your RDBMS does not support SINT or SMALLINT, use INTEGER or INT. If INTEGER is not supported, use NUMBER.
- If you use Access, you can use the NUMBER data type, but you cannot use the number delimiters at the SQL level. For example, using NUMBER(8,2) to indicate numbers with up to eight characters and two decimal places is fine in Oracle, but you cannot use it in Access—you must use NUMBER without the delimiters.
- If your RDBMS does not support primary and foreign key designations or the UNIQUE specification, delete them from the SQL code shown here.
- If you use the PRIMARY KEY designation in Oracle, you do not need the NOT NULL and UNIQUE specifications.
- The ON UPDATE CASCADE clause is part of the ANSI standard, but it may not be supported by your RDBMS. In that case, delete the ON UPDATE CASCADE clause.

```
CREATE TABLE PRODUCT (
P_CODE          VARCHAR(10)     NOT NULL        UNIQUE,
P_DESCRIPT      VARCHAR(35)     NOT NULL,
P_INDATE        DATE            NOT NULL,
P_QOH           SMALLINT        NOT NULL,
P_MIN           SMALLINT        NOT NULL,
P_PRICE         NUMBER(8,2)     NOT NULL,
P_DISCOUNT      NUMBER(5,2)     NOT NULL,
V_CODE          INTEGER,
PRIMARY KEY (P_CODE),
FOREIGN KEY (V_CODE) REFERENCES VENDOR ON UPDATE CASCADE);
```

As you examine the preceding SQL table-creating command sequences, note the following features:

- The NOT NULL specifications for the attributes ensure that a data entry will be made. When it is crucial to have the data available, the NOT NULL specification will not allow the end user to leave the attribute empty (with no data entry at all). Because this specification is made at the table level and stored in the data dictionary, application programs can use this information to create the data dictionary validation automatically.
- The UNIQUE specification creates a unique index in the respective attribute. Use it to avoid duplicated values in a column.
- The primary key attributes contain both a NOT NULL and a UNIQUE specification. Those specifications enforce the entity integrity requirements. If the NOT NULL and UNIQUE specifications are not supported, use PRIMARY KEY without the specifications. (For example, if you designate the PK in MS Access, the NOT NULL and UNIQUE specifications are automatically assumed and are not spelled out.)
- The entire table definition is enclosed in parentheses. A comma is used to separate each table element (attributes, primary key, and foreign key) definition.

NOTE

If you are working with a composite primary key, all of the primary keys attributes are contained within the parentheses and are separated with commas. For example, the LINE table in Figure 7.1 has a primary key that consists of the two attributes INV_NUMBER and LINE_NUMBER. Therefore, you would define the primary key by typing:

```
PRIMARY KEY (INV_NUMBER, LINE_NUMBER),
```

The order of the primary key components is important because the indexing starts with the first-mentioned attribute, then proceeds with the next attribute, and so on. In this example, the line numbers would be ordered within each of the invoice numbers:

INV_NUMBER	LINE_NUMBER
1001	1
1001	2
1002	1
1003	1
1003	2

- The ON UPDATE CASCADE specification ensures that if you make a change in any VENDOR's V_CODE, that change is automatically applied to all foreign key references throughout the system (cascade) to ensure that referential integrity is maintained. (Although the ON UPDATE CASCADE clause is part of the ANSI standard, some RDBMSs such as Oracle do not support ON UPDATE CASCADE. If your RDBMS does not support the clause, delete it from the code shown here.)
- An RDBMS will automatically enforce referential integrity for foreign keys. That is, you cannot have an invalid entry in the foreign key column; at the same time, you cannot delete a vendor row as long as a product row references that vendor.
- The command sequence ends with a semicolon. (Remember, your RDBMS may require that you omit the semicolon.)

NOTE

NOTE ABOUT COLUMN NAMES

Do *not* use mathematical symbols such as +, −, and / in your column names; instead, use an underscore to separate words, if necessary. For example, PER-NUM might generate an error message, but PER_NUM is acceptable. Also, do *not* use reserved words. **Reserved words** are words used by SQL to perform specific functions. For example, in some RDBMSs, the column name INITIAL will generate the message invalid column name.

7.2.6 SQL Constraints

In Chapter 3, The Relational Model, you learned that adherence to rules on entity integrity and referential integrity is crucial in a relational database environment. Fortunately, most SQL implementations support both integrity rules. Entity integrity is enforced automatically when the primary key is specified in the CREATE TABLE command sequence. For example, you can create the VENDOR table structure and set the stage for the enforcement of entity integrity rules by using:

```
PRIMARY KEY (V_CODE)
```

In the PRODUCT table's CREATE TABLE sequence, note that referential integrity has been enforced by specifying in the PRODUCT table:

```
FOREIGN KEY (V_CODE) REFERENCES VENDOR ON UPDATE CASCADE
```

NOTE

NOTE TO ORACLE USERS

When you press the Enter key after typing each line, a line number is automatically generated as long as you do not type a semicolon before pressing the Enter key. For example, Oracles execution of the CREATE TABLE command will look like this:

```
CREATE TABLE PRODUCT (
      2     P_CODE          VARCHAR2(10)
      3     CONSTRAINT      PRODUCT_P_CODE_PK PRIMARY KEY,
      4     P_DESCRIPT      VARCHAR2(35)      NOT NULL,
      5     P_INDATE        DATE              NOT NULL,
      6     P_QOH           NUMBER            NOT NULL,
      7     P_MIN           NUMBER            NOT NULL,
      8     P_PRICE         NUMBER(8,2)       NOT NULL,
      9     P_DISCOUNT      NUMBER(5,2)       NOT NULL,
     10     V_CODE          NUMBER,
     11     CONSTRAINT PRODUCT_V_CODE_FK
     12     FOREIGN KEYV_CODE REFERENCES VENDOR
     13
```

In the preceding SQL command sequence, note the following:

- The attribute definition for P_CODE starts in line 2 and ends with a comma at the end of line 3.
- The CONSTRAINT clause (line 3) allows you to define and name a constraint in Oracle. You can name the constraint to meet your own naming conventions. In this case, the constraint was named PRODUCT_P_CODE_PK.
- Examples of constraints are NOT NULL, UNIQUE, PRIMARY KEY, FOREIGN KEY, and CHECK. For additional details about constraints, see below.
- To define a PRIMARY KEY constraint, you could also use the following syntax: P_CODE VARCHAR2(10) PRIMARY KEY,.
- In this case, Oracle would automatically name the constraint.
- Lines 11 and 12 define a FOREIGN KEY constraint name PRODUCT_V_CODE_FK for the attribute V_CODE. The CONSTRAINT clause is generally used at the end of the CREATE TABLE command sequence.
- *If you do not name the constraints yourself, Oracle will automatically assign a name. Unfortunately, the Oracle-assigned name makes sense only to Oracle, so you will have a difficult time deciphering it later. You should assign a name that makes sense to human beings!*

That foreign key constraint definition ensures that:

- You cannot delete a vendor from the VENDOR table if at least one product row references that vendor. This is the default behavior for the treatment of foreign keys.
- On the other hand, if a change is made in an existing VENDOR table's V_CODE, that change must be reflected automatically in any PRODUCT table V_CODE reference (ON UPDATE CASCADE). That restriction makes it impossible for a V_CODE value to exist in the PRODUCT table pointing to a nonexistent VENDOR table V_CODE value. In other words, the ON UPDATE CASCADE specification ensures the preservation of referential integrity. (Oracle does not support ON UPDATE CASCADE.)

In general, ANSI SQL permits the use of ON DELETE and ON UPDATE clauses to cover CASCADE, SET NULL, or SET DEFAULT.

ONLINE CONTENT

For a more detailed discussion of the options for the ON DELETE and ON UPDATE clauses, see **Appendix D, Converting an ER Model into a Database Structure,** Section D.2, General Rules Governing Relationships Among Tables. Appendix D is in the Student Online Companion.

NOTE

NOTE ABOUT REFERENTIAL CONSTRAINT ACTIONS
The support for the referential constraints actions varies from product to product. For example:

- MS Access, SQL Server, and Oracle support ON DELETE CASCADE.
- MS Access and SQL Server support ON UPDATE CASCADE.
- Oracle does not support ON UPDATE CASCADE.
- Oracle supports SET NULL.
- MS Access and SQL Server do not support SET NULL.

Refer to your product manuals for additional information on referential constraints.

While MS Access does not support ON DELETE CASCADE or ON UPDATE CASCADE at the SQL command-line level, it does support them through the relationship window interface. In fact, whenever you try to establish a relationship between two tables in Access, the relationship window interface will automatically pop up.

Besides the PRIMARY KEY and FOREIGN KEY constraints, the ANSI SQL standard also defines the following constraints:

- The NOT NULL constraint ensures that a column does not accept nulls.
- The UNIQUE constraint ensures that all values in a column are unique.
- The DEFAULT constraint assigns a value to an attribute when a new row is added to a table. The end user may, of course, enter a value other than the default value.
- The CHECK constraint is used to validate data when an attribute value is entered. The CHECK constraint does precisely what its name suggests: it checks to see that a specified condition exists. Examples of such constraints include the following:
  - *The minimum order value must be at least 10.*
  - *The date must be after April 15, 2008.*

If the CHECK constraint is met for the specified attribute (that is, the condition is true), the data are accepted for that attribute. If the condition is found to be false, an error message is generated and the data are not accepted.

Note that the CREATE TABLE command lets you define constraints in two different places:

- When you create the column definition (known as a *column constraint*)
- When you use the CONSTRAINT keyword (known as a *table constraint*)

A column constraint applies to just one column; a table constraint may apply to many columns. Those constraints are supported at varying levels of compliance by enterprise RDBMSs.

In this chapter, Oracle is used to illustrate SQL constraints. For example, note that the following SQL command sequence uses the DEFAULT and CHECK constraints to define the table named CUSTOMER.

```
CREATE TABLE CUSTOMER (
CUS_CODE          NUMBER          PRIMARY KEY,
CUS_LNAME         VARCHAR(15)     NOT NULL,
CUS_FNAME         VARCHAR(15)     NOT NULL,
CUS_INITIAL       CHAR(1),
CUS_AREACODE      CHAR(3)         DEFAULT '615'      NOT NULL
                                  CHECK(CUS_AREACODE IN ('615','713','931')),
CUS_PHONE         CHAR(8)         NOT NULL,
CUS_BALANCE       NUMBER(9,2)     DEFAULT 0.00,
CONSTRAINT CUS_UI1 UNIQUE (CUS_LNAME, CUS_FNAME));
```

In this case, the CUS_AREACODE attribute is assigned a default value of '615'. Therefore, if a new CUSTOMER table row is added and the end user makes no entry for the area code, the '615' value will be recorded. Also note that the CHECK condition restricts the values for the customer's area code to 615, 713, and 931; any other values will be rejected.

It is important to note that the DEFAULT value applies only when new rows are added to a table and then only when no value is entered for the customer's area code. (The default value is not used when the table is modified.) In contrast, the CHECK condition is validated whether a customer row is added *or modified*. However, while the CHECK condition may include any valid expression, it applies only to the attributes in the table being checked. If you want to check for conditions that include attributes in other tables, you must use triggers. (See Chapter 8, Advanced SQL.) Finally, the last line of the CREATE TABLE command sequence creates a unique index constraint (named CUS_UI1) on the customer's last name and first name. The index will prevent the entry of two customers with the same last name and first name. (This index merely illustrates the process. Clearly, it should be possible to have more than one person named John Smith in the CUSTOMER table.)

Note

NOTE TO MS ACCESS USERS

MS Access does not accept the DEFAULT or CHECK constraints. However, MS Access will accept the CONSTRAINT CUS_UI1 UNIQUE (CUS_LNAME, CUS_FNAME) line and create the unique index.

In the following SQL command to create the INVOICE table, the DEFAULT constraint assigns a default date to a new invoice, and the CHECK constraint validates that the invoice date is greater than January 1, 2008.

```
CREATE TABLE INVOICE (
INV_NUMBER        NUMBER          PRIMARY KEY,
CUS_CODE          NUMBER          NOT NULL REFERENCES CUSTOMER(CUS_CODE),
INV_DATE          DATE            DEFAULT SYSDATE NOT NULL,
CONSTRAINT INV_CK1 CHECK (INV_DATE > TO_DATE('01-JAN-2008','DD-MON-YYYY')));
```

In this case, notice the following:

- The CUS_CODE attribute definition contains REFERENCES CUSTOMER (CUS_CODE) to indicate that the CUS_CODE is a foreign key. This is another way to define a foreign key.
- The DEFAULT constraint uses the SYSDATE special function. This function always returns today's date.
- The invoice date (INV_DATE) attribute is automatically given today's date (returned by SYSDATE) when a new row is added and no value is given for the attribute.
- A CHECK constraint is used to validate that the invoice date is greater than 'January 1, 2008'. When comparing a date to a manually entered date in a CHECK clause, Oracle requires the use of the TO_DATE function. The TO_DATE function takes two parameters, the literal date and the date format used.

The final SQL command sequence creates the LINE table. The LINE table has a composite primary key (INV_NUMBER, LINE_NUMBER) and uses a UNIQUE constraint in INV_NUMBER and P_CODE to ensure that the same product is not ordered twice in the same invoice.

```
CREATE TABLE LINE (
INV_NUMBER          NUMBER          NOT NULL,
LINE_NUMBER         NUMBER(2,0)     NOT NULL,
P_CODE              VARCHAR(10)     NOT NULL,
LINE_UNITS          NUMBER(9,2)     DEFAULT 0.00        NOT NULL,
LINE_PRICE          NUMBER(9,2)     DEFAULT 0.00        NOT NULL,
PRIMARY KEY (INV_NUMBER, LINE_NUMBER),
FOREIGN KEY (INV_NUMBER) REFERENCES INVOICE ON DELETE CASCADE,
FOREIGN KEY (P_CODE) REFERENCES PRODUCT(P_CODE),
CONSTRAINT LINE_UI1 UNIQUE(INV_NUMBER, P_CODE));
```

In the creation of the LINE table, note that a UNIQUE constraint is added to prevent the duplication of an invoice line. A UNIQUE constraint is enforced through the creation of a unique index. Also note that the ON DELETE CASCADE foreign key action enforces referential integrity. The use of ON DELETE CASCADE is recommended for weak entities to ensure that the deletion of a row in the strong entity automatically triggers the deletion of the corresponding rows in the dependent weak entity. In that case, the deletion of an INVOICE row will automatically delete all of the LINE rows related to the invoice. In the following section, you will learn more about indexes and how to use SQL commands to create them.

7.2.7 SQL Indexes

You learned in Chapter 3 that indexes can be used to improve the efficiency of searches and to avoid duplicate column values. In the previous section, you saw how to declare unique indexes on selected attributes when the table is created. In fact, when you declare a primary key, the DBMS automatically creates a unique index. Even with this feature, you often need additional indexes. The ability to create indexes quickly and efficiently is important. Using the **CREATE INDEX** command, SQL indexes can be created on the basis of any selected attribute. The syntax is:

CREATE [UNIQUE] INDEX *indexname* ON *tablename*(*column1* [, *column2*])

For example, based on the attribute P_INDATE stored in the PRODUCT table, the following command creates an index named P_INDATEX:

```
CREATE INDEX P_INDATEX ON PRODUCT(P_INDATE);
```

SQL does not let you write over an existing index without warning you first, thus preserving the index structure within the data dictionary. Using the UNIQUE index qualifier, you can even create an index that prevents you from using a value that has been used before. Such a feature is especially useful when the index attribute is a candidate key whose values must not be duplicated:

```
CREATE UNIQUE INDEX P_CODEX ON PRODUCT(P_CODE);
```

If you now try to enter a duplicate P_CODE value, SQL produces the error message "duplicate value in index." Many RDBMSs, including Access, automatically create a unique index on the PK attribute(s) when you declare the PK.

A common practice is to create an index on any field that is used as a search key, in comparison operations in a conditional expression, or when you want to list rows in a specific order. For example, if you want to create a report of all products by vendor, it would be useful to create an index on the V_CODE attribute in the PRODUCT table. Remember that a vendor can supply many products. Therefore, you should *not* create a UNIQUE index in this case. Better yet, to make the search as efficient as possible, a composite index is recommended.

Unique composite indexes are often used to prevent data duplication. For example, consider the case illustrated in Table 7.5, in which required employee test scores are stored. (An employee can take a test only once on a given date.) Given the structure of Table 7.5, the PK is EMP_NUM + TEST_NUM. The third test entry for employee 111 meets entity integrity requirements—the combination 111,3 is unique—yet the WEA test entry is clearly duplicated.

TABLE 7.5 A Duplicated Test Record

EMP_NUM	TEST_NUM	TEST_CODE	TEST_DATE	TEST_SCORE
110	1	WEA	15-Jan-2008	93
110	2	WEA	12-Jan-2008	87
111	1	HAZ	14-Dec-2007	91
111	2	WEA	18-Feb-2008	95
111	3	WEA	18-Feb-2008	95
112	1	CHEM	17-Aug-2007	91

Such duplication could have been avoided through the use of a unique composite index, using the attributes EMP_NUM, TEST_CODE, and TEST_DATE:

```
CREATE UNIQUE INDEX EMP_TESTDEX ON TEST(EMP_NUM, TEST_CODE, TEST_DATE);
```

By default, all indexes produce results that are listed in ascending order, but you can create an index that yields output in descending order. For example, if you routinely print a report that lists all products ordered by price from highest to lowest, you could create an index named PROD_PRICEX by typing:

```
CREATE INDEX PROD_PRICEX ON PRODUCT(P_PRICE DESC);
```

To delete an index, use the **DROP INDEX** command:

DROP INDEX *indexname*

For example, if you want to eliminate the PROD_PRICEX index, type:

```
DROP INDEX PROD_PRICEX;
```

After creating the tables and some indexes, you are ready to start entering data. The following sections use two tables (VENDOR and PRODUCT) to demonstrate most of the data manipulation commands.

7.3 DATA MANIPULATION COMMANDS

In this section, you will learn how to use the basic SQL data manipulation commands INSERT, SELECT, COMMIT, UPDATE, ROLLBACK, and DELETE.

7.3.1 Adding Table Rows

SQL requires the use of the **INSERT** command to enter data into a table. The INSERT command's basic syntax looks like this:

INSERT INTO *tablename* VALUES (*value1, value2, … , valuen*)

Because the PRODUCT table uses its V_CODE to reference the VENDOR table's V_CODE, an integrity violation will occur if those VENDOR table V_CODE values don't yet exist. Therefore, you need to enter the VENDOR rows before the PRODUCT rows. Given the VENDOR table structure defined earlier and the sample VENDOR data shown in Figure 7.2, you would enter the first two data rows as follows:

```
INSERT INTO VENDOR
        VALUES (21225,'Bryson, Inc.','Smithson','615','223-3234','TN','Y');
INSERT INTO VENDOR
        VALUES (21226,'Superloo, Inc.','Flushing','904','215-8995','FL','N');
```

and so on, until all of the VENDOR table records have been entered.

(To see the contents of the VENDOR table, use the SELECT * FROM VENDOR; command.)

The PRODUCT table rows would be entered in the same fashion, using the PRODUCT data shown in Figure 7.2. For example, the first two data rows would be entered as follows, pressing the Enter key at the end of each line:

```
INSERT INTO PRODUCT
        VALUES ('11QER/31','Power painter, 15 psi., 3-nozzle','03-Nov-07',8,5,109.99,0.00,25595);
INSERT INTO PRODUCT
        VALUES ('13-Q2/P2','7.25-in. pwr. saw blade','13-Dec-07',32,15,14.99, 0.05, 21344);
```

(To see the contents of the PRODUCT table, use the SELECT * FROM PRODUCT; command.)

NOTE

Date entry is a function of the date format expected by the DBMS. For example, March 25, 2008 might be shown as 25-Mar-2008 in Access and Oracle, or it might be displayed in other presentation formats in another RDBMS. MS Access requires the use of # delimiters when performing any computations or comparisons based on date attributes, as in P_INDATE >= #25-Mar-08#.

In the preceding data entry lines, observe that:

- The row contents are entered between parentheses. Note that the first character after VALUES is a parenthesis and that the last character in the command sequence is also a parenthesis.
- Character (string) and date values must be entered between apostrophes (').
- Numerical entries are *not* enclosed in apostrophes.
- Attribute entries are separated by commas.
- A value is required for each column in the table.

This version of the INSERT commands adds one table row at a time.

Inserting Rows with Null Attributes

Thus far, you have entered rows in which all of the attribute values are specified. But what do you do if a product does not have a vendor or if you don't yet know the vendor code? In those cases, you would want to leave the vendor code null. To enter a null, use the following syntax:

```
INSERT INTO PRODUCT
        VALUES ('BRT-345','Titanium drill bit','18-Oct-07', 75, 10, 4.50, 0.06, NULL);
```

Incidentally, note that the NULL entry is accepted only because the V_CODE attribute is optional—the NOT NULL declaration was not used in the CREATE TABLE statement for this attribute.

C6545_07 7/23/2007 16:38:31 Page 242

Inserting Rows with Optional Attributes

There might be occasions when more than one attribute is optional. Rather than declaring each attribute as NULL in the INSERT command, you can indicate just the attributes that have required values. You do that by listing the attribute names inside parentheses after the table name. For the purpose of this example, assume that the only required attributes for the PRODUCT table are P_CODE and P_DESCRIPT:

```
INSERT INTO PRODUCT(P_CODE, P_DESCRIPT) VALUES ('BRT-345','Titanium drill bit');
```

7.3.2 Saving Table Changes

Any changes made to the table contents are not saved on disk until you close the database, close the program you are using, or use the **COMMIT** command. If the database is open and a power outage or some other interruption occurs before you issue the COMMIT command, your changes will be lost and only the original table contents will be retained. The syntax for the COMMIT command is:

```
COMMIT [WORK]
```

The COMMIT command permanently saves *all* changes—such as rows added, attributes modified, and rows deleted—made to any table in the database. Therefore, if you intend to make your changes to the PRODUCT table permanent, it is a good idea to save those changes by using:

```
COMMIT;
```

Note

NOTE TO MS ACCESS USERS

MS Access doesn't support the COMMIT command because it automatically saves changes after the execution of each SQL command.

However, the COMMIT command's purpose is not just to save changes. In fact, the ultimate purpose of the COMMIT and ROLLBACK commands (see Section 7.3.5) is to ensure database update integrity in transaction management. (You will see how such issues are addressed in Chapter 10, Transaction Management and Concurrency Control.)

7.3.3 Listing Table Rows

The **SELECT** command is used to list the contents of a table. The syntax of the SELECT command is as follows:

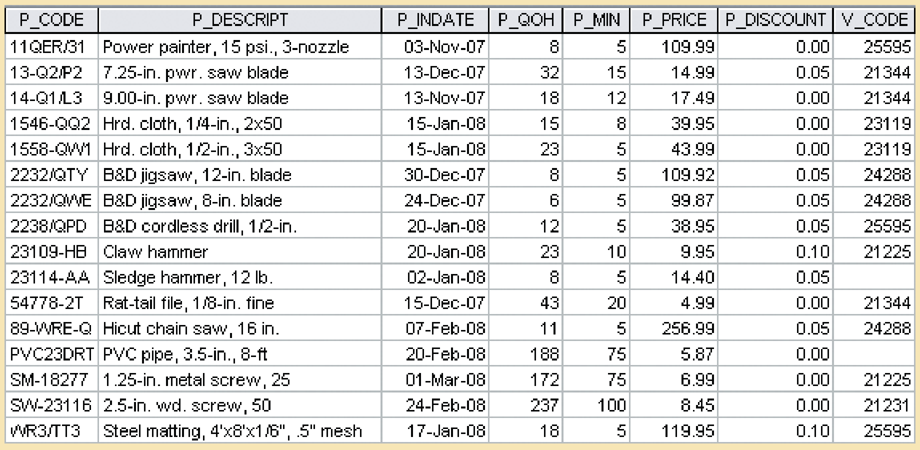
SELECT *columnlist* FROM *tablename*

The *columnlist* represents one or more attributes, separated by commas. You could use the * (asterisk) as a wildcard character to list all attributes. A **wildcard character** is a symbol that can be used as a general substitute for other characters or commands. For example, to list all attributes and all rows of the PRODUCT table, use:

```
SELECT * FROM PRODUCT;
```

Figure 7.3 shows the output generated by that command. (Figure 7.3 shows all of the rows in the PRODUCT table that serve as the basis for subsequent discussions. If you entered only the PRODUCT table's first two records, as shown in the preceding section, the output of the preceding SELECT command would show only the rows you entered. Don't worry about the difference between your SELECT output and the output shown in Figure 7.3. When you complete the work in this section, you will have created and populated your VENDOR and PRODUCT tables with the correct rows for use in future sections.)

FIGURE 7.3 **The contents of the PRODUCT table**



P_CODE	P_DESCRIPT	P_INDATE	P_QOH	P_MIN	P_PRICE	P_DISCOUNT	V_CODE
11QER/31	Power painter, 15 psi., 3-nozzle	03-Nov-07	8	5	109.99	0.00	25595
13-Q2/P2	7.25-in. pwr. saw blade	13-Dec-07	32	15	14.99	0.05	21344
14-Q1/L3	9.00-in. pwr. saw blade	13-Nov-07	18	12	17.49	0.00	21344
1546-QQ2	Hrd. cloth, 1/4-in., 2x50	15-Jan-08	15	8	39.95	0.00	23119
1558-QW1	Hrd. cloth, 1/2-in., 3x50	15-Jan-08	23	5	43.99	0.00	23119
2232/QTY	B&D jigsaw, 12-in. blade	30-Dec-07	8	5	109.92	0.05	24288
2232/QWE	B&D jigsaw, 8-in. blade	24-Dec-07	6	5	99.87	0.05	24288
2238/QPD	B&D cordless drill, 1/2-in.	20-Jan-08	12	5	38.95	0.05	25595
23109-HB	Claw hammer	20-Jan-08	23	10	9.95	0.10	21225
23114-AA	Sledge hammer, 12 lb.	02-Jan-08	8	5	14.40	0.05	
54778-2T	Rat-tail file, 1/8-in. fine	15-Dec-07	43	20	4.99	0.00	21344
89-WRE-Q	Hicut chain saw, 16 in.	07-Feb-08	11	5	256.99	0.05	24288
PVC23DRT	PVC pipe, 3.5-in., 8-ft	20-Feb-08	188	75	5.87	0.00	
SM-18277	1.25-in. metal screw, 25	01-Mar-08	172	75	6.99	0.00	21225
SW-23116	2.5-in. wd. screw, 50	24-Feb-08	237	100	8.45	0.00	21231
WR3/TT3	Steel matting, 4'x8'x1/6", .5" mesh	17-Jan-08	18	5	119.95	0.10	25595

NOTE

Your listing may not be in the order shown in Figure 7.3. The listings shown in the figure are the result of system-controlled primary-key-based index operations. You will learn later how to control the output so that it conforms to the order you have specified.

NOTE

NOTE TO ORACLE USERS

Some SQL implementations (such as Oracle's) cut the attribute labels to fit the width of the column. However, Oracle lets you set the width of the display column to show the complete attribute name. You can also change the display format, regardless of how the data are stored in the table. For example, if you want to display dollar symbols and commas in the P_PRICE output, you can declare:

```
COLUMN P_PRICE FORMAT $99,999.99
```

to change the output 12347.67 to $12,347.67.

In the same manner, to display only the first 12 characters of the P_DESCRIPT attribute, use:

```
COLUMN P_DESCRIPT FORMAT A12 TRUNCATE
```

Although SQL commands can be grouped together on a single line, complex command sequences are best shown on separate lines, with space between the SQL command and the command's components. Using that formatting convention makes it much easier to see the components of the SQL statements, making it easy to trace the SQL logic, and if necessary, to make corrections. The number of spaces used in the indention is up to you. For example, note the following format for a more complex statement:

```
SELECT     P_CODE, P_DESCRIPT, P_INDATE, P_QOH, P_MIN, P_PRICE, P_DISCOUNT, V_CODE
FROM       PRODUCT;
```

When you run a SELECT command on a table, the RDBMS returns a set of one or more rows that have the same characteristics as a relational table. In addition, the SELECT command lists all rows from the table you specified in the FROM clause. This is a very important characteristic of SQL commands. By default, most SQL data manipulation commands operate over an entire table (or relation). That is why SQL commands are said to be *set-oriented* commands. A SQL set-oriented command works over a set of rows. The set may include one or more columns and zero or more rows from one or more tables.

7.3.4 Updating Table Rows

Use the **UPDATE** command to modify data in a table. The syntax for this command is:

```
UPDATE      tablename
SET         columnname = expression [, columnname = expression]
[WHERE      conditionlist ];
```

For example, if you want to change P_INDATE from December 13, 2007, to January 18, 2008, in the second row of the PRODUCT table (see Figure 7.3), use the primary key (13-Q2/P2) to locate the correct (second) row. Therefore, type:

```
UPDATE      PRODUCT
SET         P_INDATE = '18-JAN-2008'
WHERE       P_CODE = '13-Q2/P2';
```

If more than one attribute is to be updated in the row, separate the corrections with commas:

```
UPDATE      PRODUCT
SET         P_INDATE = '18-JAN-2008', P_PRICE = 17.99, P_MIN = 10
WHERE       P_CODE = '13-Q2/P2';
```

What would have happened if the previous UPDATE command had not included the WHERE condition? The P_INDATE, P_PRICE, and P_MIN values would have been changed in *all* rows of the PRODUCT table. Remember, the UPDATE command is a set-oriented operator. Therefore, if you don't specify a WHERE condition, the UPDATE command will apply the changes to *all* rows in the specified table.

Confirm the correction(s) by using this SELECT command to check the PRODUCT table's listing:

```
SELECT * FROM PRODUCT;
```

7.3.5 Restoring Table Contents

If you have not yet used the COMMIT command to store the changes permanently in the database, you can restore the database to its previous condition with the **ROLLBACK** command. ROLLBACK undoes any changes since the last COMMIT command and brings the data back to the values that existed before the changes were made. To restore the data to their "pre-change" condition, type

```
ROLLBACK;
```

and then press the Enter key. Use the SELECT statement again to see that the ROLLBACK did, in fact, restore the data to their original values.

COMMIT and ROLLBACK work only with data manipulation commands that are used to add, modify, or delete table rows. For example, assume that you perform these actions:

1. CREATE a table called SALES.
2. INSERT 10 rows in the SALES table.
3. UPDATE two rows in the SALES table.
4. Execute the ROLLBACK command.

Will the SALES table be removed by the ROLLBACK command? No, the ROLLBACK command will undo *only* the results of the INSERT and UPDATE commands. All data definition commands (CREATE TABLE) are automatically committed to the data dictionary and cannot be rolled back. The COMMIT and ROLLBACK commands are examined in greater detail in Chapter 10.

Note

NOTE TO MS ACCESS USERS
MS Access doesn't support the ROLLBACK command.

Some RDBMSs, such as Oracle, automatically COMMIT data changes when issuing data definition commands. For example, if you had used the CREATE INDEX command after updating the two rows in the previous example, all previous changes would have been committed automatically; doing a ROLLBACK afterward wouldn't have undone anything. *Check your RDBMS manual to understand these subtle differences*.

7.3.6 Deleting Table Rows

It is easy to delete a table row using the **DELETE** statement; the syntax is:

```
DELETE FROM     tablename
[WHERE          conditionlist ];
```

For example, if you want to delete from the PRODUCT table the product that you added earlier whose code (P_CODE) is 'BRT-345', use:

```
DELETE FROM     PRODUCT
WHERE           P_CODE = 'BRT-345';
```

In that example, the primary key value lets SQL find the exact record to be deleted. However, deletions are not limited to a primary key match; any attribute may be used. For example, in your PRODUCT table, you will see that there are several products for which the P_MIN attribute is equal to 5. Use the following command to delete all rows from the PRODUCT table for which the P_MIN is equal to 5:

```
DELETE FROM     PRODUCT
WHERE           P_MIN = 5;
```

Check the PRODUCT table's contents again to verify that all products with P_MIN equal to 5 have been deleted.

Finally, remember that DELETE is a set-oriented command. And keep in mind that the WHERE condition is optional. Therefore, if you do not specify a WHERE condition, *all* rows from the specified table will be deleted!

7.3.7 Inserting Table Rows with a Select Subquery

You learned in Section 7.3.1 how to use the INSERT statement to add rows to a table. In that section, you added rows one at a time. In this section, you learn how to add multiple rows to a table, using another table as the source of the data. The syntax for the INSERT statement is:

```
INSERT INTO tablename   SELECT columnlist   FROM tablename;
```

In that case, the INSERT statement uses a SELECT subquery. A **subquery**, also known as a **nested query** or an **inner query**, is a query that is embedded (or nested) inside another query. The inner query is always executed first by the RDBMS. Given the previous SQL statement, the INSERT portion represents the outer query, and the SELECT portion represents the subquery. You can nest queries (place queries inside queries) many levels deep; in every case,

C6545_07 9/6/2007 16:24:52 Page 246

the output of the inner query is used as the input for the outer (higher-level) query. In Chapter 8 you will learn more about the various types of subqueries.

The values returned by the SELECT subquery should match the attributes and data types of the table in the INSERT statement. If the table into which you are inserting rows has one date attribute, one number attribute, and one character attribute, the SELECT subquery should return one or more rows in which the first column has date values, the second column has number values, and the third column has character values.

Populating the VENDOR and PRODUCT Tables

The following steps guide you through the process of populating the VENDOR and PRODUCT tables with the data to be used in the rest of the chapter. To accomplish that task, two tables named V and P are used as the data source. V and P have the same table structure (attributes) as the VENDOR and PRODUCT tables.

ONLINE CONTENT

Before you execute the following commands, you **MUST** do the following:

- If you are using Oracle, run the **create_P_V.sql** script file in the Online Student Companion to create the V and P tables used in the example below. To connect to the database, follow the instructions specific to your school's setup provided by your instructor.
- If you are using Access, copy the original **Ch07_SaleCo.mbd** file from the Online Student Companion.

Use the following steps to populate your VENDOR and PRODUCT tables. (If you haven't already created the PRODUCT and VENDOR tables to practice the SQL commands in the previous sections, do so before completing these steps.)

1. Delete all rows from the PRODUCT and VENDOR tables.
   - DELETE FROM PRODUCT;
   - DELETE FROM VENDOR;
2. Add the rows to VENDOR by copying all rows from V.
   - If you are using MS Access, type:
     INSERT INTO VENDOR SELECT * FROM V;
   - If you are using Oracle, type:
     INSERT INTO VENDOR SELECT * FROM TEACHER.V;
3. Add the rows to PRODUCT by copying all rows from P.
   - If you are using MS Access, type:
     INSERT INTO PRODUCT SELECT * FROM P;
   - If you are using Oracle, type:
     INSERT INTO PRODUCT SELECT * FROM TEACHER.P;
   - Oracle users must permanently save the changes by issuing the COMMIT; command.

If you followed those steps correctly, you now have the VENDOR and PRODUCT tables populated with the data that will be used in the remaining sections of the chapter.

ONLINE CONTENT

Before you execute the commands in the following sections, you **MUST** do the following:

- If you are using Oracle, run the **sqlintrodbinit.sql** script file in the Online Student Companion to create all tables and load the data in the database. To connect to the database, follow the instructions specific to your school's setup provided by your instructor.
- If you are using Access, copy the original **Ch07_SaleCo.mbd** file from the Online Student Companion.

7.4 SELECT QUERIES

In this section, you will learn how to fine-tune the SELECT command by adding restrictions to the search criteria. SELECT, coupled with appropriate search conditions, is an incredibly powerful tool that enables you to transform data into information. For example, in the following sections, you will learn how to create queries that can be used to answer questions such as these: "What products were supplied by a particular vendor?" "Which products are priced below $10?" "How many products supplied by a given vendor were sold between January 5, 2008 and March 20, 2008?"

7.4.1 Selecting Rows with Conditional Restrictions

You can select partial table contents by placing restrictions on the rows to be included in the output. This is done by using the WHERE clause to add conditional restrictions to the SELECT statement. The following syntax enables you to specify which rows to select:

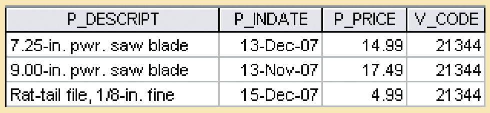
```
SELECT      columnlist
FROM        tablelist
[WHERE      conditionlist ];
```

The SELECT statement retrieves all rows that match the specified condition(s)—also known as the *conditional criteria*—you specified in the WHERE clause. The *conditionlist* in the WHERE clause of the SELECT statement is represented by one or more conditional expressions, separated by logical operators. The WHERE clause is optional. If no rows match the specified criteria in the WHERE clause, you see a blank screen or a message that tells you that no rows were retrieved. For example, the query:

```
SELECT      P_DESCRIPT, P_INDATE, P_PRICE, V_CODE
FROM        PRODUCT
WHERE       V_CODE = 21344;
```

returns the description, date, and price of products with a vendor code of 21344, as shown in Figure 7.4.

FIGURE 7.4 **Selected PRODUCT table attributes for vendor code 21344**

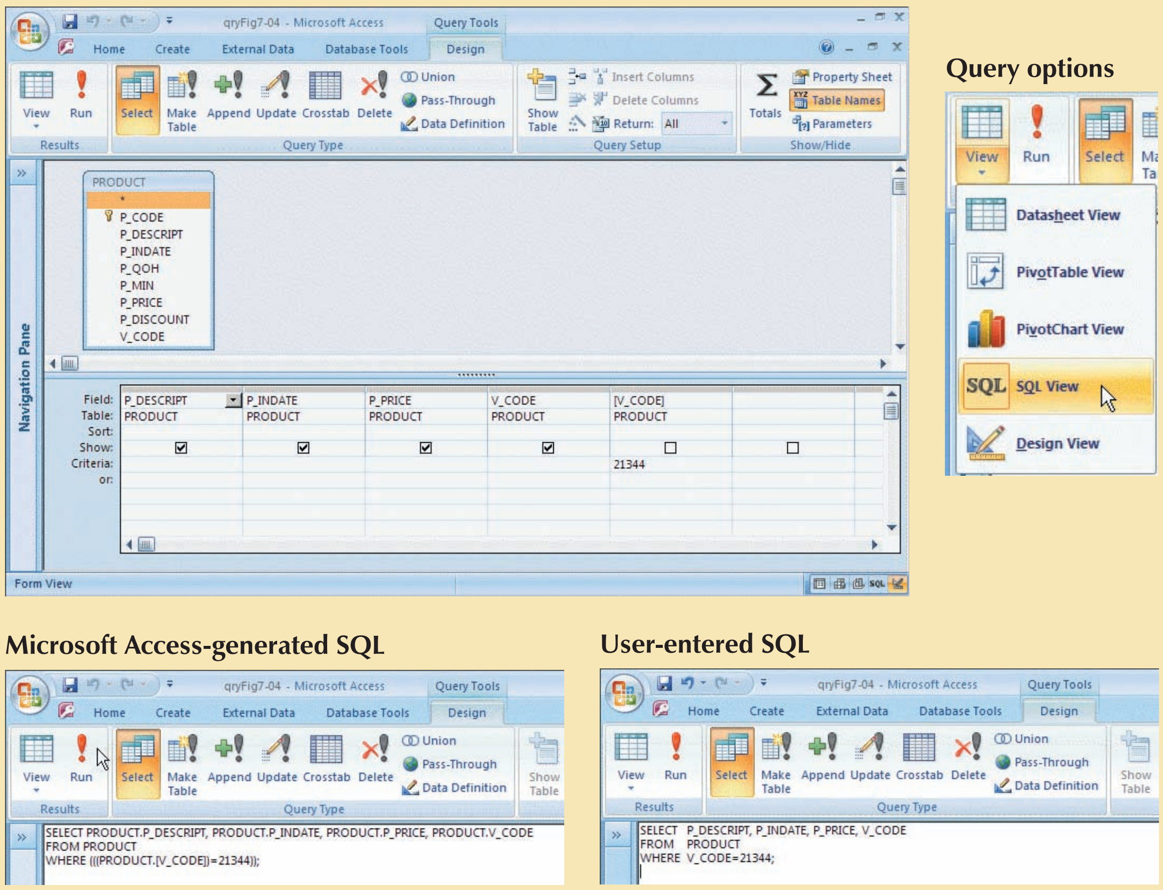


P_DESCRIPT	P_INDATE	P_PRICE	V_CODE
7.25-in. pwr. saw blade	13-Dec-07	14.99	21344
9.00-in. pwr. saw blade	13-Nov-07	17.49	21344
Rat-tail file, 1/8-in. fine	15-Dec-07	4.99	21344

MS Access users can use the Access QBE (query by example) query generator. Although the Access QBE generates its own "native" version of SQL, you can also elect to type standard SQL in the Access SQL window, as shown at the bottom of Figure 7.5. Figure 7.5 shows the Access QBE screen, the SQL window's QBE-generated SQL, and the listing of the modified SQL.

Numerous conditional restrictions can be placed on the selected table contents. For example, the comparison operators shown in Table 7.6 can be used to restrict output.

FIGURE 7.5 The Microsoft Access QBE and its SQL



Field:	P_DESCRIPT	P_INDATE	P_PRICE	V_CODE	[V_CODE]	
Table:	PRODUCT	PRODUCT	PRODUCT	PRODUCT	PRODUCT	
Sort:						
Show:	☑	☑	☑	☑	☐	☐
Criteria:					21344	
or:						

```
SELECT PRODUCT.P_DESCRIPT, PRODUCT.P_INDATE, PRODUCT.P_PRICE, PRODUCT.V_CODE
FROM PRODUCT
WHERE (((PRODUCT.[V_CODE])=21344));
```

```
SELECT   P_DESCRIPT, P_INDATE, P_PRICE, V_CODE
FROM     PRODUCT
WHERE    V_CODE=21344;
```

NOTE

NOTE TO MS ACCESS USERS

The MS Access QBE interface automatically designates the data source by using the table name as a prefix. You will discover later that the table name prefix is used to avoid ambiguity when the same column name appears in multiple tables. For example, both the VENDOR and the PRODUCT tables contain the V_CODE attribute. Therefore, if both tables are used—as they would be in a join—the source of the V_CODE attribute must be specified.

TABLE 7.6 Comparison Operators

SYMBOL	MEANING
=	Equal to
<	Less than
<=	Less than or equal to
>	Greater than
>=	Greater than or equal to
<> or !=	Not equal to

The following example uses the "not equal to" operator:

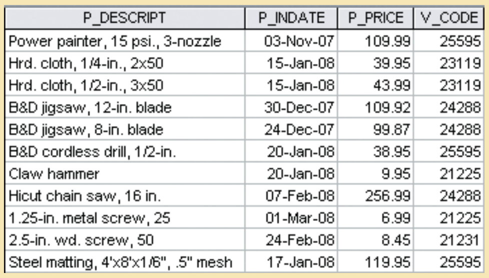
```
SELECT   P_DESCRIPT, P_INDATE, P_PRICE, V_CODE
FROM     PRODUCT
WHERE    V_CODE <> 21344;
```

The output, shown in Figure 7.6, lists all of the rows for which the vendor code is *not* 21344.

Note that in Figure 7.6, rows with nulls in the V_CODE column (see Figure 7.3) are not included in the SELECT command's output.

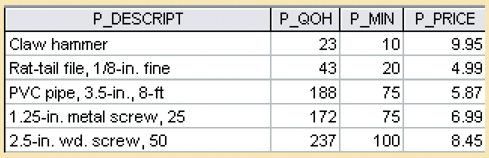
C6545_07 7/23/2007 16:59:26 Page 249

FIGURE 7.6 Selected PRODUCT table attributes for vendor codes other than 21344



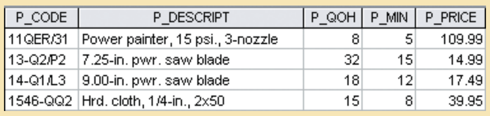
P_DESCRIPT	P_INDATE	P_PRICE	V_CODE
Power painter, 15 psi., 3-nozzle	03-Nov-07	109.99	25595
Hrd. cloth, 1/4-in., 2x50	15-Jan-08	39.95	23119
Hrd. cloth, 1/2-in., 3x50	15-Jan-08	43.99	23119
B&D jigsaw, 12-in. blade	30-Dec-07	109.92	24288
B&D jigsaw, 8-in. blade	24-Dec-07	99.87	24288
B&D cordless drill, 1/2-in.	20-Jan-08	38.95	25595
Claw hammer	20-Jan-08	9.95	21225
Hicut chain saw, 16 in.	07-Feb-08	256.99	24288
1.25-in. metal screw, 25	01-Mar-08	6.99	21225
2.5-in. wd. screw, 50	24-Feb-08	8.45	21231
Steel matting, 4'x8'x1/6", .5" mesh	17-Jan-08	119.95	25595

FIGURE 7.7 Selected PRODUCT table attributes with a P_PRICE restriction



P_DESCRIPT	P_QOH	P_MIN	P_PRICE
Claw hammer	23	10	9.95
Rat-tail file, 1/8-in. fine	43	20	4.99
PVC pipe, 3.5-in., 8-ft	188	75	5.87
1.25-in. metal screw, 25	172	75	6.99
2.5-in. wd. screw, 50	237	100	8.45

FIGURE 7.8 Selected PRODUCT table attributes: the ASCII code effect



P_CODE	P_DESCRIPT	P_QOH	P_MIN	P_PRICE
11QER/31	Power painter, 15 psi., 3-nozzle	8	5	109.99
13-Q2/P2	7.25-in. pwr. saw blade	32	15	14.99
14-Q1/L3	9.00-in. pwr. saw blade	18	12	17.49
1546-QQ2	Hrd. cloth, 1/4-in., 2x50	15	8	39.95

The command sequence:

```
SELECT      P_DESCRIPT, P_QOH, P_MIN, P_PRICE
FROM        PRODUCT
WHERE       P_PRICE <= 10;
```

yields the output shown in Figure 7.7.

Using Comparison Operators on Character Attributes

Because computers identify all characters by their (numeric) American Standard Code for Information Interchange (ASCII) codes, comparison operators may even be used to place restrictions on character-based attributes. Therefore, the command:

```
SELECT      P_CODE, P_DESCRIPT, P_QOH, P_MIN,
            P_PRICE
FROM        PRODUCT
WHERE       P_CODE < '1558-QW1';
```

would be correct and would yield a list of all rows in which the P_CODE is alphabetically less than 1558-QW1. (Because the ASCII code value for the letter *B* is greater than the value of the letter *A*, it follows that *A* is less than *B*.) Therefore, the output will be generated as shown in Figure 7.8.

String (character) comparisons are made from left to right. This left-to-right comparison is especially useful when attributes such as names are to be compared. For example, the string "Ardmore" would be judged *greater than* the string "Aarenson" but *less than* the string "Brown"; such results may be used to generate alphabetical listings like those found in a phone directory. If the characters 0–9 are stored as strings, the same left-to-right string comparisons can lead to apparent anomalies. For example, the ASCII code for the character "5" is, as expected, *greater than* the ASCII code for the character "4." Yet the same "5" will also be judged *greater than* the string "44" because the *first* character in the string "44" is less than the string "5." For that reason, you may get some unexpected results from comparisons when dates or other numbers are stored in character format. This also applies to date comparisons. For example, the left-to-right ASCII character comparison would force the conclusion that the date "01/01/2008" occurred *before* "12/31/2007." Because the leftmost character "0" in "01/01/2008" is *less than* the leftmost character "1" in "12/31/2007," "01/01/2008" is *less than* "12/31/2007." Naturally, if date strings are stored in a yyyy/mm/dd format, the comparisons will yield appropriate results, but this is a nonstandard date presentation. That's why all current RDBMSs support "date" data types; you should use them. In addition, using "date" data types gives you the benefit of date arithmetic.

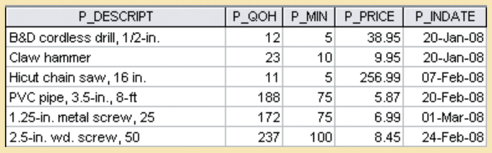
Using Comparison Operators on Dates

Date procedures are often more software-specific than other SQL procedures. For example, the query to list all of the rows in which the inventory stock dates occur on or after January 20, 2008 will look like this:

```
SELECT      P_DESCRIPT, P_QOH, P_MIN, P_PRICE, P_INDATE
FROM        PRODUCT
WHERE       P_INDATE >= '20-Jan-2008';
```

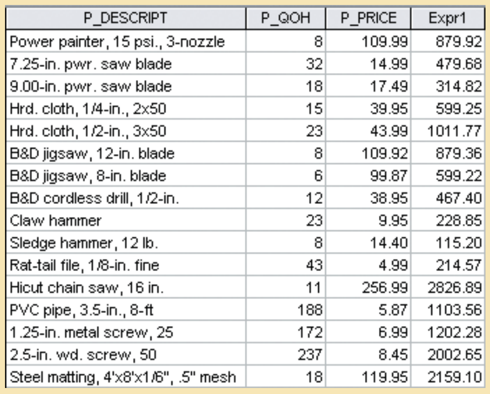
(Remember that MS Access users must use the # delimiters for dates. For example, you would use #20-Jan-08# in the above WHERE clause.) The date-restricted output is shown in Figure 7.9.

FIGURE 7.9 Selected PRODUCT table attributes: date restriction



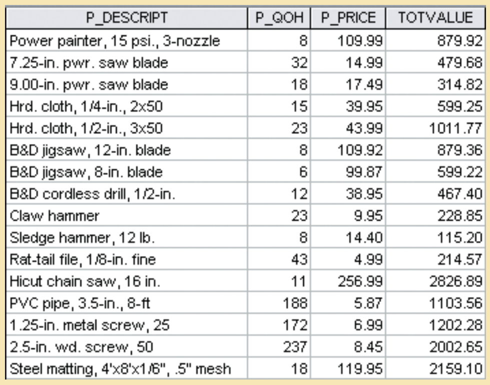
P_DESCRIPT	P_QOH	P_MIN	P_PRICE	P_INDATE
B&D cordless drill, 1/2-in.	12	5	38.95	20-Jan-08
Claw hammer	23	10	9.95	20-Jan-08
Hicut chain saw, 16 in.	11	5	256.99	07-Feb-08
PVC pipe, 3.5-in., 8-ft	188	75	5.87	20-Feb-08
1.25-in. metal screw, 25	172	75	6.99	01-Mar-08
2.5-in. wd. screw, 50	237	100	8.45	24-Feb-08

FIGURE 7.10 SELECT statement with a computed column



P_DESCRIPT	P_QOH	P_PRICE	Expr1
Power painter, 15 psi., 3-nozzle	8	109.99	879.92
7.25-in. pwr. saw blade	32	14.99	479.68
9.00-in. pwr. saw blade	18	17.49	314.82
Hrd. cloth, 1/4-in., 2x50	15	39.95	599.25
Hrd. cloth, 1/2-in., 3x50	23	43.99	1011.77
B&D jigsaw, 12-in. blade	8	109.92	879.36
B&D jigsaw, 8-in. blade	6	99.87	599.22
B&D cordless drill, 1/2-in.	12	38.95	467.40
Claw hammer	23	9.95	228.85
Sledge hammer, 12 lb.	8	14.40	115.20
Rat-tail file, 1/8-in. fine	43	4.99	214.57
Hicut chain saw, 16 in.	11	256.99	2826.89
PVC pipe, 3.5-in., 8-ft	188	5.87	1103.56
1.25-in. metal screw, 25	172	6.99	1202.28
2.5-in. wd. screw, 50	237	8.45	2002.65
Steel matting, 4'x8'x1/6", .5" mesh	18	119.95	2159.10

FIGURE 7.11 SELECT statement with a computed column and an alias



P_DESCRIPT	P_QOH	P_PRICE	TOTVALUE
Power painter, 15 psi., 3-nozzle	8	109.99	879.92
7.25-in. pwr. saw blade	32	14.99	479.68
9.00-in. pwr. saw blade	18	17.49	314.82
Hrd. cloth, 1/4-in., 2x50	15	39.95	599.25
Hrd. cloth, 1/2-in., 3x50	23	43.99	1011.77
B&D jigsaw, 12-in. blade	8	109.92	879.36
B&D jigsaw, 8-in. blade	6	99.87	599.22
B&D cordless drill, 1/2-in.	12	38.95	467.40
Claw hammer	23	9.95	228.85
Sledge hammer, 12 lb.	8	14.40	115.20
Rat-tail file, 1/8-in. fine	43	4.99	214.57
Hicut chain saw, 16 in.	11	256.99	2826.89
PVC pipe, 3.5-in., 8-ft	188	5.87	1103.56
1.25-in. metal screw, 25	172	6.99	1202.28
2.5-in. wd. screw, 50	237	8.45	2002.65
Steel matting, 4'x8'x1/6", .5" mesh	18	119.95	2159.10

Using Computed Columns and Column Aliases

Suppose you want to determine the total value of each of the products currently held in inventory. Logically, that determination requires the multiplication of each product's quantity on hand by its current price. You can accomplish this task with the following command:

```
SELECT      P_DESCRIPT, P_QOH, P_PRICE, P_QOH *
            P_PRICE
FROM        PRODUCT;
```

Entering that SQL command in Access generates the output shown in Figure 7.10.

SQL accepts any valid expressions (or formulas) in the computed columns. Such formulas can contain any valid mathematical operators and functions that are applied to attributes in any of the tables specified in the FROM clause of the SELECT statement. Note also that Access automatically adds an Expr label to all computed columns. (The first computed column would be labeled Expr1; the second, Expr2; and so on.) Oracle uses the actual formula text as the label for the computed column.

To make the output more readable, the SQL standard permits the use of aliases for any column in a SELECT statement. An **alias** is an alternative name given to a column or table in any SQL statement.

For example, you can rewrite the previous SQL statement as:

```
SELECT      P_DESCRIPT, P_QOH, P_PRICE, P_QOH *
            P_PRICE AS TOTVALUE
FROM        PRODUCT;
```

The output of that command is shown in Figure 7.11.

You could also use a computed column, an alias, and date arithmetic in a single query. For example, assume that you want to get a list of out-of-warranty products that have been stored more than 90 days. In that case, the P_INDATE is at least 90 days less than the current (system) date. The MS Access version of this query is shown as:

```
SELECT      P_CODE, P_INDATE, DATE() - 90 AS CUTDATE
FROM        PRODUCT
WHERE       P_INDATE <= DATE() - 90;
```

The Oracle version of the same query is shown below:

```
SELECT      P_CODE, P_INDATE, SYSDATE - 90 AS CUTDATE
FROM        PRODUCT
WHERE       P_INDATE <= SYSDATE - 90;
```

Note that DATE() and SYSDATE are special functions that return today's date in MS Access and Oracle, respectively. You could use the DATE() and SYSDATE functions anywhere a date literal is expected, such as in the value list of an INSERT statement, in an UPDATE statement when changing the value of a date attribute, or in a SELECT statement as shown here. Of course, the previous query output would change based on today's date.

Suppose a manager wants a list of all products, the dates they were received, and the warranty expiration date (90 days from when the product was received). To generate that list, type:

```
SELECT      P_CODE, P_INDATE, P_INDATE + 90 AS EXPDATE
FROM        PRODUCT;
```

Note that you can use all arithmetic operators with date attributes as well as with numeric attributes.

7.4.2 Arithmetic Operators: The Rule of Precedence

As you saw in the previous example, you can use arithmetic operators with table attributes in a column list or in a conditional expression. In fact, SQL commands are often used in conjunction with the arithmetic operators shown in Table 7.7.

TABLE 7.7 The Arithmetic Operators

ARITHMETIC OPERATOR	DESCRIPTION
+	Add
-	Subtract
*	Multiply
/	Divide
^	Raise to the power of (some applications use ** instead of ^)

Do not confuse the multiplication symbol (*) with the wildcard symbol used by some SQL implementations such as MS Access; the latter is used only in string comparisons, while the former is used in conjunction with mathematical procedures.

As you perform mathematical operations on attributes, remember the rules of precedence. As the name suggests, the **rules of precedence** are the rules that establish the order in which computations are completed. For example, note the order of the following computational sequence:

1. Perform operations within parentheses.
2. Perform power operations.
3. Perform multiplications and divisions.
4. Perform additions and subtractions.

The application of the rules of precedence will tell you that 8 + 2 * 5 = 8 + 10 = 18, but (8 + 2) * 5 = 10 * 5 = 50. Similarly, 4 + 5^2 * 3 = 4 + 25 * 3 = 79, but (4 + 5)^2 * 3 = 81 * 3 = 243, while the operation expressed by (4 + 5^2) * 3 yields the answer (4 + 25) * 3 = 29 * 3 = 87.

7.4.3 Logical Operators: AND, OR, and NOT

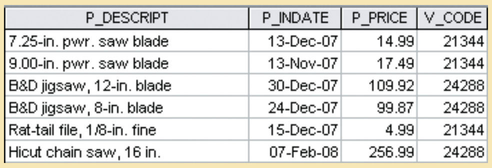
In the real world, a search of data normally involves multiple conditions. For example, when you are buying a new house, you look for a certain area, a certain number of bedrooms, bathrooms, stories, and so on. In the same way, SQL allows you to have multiple conditions in a query through the use of logical operators. The logical operators are

AND, OR, and NOT. For example, if you want a list of the table contents for either the V_CODE = 21344 **or** the V_CODE = 24288, you can use the **OR** operator, as in the following command sequence:

```
SELECT      P_DESCRIPT, P_INDATE, P_PRICE, V_CODE
FROM        PRODUCT
WHERE       V_CODE = 21344 OR V_CODE = 24288;
```

That command generates the six rows shown in Figure 7.12 that match the logical restriction.

FIGURE 7.12 Selected PRODUCT table attributes: the logical OR



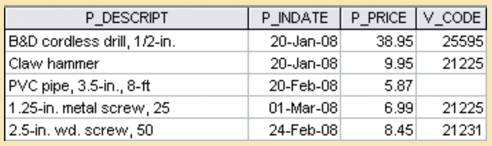
P_DESCRIPT	P_INDATE	P_PRICE	V_CODE
7.25-in. pwr. saw blade	13-Dec-07	14.99	21344
9.00-in. pwr. saw blade	13-Nov-07	17.49	21344
B&D jigsaw, 12-in. blade	30-Dec-07	109.92	24288
B&D jigsaw, 8-in. blade	24-Dec-07	99.87	24288
Rat-tail file, 1/8-in. fine	15-Dec-07	4.99	21344
Hicut chain saw, 16 in.	07-Feb-08	256.99	24288

The logical **AND** has the same SQL syntax requirement. The following command generates a list of all rows for which P_PRICE is less than $50 and for which P_INDATE is a date occurring after January 15, 2008:

```
SELECT    P_DESCRIPT, P_INDATE, P_PRICE, V_CODE
FROM      PRODUCT
WHERE     P_PRICE < 50
AND       P_INDATE > '15-Jan-2008';
```

This command will produce the output shown in Figure 7.13.

FIGURE 7.13 Selected PRODUCT table attributes: the logical AND



P_DESCRIPT	P_INDATE	P_PRICE	V_CODE
B&D cordless drill, 1/2-in.	20-Jan-08	38.95	25595
Claw hammer	20-Jan-08	9.95	21225
PVC pipe, 3.5-in., 8-ft	20-Feb-08	5.87	
1.25-in. metal screw, 25	01-Mar-08	6.99	21225
2.5-in. wd. screw, 50	24-Feb-08	8.45	21231

You can combine the logical OR with the logical AND to place further restrictions on the output. For example, suppose you want a table listing for the following conditions:

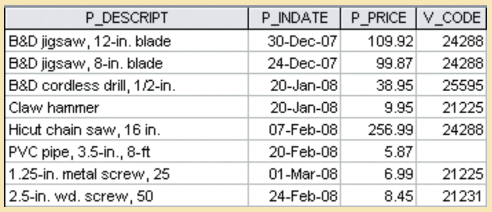
- The P_INDATE is after January 15, 2008, and the P_PRICE is less than $50.
- Or the V_CODE is 24288.

The required listing can be produced by using:

```
SELECT    P_DESCRIPT, P_INDATE, P_PRICE, V_CODE
FROM      PRODUCT
WHERE     (P_PRICE < 50 AND
          P_INDATE > '15-Jan-2008')
OR        V_CODE = 24288;
```

Note the use of parentheses to combine logical restrictions. Where you place the parentheses depends on how you want the logical restrictions to be executed. Conditions listed within parentheses are always executed first. The preceding query yields the output shown in Figure 7.14.

FIGURE 7.14 Selected PRODUCT table attributes: the logical AND and OR



P_DESCRIPT	P_INDATE	P_PRICE	V_CODE
B&D jigsaw, 12-in. blade	30-Dec-07	109.92	24288
B&D jigsaw, 8-in. blade	24-Dec-07	99.87	24288
B&D cordless drill, 1/2-in.	20-Jan-08	38.95	25595
Claw hammer	20-Jan-08	9.95	21225
Hicut chain saw, 16 in.	07-Feb-08	256.99	24288
PVC pipe, 3.5-in., 8-ft	20-Feb-08	5.87	
1.25-in. metal screw, 25	01-Mar-08	6.99	21225
2.5-in. wd. screw, 50	24-Feb-08	8.45	21231

Note that the three rows with the V_CODE = 24288 are included regardless of the P_INDATE and P_PRICE entries for those rows.

The use of the logical operators OR and AND can become quite complex when numerous restrictions are placed on the query. In fact, a specialty field in mathematics known as **Boolean algebra** is dedicated to the use of logical operators.

The logical operator **NOT** is used to negate the result of a conditional expression. That is, in SQL, all conditional expressions evaluate to true or false. If an expression is true, the row is selected; if an expression is false, the row is not selected. The NOT logical operator is typically used to find the rows that *do not* match a certain condition. For example, if you want to see a listing of all rows for which the vendor code is not 21344, use the command sequence:

```
SELECT      *
FROM        PRODUCT
WHERE       NOT (V_CODE = 21344);
```

Note that the condition is enclosed in parentheses; that practice is optional, but it is highly recommended for clarity. The logical NOT can be combined with AND and OR.

NOTE

If your SQL version does not support the logical NOT, you can generate the required output by using the condition:

```
WHERE V_CODE <> 21344
```

If your version of SQL does not support <>, use:

```
WHERE V_CODE != 21344
```

7.4.4 Special Operators

ANSI-standard SQL allows the use of special operators in conjunction with the WHERE clause. These special operators include:

BETWEEN—Used to check whether an attribute value is within a range.

IS NULL—Used to check whether an attribute value is null.

LIKE—Used to check whether an attribute value matches a given string pattern.

IN—Used to check whether an attribute value matches any value within a value list.

EXISTS—Used to check whether a subquery returns any rows.

The BETWEEN Special Operator

If you use software that implements a standard SQL, the operator BETWEEN may be used to check whether an attribute value is within a range of values. For example, if you want to see a listing for all products whose prices are between $50 and $100, use the following command sequence:

```
SELECT      *
FROM        PRODUCT
WHERE       P_PRICE BETWEEN 50.00 AND 100.00;
```

NOTE

NOTE TO ORACLE USERS
When using the BETWEEN special operator, always specify the lower range value first. If you list the higher range value first, Oracle will return an empty result set.

If your DBMS does not support BETWEEN, you can use:

```
SELECT      *
FROM        PRODUCT
WHERE       P_PRICE > 50.00 AND P_PRICE < 100.00;
```

The IS NULL Special Operator

Standard SQL allows the use of IS NULL to check for a null attribute value. For example, suppose you want to list all products that do not have a vendor assigned (V_CODE is null). Such a null entry could be found by using the command sequence:

```
SELECT      P_CODE, P_DESCRIPT, V_CODE
FROM        PRODUCT
WHERE       V_CODE IS NULL;
```

Similarly, if you want to check a null date entry, the command sequence is:

```
SELECT      P_CODE, P_DESCRIPT, P_INDATE
FROM        PRODUCT
WHERE       P_INDATE IS NULL;
```

Note that SQL uses a special operator to test for nulls. Why? Couldn't you just enter a condition such as "V_CODE = NULL"? No. Technically, NULL is not a "value" the way the number 0 (zero) or the blank space is, but instead a NULL is a special property of an attribute that represents precisely the absence of any value.

The LIKE Special Operator

The LIKE special operator is used in conjunction with wildcards to find patterns within string attributes. Standard SQL allows you to use the percent sign (%) and underscore (_) wildcard characters to make matches when the entire string is not known:

- % means any and all *following* or preceding characters are eligible. For example,
  'J%' includes Johnson, Jones, Jernigan, July, and J-231Q.
  'Jo%' includes Johnson and Jones.
  '%n' includes Johnson and Jernigan.
- _ means any *one* character may be substituted for the underscore. For example,
  '_23-456-6789' includes 123-456-6789, 223-456-6789, and 323-456-6789.
  '_23-_56-678_' includes 123-156-6781, 123-256-6782, and 823-956-6788.
  '_o_es' includes Jones, Cones, Cokes, totes, and roles.

NOTE

Some RDBMSs, such as Microsoft Access, use the wildcard characters * and ? instead of % and _.

For example, the following query would find all VENDOR rows for contacts whose last names begin with *Smith*.

```
SELECT      V_NAME, V_CONTACT, V_AREACODE, V_PHONE
FROM        VENDOR
WHERE       V_CONTACT LIKE 'Smith%';
```

If you check the original VENDOR data in Figure 7.2 again, you'll see that this SQL query yields three records: two Smiths and one Smithson.

Keep in mind that most SQL implementations yield case-sensitive searches. For example, Oracle will not yield a return that includes *Jones* if you use the wildcard search delimiter 'jo%' in a search for last names. The reason is because *Jones* begins with a capital *J* and your wildcard search starts with a lowercase *j*. On the other hand, MS Access searches are not case sensitive.

For example, suppose you typed the following query in Oracle:

```
SELECT      V_NAME, V_CONTACT, V_AREACODE, V_PHONE
FROM        VENDOR
WHERE       V_CONTACT LIKE 'SMITH%';
```

No rows will be returned because character-based queries may be case sensitive. That is, an uppercase character has a different ASCII code than a lowercase character, thus causing *SMITH, Smith,* and *smith* to be evaluated as different (unequal) entries. Because the table contains no vendor whose last name begins with (uppercase) *SMITH,* the (uppercase) 'SMITH%' used in the query cannot make a match. Matches can be made only when the query entry is written exactly like the table entry.

Some RDBMSs, such as Microsoft Access, automatically make the necessary conversions to eliminate case sensitivity. Others, such as Oracle, provide a special UPPER function to convert both table and query character entries to uppercase. (The conversion is done in the computer's memory only; the conversion has no effect on how the value is actually stored in the table.) So if you want to avoid a no-match result based on case sensitivity, and if your RDBMS allows the use of the UPPER function, you can generate the same results by using the query:

```
SELECT      V_NAME, V_CONTACT, V_AREACODE, V_PHONE
FROM        VENDOR
WHERE       UPPER(V_CONTACT) LIKE 'SMITH%';
```

The preceding query produces a list including all rows that contain a last name that begins with *Smith*, regardless of uppercase or lowercase letter combinations such as *Smith, smith,* and *SMITH*.

The logical operators may be used in conjunction with the special operators. For instance, the query:

```
SELECT      V_NAME, V_CONTACT, V_AREACODE, V_PHONE
FROM        VENDOR
WHERE       V_CONTACT NOT LIKE 'Smith%';
```

will yield an output of all vendors whose names do not start with *Smith.*

Suppose you do not know whether a person's name is spelled Johnson or Johnsen. The wildcard character _ lets you find a match for either spelling. The proper search would be instituted by the query:

```
SELECT      *
FROM        VENDOR
WHERE       V_CONTACT LIKE 'Johns_n';
```

Thus, the wildcards allow you to make matches when only approximate spellings are known. Wildcard characters may be used in combinations. For example, the wildcard search based on the string '_l%' can yield the strings Al, Alton, Elgin, Blakeston, blank, bloated, and eligible.

The IN Special Operator

Many queries that would require the use of the logical OR can be more easily handled with the help of the special operator IN. For example, the query:

```
SELECT      *
FROM        PRODUCT
WHERE       V_CODE = 21344
OR          V_CODE = 24288;
```

can be handled more efficiently with:

```
SELECT     *
FROM       PRODUCT
WHERE      V_CODE IN (21344, 24288);
```

Note that the IN operator uses a value list. All of the values in the list must be of the same data type. Each of the values in the value list is compared to the attribute—in this case, V_CODE. If the V_CODE value matches any of the values in the list, the row is selected. In this example, the rows selected will be only those in which the V_CODE is either 21344 or 24288.

If the attribute used is of a character data type, the list values must be enclosed in single quotation marks. For instance, if the V_CODE had been defined as CHAR(5) when the table was created, the preceding query would have read:

```
SELECT     *
FROM       PRODUCT
WHERE      V_CODE IN ('21344', '24288');
```

The IN operator is especially valuable when it is used in conjunction with subqueries. For example, suppose you want to list the V_CODE and V_NAME of only those vendors who provide products. In that case, you could use a subquery within the IN operator to automatically generate the value list. The query would be:

```
SELECT     V_CODE, V_NAME
FROM       VENDOR
WHERE      V_CODE IN (SELECT V_CODE FROM PRODUCT);
```

The preceding query will be executed in two steps:

1. The inner query or subquery will generate a list of V_CODE values from the PRODUCT tables. Those V_CODE values represent the vendors who supply products.
2. The IN operator will compare the values generated by the subquery to the V_CODE values in the VENDOR table and will select only the rows with matching values—that is, the vendors who provide products.

The IN special operator will receive additional attention in Chapter 8, where you will learn more about subqueries.

The EXISTS Special Operator

The EXISTS special operator can be used whenever there is a requirement to execute a command based on the result of another query. That is, if a subquery returns any rows, run the main query; otherwise, don't. For example, the following query will list all vendors, but only if there are products to order:

```
SELECT     *
FROM       VENDOR
WHERE      EXISTS (SELECT * FROM PRODUCT WHERE P_QOH <= P_MIN);
```

The EXISTS special operator is used in the following example to list all vendors, but only if there are products with the quantity on hand, less than double the minimum quantity:

```
SELECT     *
FROM       VENDOR
WHERE      EXISTS (SELECT * FROM PRODUCT WHERE P_QOH < P_MIN * 2);
```

The EXISTS special operator will receive additional attention in Chapter 8, where you will learn more about subqueries.

7.5 ADVANCED DATA DEFINITION COMMANDS

In this section, you learn how to change (alter) table structures by changing attribute characteristics and by adding columns. Then you will learn how to do advanced data updates to the new columns. Finally, you will learn how to copy tables or parts of tables and how to delete tables.

All changes in the table structure are made by using the **ALTER TABLE** command, followed by a keyword that produces the specific change you want to make. Three options are available: ADD, MODIFY, and DROP. You use ADD to add a column, MODIFY to change column characteristics, and DROP to delete a column from a table. Most RDBMSs do not allow you to delete a column (unless the column does not contain any values) because such an action might delete crucial data that are used by other tables. The basic syntax to add or modify columns is:

```
ALTER TABLE tablename
        {ADD | MODIFY} ( columnname datatype [ {ADD | MODIFY} columnname datatype] ) ;
```

The ALTER TABLE command can also be used to add table constraints. In those cases, the syntax would be:

```
ALTER TABLE tablename
        ADD constraint [ ADD constraint ] ;
```

where *constraint* refers to a constraint definition similar to those you learned in Section 7.2.6.

You could also use the ALTER TABLE command to remove a column or table constraint. The syntax would be as follows:

```
ALTER TABLE tablename
        DROP{PRIMARY KEY | COLUMN columnname | CONSTRAINT constraintname };
```

Notice that when removing a constraint, you need to specify the name given to the constraint. That is one reason why you should always name your constraints in your CREATE TABLE or ALTER TABLE statement.

7.5.1 Changing a Column's Data Type

Using the ALTER syntax, the (integer) V_CODE in the PRODUCT table can be changed to a character V_CODE by using:

```
ALTER TABLE PRODUCT
        MODIFY (V_CODE CHAR(5));
```

Some RDBMSs, such as Oracle, do not let you change data types unless the column to be changed is empty. For example, if you want to change the V_CODE field from the current number definition to a character definition, the above command will yield an error message, because the V_CODE column already contains data. The error message is easily explained. Remember that the V_CODE in PRODUCT references the V_CODE in VENDOR. If you change the V_CODE data type, the data types don't match, and there is a referential integrity violation, thus triggering the error message. If the V_CODE column does not contain data, the preceding command sequence will produce the expected table structure alteration (if the foreign key reference was not specified during the creation of the PRODUCT table).

7.5.2 Changing a Column's Data Characteristics

If the column to be changed already contains data, you can make changes in the column's characteristics if those changes do not alter the data *type*. For example, if you want to increase the width of the P_PRICE column to nine digits, use the command:

```
ALTER TABLE PRODUCT
        MODIFY (P_PRICE DECIMAL(9,2));
```

If you now list the table contents, you see that the column width of P_PRICE has increased by one digit.

NOTE

Some DBMSs impose limitations on when it's possible to change attribute characteristics. For example, Oracle lets you increase (but not decrease) the size of a column. The reason for this restriction is that an attribute modification will affect the integrity of the data in the database. In fact, some attribute changes can be done only when there are no data in any rows for the affected attribute.

7.5.3 ADDING A COLUMN

You can alter an existing table by adding one or more columns. In the following example, you add the column named P_SALECODE to the PRODUCT table. (This column will be used later to determine whether goods that have been in inventory for a certain length of time should be placed on special sale.)

Suppose you expect the P_SALECODE entries to be 1, 2, or 3. Because there will be no arithmetic performed with the P_SALECODE, the P_SALECODE will be classified as a single-character attribute. Note the inclusion of all required information in the following ALTER command:

```
ALTER TABLE PRODUCT
        ADD (P_SALECODE CHAR(1));
```

ONLINE CONTENT

If you are using the MS Access databases provided in the Student Online Companion, you can track each of the updates in the following sections. For example, look at the copies of the PRODUCT table in the **Ch07_SaleCo** database, one named Product_2 and one named PRODUCT_3. Each of the two copies includes the new P_SALECODE column. If you want to see the *cumulative* effect of all UPDATE commands, you can continue using the PRODUCT table with the P_SALECODE modification and all of the changes you will make in the following sections. (You might even want to use both options, first to examine the individual effects of the update queries and then to examine the cumulative effects.)

When adding a column, be careful not to include the NOT NULL clause for the new column. Doing so will cause an error message; if you add a new column to a table that already has rows, the existing rows will default to a value of null for the new column. Therefore, it is not possible to add the NOT NULL clause for this new column. (You can, of course, add the NOT NULL clause to the table structure after all of the data for the new column have been entered and the column no longer contains nulls.)

7.5.4 DROPPING A COLUMN

Occasionally, you might want to modify a table by deleting a column. Suppose you want to delete the V_ORDER attribute from the VENDOR table. To accomplish that, you would use the following command:

```
ALTER TABLE VENDOR
        DROP COLUMN V_ORDER;
```

Again, some RDBMSs impose restrictions on attribute deletion. For example, you may not drop attributes that are involved in foreign key relationships, nor may you delete an attribute of a table that contains only that one attribute.

7.5.5 Advanced Data Updates

To make data entries in an existing row's columns, SQL allows the UPDATE command. The UPDATE command updates only data in existing rows. For example, to enter the P_SALECODE value '2' in the fourth row, use the UPDATE command together with the primary key P_CODE '1546-QQ2'. Enter the value by using the command sequence:

```
UPDATE    PRODUCT
SET       P_SALECODE = '2'
WHERE     P_CODE = '1546-QQ2';
```

Subsequent data can be entered the same way, defining each entry location by its primary key (P_CODE) and its column location (P_SALECODE). For example, if you want to enter the P_SALECODE value '1' for the P_CODE values '2232/QWE' and '2232/QTY', you use:

```
UPDATE    PRODUCT
SET       P_SALECODE = '1'
WHERE     P_CODE IN ('2232/QWE', '2232/QTY');
```

If your RDBMS does not support IN, use the following command:

```
UPDATE    PRODUCT
SET       P_SALECODE = '1'
WHERE     P_CODE = '2232/QWE' OR P_CODE = '2232/QTY';
```

The results of your efforts can be checked by using:

```
SELECT    P_CODE, P_DESCRIPT, P_INDATE, P_PRICE, P_SALECODE
FROM      PRODUCT;
```

Although the UPDATE sequences just shown allow you to enter values into specified table cells, the process is very cumbersome. Fortunately, if a relationship can be established between the entries and the existing columns, the relationship can be used to assign values to their appropriate slots. For example, suppose you want to place sales codes based on the P_INDATE into the table, using the following schedule:

P_INDATE	P_SALECODE
before December 25, 2007	2
between January 16, 2008, and February 10, 2008	1

Using the PRODUCT table, the following two command sequences make the appropriate assignments:

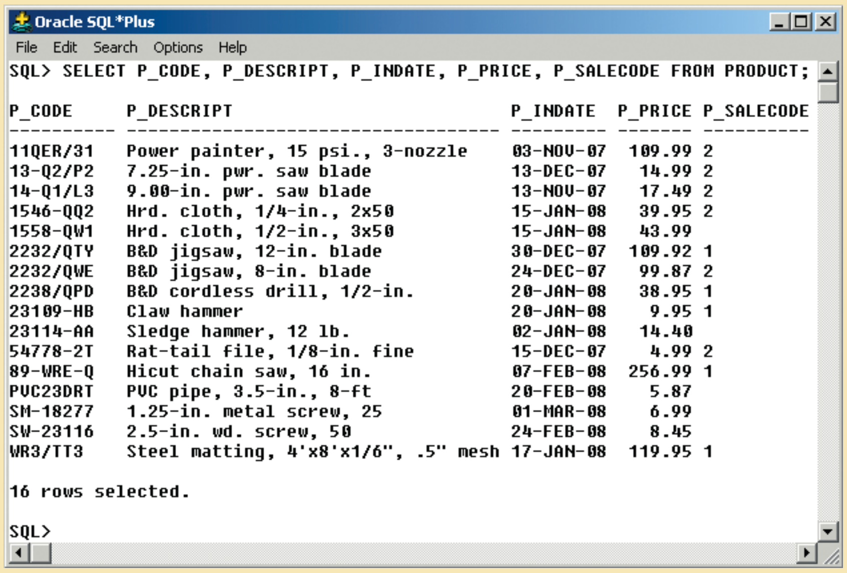
```
UPDATE    PRODUCT
SET       P_SALECODE = '2'
WHERE     P_INDATE < '25-Dec-2007';

UPDATE    PRODUCT
SET       P_SALECODE = '1'
WHERE     P_INDATE >= '16-Jan-2008'
          AND P_INDATE <='10-Feb-2008';
```

To check the results of those two command sequences, use:

```
SELECT    P_CODE, P_DESCRIPT, P_INDATE, P_PRICE, P_SALECODE
FROM      PRODUCT;
```

If you have made *all* of the updates shown in this section using Oracle, your PRODUCT table should look like Figure 7.15. *Make sure that you issue a COMMIT statement to save these changes.*

FIGURE 7.15 The cumulative effect of the multiple updates in the PRODUCT table (Oracle)



```
SQL> SELECT P_CODE, P_DESCRIPT, P_INDATE, P_PRICE, P_SALECODE FROM PRODUCT;

P_CODE     P_DESCRIPT                          P_INDATE  P_PRICE P_SALECODE
---------- ----------------------------------- --------- ------- ----------
11QER/31   Power painter, 15 psi., 3-nozzle    03-NOV-07  109.99 2
13-Q2/P2   7.25-in. pwr. saw blade             13-DEC-07   14.99 2
14-Q1/L3   9.00-in. pwr. saw blade             13-NOV-07   17.49 2
1546-QQ2   Hrd. cloth, 1/4-in., 2x50           15-JAN-08   39.95 2
1558-QW1   Hrd. cloth, 1/2-in., 3x50           15-JAN-08   43.99
2232/QTY   B&D jigsaw, 12-in. blade            30-DEC-07  109.92 1
2232/QWE   B&D jigsaw, 8-in. blade             24-DEC-07   99.87 2
2238/QPD   B&D cordless drill, 1/2-in.         20-JAN-08   38.95 1
23109-HB   Claw hammer                         20-JAN-08    9.95 1
23114-AA   Sledge hammer, 12 lb.               02-JAN-08   14.40
54778-2T   Rat-tail file, 1/8-in. fine         15-DEC-07    4.99 2
89-WRE-Q   Hicut chain saw, 16 in.             07-FEB-08  256.99 1
PVC23DRT   PVC pipe, 3.5-in., 8-ft             20-FEB-08    5.87
SM-18277   1.25-in. metal screw, 25            01-MAR-08    6.99
SW-23116   2.5-in. wd. screw, 50               24-FEB-08    8.45
WR3/TT3    Steel matting, 4'x8'x1/6", .5" mesh 17-JAN-08  119.95 1

16 rows selected.

SQL>
```

The arithmetic operators are particularly useful in data updates. For example, if the quantity on hand in your PRODUCT table has dropped below the minimum desirable value, you'll order more of the product. Suppose, for example, you have ordered 20 units of product 2232/QWE. When the 20 units arrive, you'll want to add them to inventory, using:

```
UPDATE    PRODUCT
SET       P_QOH = P_QOH + 20
WHERE     P_CODE = '2232/QWE';
```

If you want to add 10 percent to the price for all products that have current prices below $50, you can use:

```
UPDATE    PRODUCT
SET       P_PRICE = P_PRICE * 1.10
WHERE     P_PRICE < 50.00;
```

If you are using Oracle, issue a ROLLBACK command to undo the changes made by the last two UPDATE statements.

NOTE

If you fail to roll back the changes of the preceding UPDATE queries, the output of the subsequent queries will not match the results shown in the figures. Therefore:

- If you are using Oracle, use the ROLLBACK command to restore the database to its previous state.
- If you are using Access, copy the original **Ch07_SaleCo.mdb** file from the Student Online Companion.

7.5.6 Copying Parts of Tables

As you will discover in later chapters on database design, sometimes it is necessary to break up a table structure into several component parts (or smaller tables). Fortunately, SQL allows you to copy the contents of selected table columns so that the data need not be reentered manually into the newly created table(s). For example, if you want to copy P_CODE, P_DESCRIPT, P_PRICE, and V_CODE from the PRODUCT table to a new table named PART, you create the PART table structure first, as follows:

```
CREATE TABLE PART(
PART_CODE          CHAR(8)          NOT NULL          UNIQUE,
PART_DESCRIPT      CHAR(35),
PART_PRICE         DECIMAL(8,2),
V_CODE             INTEGER,
PRIMARY KEY (PART_CODE));
```

Note that the PART column names need not be identical to those of the original table and that the new table need not have the same number of columns as the original table. In this case, the first column in the PART table is PART_CODE, rather than the original P_CODE found in the PRODUCT table. And the PART table contains only four columns rather than the seven columns found in the PRODUCT table. However, column characteristics must match; you cannot copy a character-based attribute into a numeric structure and vice versa.

Next, you need to add the rows to the new PART table, using the PRODUCT table rows. To do that, you use the INSERT command you learned in Section 7.3.7. The syntax is:

```
INSERT INTO    target_tablename[(target_columnlist)]
SELECT         source_columnlist
FROM           source_tablename;
```

Note that the target column list is required if the source column list doesn't match all of the attribute names and characteristics of the target table (including the order of the columns). Otherwise, you do not need to specify the target column list. In this example, you must specify the target column list in the INSERT command below because the column names of the target table are different:

```
INSERT INTO    PART (PART_CODE, PART_DESCRIPT, PART_PRICE, V_CODE)
SELECT         P_CODE, P_DESCRIPT, P_PRICE, V_CODE FROM PRODUCT;
```

The contents of the PART table can now be examined by using the query:

```
SELECT * FROM PART;
```

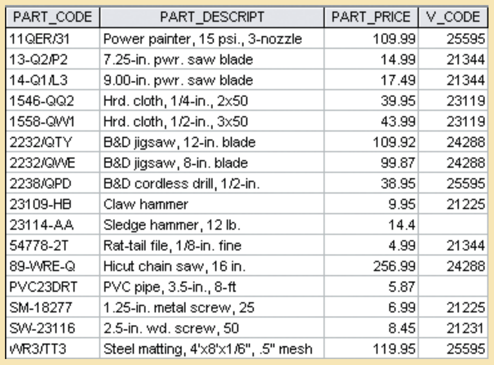
to generate the new PART table's contents, shown in Figure 7.16.

SQL also provides another way to rapidly create a new table based on selected columns and rows of an existing table. In this case, the new table will copy the attribute names, data characteristics, and rows of the original table. The Oracle version of the command is:

```
CREATE TABLE PART AS
SELECT         P_CODE AS PART_CODE, P_DESCRIPT AS PART_DESCRIPT,
               P_PRICE AS PART_PRICE, V_CODE
FROM           PRODUCT;
```

If the PART table already exists, Oracle will not let you overwrite the existing table. To run this command, you must first delete the existing PART table. (See Section 7.5.8.)

FIGURE 7.16 **PART table attributes copied from the PRODUCT table**



PART_CODE	PART_DESCRIPT	PART_PRICE	V_CODE
11QER/31	Power painter, 15 psi., 3-nozzle	109.99	25595
13-Q2/P2	7.25-in. pwr. saw blade	14.99	21344
14-Q1/L3	9.00-in. pwr. saw blade	17.49	21344
1546-QQ2	Hrd. cloth, 1/4-in., 2x50	39.95	23119
1558-QW1	Hrd. cloth, 1/2-in., 3x50	43.99	23119
2232/QTY	B&D jigsaw, 12-in. blade	109.92	24288
2232/QWE	B&D jigsaw, 8-in. blade	99.87	24288
2238/QPD	B&D cordless drill, 1/2-in.	38.95	25595
23109-HB	Claw hammer	9.95	21225
23114-AA	Sledge hammer, 12 lb.	14.4	
54778-2T	Rat-tail file, 1/8-in. fine	4.99	21344
89-WRE-Q	Hicut chain saw, 16 in.	256.99	24288
PVC23DRT	PVC pipe, 3.5-in., 8-ft	5.87	
SM-18277	1.25-in. metal screw, 25	6.99	21225
SW-23116	2.5-in. wd. screw, 50	8.45	21231
WR3/TT3	Steel matting, 4'x8'x1/6", .5" mesh	119.95	25595

The MS Access version of this command is:

```
SELECT    P_CODE AS PART_CODE, P_DESCRIPT AS
          PART_DESCRIPT,
          P_PRICE AS PART_PRICE,
          V_CODE INTO PART
FROM      PRODUCT;
```

If the PART table already exists, MS Access will ask if you want to delete the existing table and continue with the creation of the new PART table.

The SQL command just shown creates a new PART table with PART_CODE, PART_DESCRIPT, PART_PRICE, and V_CODE columns. In addition, all of the data rows (for the selected columns) will be copied automatically. *But note that no entity integrity (primary key) or referential integrity (foreign key) rules are automatically applied to the new table*. In the next section, you will learn how to define the PK to enforce entity integrity and the FK to enforce referential integrity.

7.5.7 ADDING PRIMARY AND FOREIGN KEY DESIGNATIONS

When you create a new table based on another table, the new table does not include integrity rules from the old table. In particular, there is no primary key. To define the primary key for the new PART table, use the following command:

```
ALTER TABLE   PART
     ADD      PRIMARY KEY (PART_CODE);
```

Aside from the fact that the integrity rules are not automatically transferred to a new table that derives its data from one or more other tables, several other scenarios could leave you without entity and referential integrity. For example, you might have forgotten to define the primary and foreign keys when you created the original tables. Or if you imported tables from a different database, you might have discovered that the importing procedure did not transfer the integrity rules. In any case, you can reestablish the integrity rules by using the ALTER command. For example, if the PART table's foreign key has not yet been designated, it can be designated by:

```
ALTER TABLE   PART
     ADD      FOREIGN KEY (V_CODE) REFERENCES VENDOR;
```

Alternatively, if neither the PART table's primary key nor its foreign key has been designated, you can incorporate both changes at once, using:

```
ALTER TABLE   PART
     ADD      PRIMARY KEY (PART_CODE)
     ADD      FOREIGN KEY (V_CODE) REFERENCES VENDOR;
```

Even composite primary keys and multiple foreign keys can be designated in a single SQL command. For example, if you want to enforce the integrity rules for the LINE table shown in Figure 7.1, you can use:

```
ALTER TABLE   LINE
     ADD      PRIMARY KEY (INV_NUMBER, LINE_NUMBER)
     ADD      FOREIGN KEY (INV_NUMBER) REFERENCES INVOICE
     ADD      FOREIGN KEY (PROD_CODE) REFERENCES PRODUCT;
```

7.5.8 Deleting a Table from the Database

A table can be deleted from the database using the **DROP TABLE** command. For example, you can delete the PART table you just created with:

```
DROP TABLE PART;
```

You can drop a table only if that table is not the "one" side of any relationship. If you try to drop a table otherwise, the RDBMS will generate an error message indicating that a foreign key integrity violation has occurred.

7.6 ADVANCED SELECT QUERIES

One of the most important advantages of SQL is its ability to produce complex free-form queries. The logical operators that were introduced earlier to update table contents work just as well in the query environment. In addition, SQL provides useful functions that count, find minimum and maximum values, calculate averages, and so on. Better yet, SQL allows the user to limit queries to only those entries that have no duplicates or entries whose duplicates can be grouped.

7.6.1 Ordering a Listing

The **ORDER BY** clause is especially useful when the listing order is important to you. The syntax is:

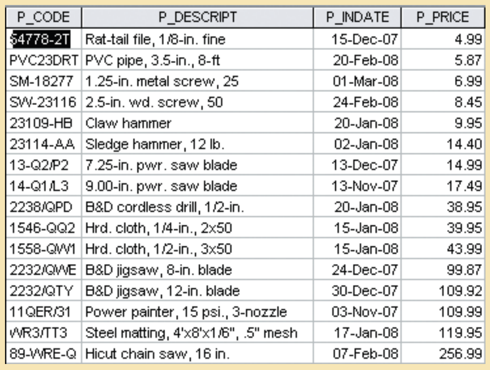
```
SELECT      columnlist
FROM        tablelist
[WHERE      conditionlist ]
[ORDER BY   columnlist [ASC | DESC] ] ;
```

Although you have the option of declaring the order type—ascending or descending—the default order is ascending. For example, if you want the contents of the PRODUCT table listed by P_PRICE in ascending order, use:

```
SELECT      P_CODE, P_DESCRIPT, P_INDATE, P_PRICE
FROM        PRODUCT
ORDER BY    P_PRICE;
```

The output is shown in Figure 7.17. Note that ORDER BY yields an ascending price listing.

FIGURE 7.17 Selected PRODUCT table attributes: ordered by (ascending) P_PRICE



P_CODE	P_DESCRIPT	P_INDATE	P_PRICE
54778-2T	Rat-tail file, 1/8-in. fine	15-Dec-07	4.99
PVC23DRT	PVC pipe, 3.5-in., 8-ft	20-Feb-08	5.87
SM-18277	1.25-in. metal screw, 25	01-Mar-08	6.99
SW-23116	2.5-in. wd. screw, 50	24-Feb-08	8.45
23109-HB	Claw hammer	20-Jan-08	9.95
23114-AA	Sledge hammer, 12 lb.	02-Jan-08	14.40
13-Q2/P2	7.25-in. pwr. saw blade	13-Dec-07	14.99
14-Q1/L3	9.00-in. pwr. saw blade	13-Nov-07	17.49
2238/QPD	B&D cordless drill, 1/2-in.	20-Jan-08	38.95
1546-QQ2	Hrd. cloth, 1/4-in., 2x50	15-Jan-08	39.95
1558-QW1	Hrd. cloth, 1/2-in., 3x50	15-Jan-08	43.99
2232/QWE	B&D jigsaw, 8-in. blade	24-Dec-07	99.87
2232/QTY	B&D jigsaw, 12-in. blade	30-Dec-07	109.92
11QER/31	Power painter, 15 psi., 3-nozzle	03-Nov-07	109.99
WR3/TT3	Steel matting, 4'x8'x1/6", .5" mesh	17-Jan-08	119.95
89-WRE-Q	Hicut chain saw, 16 in.	07-Feb-08	256.99

Comparing the listing in Figure 7.17 to the actual table contents shown earlier in Figure 7.2, you will see that in Figure 7.17, the lowest-priced product is listed first, followed by the next lowest-priced product, and so on. However, although ORDER BY produces a sorted output, the actual table contents are unaffected by the ORDER command.

To produce the list in descending order, you would enter:

```
SELECT      P_CODE, P_DESCRIPT, P_INDATE,
            P_PRICE
FROM        PRODUCT
ORDER BY    P_PRICE DESC;
```

Ordered listings are used frequently. For example, suppose you want to create a phone directory. It would be helpful if you could produce an ordered sequence (last name, first name, initial) in three stages:

1. ORDER BY last name.
2. Within the last names, ORDER BY first name.
3. Within the first and last names, ORDER BY middle initial.

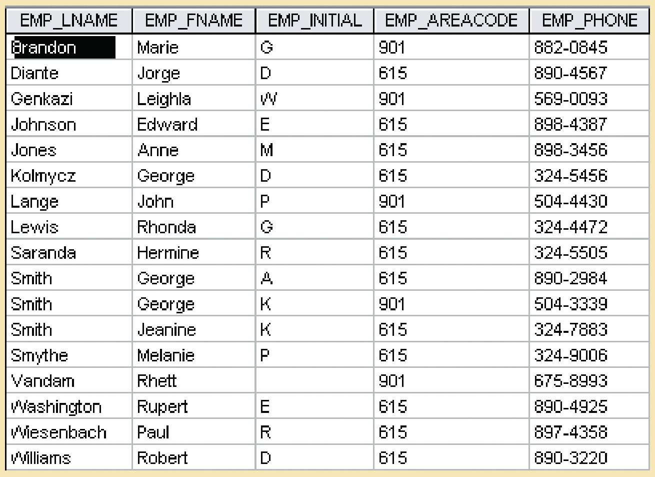
Such a multilevel ordered sequence is known as a **cascading order sequence**, and it can be created easily by listing several attributes, separated by commas, after the ORDER BY clause.

The cascading order sequence is the basis for any telephone directory. To illustrate a cascading order sequence, use the following SQL command on the EMPLOYEE table:

```
SELECT      EMP_LNAME, EMP_FNAME, EMP_INITIAL, EMP_AREACODE, EMP_PHONE
FROM        EMPLOYEE
ORDER BY    EMP_LNAME, EMP_FNAME, EMP_INITIAL;
```

That command yields the results shown in Figure 7.18.

FIGURE 7.18 Telephone list query results



EMP_LNAME	EMP_FNAME	EMP_INITIAL	EMP_AREACODE	EMP_PHONE
Brandon	Marie	G	901	882-0845
Diante	Jorge	D	615	890-4567
Genkazi	Leighla	W	901	569-0093
Johnson	Edward	E	615	898-4387
Jones	Anne	M	615	898-3456
Kolmycz	George	D	615	324-5456
Lange	John	P	901	504-4430
Lewis	Rhonda	G	615	324-4472
Saranda	Hermine	R	615	324-5505
Smith	George	A	615	890-2984
Smith	George	K	901	504-3339
Smith	Jeanine	K	615	324-7883
Smythe	Melanie	P	615	324-9006
Vandam	Rhett		901	675-8993
Washington	Rupert	E	615	890-4925
Wiesenbach	Paul	R	615	897-4358
Williams	Robert	D	615	890-3220

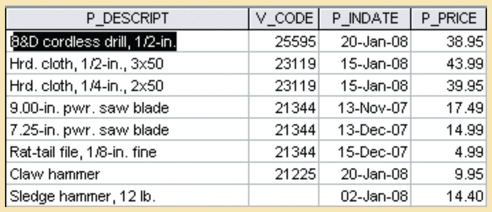
The ORDER BY clause is useful in many applications, especially because the DESC qualifier can be invoked. For example, listing the most recent items first is a standard procedure. Typically, invoice due dates are listed in descending order. Or if you want to examine budgets, it's probably useful to list the largest budget line items first.

You can use the ORDER BY clause in conjunction with other SQL commands, too. For example, note the use of restrictions on date and price in the following command sequence:

```
SELECT      P_DESCRIPT, V_CODE, P_INDATE, P_PRICE
FROM        PRODUCT
WHERE       P_INDATE < '21-Jan-2008' AND
            P_PRICE <= 50.00
ORDER BY    V_CODE, P_PRICE DESC;
```

The output is shown in Figure 7.19. Note that within each V_CODE, the P_PRICE values are in descending order.

FIGURE 7.19 A query based on multiple restrictions



P_DESCRIPT	V_CODE	P_INDATE	P_PRICE
B&D cordless drill, 1/2-in.	25595	20-Jan-08	38.95
Hrd. cloth, 1/2-in., 3x50	23119	15-Jan-08	43.99
Hrd. cloth, 1/4-in., 2x50	23119	15-Jan-08	39.95
9.00-in. pwr. saw blade	21344	13-Nov-07	17.49
7.25-in. pwr. saw blade	21344	13-Dec-07	14.99
Rat-tail file, 1/8-in. fine	21344	15-Dec-07	4.99
Claw hammer	21225	20-Jan-08	9.95
Sledge hammer, 12 lb.		02-Jan-08	14.40

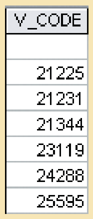
NOTE

If the ordering column has nulls, they are listed either first or last, depending on the RDBMS.

The ORDER BY clause must always be listed last in the SELECT command sequence.

7.6.2 Listing Unique Values

FIGURE 7.20 A listing of distinct (different) V_CODE values in the PRODUCT table



V_CODE
21225
21231
21344
23119
24288
25595

How many *different* vendors are currently represented in the PRODUCT table? A simple listing (SELECT) is not very useful if the table contains several thousand rows and you have to sift through the vendor codes manually. Fortunately, SQL's **DISTINCT** clause produces a list of only those values that are different from one another. For example, the command:

```
SELECT      DISTINCT V_CODE
FROM        PRODUCT;
```

yields only the different (distinct) vendor codes (V_CODE) that are encountered in the PRODUCT table, as shown in Figure 7.20. Note that the first output row shows the null. (By default, Access places the null V_CODE at the top of the list, while Oracle places it at the bottom. The placement of nulls does not affect the list contents. In Oracle, you could use ORDER BY V_CODE NULLS FIRST to place nulls at the top of the list.)

TABLE 7.8 Some Basic SQL Aggregate Functions

FUNCTION	OUTPUT
COUNT	The number of rows containing non-null values
MIN	The minimum attribute value encountered in a given column
MAX	The maximum attribute value encountered in a given column
SUM	The sum of all values for a given column
AVG	The arithmetic mean (average) for a specified column

7.6.3 Aggregate Functions

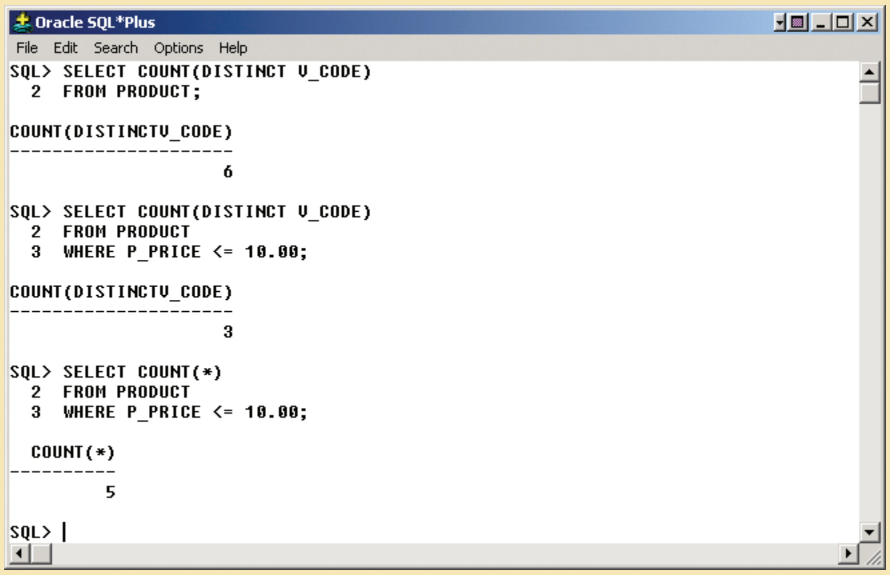
SQL can perform various mathematical summaries for you, such as counting the number of rows that contain a specified condition, finding the minimum or maximum values for some specified attribute, summing the values in a specified column, and averaging the values in a specified column. Those aggregate functions are shown in Table 7.8.

To illustrate another standard SQL command format, most of the remaining input and output sequences are presented using the Oracle RDBMS.

COUNT

The **COUNT** function is used to tally the number of non-null values of an attribute. COUNT can be used in conjunction with the DISTINCT clause. For example, suppose you want to find out how many different vendors are in the PRODUCT table. The answer, generated by the first SQL code set shown in Figure 7.21, is 6. The answer indicates that six different VENDOR codes are found in the PRODUCT table. (Note that the nulls are not counted as V_CODE values.)

FIGURE 7.21 COUNT function output examples



```
SQL> SELECT COUNT(DISTINCT V_CODE)
  2  FROM PRODUCT;

COUNT(DISTINCTV_CODE)
---------------------
                    6

SQL> SELECT COUNT(DISTINCT V_CODE)
  2  FROM PRODUCT
  3  WHERE P_PRICE <= 10.00;

COUNT(DISTINCTV_CODE)
---------------------
                    3

SQL> SELECT COUNT(*)
  2  FROM PRODUCT
  3  WHERE P_PRICE <= 10.00;

  COUNT(*)
----------
         5

SQL> |
```

The aggregate functions can be combined with the SQL commands explored earlier. For example, the second SQL command set in Figure 7.21 supplies the answer to the question, “How many vendors referenced in the PRODUCT table have supplied products with prices that are less than or equal to $10?” The answer is three, indicating that three vendors referenced in the PRODUCT table have supplied products that meet the price specification.

The COUNT aggregate function uses one parameter within parentheses, generally a column name such as COUNT(V_CODE) or COUNT(P_CODE). The parameter may also be an expression such as COUNT(DISTINCT V_CODE) or COUNT(P_PRICE+10). Using that syntax, COUNT always returns the number of non-null values in the given column. (Whether the column values are computed or show stored table row values is immaterial). In contrast, the syntax COUNT(*) returns the number of total rows returned by the query, including the rows that contain nulls. In the example in Figure 7.21, SELECT COUNT(P_CODE) FROM PRODUCT and SELECT COUNT(*) FROM PRODUCT will yield the same answer because there are no null values in the P_CODE primary key column.

Note that the third SQL command set in Figure 7.21 uses the COUNT(*) command to answer the question, “How many rows in the PRODUCT table have a P_PRICE value less than or equal to $10?” The answer, five, indicates that five products have a listed price that meets the price specification. The COUNT(*) aggregate function is used to count rows in a query result set. In contrast, the COUNT(*column*) aggregate function counts the number of non-null values in a given column. For example, in Figure 7.20, the COUNT(*) function would return a value of 7 to indicate seven rows returned by the query. The COUNT(V_CODE) function would return a value of 6 to indicate the six non-null vendor code values.

NOTE

NOTE TO MS ACCESS USERS

MS Access does not support the use of COUNT with the DISTINCT clause. If you want to use such queries in MS Access, you must create subqueries with DISTINCT and NOT NULL clauses. For example, the equivalent MS Access queries for the first two queries shown in Figure 7.21 are:

```
SELECT     COUNT(*)
FROM       (SELECT DISTINCT V_CODE FROM PRODUCT WHERE V_CODE IS NOT NULL)
```

and

```
SELECT     COUNT(*)
FROM       (SELECT DISTINCT(V_CODE)
           FROM
           (SELECT V_CODE, P_PRICE FROM PRODUCT
           WHERE V_CODE IS NOT NULL AND P_PRICE < 10))
```

Those two queries can be found in the Student Online Companion in the **Ch07_SaleCo** (Access) database. MS Access does add a trailer at the end of the query after you have executed it, but you can delete that trailer the next time you use the query.

MAX and MIN

The **MAX** and **MIN** functions help you find answers to problems such as the:

- Highest (maximum) price in the PRODUCT table.
- Lowest (minimum) price in the PRODUCT table.

The highest price, $256.99, is supplied by the first SQL command set in Figure 7.22. The second SQL command set shown in Figure 7.22 yields the minimum price of $4.99.

The third SQL command set in Figure 7.22 demonstrates that the numeric functions can be used in conjunction with more complex queries. However, you must remember that *the numeric functions yield only one value* based on all of the values found in the table: a single maximum value, a single minimum value, a single count, or a single average value. *It is easy to overlook this warning*. For example, examine the question, “Which product has the highest price?”

Although that query seems simple enough, the SQL command sequence:

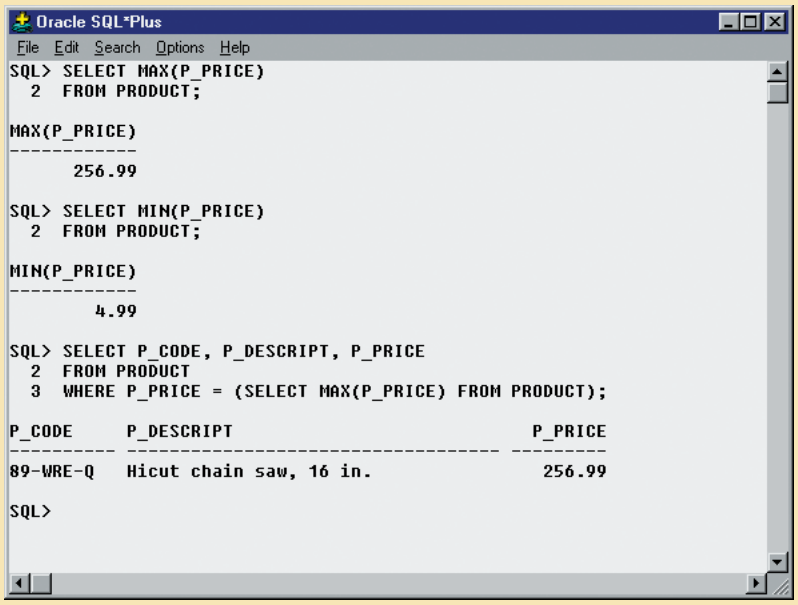
```
SELECT     P_CODE, P_DESCRIPT, P_PRICE
FROM       PRODUCT
WHERE      P_PRICE = MAX(P_PRICE);
```

does not yield the expected results. This is because the use of MAX(P_PRICE) to the right side of a comparison operator is incorrect, thus producing an error message. The aggregate function MAX(*columnname*) can be used only in the column list of a SELECT statement. Also, in a comparison that uses an equality symbol, you can use only a single value to the right of the equals sign.

To answer the question, therefore, you must compute the maximum price first, then compare it to each price returned by the query. To do that, you need a nested query. In this case, the nested query is composed of two parts:

- The *inner query*, which is executed first.
- The *outer query*, which is executed last. (Remember that the outer query is always the first SQL command you encounter—in this case, SELECT.)

FIGURE 7.22 **MAX and MIN function output examples**



```
SQL> SELECT MAX(P_PRICE)
  2  FROM PRODUCT;

MAX(P_PRICE)
------------
      256.99

SQL> SELECT MIN(P_PRICE)
  2  FROM PRODUCT;

MIN(P_PRICE)
------------
        4.99

SQL> SELECT P_CODE, P_DESCRIPT, P_PRICE
  2  FROM PRODUCT
  3  WHERE P_PRICE = (SELECT MAX(P_PRICE) FROM PRODUCT);

P_CODE     P_DESCRIPT                            P_PRICE
---------- ----------------------------------- ---------
89-WRE-Q   Hicut chain saw, 16 in.                256.99

SQL>
```

Using the following command sequence as an example, note that the inner query first finds the maximum price value, which is stored in memory. Because the outer query now has a value to which to compare each P_PRICE value, the query executes properly.

```
SELECT     P_CODE, P_DESCRIPT, P_PRICE
FROM       PRODUCT
WHERE      P_PRICE = (SELECT MAX(P_PRICE) FROM PRODUCT);
```

The execution of that nested query yields the correct answer shown below the third (nested) SQL command set in Figure 7.22.

The MAX and MIN aggregate functions can also be used with date columns. For example, to find out the product that has the oldest date, you would use MIN(P_INDATE). In the same manner, to find out the most recent product, you would use MAX(P_INDATE).

NOTE

You can use expressions anywhere a column name is expected. Suppose you want to know what product has the highest inventory value. To find the answer, you can write the following query:

```
SELECT     *
FROM       PRODUCT
WHERE      P_QOH * P_PRICE = (SELECT MAX(P_QOH * P_PRICE) FROM PRODUCT);
```

SUM

The **SUM** function computes the total sum for any specified attribute, using whatever condition(s) you have imposed. For example, if you want to compute the total amount owed by your customers, you could use the following command:

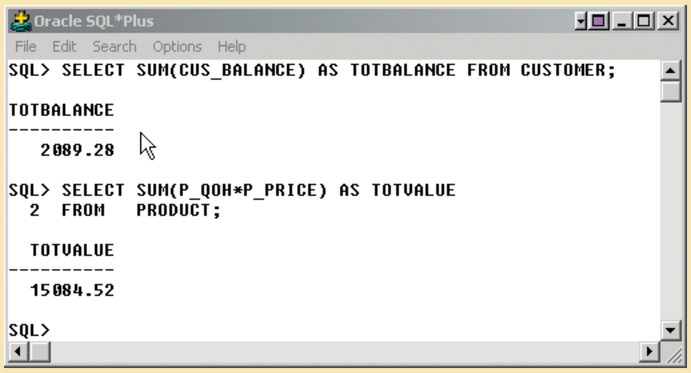
```
SELECT      SUM(CUS_BALANCE) AS TOTBALANCE
FROM        CUSTOMER;
```

You could also compute the sum total of an expression. For example, if you want to find the total value of all items carried in inventory, you could use:

```
SELECT      SUM(P_QOH * P_PRICE) AS TOTVALUE
FROM        PRODUCT;
```

because the total value is the sum of the product of the quantity on hand and the price for all items. See Figure 7.23.

FIGURE 7.23 The total value of all items in the PRODUCT table

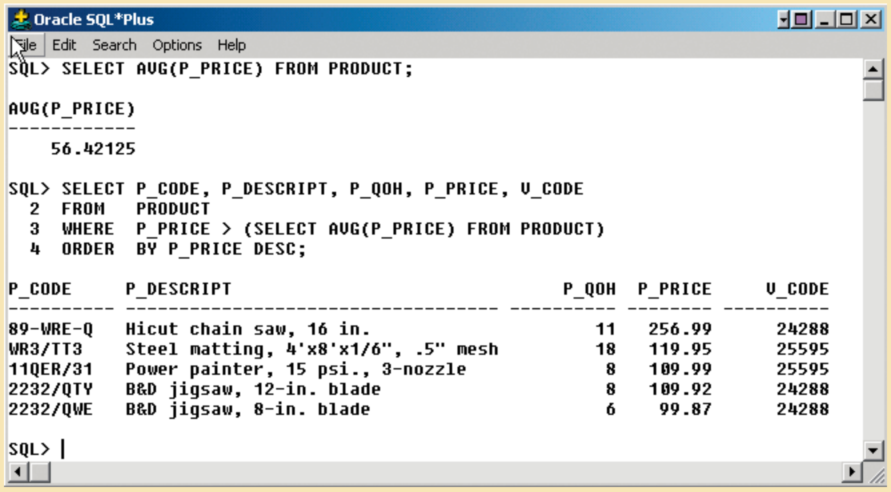


```
SQL> SELECT SUM(CUS_BALANCE) AS TOTBALANCE FROM CUSTOMER;

TOTBALANCE
----------
   2089.28

SQL> SELECT SUM(P_QOH*P_PRICE) AS TOTVALUE
  2  FROM   PRODUCT;

  TOTVALUE
----------
  15084.52

SQL>
```

AVG

The **AVG** function format is similar to that of MIN and MAX and is subject to the same operating restrictions. The first SQL command set shown in Figure 7.24 shows how a simple average P_PRICE value can be generated to yield the computed average price of 56.42125. The second SQL command set in Figure 7.24 produces five output lines that describe products whose prices exceed the average product price. Note that the second query uses nested SQL commands and the ORDER BY clause examined earlier.

FIGURE 7.24 AVG function output examples



```
SQL> SELECT AVG(P_PRICE) FROM PRODUCT;

AVG(P_PRICE)
------------
    56.42125

SQL> SELECT P_CODE, P_DESCRIPT, P_QOH, P_PRICE, V_CODE
  2  FROM   PRODUCT
  3  WHERE  P_PRICE > (SELECT AVG(P_PRICE) FROM PRODUCT)
  4  ORDER  BY P_PRICE DESC;

P_CODE     P_DESCRIPT                               P_QOH  P_PRICE     V_CODE
---------- ----------------------------------- ---------- -------- ----------
89-WRE-Q   Hicut chain saw, 16 in.                     11   256.99      24288
WR3/TT3    Steel matting, 4'x8'x1/6", .5" mesh         18   119.95      25595
11QER/31   Power painter, 15 psi., 3-nozzle             8   109.99      25595
2232/QTY   B&D jigsaw, 12-in. blade                     8   109.92      24288
2232/QWE   B&D jigsaw, 8-in. blade                      6    99.87      24288

SQL> |
```

7.6.4 Grouping Data

Frequency distributions can be created quickly and easily using the **GROUP BY** clause within the SELECT statement. The syntax is:

```
SELECT       columnlist
FROM         tablelist
[WHERE       conditionlist ]
[GROUP BY    columnlist ]
[HAVING      conditionlist ]
[ORDER BY    columnlist [ASC | DESC] ] ;
```

The GROUP BY clause is generally used when you have attribute columns combined with aggregate functions in the SELECT statement. For example, to determine the minimum price for each sales code, use the first SQL command set shown in Figure 7.25.

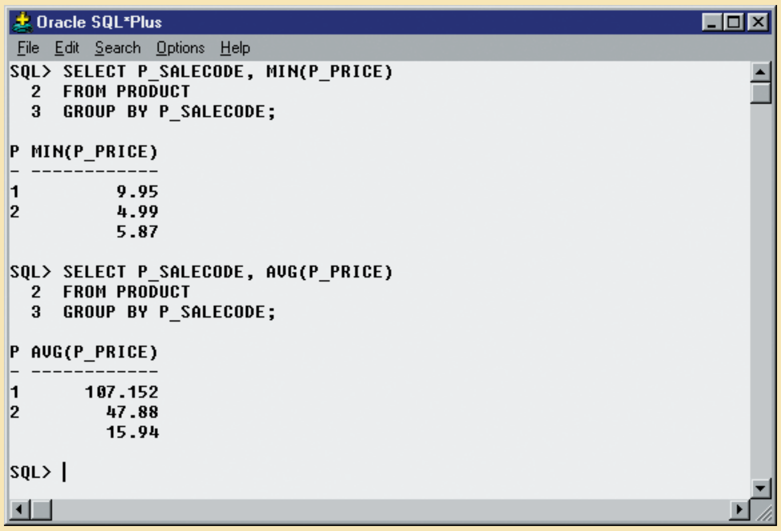
The second SQL command set in Figure 7.25 generates the average price within each sales code. Note that the P_SALECODE nulls are included within the grouping.

The GROUP BY clause is valid only when used in conjunction with one of the SQL aggregate functions, such as COUNT, MIN, MAX, AVG, and SUM. For example, as shown in the first command set in Figure 7.26, if you try to group the output by using:

```
SELECT       V_CODE, P_CODE, P_DESCRIPT, P_PRICE
FROM         PRODUCT
GROUP BY     V_CODE;
```

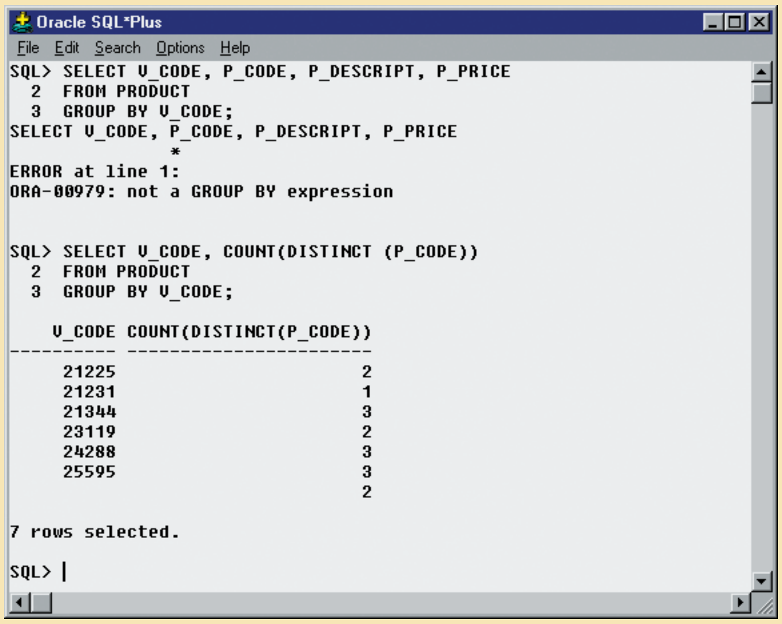
you generate a “not a GROUP BY expression” error. However, if you write the preceding SQL command sequence in conjunction with some aggregate function, the GROUP BY clause works properly. The second SQL command sequence in Figure 7.26 properly answers the question, “How many products are supplied by each vendor?,” because it uses a COUNT aggregate function.

FIGURE 7.25 GROUP BY clause output examples



```
SQL> SELECT P_SALECODE, MIN(P_PRICE)
  2  FROM PRODUCT
  3  GROUP BY P_SALECODE;

P MIN(P_PRICE)
- ------------
1         9.95
2         4.99
          5.87

SQL> SELECT P_SALECODE, AVG(P_PRICE)
  2  FROM PRODUCT
  3  GROUP BY P_SALECODE;

P AVG(P_PRICE)
- ------------
1      107.152
2        47.88
         15.94

SQL> |
```

FIGURE 7.26 Incorrect and correct use of the GROUP BY clause



```
SQL> SELECT V_CODE, P_CODE, P_DESCRIPT, P_PRICE
  2  FROM PRODUCT
  3  GROUP BY V_CODE;
SELECT V_CODE, P_CODE, P_DESCRIPT, P_PRICE
               *
ERROR at line 1:
ORA-00979: not a GROUP BY expression


SQL> SELECT V_CODE, COUNT(DISTINCT (P_CODE))
  2  FROM PRODUCT
  3  GROUP BY V_CODE;

    V_CODE COUNT(DISTINCT(P_CODE))
---------- -----------------------
     21225                       2
     21231                       1
     21344                       3
     23119                       2
     24288                       3
     25595                       3
                                 2

7 rows selected.

SQL> |
```

Note that the last output line in Figure 7.26 shows a null for the V_CODE, indicating that two products were not supplied by a vendor. Perhaps those products were produced in-house, or they might have been bought via a nonvendor channel, or the person making the data entry might have merely forgotten to enter a vendor code. (Remember that nulls can be the result of many things.)

NOTE

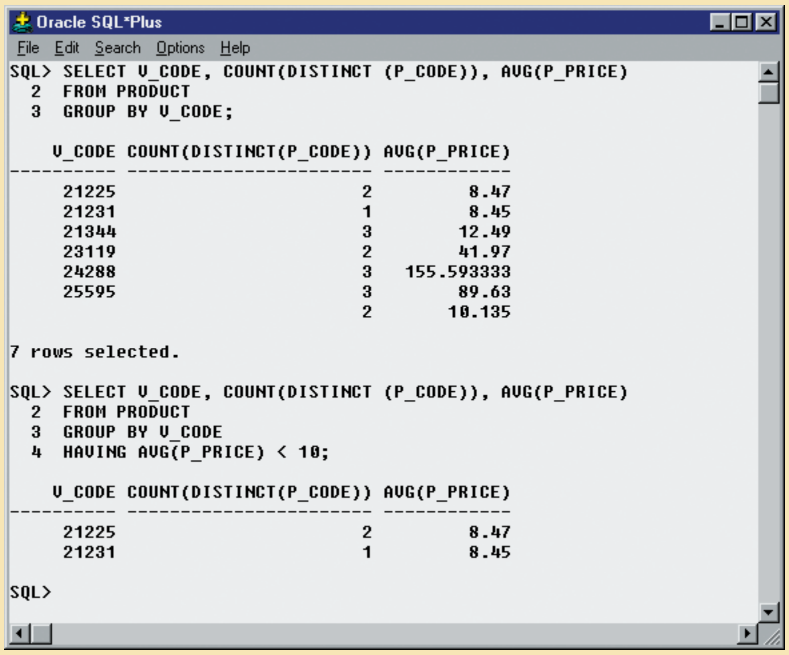
When using the GROUP BY clause with a SELECT statement:

- The SELECT's *columnlist* must include a combination of column names and aggregate functions.
- The GROUP BY clauses *columnlist* must include all nonaggregate function columns specified in the SELECTs *columnlist*. If required, you could also group by any aggregate function columns that appear in the SELECT's *columnlist*.
- The GROUP BY clause *columnlist* can include any columns from the tables in the FROM clause of the SELECT statement, even if they do not appear in the SELECT's *columnlist*.

The GROUP BY Feature's HAVING Clause

A particularly useful extension of the GROUP BY feature is the **HAVING** clause. The HAVING operates very much like the WHERE clause in the SELECT statement. However, the WHERE clause applies to columns and expressions for individual rows, while the HAVING clause is applied to the output of a GROUP BY operation. For example, suppose you want to generate a listing of the number of products in the inventory supplied by each vendor. But this time you want to limit the listing to products whose prices average below $10. The first part of that requirement is satisfied with the help of the GROUP BY clause, as illustrated in the first SQL command set in Figure 7.27. Note that the HAVING clause is used in conjunction with the GROUP BY clause in the second SQL command set in Figure 7.27 to generate the desired result.

FIGURE 7.27 An application of the HAVING clause



```
SQL> SELECT V_CODE, COUNT(DISTINCT (P_CODE)), AVG(P_PRICE)
  2  FROM PRODUCT
  3  GROUP BY V_CODE;

    V_CODE COUNT(DISTINCT(P_CODE)) AVG(P_PRICE)
---------- ----------------------- ------------
     21225                       2         8.47
     21231                       1         8.45
     21344                       3        12.49
     23119                       2        41.97
     24288                       3   155.593333
     25595                       3        89.63
                                 2       10.135

7 rows selected.

SQL> SELECT V_CODE, COUNT(DISTINCT (P_CODE)), AVG(P_PRICE)
  2  FROM PRODUCT
  3  GROUP BY V_CODE
  4  HAVING AVG(P_PRICE) < 10;

    V_CODE COUNT(DISTINCT(P_CODE)) AVG(P_PRICE)
---------- ----------------------- ------------
     21225                       2         8.47
     21231                       1         8.45

SQL>
```

Using the WHERE clause instead of the HAVING clause— the second SQL command set in Figure 7.27 will produce an error message.

You can also combine multiple clauses and aggregate functions. For example, consider the following SQL statement:

```
SELECT      V_CODE, SUM(P_QOH * P_PRICE) AS TOTCOST
FROM        PRODUCT
GROUP BY    V_CODE
HAVING      (SUM(P_QOH * P_PRICE) > 500)
ORDER BY    SUM(P_QOH * P_PRICE) DESC;
```

This statement will do the following:

- Aggregate the total cost of products grouped by V_CODE.
- Select only the rows having totals that exceed $500.
- List the results in descending order by the total cost.

Note the syntax used in the HAVING and ORDER BY clauses; in both cases, you must specify the column expression (formula) used in the SELECT statement's column list, rather than the column alias (TOTCOST). Some RDBMSs allow you to substitute the column expression with the column alias, while others do not.

7.7 VIRTUAL TABLES: CREATING A VIEW

As you learned earlier, the output of a relational operator such as SELECT is another relation (or table). Suppose that at the end of every day, you would like to get a list of all products to reorder, that is, products with a quantity on hand that is less than or equal to the minimum quantity. Instead of typing the same query at the end of every day, wouldn't it be better to permanently save that query in the database? That's the function of a relational view. A **view** is a virtual table based on a SELECT query. The query can contain columns, computed columns, aliases, and aggregate functions from one or more tables. The tables on which the view is based are called **base tables**.

You can create a view by using the **CREATE VIEW** command:

CREATE VIEW *viewname* AS SELECT *query*

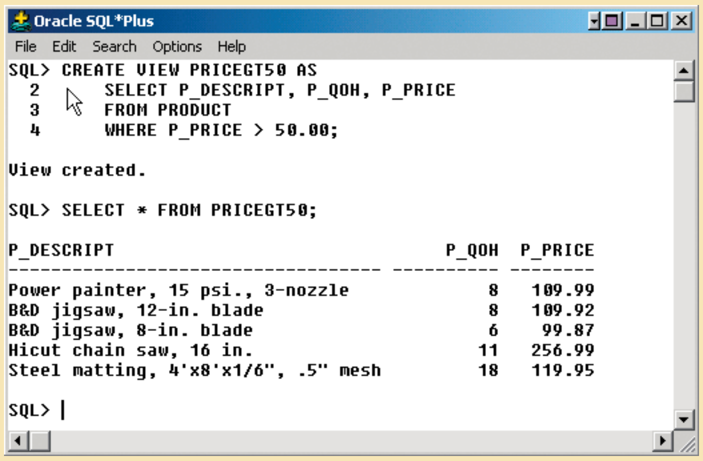
The CREATE VIEW statement is a data definition command that stores the subquery specification—the SELECT statement used to generate the virtual table—in the data dictionary.

The first SQL command set in Figure 7.28 shows the syntax used to create a view named PRICEGT50. This view contains only the designated three attributes (P_DESCRIPT, P_QOH, and P_PRICE) and only rows in which the price is over $50. The second SQL command sequence in Figure 7.28 shows the rows that make up the view.

Note

NOTE TO MS ACCESS USERS
The CREATE VIEW command is not directly supported in MS Access. To create a view in MS Access, you just need to create a SQL query and then save it.

FIGURE 7.28 Creating a virtual table with the CREATE VIEW command



```
SQL> CREATE VIEW PRICEGT50 AS
  2      SELECT P_DESCRIPT, P_QOH, P_PRICE
  3      FROM PRODUCT
  4      WHERE P_PRICE > 50.00;

View created.

SQL> SELECT * FROM PRICEGT50;

P_DESCRIPT                                P_QOH  P_PRICE
----------------------------------- ---------- --------
Power painter, 15 psi., 3-nozzle              8   109.99
B&D jigsaw, 12-in. blade                      8   109.92
B&D jigsaw, 8-in. blade                       6    99.87
Hicut chain saw, 16 in.                      11   256.99
Steel matting, 4'x8'x1/6", .5" mesh          18   119.95

SQL> |
```

A relational view has several special characteristics:

- You can use the name of a view anywhere a table name is expected in a SQL statement.
- Views are dynamically updated. That is, the view is re-created on demand each time it is invoked. Therefore, if new products are added (or deleted) to meet the criterion P_PRICE > 50.00, those new products will automatically appear (or disappear) in the PRICEGT50 view the next time the view is invoked.
- Views provide a level of security in the database because the view can restrict users to only specified columns and specified rows in a table. For example, if you have a company with hundreds of employees in several departments, you could give the secretary of each department a view of only certain attributes and for the employees that belong only to that secretary's department.
- Views may also be used as the basis for reports. For example, if you need a report that shows a summary of total product cost and quantity-on-hand statistics grouped by vendor, you could create a PROD_STATS view as:

```
CREATE VIEW PROD_STATS AS
SELECT      V_CODE, SUM(P_QOH*P_PRICE) AS TOTCOST,
            MAX(P_QOH) AS MAXQTY, MIN(P_QOH) AS MINQTY,
            AVG(P_QOH) AS AVGQTY
FROM        PRODUCT
GROUP BY    V_CODE;
```

In Chapter 8, you will learn more about views and, in particular, about updating data in base tables through views.

7.8 JOINING DATABASE TABLES

The ability to combine (join) tables on common attributes is perhaps the most important distinction between a relational database and other databases. A join is performed when data are retrieved from more than one table at a time. (If necessary, review the join definitions and examples in Chapter 3, The Relational Database Model.)

To join tables, you simply list the tables in the FROM clause of the SELECT statement. The DBMS will create the Cartesian product of every table in the FROM clause. (Review Chapter 3 to revisit these terms, if necessary.) However, to get the correct result—that is, a natural join—you must select only the rows in which the common attribute values match. To do this, use the WHERE clause to indicate the common attributes used to link the tables (this WHERE clause is sometimes referred to as the *join condition*).

The join condition is generally composed of an equality comparison between the foreign key and the primary key of related tables. For example, suppose you want to join the two tables VENDOR and PRODUCT. Because V_CODE is the foreign key in the PRODUCT table and the primary key in the VENDOR table, the link is established on V_CODE. (See Table 7.9.)

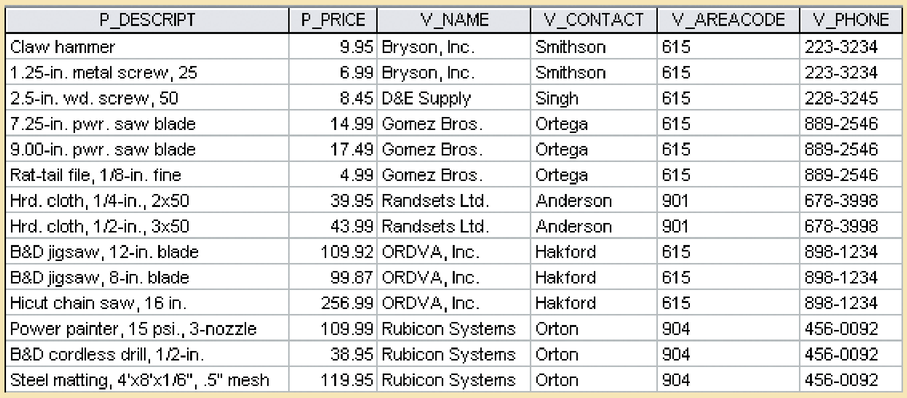
TABLE 7.9 Creating Links Through Foreign Keys

TABLE	ATTRIBUTES TO BE SHOWN	LINKING ATTRIBUTE
PRODUCT	P_DESCRIPT, P_PRICE	V_CODE
VENDOR	V_COMPANY, V_PHONE	V_CODE

When the same attribute name appears in more than one of the joined tables, the source table of the attributes listed in the SELECT command sequence must be defined. To join the PRODUCT and VENDOR tables, you would use the following, which produces the output shown in Figure 7.29:

```
SELECT      P_DESCRIPT, P_PRICE, V_NAME, V_CONTACT, V_AREACODE, V_PHONE
FROM        PRODUCT, VENDOR
WHERE       PRODUCT.V_CODE = VENDOR.V_CODE;
```

FIGURE 7.29 The results of a join



P_DESCRIPT	P_PRICE	V_NAME	V_CONTACT	V_AREACODE	V_PHONE
Claw hammer	9.95	Bryson, Inc.	Smithson	615	223-3234
1.25-in. metal screw, 25	6.99	Bryson, Inc.	Smithson	615	223-3234
2.5-in. wd. screw, 50	8.45	D&E Supply	Singh	615	228-3245
7.25-in. pwr. saw blade	14.99	Gomez Bros.	Ortega	615	889-2546
9.00-in. pwr. saw blade	17.49	Gomez Bros.	Ortega	615	889-2546
Rat-tail file, 1/8-in. fine	4.99	Gomez Bros.	Ortega	615	889-2546
Hrd. cloth, 1/4-in., 2x50	39.95	Randsets Ltd.	Anderson	901	678-3998
Hrd. cloth, 1/2-in., 3x50	43.99	Randsets Ltd.	Anderson	901	678-3998
B&D jigsaw, 12-in. blade	109.92	ORDVA, Inc.	Hakford	615	898-1234
B&D jigsaw, 8-in. blade	99.87	ORDVA, Inc.	Hakford	615	898-1234
Hicut chain saw, 16 in.	256.99	ORDVA, Inc.	Hakford	615	898-1234
Power painter, 15 psi., 3-nozzle	109.99	Rubicon Systems	Orton	904	456-0092
B&D cordless drill, 1/2-in.	38.95	Rubicon Systems	Orton	904	456-0092
Steel matting, 4'x8'x1/6", .5" mesh	119.95	Rubicon Systems	Orton	904	456-0092

Your output might be presented in a different order because the SQL command produces a listing in which the order of the columns is not relevant. In fact, you are likely to get a different order of the same listing the next time you execute the command. However, you can generate a more predictable list by using an ORDER BY clause:

```
SELECT      P_DESCRIPT, P_PRICE, V_NAME, V_CONTACT, V_AREACODE, V_PHONE
FROM        PRODUCT, VENDOR
WHERE       PRODUCT.V_CODE = VENDOR.V_CODE
ORDER BY    P_PRICE;
```

In that case, your listing will always be arranged from the lowest price to the highest price.

NOTE

Table names were used as prefixes in the preceding SQL command sequence. For example, PRODUCT.P_PRICE was used rather than P_PRICE. Most current-generation RDBMSs do not require table names to be used as prefixes unless the same attribute name occurs in several of the tables being joined. In that case, V_CODE is used as a foreign key in PRODUCT and as a primary key in VENDOR; therefore, you must use the table names as prefixes in the WHERE clause. In other words, you can write the previous query as:

```
SELECT    P_DESCRIPT, P_PRICE, V_NAME, V_CONTACT, V_AREACODE, V_PHONE
FROM      PRODUCT, VENDOR WHERE PRODUCT.V_CODE = VENDOR.V_CODE;
```

Naturally, if an attribute name occurs in several places, its origin (table) must be specified. If you fail to provide such a specification, SQL will generate an error message to indicate that you have been ambiguous about the attributes origin.

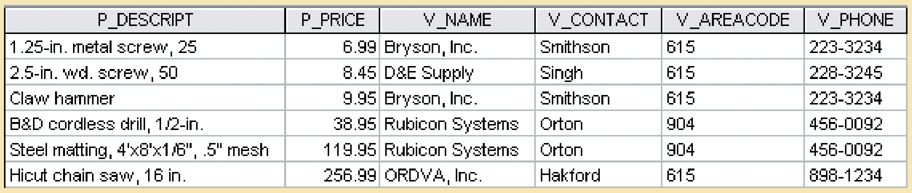
The preceding SQL command sequence joins a row in the PRODUCT table with a row in the VENDOR table in which the V_CODE values of these rows are the same, as indicated in the WHERE clause's condition. Because any vendor can deliver any number of ordered products, the PRODUCT table might contain multiple V_CODE entries for each V_CODE entry in the VENDOR table. In other words, each V_CODE in VENDOR can be matched with many V_CODE rows in PRODUCT.

If you do not specify the WHERE clause, the result will be the Cartesian product of PRODUCT and VENDOR. Because the PRODUCT table contains 16 rows and the VENDOR table contains 11 rows, the Cartesian product would produce a listing of $(16 \times 11) = 176$ rows. (Each row in PRODUCT would be joined to each row in the VENDOR table.)

All of the SQL commands can be used on the joined tables. For example, the following command sequence is quite acceptable in SQL and produces the output shown in Figure 7.30:

```
SELECT    P_DESCRIPT, P_PRICE, V_NAME, V_CONTACT, V_AREACODE, V_PHONE
FROM      PRODUCT, VENDOR
WHERE     PRODUCT.V_CODE = VENDOR.V_CODE
AND       P_INDATE > '15-Jan-2008';
```

FIGURE 7.30 An ordered and limited listing after a join



P_DESCRIPT	P_PRICE	V_NAME	V_CONTACT	V_AREACODE	V_PHONE
1.25-in. metal screw, 25	6.99	Bryson, Inc.	Smithson	615	223-3234
2.5-in. wd. screw, 50	8.45	D&E Supply	Singh	615	228-3245
Claw hammer	9.95	Bryson, Inc.	Smithson	615	223-3234
B&D cordless drill, 1/2-in.	38.95	Rubicon Systems	Orton	904	456-0092
Steel matting, 4'x8'x1/6", .5" mesh	119.95	Rubicon Systems	Orton	904	456-0092
Hicut chain saw, 16 in.	256.99	ORDVA, Inc.	Hakford	615	898-1234

When joining three or more tables, you need to specify a join condition for each pair of tables. The number of join conditions will always be N-1, where N represents the number of tables listed in the FROM clause. For example, if you have three tables, you must have two join conditions; if you have five tables, you must have four join conditions; and so on.

Remember, the join condition will match the foreign key of a table to the primary key of the related table. For example, using Figure 7.1, if you want to list the customer last name, invoice number, invoice date, and product descriptions for all invoices for customer 10014, you must type the following:

```
SELECT      CUS_LNAME, INV_NUMBER, INV_DATE, P_DESCRIPT
FROM        CUSTOMER, INVOICE, LINE, PRODUCT
WHERE       CUSTOMER.CUS_CODE = INVOICE.CUS_CODE
AND         INVOICE.INV_NUMBER = LINE.INV_NUMBER
AND         LINE.P_CODE = PRODUCT.P_CODE
AND         CUSTOMER.CUS_CODE = 10014
ORDER BY    INV_NUMBER;
```

Finally, be careful not to create circular join conditions. For example, if Table A is related to Table B, Table B is related to Table C, and Table C is also related to Table A, create only two join conditions: join A with B and B with C. Do not join C with A!

7.8.1 Joining Tables with an Alias

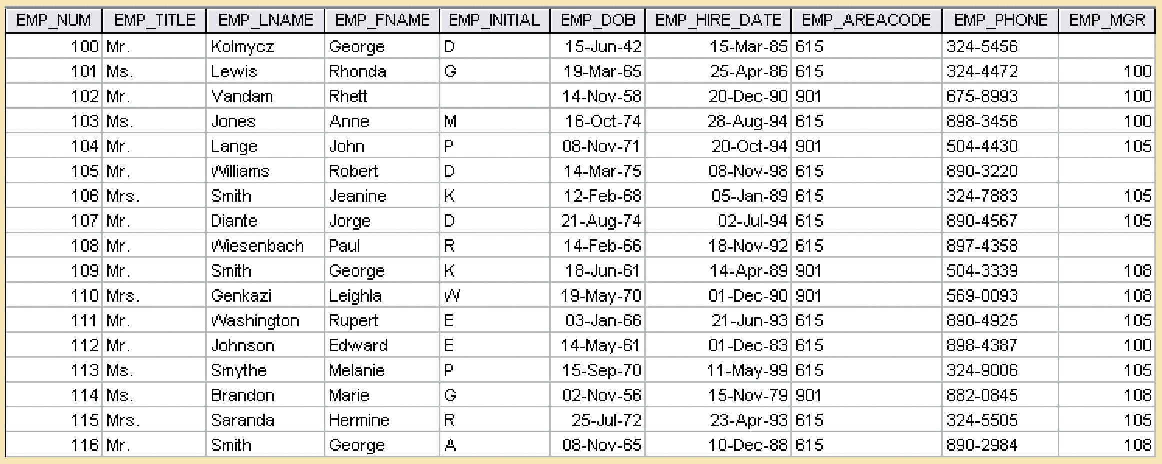
An alias may be used to identify the source table from which the data are taken. The aliases P and V are used to label the PRODUCT and VENDOR tables in the next command sequence. Any legal table name may be used as an alias. (Also notice that there are no table name prefixes because the attribute listing contains no duplicate names in the SELECT statement.)

```
SELECT      P_DESCRIPT, P_PRICE, V_NAME, V_CONTACT, V_AREACODE, V_PHONE
FROM        PRODUCT P, VENDOR V
WHERE       P.V_CODE = V.V_CODE
ORDER BY    P_PRICE;
```

7.8.2 Recursive Joins

An alias is especially useful when a table must be joined to itself in a **recursive query**. For example, suppose you are working with the EMP table shown in Figure 7.31.

FIGURE 7.31 The contents of the EMP table



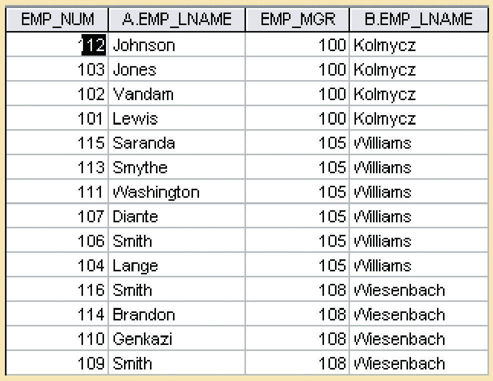
EMP_NUM	EMP_TITLE	EMP_LNAME	EMP_FNAME	EMP_INITIAL	EMP_DOB	EMP_HIRE_DATE	EMP_AREACODE	EMP_PHONE	EMP_MGR
100	Mr.	Kolmycz	George	D	15-Jun-42	15-Mar-85	615	324-5456	
101	Ms.	Lewis	Rhonda	G	19-Mar-65	25-Apr-86	615	324-4472	100
102	Mr.	Vandam	Rhett		14-Nov-58	20-Dec-90	901	675-8993	100
103	Ms.	Jones	Anne	M	16-Oct-74	28-Aug-94	615	898-3456	100
104	Mr.	Lange	John	P	08-Nov-71	20-Oct-94	901	504-4430	105
105	Mr.	Williams	Robert	D	14-Mar-75	08-Nov-98	615	890-3220	
106	Mrs.	Smith	Jeanine	K	12-Feb-68	05-Jan-89	615	324-7883	105
107	Mr.	Diante	Jorge	D	21-Aug-74	02-Jul-94	615	890-4567	105
108	Mr.	Wiesenbach	Paul	R	14-Feb-66	18-Nov-92	615	897-4358	
109	Mr.	Smith	George	K	18-Jun-61	14-Apr-89	901	504-3339	108
110	Mrs.	Genkazi	Leighla	W	19-May-70	01-Dec-90	901	569-0093	108
111	Mr.	Washington	Rupert	E	03-Jan-66	21-Jun-93	615	890-4925	105
112	Mr.	Johnson	Edward	E	14-May-61	01-Dec-83	615	898-4387	100
113	Ms.	Smythe	Melanie	P	15-Sep-70	11-May-99	615	324-9006	105
114	Ms.	Brandon	Marie	G	02-Nov-56	15-Nov-79	901	882-0845	108
115	Mrs.	Saranda	Hermine	R	25-Jul-72	23-Apr-93	615	324-5505	105
116	Mr.	Smith	George	A	08-Nov-65	10-Dec-88	615	890-2984	108

Using the data in the EMP table, you can generate a list of all employees with their managers' names by joining the EMP table to itself. In that case, you would also use aliases to differentiate the table from itself. The SQL command sequence would look like this:

```
SELECT     E.EMP_MGR, M.EMP_LNAME, E.EMP_NUM, E.EMP_LNAME
FROM       EMP E, EMP M
WHERE      E.EMP_MGR=M.EMP_NUM
ORDER BY   E.EMP_MGR;
```

The output of the above command sequence is shown in Figure 7.32.

FIGURE 7.32 **Using an alias to join a table to itself**



EMP_NUM	A.EMP_LNAME	EMP_MGR	B.EMP_LNAME
112	Johnson	100	Kolmycz
103	Jones	100	Kolmycz
102	Vandam	100	Kolmycz
101	Lewis	100	Kolmycz
115	Saranda	105	Williams
113	Smythe	105	Williams
111	Washington	105	Williams
107	Diante	105	Williams
106	Smith	105	Williams
104	Lange	105	Williams
116	Smith	108	Wiesenbach
114	Brandon	108	Wiesenbach
110	Genkazi	108	Wiesenbach
109	Smith	108	Wiesenbach

7.8.3 Outer Joins

Figure 7.29 showed the results of joining the PRODUCT and VENDOR tables. If you examine the output, note that 14 product rows are listed. Compare the output to the PRODUCT table in Figure 7.2, and note that two products are missing. Why? The reason is that there are two products with nulls in the V_CODE attribute. Because there is no matching null "value" in the VENDOR table's V_CODE attribute, the products do not show up in the final output based on the join. Also, note that in the VENDOR table in Figure 7.2, several vendors have no matching V_CODE in the PRODUCT table. To include those rows in the final join output, you must use an outer join.

Note

In MS Access, add AS to the previous SQL command sequence, making it read:

```
SELECT     E.EMP_MGR,M.EMP_LNAME,E.EMP_NUM,E.EMP_LNAME
FROM       EMP AS E, EMP AS M
WHERE      E.EMP_MGR = M.EMP_NUM
ORDER BY   E.EMP_MGR;
```

There are two types of outer joins: left and right. (See Chapter 3.) Given the contents of the PRODUCT and VENDOR tables, the following left outer join will show all VENDOR rows and all matching PRODUCT rows:

```
SELECT      P_CODE, VENDOR.V_CODE, V_NAME
FROM        VENDOR LEFT JOIN PRODUCT
            ON VENDOR.V_CODE = PRODUCT.V_CODE;
```

Figure 7.33 shows the output generated by the left outer join command in MS Access. Oracle yields the same result, but shows the output in a different order.

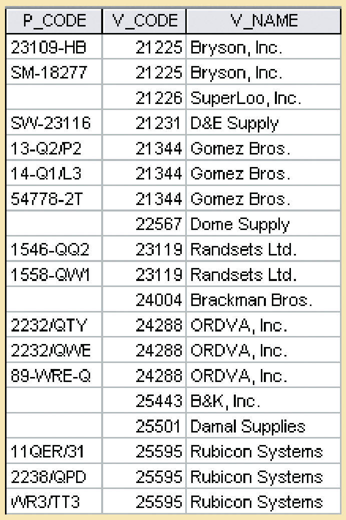
The right outer join will join both tables and show all product rows with all matching vendor rows. The SQL command for the right outer join is:

```
SELECT      PRODUCT.P_CODE, VENDOR.V_CODE, V_NAME
FROM        VENDOR RIGHT JOIN PRODUCT
            ON VENDOR.V_CODE = PRODUCT.V_CODE;
```

Figure 7.34 shows the output generated by the right outer join command sequence in MS Access. Again, Oracle yields the same result, but shows the output in a different order.

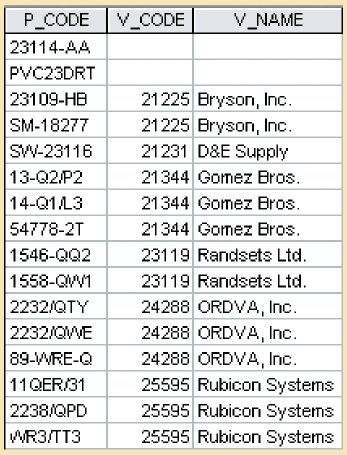
In Chapter 8, you will learn more about joins and how to use the latest ANSI SQL standard syntax.

FIGURE 7.33 **The left outer join results**



P_CODE	V_CODE	V_NAME
23109-HB	21225	Bryson, Inc.
SM-18277	21225	Bryson, Inc.
	21226	SuperLoo, Inc.
SW-23116	21231	D&E Supply
13-Q2/P2	21344	Gomez Bros.
14-Q1/L3	21344	Gomez Bros.
54778-2T	21344	Gomez Bros.
	22567	Dome Supply
1546-QQ2	23119	Randsets Ltd.
1558-QW1	23119	Randsets Ltd.
	24004	Brackman Bros.
2232/QTY	24288	ORDVA, Inc.
2232/QWE	24288	ORDVA, Inc.
89-WRE-Q	24288	ORDVA, Inc.
	25443	B&K, Inc.
	25501	Damal Supplies
11QER/31	25595	Rubicon Systems
2238/QPD	25595	Rubicon Systems
WR3/TT3	25595	Rubicon Systems

FIGURE 7.34 **The right outer join results**



P_CODE	V_CODE	V_NAME
23114-AA		
PVC23DRT		
23109-HB	21225	Bryson, Inc.
SM-18277	21225	Bryson, Inc.
SW-23116	21231	D&E Supply
13-Q2/P2	21344	Gomez Bros.
14-Q1/L3	21344	Gomez Bros.
54778-2T	21344	Gomez Bros.
1546-QQ2	23119	Randsets Ltd.
1558-QW1	23119	Randsets Ltd.
2232/QTY	24288	ORDVA, Inc.
2232/QWE	24288	ORDVA, Inc.
89-WRE-Q	24288	ORDVA, Inc.
11QER/31	25595	Rubicon Systems
2238/QPD	25595	Rubicon Systems
WR3/TT3	25595	Rubicon Systems

ONLINE CONTENT

For a complete walk-through example of converting an ER model into a database structure and using SQL commands to create tables, see **Appendix D, Converting an ER Model into a Database Structure**, in the Student Online Companion.

SUMMARY

- The SQL commands can be divided into two overall categories: data definition language (DDL) commands and data manipulation language (DML) commands.
- The ANSI standard data types are supported by all RDBMS vendors in different ways. The basic data types are NUMBER, INTEGER, CHAR, VARCHAR, and DATE.
- The basic data definition commands allow you to create tables, indexes, and views. Many SQL constraints can be used with columns. The commands are CREATE TABLE, CREATE INDEX, CREATE VIEW, ALTER TABLE, DROP TABLE, DROP VIEW, and DROP INDEX.
- DML commands allow you to add, modify, and delete rows from tables. The basic DML commands are SELECT, INSERT, UPDATE, DELETE, COMMIT, and ROLLBACK.
- The INSERT command is used to add new rows to tables. The UPDATE command is used to modify data values in existing rows of a table. The DELETE command is used to delete rows from tables. The COMMIT and ROLLBACK commands are used to permanently save or roll back changes made to the rows. Once you COMMIT the changes, you cannot undo them with a ROLLBACK command.
- The SELECT statement is the main data retrieval command in SQL. A SELECT statement has the following syntax:

```
SELECT      columnlist
FROM        tablelist
[WHERE      conditionlist ]
[GROUP BY   columnlist ]
[HAVING     conditionlist ]
[ORDER BY   columnlist [ASC | DESC] ] ;
```

- The column list represents one or more column names separated by commas. The column list may also include computed columns, aliases, and aggregate functions. A computed column is represented by an expression or formula (for example, P_PRICE * P_QOH). The FROM clause contains a list of table names or view names.
- The WHERE clause can be used with the SELECT, UPDATE, and DELETE statements to restrict the rows affected by the DDL command. The condition list represents one or more conditional expressions separated by logical operators (AND, OR, and NOT). The conditional expression can contain any comparison operators (=, >, <, >=, <=, and <>) as well as special operators (BETWEEN, IS NULL, LIKE, IN, and EXISTS).
- Aggregate functions (COUNT, MIN, MAX, and AVG) are special functions that perform arithmetic computations over a set of rows. The aggregate functions are usually used in conjunction with the GROUP BY clause to group the output of aggregate computations by one or more attributes. The HAVING clause is used to restrict the output of the GROUP BY clause by selecting only the aggregate rows that match a given condition.
- The ORDER BY clause is used to sort the output of a SELECT statement. The ORDER BY clause can sort by one or more columns and can use either ascending or descending order.
- You can join the output of multiple tables with the SELECT statement. The join operation is performed every time you specify two or more tables in the FROM clause and use a join condition in the WHERE clause to match the foreign key of one table to the primary key of the related table. If you do not specify a join condition, the DBMS will automatically perform a Cartesian product of the tables you specify in the FROM clause.
- The natural join uses the join condition to match only rows with equal values in the specified columns. You could also do a right outer join and left outer join to select the rows that have no matching values in the other related table.

KEY TERMS

alias, 250
ALTER TABLE, 257
AND, 252
authentication, 229
AVG, 269
base tables, 273
BETWEEN, 253
Boolean algebra, 252
cascading order sequence, 264
COMMIT, 242
COUNT, 266
CREATE INDEX, 239
CREATE TABLE, 232
CREATE VIEW, 273
DELETE, 245
DISTINCT, 265
DROP INDEX, 240
DROP TABLE, 263
EXISTS, 253
GROUP BY, 270
HAVING, 272
IN, 253
inner query, 245
INSERT, 240
IS NULL, 253
LIKE, 253
MAX, 267
MIN, 267
nested query, 245
NOT, 252
OR, 252
ORDER BY, 263
recursive query, 277
reserved words, 235
ROLLBACK, 244
rules of precedence, 251
schema, 229
SELECT, 242
subquery, 245
SUM, 269
UPDATE, 244
view, 273
wildcard character, 242

ONLINE CONTENT

Answers to selected Review Questions and Problems for this chapter are contained in the Student Online Companion for this book.

ONLINE CONTENT

The Review Questions in this chapter are based on the **Ch07_Review** database located in the Student Online Companion. This database is stored in Microsoft Access format. If you use another DBMS such as Oracle, SQL Server, MySQL, or DB2, use its import utilities to move the Access database contents. The Student Online Companion provides Oracle and SQL script files.

REVIEW QUESTIONS

The **Ch07_Review** database stores data for a consulting company that tracks all charges to projects. The charges are based on the hours each employee works on each project. The structure and contents of the **Ch07_Review** database are shown in Figure Q7.1.

Note that the ASSIGNMENT table in Figure Q7.1 stores the JOB_CHG_HOUR values as an attribute (ASSIGN_CHG_HR) to maintain historical accuracy of the data. The JOB_CHG_HOUR values are likely to change over time. In fact, a JOB_CHG_HOUR change will be reflected in the ASSIGNMENT table. And, naturally, the employee primary job assignment might change, so the ASSIGN_JOB is also stored. Because those attributes are required to maintain the historical accuracy of the data, they are *not* redundant.

FIGURE Q7.1 Structure and contents of the Ch07_Review database

Database name: Ch07_Review

Relational diagram

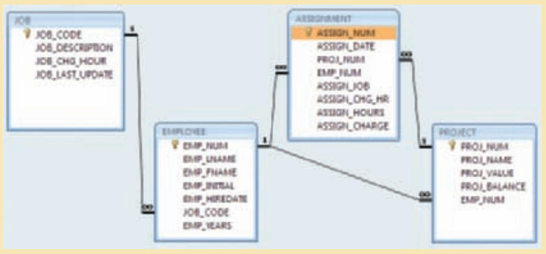


Table name: EMPLOYEE

EMP_NUM	EMP_LNAME	EMP_FNAME	EMP_INITIAL	EMP_HIREDATE	JOB_CODE	EMP_YEARS
101	News	John	G	08-Nov-00	502	4
102	Senior	David	H	12-Jul-89	501	15
103	Arbough	June	E	01-Dec-96	503	8
104	Ramoras	Anne	K	15-Nov-87	501	17
105	Johnson	Alice	K	01-Feb-93	502	12
106	Smithfield	William		22-Jun-04	500	0
107	Alonzo	Maria	D	10-Oct-93	500	11
108	Washington	Ralph	B	22-Aug-91	501	13
109	Smith	Larry	W	18-Jul-97	501	7
110	Olenko	Gerald	A	11-Dec-95	505	9
111	Wabash	Geoff	B	04-Apr-91	506	14
112	Smithson	Darlene	M	23-Oct-94	507	10
113	Joenbrood	Delbert	K	15-Nov-96	508	8
114	Jones	Annelise		20-Aug-93	508	11
115	Bawangi	Travis	B	25-Jan-92	501	13
116	Pratt	Gerald	L	05-Mar-97	510	8
117	Williamson	Angie	H	19-Jun-96	509	8
118	Frommer	James	J	04-Jan-05	510	0

Table name: JOB

JOB_CODE	JOB_DESCRIPTION	JOB_CHG_HOUR	JOB_LAST_UPDATE
500	Programmer	35.75	20-Nov-07
501	Systems Analyst	96.75	20-Nov-07
502	Database Designer	125.00	24-Mar-08
503	Electrical Engineer	84.50	20-Nov-07
504	Mechanical Engineer	67.90	20-Nov-07
505	Civil Engineer	55.78	20-Nov-07
506	Clerical Support	26.87	20-Nov-07
507	DSS Analyst	45.95	20-Nov-07
508	Applications Designer	48.10	24-Mar-08
509	Bio Technician	34.55	20-Nov-07
510	General Support	18.36	20-Nov-07

Table name: ASSIGNMENT

ASSIGN_NUM	ASSIGN_DATE	PROJ_NUM	EMP_NUM	ASSIGN_JOB	ASSIGN_CHG_HR	ASSIGN_HOURS	ASSIGN_CHARGE
1001	22-Mar-08	18	103	503	84.50	3.5	295.75
1002	22-Mar-08	22	117	509	34.55	4.2	145.11
1003	22-Mar-08	18	117	509	34.55	2.0	69.10
1004	22-Mar-08	18	103	503	84.50	5.9	498.55
1005	22-Mar-08	25	108	501	96.75	2.2	212.85
1006	22-Mar-08	22	104	501	96.75	4.2	406.35
1007	22-Mar-08	25	113	508	50.75	3.8	192.85
1008	22-Mar-08	18	103	503	84.50	0.9	76.05
1009	23-Mar-08	15	115	501	96.75	5.6	541.80
1010	23-Mar-08	15	117	509	34.55	2.4	82.92
1011	23-Mar-08	25	105	502	105.00	4.3	451.50
1012	23-Mar-08	18	108	501	96.75	3.4	328.95
1013	23-Mar-08	25	115	501	96.75	2.0	193.50
1014	23-Mar-08	22	104	501	96.75	2.8	270.90
1015	23-Mar-08	15	103	503	84.50	6.1	515.45
1016	23-Mar-08	22	105	502	105.00	4.7	493.50
1017	23-Mar-08	18	117	509	34.55	3.8	131.29
1018	23-Mar-08	25	117	509	34.55	2.2	76.01
1019	24-Mar-08	25	104	501	110.50	4.9	541.45
1020	24-Mar-08	15	101	502	125.00	3.1	387.50
1021	24-Mar-08	22	108	501	110.50	2.7	298.35
1022	24-Mar-08	22	115	501	110.50	4.9	541.45
1023	24-Mar-08	22	105	502	125.00	3.5	437.50
1024	24-Mar-08	15	103	503	84.50	3.3	278.85
1025	24-Mar-08	18	117	509	34.55	4.2	145.11

Table name: PROJECT

PROJ_NUM	PROJ_NAME	PROJ_VALUE	PROJ_BALANCE	EMP_NUM
15	Evergreen	1453500.00	1002350.00	103
18	Amber Wave	3500500.00	2110346.00	108
22	Rolling Tide	805000.00	500345.20	102
25	Starflight	2650500.00	2309880.00	107

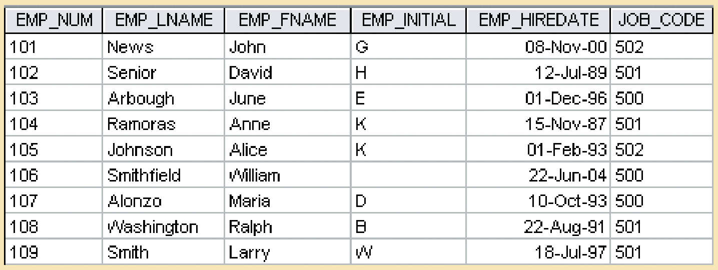
Given the structure and contents of the **Ch07_Review** database shown in Figure Q7.1, use SQL commands to answer Questions 1–25.

1. Write the SQL code that will create the table structure for a table named EMP_1. This table is a subset of the EMPLOYEE table. The basic EMP_1 table structure is summarized in the table below. (Note that the JOB_CODE is the FK to JOB.)

ATTRIBUTE (FIELD) NAME	DATA DECLARATION
EMP_NUM	CHAR(3)
EMP_LNAME	VARCHAR(15)
EMP_FNAME	VARCHAR(15)
EMP_INITIAL	CHAR(1)
EMP_HIREDATE	DATE
JOB_CODE	CHAR(3)

2. Having created the table structure in Question 1, write the SQL code to enter the first two rows for the table shown in Figure Q7.2.
3. Assuming the data shown in the EMP_1 table have been entered, write the SQL code that will list all attributes for a job code of 502.
4. Write the SQL code that will save the changes made to the EMP_1 table.
5. Write the SQL code to change the job code to 501 for the person whose employee number (EMP_NUM) is 107. After you have completed the task, examine the results, and then reset the job code to its original value.

FIGURE Q7.2 The contents of the EMP_1 table



EMP_NUM	EMP_LNAME	EMP_FNAME	EMP_INITIAL	EMP_HIREDATE	JOB_CODE
101	News	John	G	08-Nov-00	502
102	Senior	David	H	12-Jul-89	501
103	Arbough	June	E	01-Dec-96	500
104	Ramoras	Anne	K	15-Nov-87	501
105	Johnson	Alice	K	01-Feb-93	502
106	Smithfield	William		22-Jun-04	500
107	Alonzo	Maria	D	10-Oct-93	500
108	Washington	Ralph	B	22-Aug-91	501
109	Smith	Larry	W	18-Jul-97	501

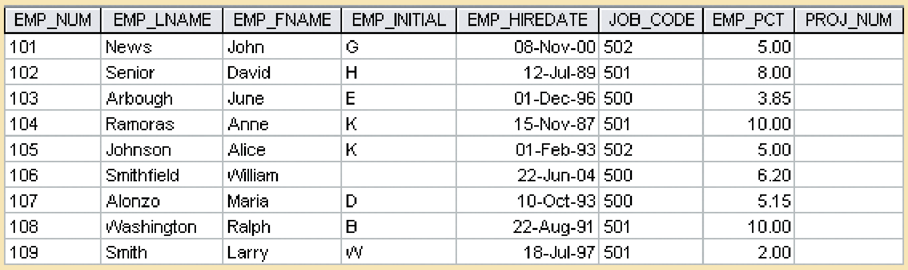
6. Write the SQL code to delete the row for the person named William Smithfield, who was hired on June 22, 2004, and whose job code classification is 500. (*Hint*: Use logical operators to include all of the information given in this problem.)
7. Write the SQL code that will restore the data to its original status; that is, the table should contain the data that existed before you made the changes in Questions 5 and 6.
8. Write the SQL code to create a copy of EMP_1, naming the copy EMP_2. Then write the SQL code that will add the attributes EMP_PCT and PROJ_NUM to its structure. The EMP_PCT is the bonus percentage to be paid to each employee. The new attribute characteristics are:

   EMP_PCTNUMBER(4,2)

   PROJ_NUMCHAR(3)

   (*Note*: If your SQL implementation allows it, you may use DECIMAL(4,2) rather than NUMBER(4,2).)
9. Write the SQL code to change the EMP_PCT value to 3.85 for the person whose employee number (EMP_NUM) is 103. Next, write the SQL command sequences to change the EMP_PCT values as shown in Figure Q7.9.

FIGURE Q7.9 The contents of the EMP_2 table

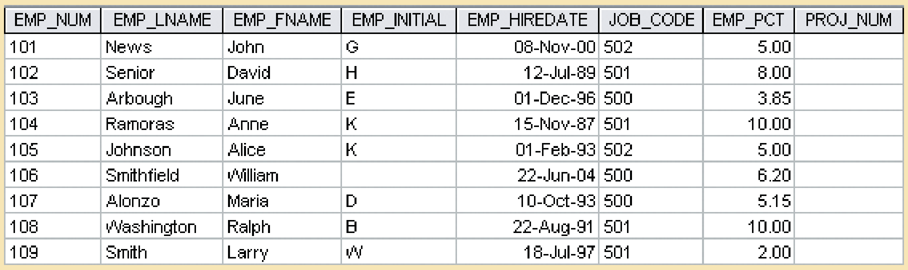


EMP_NUM	EMP_LNAME	EMP_FNAME	EMP_INITIAL	EMP_HIREDATE	JOB_CODE	EMP_PCT	PROJ_NUM
101	News	John	G	08-Nov-00	502	5.00	
102	Senior	David	H	12-Jul-89	501	8.00	
103	Arbough	June	E	01-Dec-96	500	3.85	
104	Ramoras	Anne	K	15-Nov-87	501	10.00	
105	Johnson	Alice	K	01-Feb-93	502	5.00	
106	Smithfield	William		22-Jun-04	500	6.20	
107	Alonzo	Maria	D	10-Oct-93	500	5.15	
108	Washington	Ralph	B	22-Aug-91	501	10.00	
109	Smith	Larry	W	18-Jul-97	501	2.00	

10. Using a single command sequence, write the SQL code that will change the project number (PROJ_NUM) to 18 for all employees whose job classification (JOB_CODE) is 500.
11. Using a single command sequence, write the SQL code that will change the project number (PROJ_NUM) to 25 for all employees whose job classification (JOB_CODE) is 502 or higher. When you finish Questions 10 and 11, the EMP_2 table will contain the data shown in Figure Q7.11.

    (You may assume that the table has been saved again at this point.)

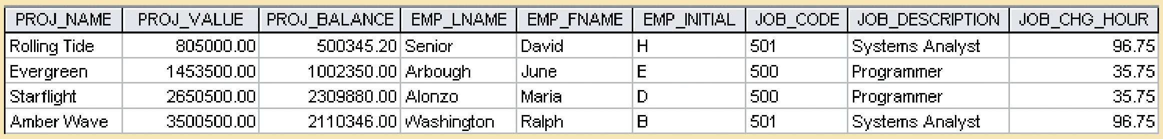
FIGURE Q7.11 The EMP_2 table contents after the modifications



EMP_NUM	EMP_LNAME	EMP_FNAME	EMP_INITIAL	EMP_HIREDATE	JOB_CODE	EMP_PCT	PROJ_NUM
101	News	John	G	08-Nov-00	502	5.00	
102	Senior	David	H	12-Jul-89	501	8.00	
103	Arbough	June	E	01-Dec-96	500	3.85	
104	Ramoras	Anne	K	15-Nov-87	501	10.00	
105	Johnson	Alice	K	01-Feb-93	502	5.00	
106	Smithfield	William		22-Jun-04	500	6.20	
107	Alonzo	Maria	D	10-Oct-93	500	5.15	
108	Washington	Ralph	B	22-Aug-91	501	10.00	
109	Smith	Larry	W	18-Jul-97	501	2.00	

12. Write the SQL code that will change the PROJ_NUM to 14 for those employees who were hired before January 1, 1994 and whose job code is at least 501. (You may assume that the table will be restored to its condition preceding this question.)
13. Write the two SQL command sequences required to:
    a. Create a temporary table named TEMP_1 whose structure is composed of the EMP_2 attributes EMP_NUM and EMP_PCT.
    b. Copy the matching EMP_2 values into the TEMP_1 table.
14. Write the SQL command that will delete the newly created TEMP_1 table from the database.
15. Write the SQL code required to list all employees whose last names start with *Smith*. In other words, the rows for both Smith and Smithfield should be included in the listing. Assume case sensitivity.
16. Using the EMPLOYEE, JOB, and PROJECT tables in the **Ch07_Review** database (see Figure Q7.1), write the SQL code that will produce the results shown in Figure Q7.16.

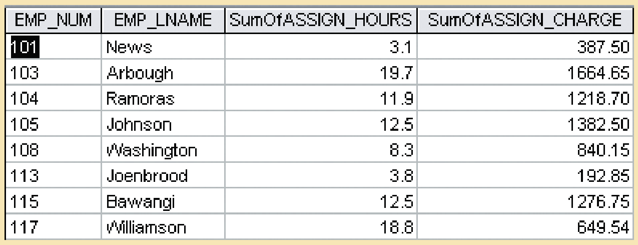
FIGURE Q7.16 The query results for Question 16



PROJ_NAME	PROJ_VALUE	PROJ_BALANCE	EMP_LNAME	EMP_FNAME	EMP_INITIAL	JOB_CODE	JOB_DESCRIPTION	JOB_CHG_HOUR
Rolling Tide	805000.00	500345.20	Senior	David	H	501	Systems Analyst	96.75
Evergreen	1453500.00	1002350.00	Arbough	June	E	500	Programmer	35.75
Starflight	2650500.00	2309880.00	Alonzo	Maria	D	500	Programmer	35.75
Amber Wave	3500500.00	2110346.00	Washington	Ralph	B	501	Systems Analyst	96.75

17. Write the SQL code that will produce a virtual table named REP_1. The virtual table should contain the same information that was shown in Question 16.
18. Write the SQL code to find the average bonus percentage in the EMP_2 table you created in Question 8.
19. Write the SQL code that will produce a listing for the data in the EMP_2 table in ascending order by the bonus percentage.
20. Write the SQL code that will list only the distinct project numbers found in the EMP_2 table.
21. Write the SQL code to calculate the ASSIGN_CHARGE values in the ASSIGNMENT table in the **Ch07_Review** database. (See Figure Q7.1.) Note that ASSIGN_CHARGE is a derived attribute that is calculated by multiplying ASSIGN_CHG_HR by ASSIGN_HOURS.
22. Using the data in the ASSIGNMENT table, write the SQL code that will yield the total number of hours worked for each employee and the total charges stemming from those hours worked. The results of running that query are shown in Figure Q7.22.

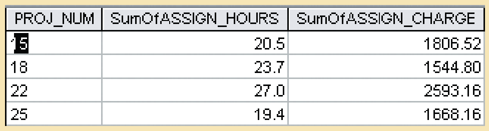
FIGURE Q7.22 Total hours and charges by employee



EMP_NUM	EMP_LNAME	SumOfASSIGN_HOURS	SumOfASSIGN_CHARGE
101	News	3.1	387.50
103	Arbough	19.7	1664.65
104	Ramoras	11.9	1218.70
105	Johnson	12.5	1382.50
108	Washington	8.3	840.15
113	Joenbrood	3.8	192.85
115	Bawangi	12.5	1276.75
117	Williamson	18.8	649.54

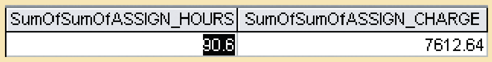
23. Write a query to produce the total number of hours and charges for each of the projects represented in the ASSIGNMENT table. The output is shown in Figure Q7.23.

FIGURE Q7.23 Total hour and charges by project



PROJ_NUM	SumOfASSIGN_HOURS	SumOfASSIGN_CHARGE
15	20.5	1806.52
18	23.7	1544.80
22	27.0	2593.16
25	19.4	1668.16

FIGURE Q7.24 Total hours and charges, all employees



SumOfSumOfASSIGN_HOURS	SumOfSumOfASSIGN_CHARGE
90.6	7612.64

24. Write the SQL code to generate the total hours worked and the total charges made by all employees. The results are shown in Figure Q7.24. (*Hint:* This is a nested query. If you use Microsoft Access, you can generate the result by using the query output shown in Figure Q7.22 as the basis for the query that will produce the output shown in Figure Q7.24.)

25. Write the SQL code to generate the total hours worked and the total charges made to all projects. The results should be the same as those shown in Figure Q7.24. (*Hint:* This is a nested query. If you use Microsoft Access, you can generate the result by using the query output shown in Figure Q7.23 as the basis for this query.)

PROBLEMS

ONLINE CONTENT

Problems 1-15 are based on the **Ch07_AviaCo** database located in the Student Online Companion. This database is stored in Microsoft Access format. If you use another DBMS such as Oracle, SQL Server, MySQL, or DB2, use its import utilities to move the Access database contents. The Student Online Companion provides Oracle and SQL script files.

Before you attempt to write any SQL queries, familiarize yourself with the **Ch07_AviaCo** database structure and contents shown in Figure P7.1. Although the relational schema does not show optionalities, keep in mind that all pilots are employees, but not all employees are flight crew members. (Although in this database, the crew member assignments all involve pilots and copilots, the design is sufficiently flexible to accommodate crew member assignments—such as loadmasters and flight attendants—of people who are not pilots. That's why the relationship between CHARTER and EMPLOYEE is implemented through CREW.) Note also that this design implementation does not include multivalued attributes. For example, multiple ratings such as Instrument and Certified Flight Instructor ratings are stored in the (composite) EARNEDRATINGS table. Nor does the CHARTER table include multiple crew assignments, which are properly stored in the CREW table.

FIGURE P7.1 The Ch07_AviaCo database

Database name: Ch7_AviaCo

Relational diagram

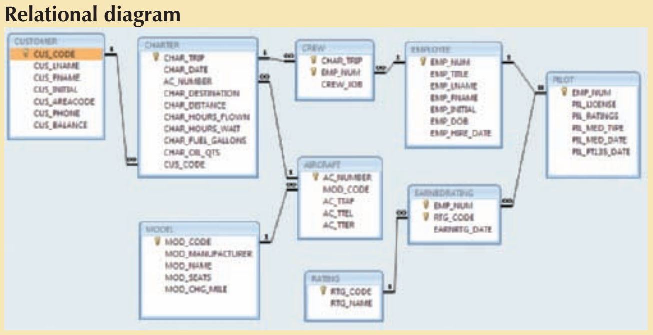


Table name: CREW

CHAR_TRIP	EMP_NUM	CREW_JOB
10001	104	Pilot
10002	101	Pilot
10003	105	Pilot
10003	109	Copilot
10004	106	Pilot
10005	101	Pilot
10006	109	Pilot
10007	104	Pilot
10007	105	Copilot
10008	106	Pilot
10009	105	Pilot
10010	108	Pilot
10011	101	Pilot

Table name: RATING

RTG_CODE	RTG_NAME
CFI	Certified Flight Instructor
CFII	Certified Flight Instructor, Instrument
INSTR	Instrument
MEL	Multiengine Land
SEL	Single Engine, Land
SES	Single Engine, Sea

Table name: EMPLOYEE

EMP_NUM	EMP_TITLE	EMP_LNAME	EMP_FNAME	EMP_INITIAL	EMP_DOB	EMP_HIRE_DATE
100	Mr.	Kolmycz	George	D	15-Jun-1942	15-Mar-1987
101	Ms.	Lewis	Rhonda	G	19-Mar-1965	25-Apr-1988
102	Mr.	Vandam	Rhett		14-Nov-1958	20-Dec-1992
103	Ms.	Jones	Anne	M	16-Oct-1974	28-Aug-2005
104	Mr.	Lange	John	P	08-Nov-1971	20-Oct-1996
105	Mr.	Williams	Robert	D	14-Mar-1975	08-Jan-2006
106	Mrs.	Duzak	Jeanine	K	12-Feb-1968	05-Jan-1991
107	Mr.	Diante	Jorge	D	21-Aug-1974	02-Jul-1996
108	Mr.	Wiesenbach	Paul	R	14-Feb-1966	18-Nov-1994
109	Ms.	Travis	Elizabeth	K	18-Jun-1961	14-Apr-1991
110	Mrs.	Genkazi	Leighla	W	19-May-1970	01-Dec-1992

Table name: CUSTOMER

CUS_CODE	CUS_LNAME	CUS_FNAME	CUS_INITIAL	CUS_AREACODE	CUS_PHONE	CUS_BALANCE
10010	Ramas	Alfred	A	615	844-2573	0.00
10011	Dunne	Leona	K	713	894-1238	0.00
10012	Smith	Kathy	W	615	894-2285	896.54
10013	Olowski	Paul	F	615	894-2180	1285.19
10014	Orlando	Myron		615	222-1672	673.21
10015	O'Brian	Amy	B	713	442-3381	1014.56
10016	Brown	James	G	615	297-1228	0.00
10017	Williams	George		615	290-2556	0.00
10018	Farriss	Anne	G	713	382-7185	0.00
10019	Smith	Olette	K	615	297-3809	453.98

Table name: PILOT

EMP_NUM	PIL_LICENSE	PIL_RATINGS	PIL_MED_TYPE	PIL_MED_DATE	PIL_PT135_DATE
101	ATP	SEL/MEL/Instr/CFII	1	12-Apr-2008	15-Jun-2007
104	ATP	SEL/MEL/Instr	1	10-Jun-2007	23-Mar-2008
105	COM	SEL/MEL/Instr/CFI	2	25-Feb-2008	12-Feb-2008
106	COM	SEL/MEL/Instr	2	02-Apr-2008	24-Dec-2007
109	COM	SEL/MEL/SES/Instr/CFII	1	14-Apr-2008	21-Apr-2008

Table name: CHARTER

CHAR_TRIP	CHAR_DATE	AC_NUMBER	CHAR_DESTINATION	CHAR_DISTANCE	CHAR_HOURS_FLOWN	CHAR_HOURS_WAIT	CHAR_FUEL_GALLONS	CHAR_OIL_QTS	CUS_CODE
10001	05-Feb-08	2289L	ATL	936.0	5.1	2.2	354.1	1	10011
10002	05-Feb-08	2778V	BNA	320.0	1.6	0	72.6	0	10016
10003	05-Feb-08	4278Y	GNV	1574.0	7.8	0	339.8	2	10014
10004	06-Feb-08	1484P	STL	472.0	2.9	4.9	97.2	1	10019
10005	06-Feb-08	2289L	ATL	1023.0	5.7	3.5	397.7	2	10011
10006	06-Feb-08	4278Y	STL	472.0	2.6	5.2	117.1	0	10017
10007	06-Feb-08	2778V	GNV	1574.0	7.9	0	348.4	2	10012
10008	07-Feb-08	1484P	TYS	644.0	4.1	0	140.6	1	10014
10009	07-Feb-08	2289L	GNV	1574.0	6.6	23.4	459.9	0	10017
10010	07-Feb-08	4278Y	ATL	998.0	6.2	3.2	279.7	0	10016
10011	07-Feb-08	1484P	BNA	352.0	1.9	5.3	66.4	1	10012
10012	08-Feb-08	2778V	MOB	884.0	4.8	4.2	215.1	0	10010
10013	08-Feb-08	4278Y	TYS	644.0	3.9	4.5	174.3	1	10011
10014	09-Feb-08	4278Y	ATL	936.0	6.1	2.1	302.6	0	10017
10015	09-Feb-08	2289L	GNV	1645.0	6.7	0	459.5	2	10016
10016	09-Feb-08	2778V	MQY	312.0	1.5	0	67.2	0	10011
10017	10-Feb-08	1484P	STL	508.0	3.1	0	105.5	0	10014
10018	10-Feb-08	4278Y	TYS	644.0	3.8	4.5	167.4	0	10017

Table name: EARNEDRATING

EMP_NUM	RTG_CODE	EARNRTG_DATE
101	CFI	18-Feb-98
101	CFII	15-Dec-05
101	INSTR	08-Nov-93
101	MEL	23-Jun-94
101	SEL	21-Apr-93
104	INSTR	15-Jul-96
104	MEL	29-Jan-97
104	SEL	12-Mar-95
105	CFI	18-Nov-97
105	INSTR	17-Apr-95
105	MEL	12-Aug-95
105	SEL	23-Sep-94
106	INSTR	20-Dec-95
106	MEL	02-Apr-96
106	SEL	10-Mar-94
109	CFI	05-Nov-98
109	CFII	21-Jun-03
109	INSTR	23-Jul-96
109	MEL	15-Mar-97
109	SEL	05-Feb-96
109	SES	12-May-96

Table name: AIRCRAFT

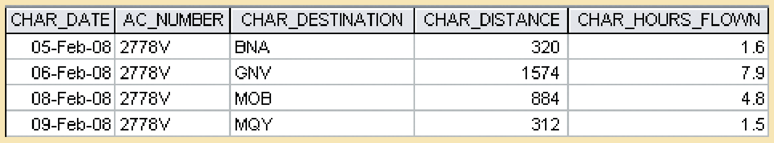
AC_NUMBER	MOD_CODE	AC_TTAF	AC_TTEL	AC_TTER
1484P	PA23-250	1833.1	1833.1	101.8
2289L	C-90A	4243.8	768.9	1123.4
2778V	PA31-350	7992.9	1513.1	789.5
4278Y	PA31-350	2147.3	622.1	243.2

Table name: MODEL

MOD_CODE	MOD_MANUFACTURER	MOD_NAME	MOD_SEATS	MOD_CHG_MILE
C-90A	Beechcraft	KingAir	8	2.67
PA23-250	Piper	Aztec	6	1.93
PA31-350	Piper	Navajo Chieftain	10	2.35

1. Write the SQL code that will list the values for the first four attributes in the CHARTER table.
2. Using the contents of the CHARTER table, write the SQL query that will produce the output shown in Figure P7.2. Note that the output is limited to selected attributes for aircraft number 2778V.

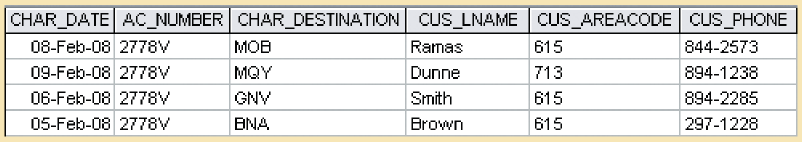
FIGURE P7.2 **Problem 2 query results**



CHAR_DATE	AC_NUMBER	CHAR_DESTINATION	CHAR_DISTANCE	CHAR_HOURS_FLOWN
05-Feb-08	2778V	BNA	320	1.6
06-Feb-08	2778V	GNV	1574	7.9
08-Feb-08	2778V	MOB	884	4.8
09-Feb-08	2778V	MQY	312	1.5

3. Create a virtual table (named AC2778V) containing the output presented in Problem 2.
4. Produce the output shown in Figure P7.4 for aircraft 2778V. Note that this output includes data from the CHARTER and CUSTOMER tables. (*Hint:* Use a JOIN in this query.)

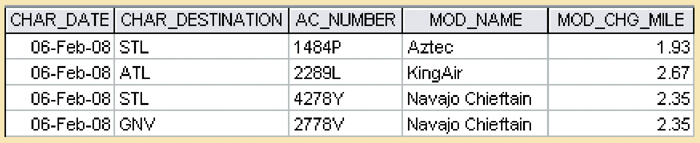
FIGURE P7.4 **Problem 4 query results**



CHAR_DATE	AC_NUMBER	CHAR_DESTINATION	CUS_LNAME	CUS_AREACODE	CUS_PHONE
08-Feb-08	2778V	MOB	Ramas	615	844-2573
09-Feb-08	2778V	MQY	Dunne	713	894-1238
06-Feb-08	2778V	GNV	Smith	615	894-2285
05-Feb-08	2778V	BNA	Brown	615	297-1228

5. Produce the output shown in Figure P7.5. The output, derived from the CHARTER and MODEL tables, is limited to February 6, 2008. (*Hint:* The join passes through another table. Note that the "connection" between CHARTER and MODEL requires the existence of AIRCRAFT because the CHARTER table does not contain a foreign key to MODEL. However, CHARTER does contain AC_NUMBER, a foreign key to AIRCRAFT, which contains a foreign key to MODEL.)

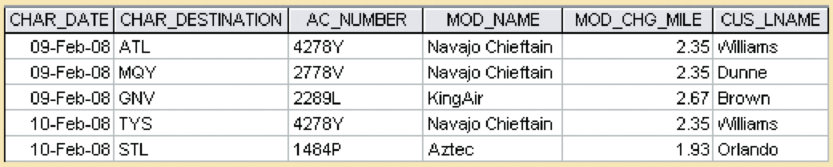
FIGURE P7.5 **Problem 5 query results**



CHAR_DATE	CHAR_DESTINATION	AC_NUMBER	MOD_NAME	MOD_CHG_MILE
06-Feb-08	STL	1484P	Aztec	1.93
06-Feb-08	ATL	2289L	KingAir	2.67
06-Feb-08	STL	4278Y	Navajo Chieftain	2.35
06-Feb-08	GNV	2778V	Navajo Chieftain	2.35

6. Modify the query in Problem 5 to include data from the CUSTOMER table. This time the output is limited to charter records generated since February 9, 2008. (The query results are shown in Figure P7.6.)

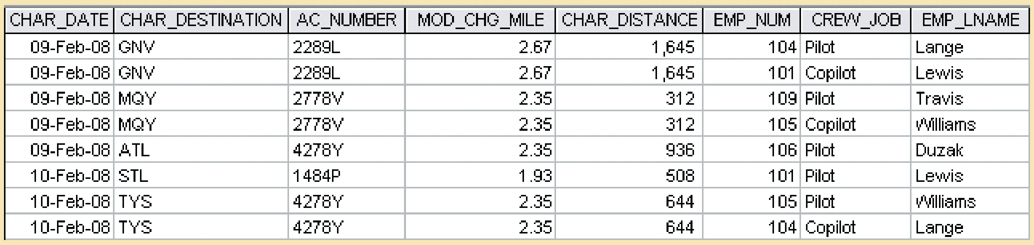
FIGURE P7.6 **Problem 6 query results**



CHAR_DATE	CHAR_DESTINATION	AC_NUMBER	MOD_NAME	MOD_CHG_MILE	CUS_LNAME
09-Feb-08	ATL	4278Y	Navajo Chieftain	2.35	Williams
09-Feb-08	MQY	2778V	Navajo Chieftain	2.35	Dunne
09-Feb-08	GNV	2289L	KingAir	2.67	Brown
10-Feb-08	TYS	4278Y	Navajo Chieftain	2.35	Williams
10-Feb-08	STL	1484P	Aztec	1.93	Orlando

7. Modify the query in Problem 6 to produce the output shown in Figure P7.7. The date limitation in Problem 6 applies to this problem, too. Note that this query includes data from the CREW and EMPLOYEE tables. (*Note*: You might wonder why the date restriction seems to generate more records than it did in Problem 6. Actually, the number of (CHARTER) records is the same, but several records are listed twice to reflect a crew of two: a pilot and a copilot. For example, the record for the 09-Feb-2008 flight to GNV, using aircraft 2289L, required a crew consisting of a pilot (Lange) and a copilot (Lewis).)

FIGURE P7.7 **Problem 7 query results**



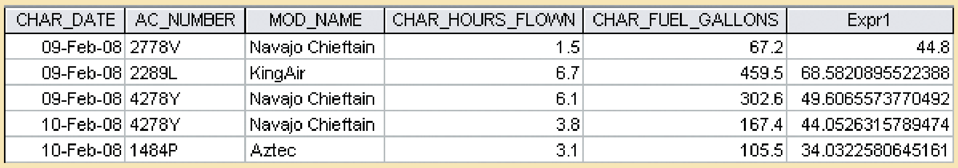
CHAR_DATE	CHAR_DESTINATION	AC_NUMBER	MOD_CHG_MILE	CHAR_DISTANCE	EMP_NUM	CREW_JOB	EMP_LNAME
09-Feb-08	GNV	2289L	2.67	1,645	104	Pilot	Lange
09-Feb-08	GNV	2289L	2.67	1,645	101	Copilot	Lewis
09-Feb-08	MQY	2778V	2.35	312	109	Pilot	Travis
09-Feb-08	MQY	2778V	2.35	312	105	Copilot	Williams
09-Feb-08	ATL	4278Y	2.35	936	106	Pilot	Duzak
10-Feb-08	STL	1484P	1.93	508	101	Pilot	Lewis
10-Feb-08	TYS	4278Y	2.35	644	105	Pilot	Williams
10-Feb-08	TYS	4278Y	2.35	644	104	Copilot	Lange

8. Modify the query in Problem 5 to include the computed (derived) attribute "fuel per hour." (*Hint:* It is possible to use SQL to produce computed "attributes" that are not stored in any table. For example, the SQL query:

```
SELECT    CHAR_DISTANCE, CHAR_FUEL_GALLONS/CHAR_DISTANCE
FROM      CHARTER;
```

is perfectly acceptable. The above query produces the "gallons per mile flown" value.) Use a similar technique on joined tables to produce the "gallons per hour" output shown in Figure P7.8. (Note that 67.2 gallons/1.5 hours produces 44.8 gallons per hour.)

FIGURE P7.8 **Problem 8 query results**



CHAR_DATE	AC_NUMBER	MOD_NAME	CHAR_HOURS_FLOWN	CHAR_FUEL_GALLONS	Expr1
09-Feb-08	2778V	Navajo Chieftain	1.5	67.2	44.8
09-Feb-08	2289L	KingAir	6.7	459.5	68.5820895522388
09-Feb-08	4278Y	Navajo Chieftain	6.1	302.6	49.6065573770492
10-Feb-08	4278Y	Navajo Chieftain	3.8	167.4	44.0526315789474
10-Feb-08	1484P	Aztec	3.1	105.5	34.0322580645161

Query output such as the "gallons per hour" result shown in Figure P7.8 provide managers with very important information. In this case, why is the fuel burn for the Navajo Chieftain 4278Y flown on 9-Feb-08 so much higher than the fuel burn for that aircraft on 10-Feb-08? Such a query result might lead to additional queries to find out who flew the aircraft or what special circumstances might have existed. Is the fuel burn difference due to poor fuel management by the pilot, does it reflect an engine fuel metering problem, or was there an error in the fuel recording? The ability to generate useful query output is an important management asset.

NOTE

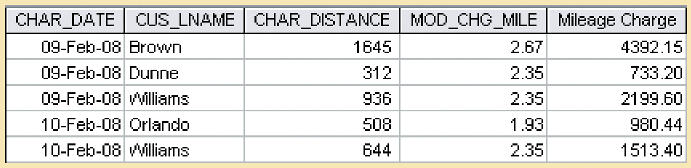
The output format is determined by the RDBMS you use. In this example, the Access software defaulted to an output heading labeled Expr1 to indicate the expression resulting from the division:

[CHARTER]![CHAR_FUEL_GALLONS]/[CHARTER]![CHAR_HOURS]

created by its expression builder. Oracle defaults to the full division label. You should learn to control the output format with the help of your RDBMSs utility software.

9. Create a query to produce the output shown in Figure P7.9. Note that, in this case, the computed attribute requires data found in two different tables. (*Hint:* The MODEL table contains the charge per mile, and the CHARTER table contains the total miles flown.) Note also that the output is limited to charter records generated since February 9, 2008. In addition, the output is ordered by date and, within the date, by the customer's last name.

FIGURE P7.9 **Problem 9 query results**



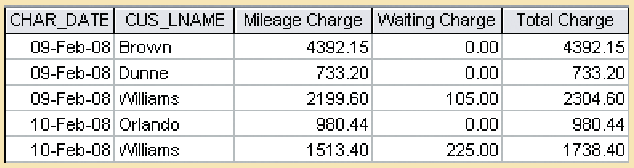
CHAR_DATE	CUS_LNAME	CHAR_DISTANCE	MOD_CHG_MILE	Mileage Charge
09-Feb-08	Brown	1645	2.67	4392.15
09-Feb-08	Dunne	312	2.35	733.20
09-Feb-08	Williams	936	2.35	2199.60
10-Feb-08	Orlando	508	1.93	980.44
10-Feb-08	Williams	644	2.35	1513.40

10. Use the techniques that produced the output in Problem 9 to produce the charges shown in Figure P7.10. The total charge to the customer is computed by:

- Miles flown * charge per mile.
- Hours waited * $50 per hour.

The miles flown (CHAR_DISTANCE) value is found in the CHARTER table, the charge per mile (MOD_CHG_MILE) value is found in the MODEL table, and the hours waited (CHAR_HOURS_WAIT) value is found in the CHARTER table.

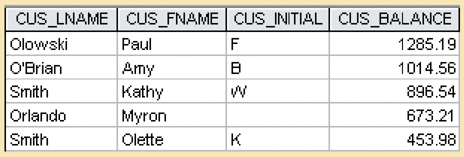
FIGURE P7.10 **Problem 10 query results**



CHAR_DATE	CUS_LNAME	Mileage Charge	Waiting Charge	Total Charge
09-Feb-08	Brown	4392.15	0.00	4392.15
09-Feb-08	Dunne	733.20	0.00	733.20
09-Feb-08	Williams	2199.60	105.00	2304.60
10-Feb-08	Orlando	980.44	0.00	980.44
10-Feb-08	Williams	1513.40	225.00	1738.40

11. Create the SQL query that will produce a list of customers who have an unpaid balance. The required output is shown in Figure P7.11. Note that the balances are listed in descending order.

FIGURE P7.11 **A list of customers with unpaid balances**

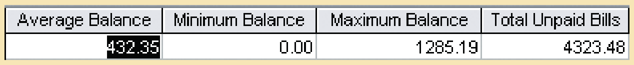


CUS_LNAME	CUS_FNAME	CUS_INITIAL	CUS_BALANCE
Olowski	Paul	F	1285.19
O'Brian	Amy	B	1014.56
Smith	Kathy	W	896.54
Orlando	Myron		673.21
Smith	Olette	K	453.98

12. Find the average customer balance, the minimum balance, the maximum balance, and the total of the unpaid balances. The resulting values are shown in Figure P7.12.

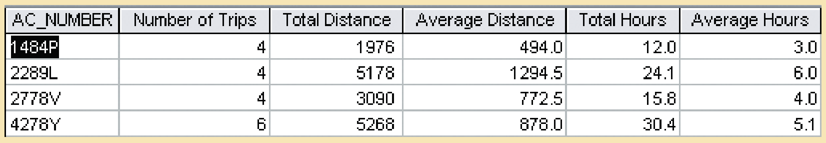
13. Using the CHARTER table as the source, group the aircraft data. Then use the SQL functions to produce the output shown in Figure P7.13. (Utility software was used to modify the headers, so your headers might look different.)

FIGURE P7.12 **Customer balance summary**



Average Balance	Minimum Balance	Maximum Balance	Total Unpaid Bills
432.35	0.00	1285.19	4323.48

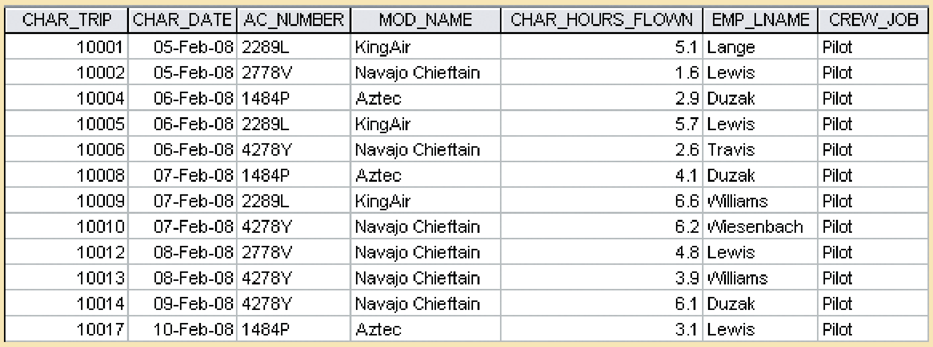
FIGURE P7.13 **The AIRCRAFT data summary statement**



AC_NUMBER	Number of Trips	Total Distance	Average Distance	Total Hours	Average Hours
1484P	4	1976	494.0	12.0	3.0
2289L	4	5178	1294.5	24.1	6.0
2778V	4	3090	772.5	15.8	4.0
4278Y	6	5268	878.0	30.4	5.1

14. Write the SQL code to generate the output shown in Figure P7.14. Note that the listing includes all CHARTER flights that did not include a copilot crew assignment. (*Hint:* The crew assignments are listed in the CREW table. Also note that the pilot's last name requires access to the EMPLOYEE table, while the MOD_CODE requires access to the MODEL table.)

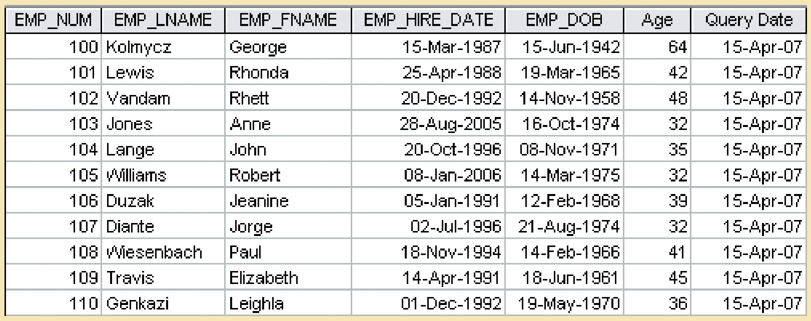
FIGURE P7.14 **Charter flights that did not use a copilot**



CHAR_TRIP	CHAR_DATE	AC_NUMBER	MOD_NAME	CHAR_HOURS_FLOWN	EMP_LNAME	CREW_JOB
10001	05-Feb-08	2289L	KingAir	5.1	Lange	Pilot
10002	05-Feb-08	2778V	Navajo Chieftain	1.6	Lewis	Pilot
10004	06-Feb-08	1484P	Aztec	2.9	Duzak	Pilot
10005	06-Feb-08	2289L	KingAir	5.7	Lewis	Pilot
10006	06-Feb-08	4278Y	Navajo Chieftain	2.6	Travis	Pilot
10008	07-Feb-08	1484P	Aztec	4.1	Duzak	Pilot
10009	07-Feb-08	2289L	KingAir	6.6	Williams	Pilot
10010	07-Feb-08	4278Y	Navajo Chieftain	6.2	Wiesenbach	Pilot
10012	08-Feb-08	2778V	Navajo Chieftain	4.8	Lewis	Pilot
10013	08-Feb-08	4278Y	Navajo Chieftain	3.9	Williams	Pilot
10014	09-Feb-08	4278Y	Navajo Chieftain	6.1	Duzak	Pilot
10017	10-Feb-08	1484P	Aztec	3.1	Lewis	Pilot

15. Write a query that will list the ages of the employees and the date the query was run. The required output is shown in Figure P7.15. (As you can tell, the query was run on May 16, 2007, so the ages of the employees are current as of that date.)

FIGURE P7.15 Employee ages and date of query



EMP_NUM	EMP_LNAME	EMP_FNAME	EMP_HIRE_DATE	EMP_DOB	Age	Query Date
100	Kolmycz	George	15-Mar-1987	15-Jun-1942	64	15-Apr-07
101	Lewis	Rhonda	25-Apr-1988	19-Mar-1965	42	15-Apr-07
102	Vandam	Rhett	20-Dec-1992	14-Nov-1958	48	15-Apr-07
103	Jones	Anne	28-Aug-2005	16-Oct-1974	32	15-Apr-07
104	Lange	John	20-Oct-1996	08-Nov-1971	35	15-Apr-07
105	Williams	Robert	08-Jan-2006	14-Mar-1975	32	15-Apr-07
106	Duzak	Jeanine	05-Jan-1991	12-Feb-1968	39	15-Apr-07
107	Diante	Jorge	02-Jul-1996	21-Aug-1974	32	15-Apr-07
108	Wiesenbach	Paul	18-Nov-1994	14-Feb-1966	41	15-Apr-07
109	Travis	Elizabeth	14-Apr-1991	18-Jun-1961	45	15-Apr-07
110	Genkazi	Leighla	01-Dec-1992	19-May-1970	36	15-Apr-07

ONLINE CONTENT

Problems 16–33 are based on the **Ch07_SaleCo** database located in the Student Online Companion. This database is stored in Microsoft Access format. If you use another DBMS such as Oracle, SQL Server, MySQL, or DB2, use its import utilities to move the Access database contents. The Student Online Companion provides Oracle and SQL script files.

The structure and contents of the **Ch07_SaleCo** database are shown in Figure P7.16. Use this database to answer the following problems. Save each query as QXX, where XX is the problem number.

FIGURE P7.16 The Ch07_SaleCo database

Relational diagram

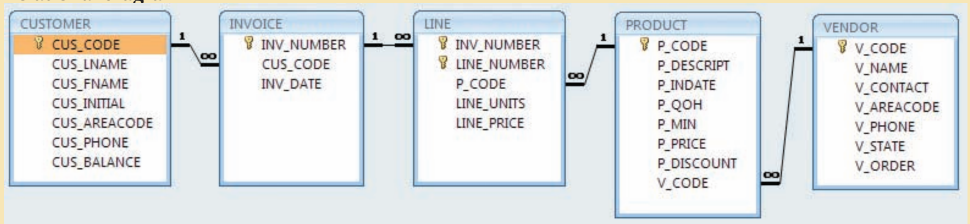


Table name: CUSTOMER

CUS_CODE	CUS_LNAME	CUS_FNAME	CUS_INITIAL	CUS_AREACODE	CUS_PHONE	CUS_BALANCE
10010	Ramas	Alfred	A	615	844-2573	0.00
10011	Dunne	Leona	K	713	894-1238	0.00
10012	Smith	Kathy	W	615	894-2285	345.86
10013	Olowski	Paul	F	615	894-2180	536.75
10014	Orlando	Myron		615	222-1672	0.00
10015	O'Brian	Amy	B	713	442-3381	0.00
10016	Brown	James	G	615	297-1228	221.19
10017	Williams	George		615	290-2556	768.93
10018	Farriss	Anne	G	713	382-7185	216.55
10019	Smith	Olette	K	615	297-3809	0.00

Table name: VENDOR

V_CODE	V_NAME	V_CONTACT	V_AREACODE	V_PHONE	V_STATE	V_ORDER
21225	Bryson, Inc.	Smithson	615	223-3234	TN	Y
21226	SuperLoo, Inc.	Flushing	904	215-8995	FL	N
21231	D&E Supply	Singh	615	228-3245	TN	Y
21344	Gomez Bros.	Ortega	615	889-2546	KY	N
22567	Dome Supply	Smith	901	678-1419	GA	N
23119	Randsets Ltd.	Anderson	901	678-3998	GA	Y
24004	Brackman Bros.	Browning	615	228-1410	TN	N
24288	ORDVA, Inc.	Hakford	615	898-1234	TN	Y
25443	B&K, Inc.	Smith	904	227-0093	FL	N
25501	Damal Supplies	Smythe	615	890-3529	TN	N
25595	Rubicon Systems	Orton	904	456-0092	FL	Y

Table name: INVOICE

INV_NUMBER	CUS_CODE	INV_DATE
1001	10014	16-Mar-08
1002	10011	16-Mar-08
1003	10012	16-Mar-08
1004	10011	17-Mar-08
1005	10018	17-Mar-08
1006	10014	17-Mar-08
1007	10015	17-Mar-08
1008	10011	17-Mar-08

Table name: LINE

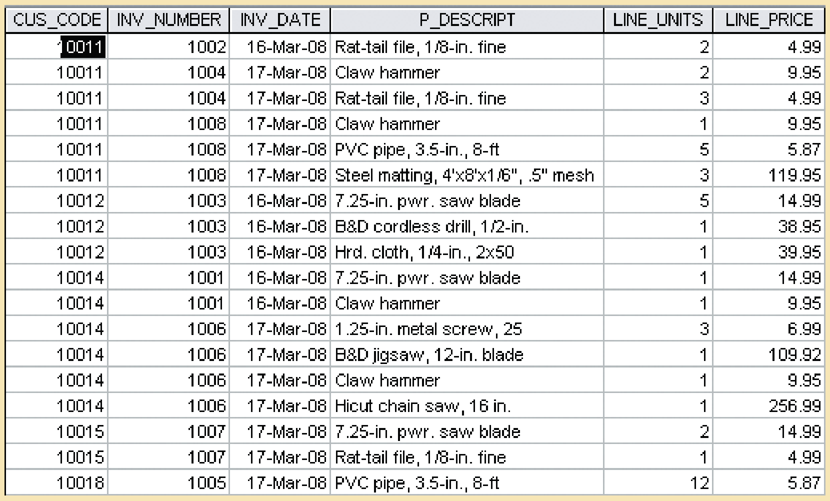
INV_NUMBER	LINE_NUMBER	P_CODE	LINE_UNITS	LINE_PRICE
1001	1	13-Q2/P2	1	14.99
1001	2	23109-HB	1	9.95
1002	1	54778-2T	2	4.99
1003	1	2238/QPD	1	38.95
1003	2	1546-QQ2	1	39.95
1003	3	13-Q2/P2	5	14.99
1004	1	54778-2T	3	4.99
1004	2	23109-HB	2	9.95
1005	1	PVC23DRT	12	5.87
1006	1	SM-18277	3	6.99
1006	2	2232/QTY	1	109.92
1006	3	23109-HB	1	9.95
1006	4	89-WRE-Q	1	256.99
1007	1	13-Q2/P2	2	14.99
1007	2	54778-2T	1	4.99
1008	1	PVC23DRT	5	5.87
1008	2	WR3/TT3	3	119.95
1008	3	23109-HB	1	9.95

Table name: PRODUCT

P_CODE	P_DESCRIPT	P_INDATE	P_QOH	P_MIN	P_PRICE	P_DISCOUNT	V_CODE
11QER/31	Power painter, 15 psi., 3-nozzle	03-Nov-07	8	5	109.99	0.00	25595
13-Q2/P2	7.25-in. pwr. saw blade	13-Dec-07	32	15	14.99	0.05	21344
14-Q1/L3	9.00-in. pwr. saw blade	13-Nov-07	18	12	17.49	0.00	21344
1546-QQ2	Hrd. cloth, 1/4-in., 2x50	15-Jan-08	15	8	39.95	0.00	23119
1558-QW1	Hrd. cloth, 1/2-in., 3x50	15-Jan-08	23	5	43.99	0.00	23119
2232/QTY	B&D jigsaw, 12-in. blade	30-Dec-07	8	5	109.92	0.05	24288
2232/QWE	B&D jigsaw, 8-in. blade	24-Dec-07	6	5	99.87	0.05	24288
2238/QPD	B&D cordless drill, 1/2-in.	20-Jan-08	12	5	38.95	0.05	25595
23109-HB	Claw hammer	20-Jan-08	23	10	9.95	0.10	21225
23114-AA	Sledge hammer, 12 lb.	02-Jan-08	8	5	14.40	0.05	
54778-2T	Rat-tail file, 1/8-in. fine	15-Dec-07	43	20	4.99	0.00	21344
89-WRE-Q	Hicut chain saw, 16 in.	07-Feb-08	11	5	256.99	0.05	24288
PVC23DRT	PVC pipe, 3.5-in., 8-ft	20-Feb-08	188	75	5.87	0.00	
SM-18277	1.25-in. metal screw, 25	01-Mar-08	172	75	6.99	0.00	21225
SW-23116	2.5-in. wd. screw, 50	24-Feb-08	237	100	8.45	0.00	21231
WR3/TT3	Steel matting, 4'x8'x1/6", .5" mesh	17-Jan-08	18	5	119.95	0.10	25595

16. Write a query to count the number of invoices.
17. Write a query to count the number of customers with a customer balance over $500.
18. Generate a listing of all purchases made by the customers, using the output shown in Figure P7.18 as your guide. (*Hint:* Use the ORDER BY clause to order the resulting rows shown in Figure P7.18.)

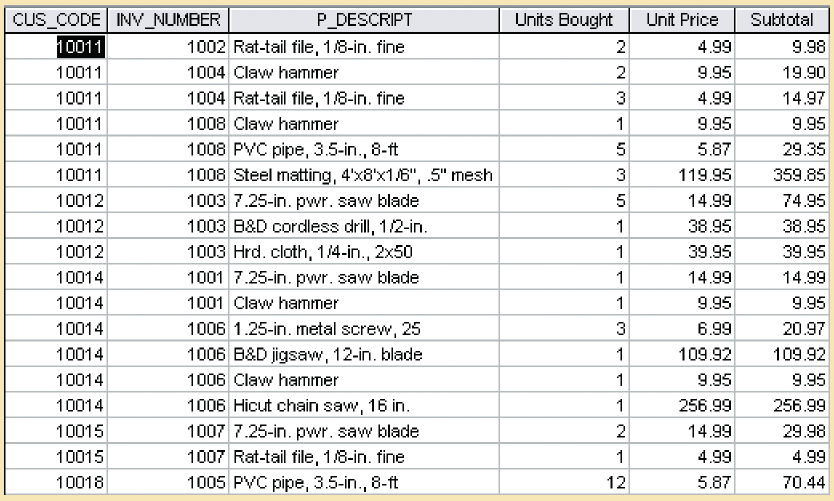
FIGURE P7.18 List of customer purchases



CUS_CODE	INV_NUMBER	INV_DATE	P_DESCRIPT	LINE_UNITS	LINE_PRICE
10011	1002	16-Mar-08	Rat-tail file, 1/8-in. fine	2	4.99
10011	1004	17-Mar-08	Claw hammer	2	9.95
10011	1004	17-Mar-08	Rat-tail file, 1/8-in. fine	3	4.99
10011	1008	17-Mar-08	Claw hammer	1	9.95
10011	1008	17-Mar-08	PVC pipe, 3.5-in., 8-ft	5	5.87
10011	1008	17-Mar-08	Steel matting, 4'x8'x1/6", .5" mesh	3	119.95
10012	1003	16-Mar-08	7.25-in. pwr. saw blade	5	14.99
10012	1003	16-Mar-08	B&D cordless drill, 1/2-in.	1	38.95
10012	1003	16-Mar-08	Hrd. cloth, 1/4-in., 2x50	1	39.95
10014	1001	16-Mar-08	7.25-in. pwr. saw blade	1	14.99
10014	1001	16-Mar-08	Claw hammer	1	9.95
10014	1006	17-Mar-08	1.25-in. metal screw, 25	3	6.99
10014	1006	17-Mar-08	B&D jigsaw, 12-in. blade	1	109.92
10014	1006	17-Mar-08	Claw hammer	1	9.95
10014	1006	17-Mar-08	Hicut chain saw, 16 in.	1	256.99
10015	1007	17-Mar-08	7.25-in. pwr. saw blade	2	14.99
10015	1007	17-Mar-08	Rat-tail file, 1/8-in. fine	1	4.99
10018	1005	17-Mar-08	PVC pipe, 3.5-in., 8-ft	12	5.87

19. Using the output shown in Figure P7.19 as your guide, generate a list of customer purchases, including the subtotals for each of the invoice line numbers. (*Hint:* Modify the query format used to produce the list of customer purchases in Problem 18, delete the INV_DATE column, and add the derived (computed) attribute LINE_UNITS * LINE_PRICE to calculate the subtotals.)

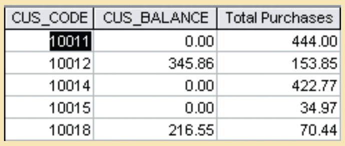
FIGURE P7.19 Summary of customer purchases with subtotals



CUS_CODE	INV_NUMBER	P_DESCRIPT	Units Bought	Unit Price	Subtotal
10011	1002	Rat-tail file, 1/8-in. fine	2	4.99	9.98
10011	1004	Claw hammer	2	9.95	19.90
10011	1004	Rat-tail file, 1/8-in. fine	3	4.99	14.97
10011	1008	Claw hammer	1	9.95	9.95
10011	1008	PVC pipe, 3.5-in., 8-ft	5	5.87	29.35
10011	1008	Steel matting, 4'x8'x1/6", .5" mesh	3	119.95	359.85
10012	1003	7.25-in. pwr. saw blade	5	14.99	74.95
10012	1003	B&D cordless drill, 1/2-in.	1	38.95	38.95
10012	1003	Hrd. cloth, 1/4-in., 2x50	1	39.95	39.95
10014	1001	7.25-in. pwr. saw blade	1	14.99	14.99
10014	1001	Claw hammer	1	9.95	9.95
10014	1006	1.25-in. metal screw, 25	3	6.99	20.97
10014	1006	B&D jigsaw, 12-in. blade	1	109.92	109.92
10014	1006	Claw hammer	1	9.95	9.95
10014	1006	Hicut chain saw, 16 in.	1	256.99	256.99
10015	1007	7.25-in. pwr. saw blade	2	14.99	29.98
10015	1007	Rat-tail file, 1/8-in. fine	1	4.99	4.99
10018	1005	PVC pipe, 3.5-in., 8-ft	12	5.87	70.44

20. Modify the query used in Problem 19 to produce the summary shown in Figure P7.20.

FIGURE P7.20 Customer purchase summary

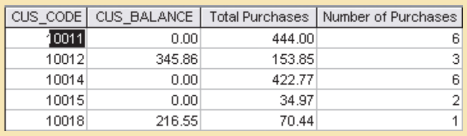


CUS_CODE	CUS_BALANCE	Total Purchases
10011	0.00	444.00
10012	345.86	153.85
10014	0.00	422.77
10015	0.00	34.97
10018	216.55	70.44

21. Modify the query in Problem 20 to include the number of individual product purchases made by each customer. (In other words, if the customer's invoice is based on three products, one per LINE_NUMBER, you would count three product purchases. Note that in the original invoice data, customer 10011 generated three invoices, which contained a total of six lines, each representing a product purchase.) Your output values must match those shown in Figure P7.21.

22. Use a query to compute the average purchase amount per product made by each customer. (*Hint:* Use the results of Problem 21 as the basis for this query.) Your output values must match those shown in Figure P7.22. Note that the average purchase amount is equal to the total purchases divided by the number of purchases.

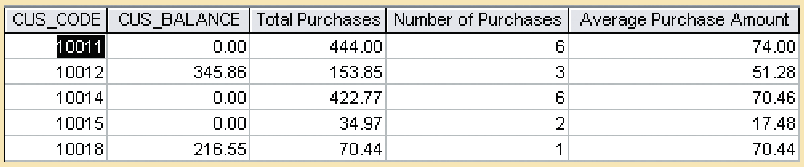
FIGURE P7.21 Customer total purchase amounts and number of purchases



CUS_CODE	CUS_BALANCE	Total Purchases	Number of Purchases
10011	0.00	444.00	6
10012	345.86	153.85	3
10014	0.00	422.77	6
10015	0.00	34.97	2
10018	216.55	70.44	1

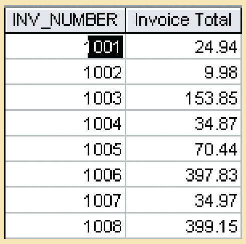
23. Create a query to produce the total purchase per invoice, generating the results shown in Figure P7.23. The invoice total is the sum of the product purchases in the LINE that corresponds to the INVOICE.

FIGURE P7.22 Average purchase amount by customer



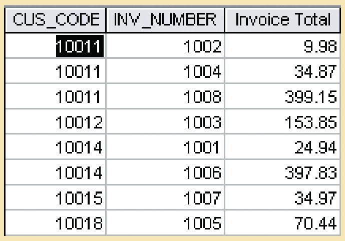
CUS_CODE	CUS_BALANCE	Total Purchases	Number of Purchases	Average Purchase Amount
10011	0.00	444.00	6	74.00
10012	345.86	153.85	3	51.28
10014	0.00	422.77	6	70.46
10015	0.00	34.97	2	17.48
10018	216.55	70.44	1	70.44

FIGURE P7.23 Invoice totals



INV_NUMBER	Invoice Total
1001	24.94
1002	9.98
1003	153.85
1004	34.87
1005	70.44
1006	397.83
1007	34.97
1008	399.15

FIGURE P7.24 Invoice totals by customer



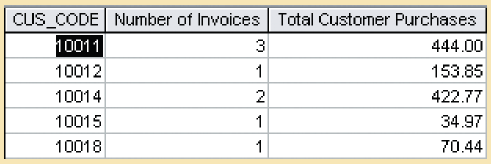
CUS_CODE	INV_NUMBER	Invoice Total
10011	1002	9.98
10011	1004	34.87
10011	1008	399.15
10012	1003	153.85
10014	1001	24.94
10014	1006	397.83
10015	1007	34.97
10018	1005	70.44

24. Use a query to show the invoices and invoice totals as shown in Figure P7.24. (*Hint:* Group by the CUS_CODE.)

25. Write a query to produce the number of invoices and the total purchase amounts by customer, using the output shown in Figure P7.25 as your guide. (Compare this summary to the results shown in Problem 24.)

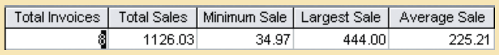
26. Using the query results in Problem 25 as your basis, write a query to generate the total number of invoices, the invoice total for all of the invoices, the smallest invoice amount, the largest invoice amount, and the average of all of the invoices. (*Hint:* Check the figure output in Problem 25.) Your output must match Figure P7.26.

FIGURE P7.25 Number of invoices and total purchase amounts by customer



CUS_CODE	Number of Invoices	Total Customer Purchases
10011	3	444.00
10012	1	153.85
10014	2	422.77
10015	1	34.97
10018	1	70.44

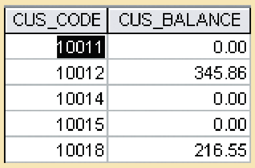
FIGURE P7.26 Number of invoices; invoice totals; minimum, maximum, and average sales



Total Invoices	Total Sales	Minimum Sale	Largest Sale	Average Sale
8	1126.03	34.97	444.00	225.21

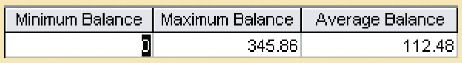
27. List the balance characteristics of the customers who have made purchases during the current invoice cycle—that is, for the customers who appear in the INVOICE table. The results of this query are shown in Figure P7.27.
28. Using the results of the query created in Problem 27, provide a summary of the customer balance characteristics as shown in Figure P7.28.

FIGURE P7.27 Balances of customers who made purchases



CUS_CODE	CUS_BALANCE
10011	0.00
10012	345.86
10014	0.00
10015	0.00
10018	216.55

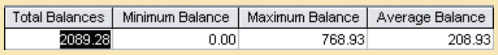
FIGURE P7.28 Balance summary for customers who made purchases



Minimum Balance	Maximum Balance	Average Balance
0	345.86	112.48

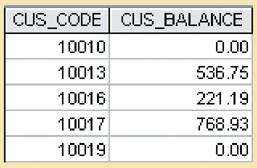
29. Create a query to find the customer balance characteristics for all customers, including the total of the outstanding balances. The results of this query are shown in Figure P7.29.
30. Find the listing of customers who did not make purchases during the invoicing period. Your output must match the output shown in Figure P7.30.

FIGURE P7.29 Balance summary for all customers



Total Balances	Minimum Balance	Maximum Balance	Average Balance
2089.28	0.00	768.93	208.93

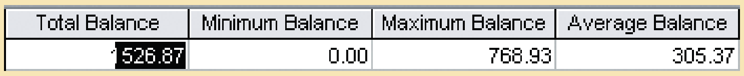
FIGURE P7.30 Balances of customers who did not make purchases



CUS_CODE	CUS_BALANCE
10010	0.00
10013	536.75
10016	221.19
10017	768.93
10019	0.00

31. Find the customer balance summary for all customers who have not made purchases during the current invoicing period. The results are shown in Figure P7.31.

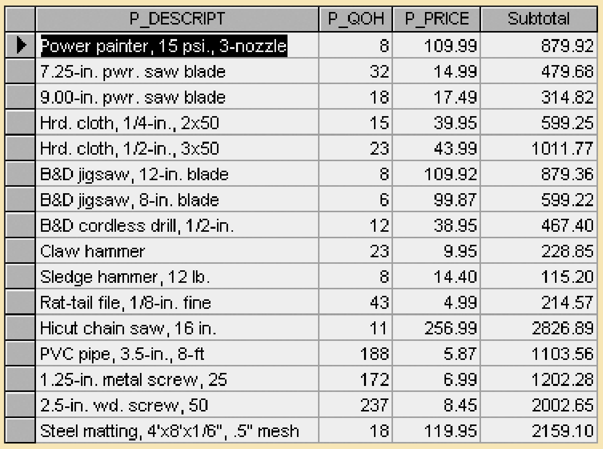
FIGURE P7.31 **Balance summary for customers who did not make purchases**



Total Balance	Minimum Balance	Maximum Balance	Average Balance
1526.87	0.00	768.93	305.37

32. Create a query to produce the summary of the value of products currently in inventory. Note that the value of each product is produced by the multiplication of the units currently in inventory and the unit price. Use the ORDER BY clause to match the order shown in Figure P7.32.

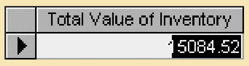
FIGURE P7.32 **Value of products currently in inventory**



P_DESCRIPT	P_QOH	P_PRICE	Subtotal
Power painter, 15 psi., 3-nozzle	8	109.99	879.92
7.25-in. pwr. saw blade	32	14.99	479.68
9.00-in. pwr. saw blade	18	17.49	314.82
Hrd. cloth, 1/4-in., 2x50	15	39.95	599.25
Hrd. cloth, 1/2-in., 3x50	23	43.99	1011.77
B&D jigsaw, 12-in. blade	8	109.92	879.36
B&D jigsaw, 8-in. blade	6	99.87	599.22
B&D cordless drill, 1/2-in.	12	38.95	467.40
Claw hammer	23	9.95	228.85
Sledge hammer, 12 lb.	8	14.40	115.20
Rat-tail file, 1/8-in. fine	43	4.99	214.57
Hicut chain saw, 16 in.	11	256.99	2826.89
PVC pipe, 3.5-in., 8-ft	188	5.87	1103.56
1.25-in. metal screw, 25	172	6.99	1202.28
2.5-in. wd. screw, 50	237	8.45	2002.65
Steel matting, 4'x8'x1/6", .5" mesh	18	119.95	2159.10

33. Using the results of the query created in Problem 32, find the total value of the product inventory. The results are shown in Figure P7.33.

FIGURE P7.33 **Total value of all products in inventory**



Total Value of Inventory
15084.52