Concepts of Database Management
Eighth Edition

Chapter 2

The Relational Model 1: Introduction, QBE, and Relational Algebra

Relational Databases

- A relational database is a collection of tables
- Each entity is stored in its own table
- Attributes of an entity become the fields or columns in the table
- Relationships are implemented through common columns in two or more tables
- Should not permit multiple entries (**repeating groups**) in a table

Relational Databases (continued)

- **Relation**: two-dimensional table in which:
  - Entries are single-valued
  - Each column has a distinct name (called the attribute name)
  - All values in a column are values of the same attribute
  - Order of columns is immaterial
  - Each row is distinct
  - Order of rows is immaterial

Relational Databases (continued)

- **Relational database**: collection of relations
- **Unnormalized relation**
  – A structure that satisfies all properties of a relation except for the first item
  – Entries contain repeating groups; they are not single-valued

Relational Databases (continued)

- Database structure representation
  - Write name of the table followed by a list of all columns within parentheses
  - Each table should appear on its own line
  - Notation to be used with duplicate column names within a database: Tablename.Columnname
    - You **qualify** the column names
- **Primary key**: column or collection of columns of a table (relation) that uniquely identifies a given row in that table

Query-by-Example (QBE)

- **Query**: question represented in a way the DBMS can recognize and process
- **Query-By-Example (QBE)**
  - Visual approach to writing queries
  - Users ask their questions using an on-screen grid
  - Data appears on the screen in tabular form

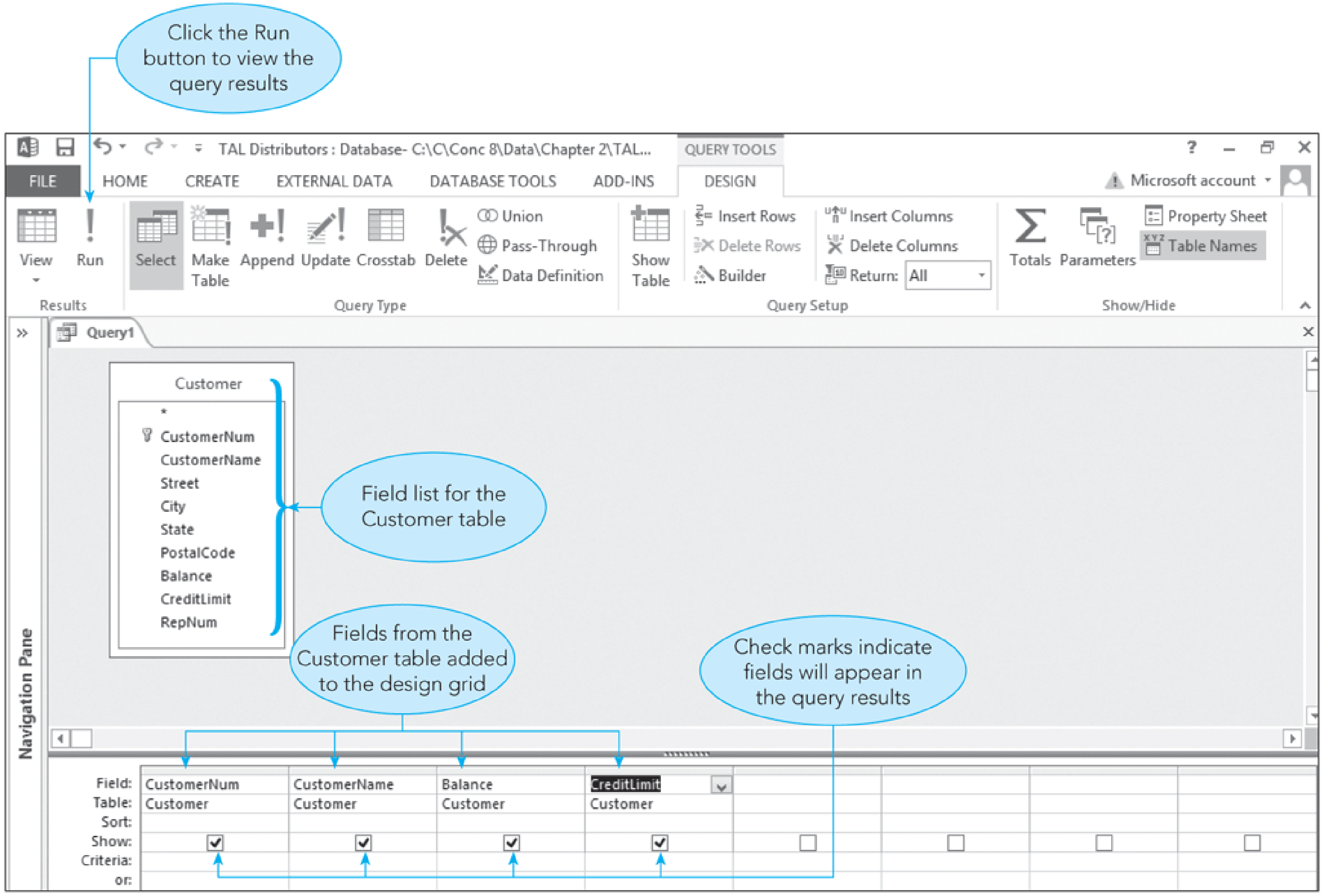
Query-by-Example (QBE) (continued)

- Query window in Access has two panes
  - Upper portion contains a field list for each table you want to query
  - Lower pane contains the **design grid**, where you specify:
    - Format of output
    - Fields to be included in the query results
    - Sort order for query results
    - Any criteria the records must satisfy

Simple Queries

- To include a field in an Access query, double-click the field in the field list to place it in the design grid
- Clicking Run button in Results group on the QUERY TOOLS DESIGN tab runs query and displays query results
- Add all fields from a table to the design grid by double-clicking the asterisk in the table’s field list

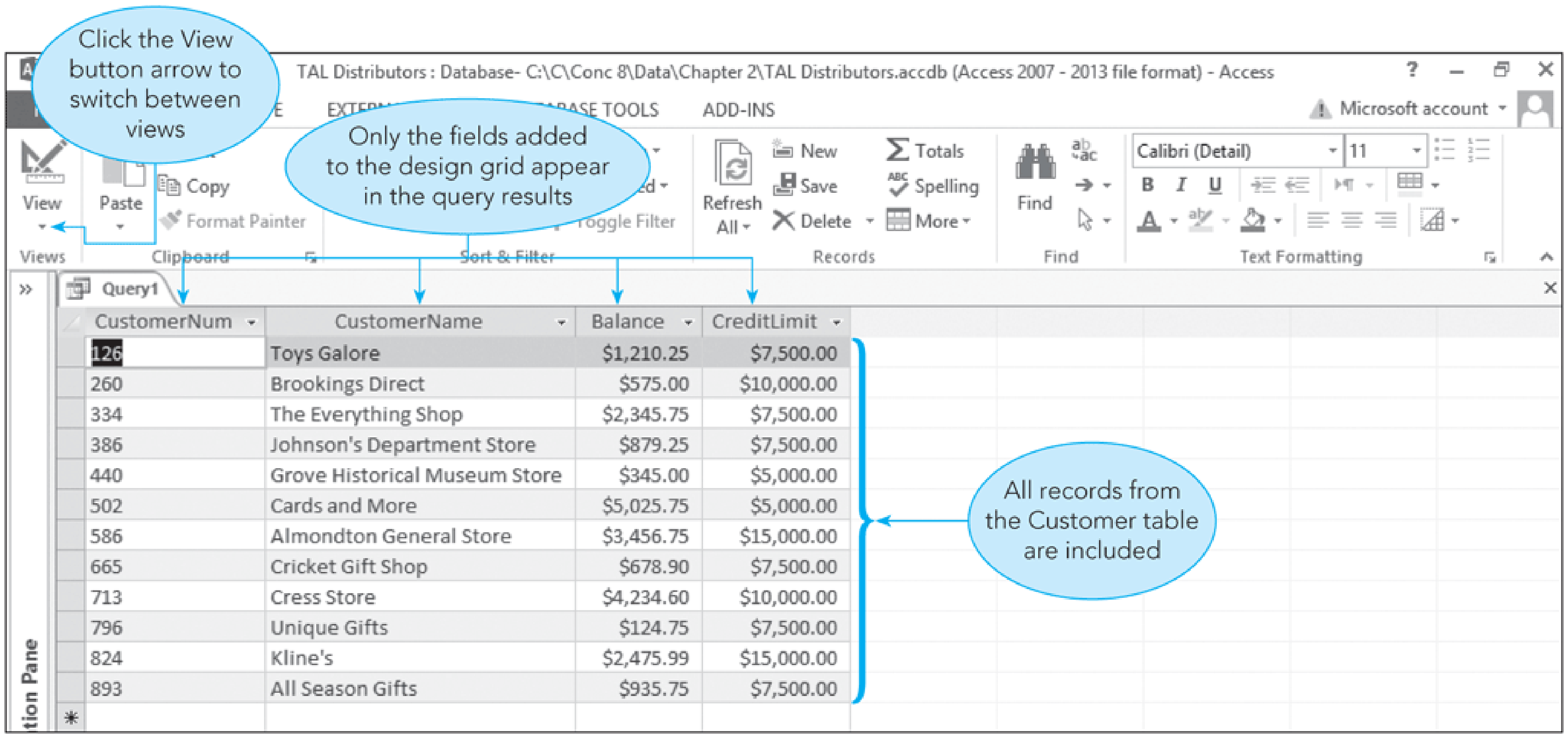
Simple Queries (continued)



Field:	CustomerNum	CustomerName	Balance	CreditLimit				
Table:	Customer	Customer	Customer	Customer				
Sort:								
Show:	☑	☑	☑	☑	☐	☐	☐	☐
Criteria:								
or:								

FIGURE 2-3: Fields added to the design grid

Simple Queries (continued)


Click the View button arrow to switch between views
Only the fields added to the design grid appear in the query results
All records from the Customer table are included
TAL Distributors : Database- C:\C\Conc 8\Data\Chapter 2\TAL Distributors.accdb (Access 2007 - 2013 file format) - Access
Query1

CustomerNum	CustomerName	Balance	CreditLimit
126	Toys Galore	$1,210.25	$7,500.00
260	Brookings Direct	$575.00	$10,000.00
334	The Everything Shop	$2,345.75	$7,500.00
386	Johnson's Department Store	$879.25	$7,500.00
440	Grove Historical Museum Store	$345.00	$5,000.00
502	Cards and More	$5,025.75	$5,000.00
586	Almondton General Store	$3,456.75	$15,000.00
665	Cricket Gift Shop	$678.90	$7,500.00
713	Cress Store	$4,234.60	$10,000.00
796	Unique Gifts	$124.75	$7,500.00
824	Kline's	$2,475.99	$15,000.00
893	All Season Gifts	$935.75	$7,500.00

FIGURE 2-4: Query results

Simple Criteria

- **Criteria**: conditions that data must satisfy
- **Criterion**: single condition that data must satisfy
- To enter a criterion for a field:
  - Include field in the design grid
  - Enter criterion in Criteria row for that field

Simple Criteria (continued)

- **Comparison operator**
  - Also called a **relational operator**
  - Used to find something other than an exact match

  = (equal to)

  > (greater than)

  < (less than)

  >= (greater than or equal to)

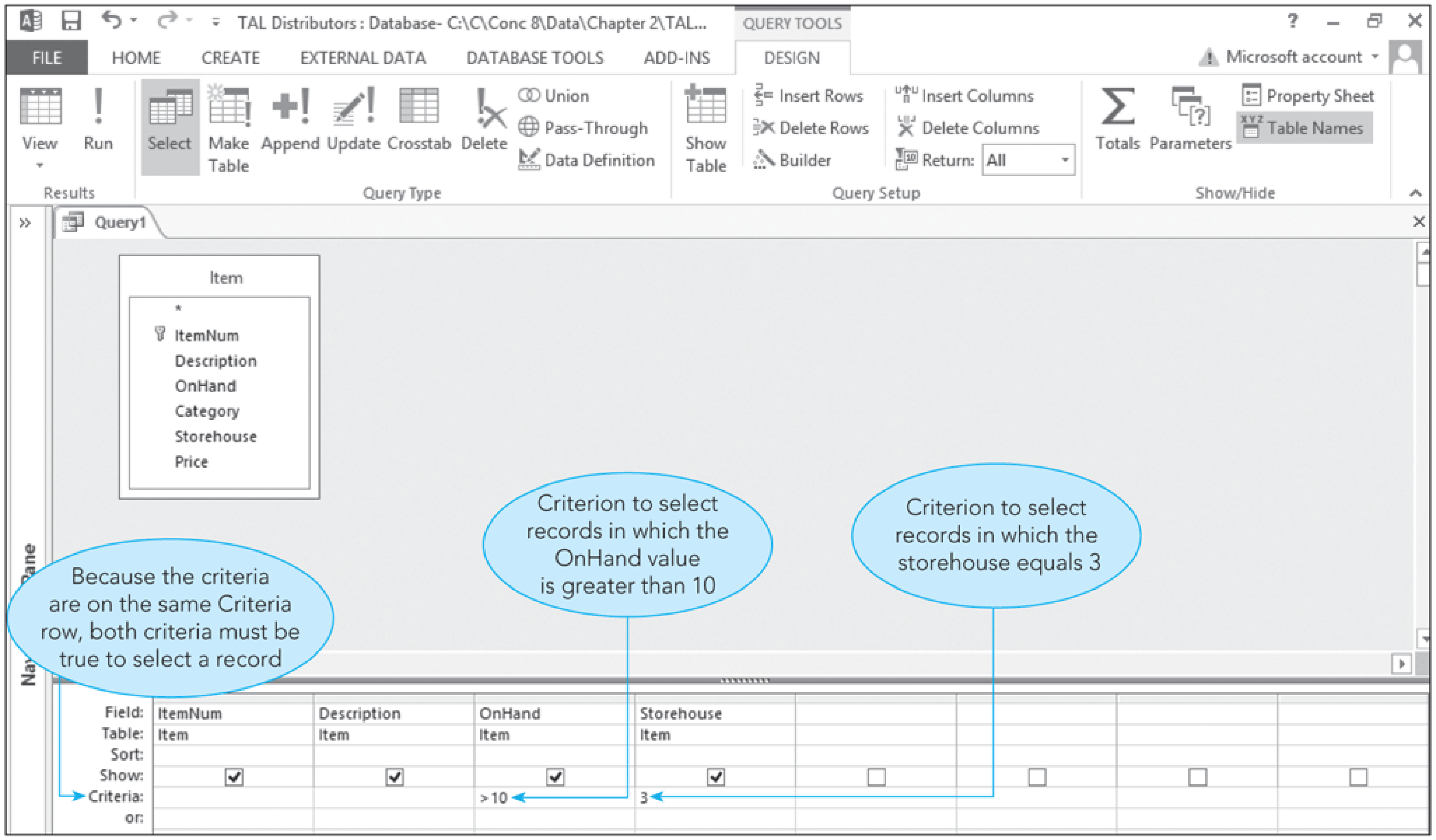
  <= (less than or equal to)

  NOT (not equal to)

Compound Criteria

- **Compound criteria**, or **compound conditions**
  - **AND criterion**: both criteria must be true for the compound criterion to be true
  - **OR criterion**: either criteria must be true for the compound criterion to be true
- To create an AND criterion in QBE:
  - Place the criteria for multiple fields on the same Criteria row in the design grid
- To create an OR criterion in QBE:
  - Place the criteria for multiple fields on different Criteria rows in the design grid

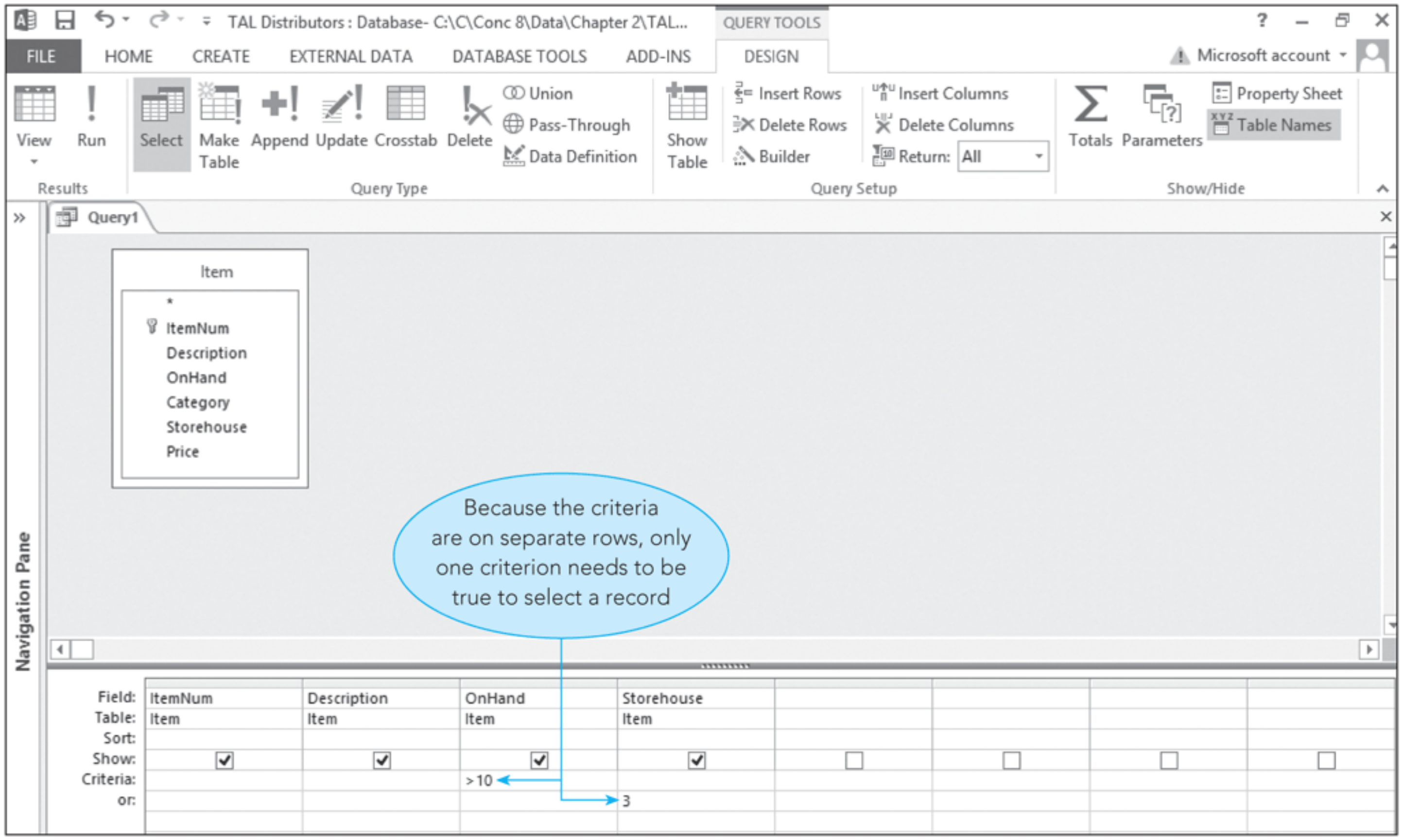
Compound Criteria (continued)



Field:	ItemNum	Description	OnHand	Storehouse				
Table:	Item	Item	Item	Item				
Sort:								
Show:	☑	☑	☑	☑	☐	☐	☐	☐
Criteria:			>10	3				
or:								

FIGURE 2-9: Query that uses an AND criterion

Compound Criteria (continued)


TAL Distributors : Database- C:\C\Conc 8\Data\Chapter 2\TAL...
QUERY TOOLS
FILE HOME CREATE EXTERNAL DATA DATABASE TOOLS ADD-INS DESIGN
Microsoft account
View Run Select Make Table Append Update Crosstab Delete Union Pass-Through Data Definition
Show Table Insert Rows Delete Rows Builder Insert Columns Delete Columns Return: All
Totals Parameters Property Sheet Table Names
Results Query Type Query Setup Show/Hide
Navigation Pane
Query1
Item
*
ItemNum
Description
OnHand
Category
Storehouse
Price

Because the criteria are on separate rows, only one criterion needs to be true to select a record

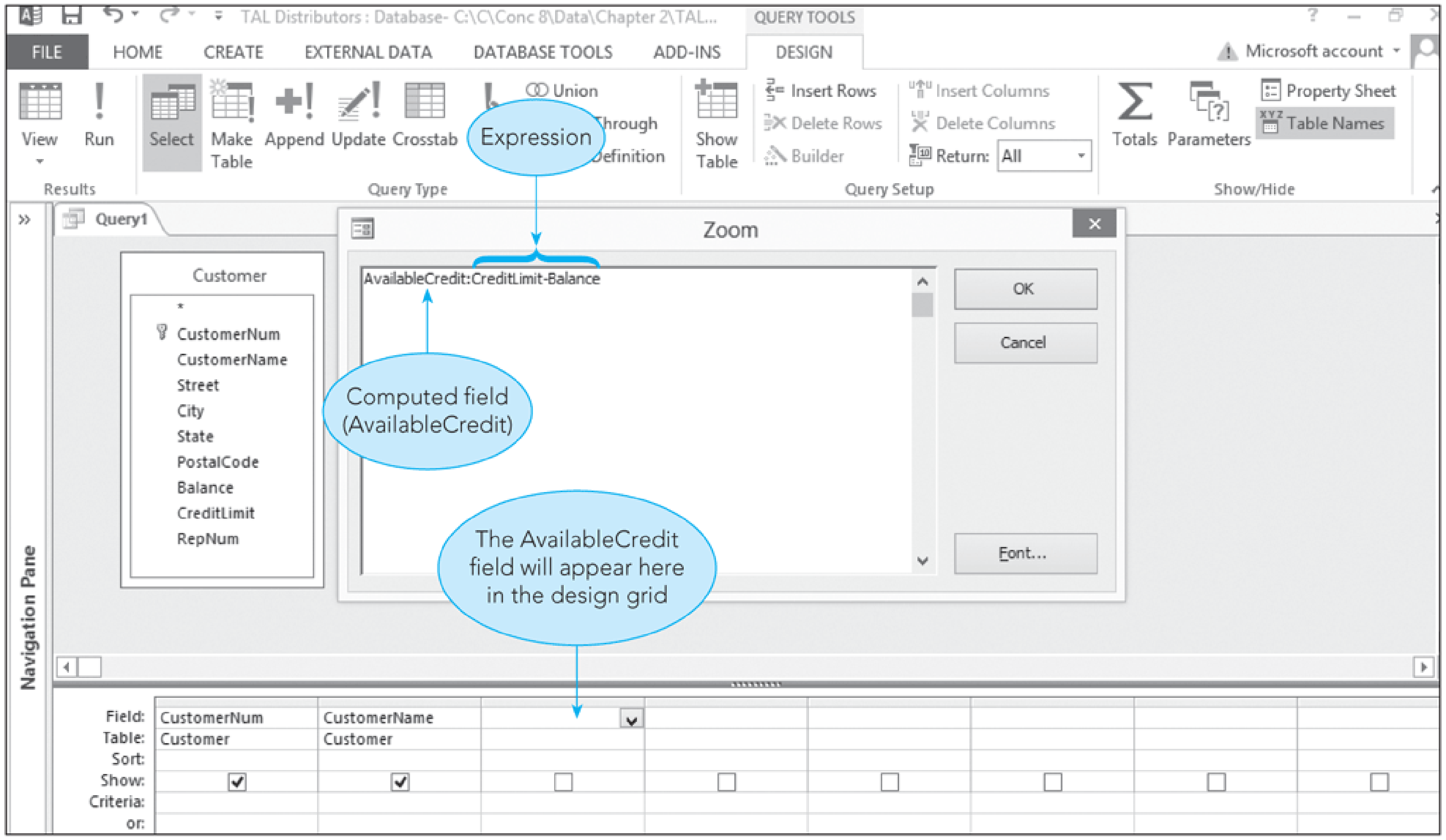
Field:	ItemNum	Description	OnHand	Storehouse				
Table:	Item	Item	Item	Item				
Sort:								
Show:	☑	☑	☑	☑	☐	☐	☐	☐
Criteria:			>10					
or:				3				

FIGURE 2-11: Query that uses an OR criterion

Computed Fields

- **Computed field** or **calculated field**
  - Result of a calculation on one or more existing fields
- To include a computed field in a query:
  - Enter a name for the computed field, followed by a colon, followed by an expression in one of the columns in the Field row
- Alternative method
  - Right-click the column in the Field row, and then click Zoom to open the Zoom dialog box
  - Type the expression in the Zoom dialog box

Computed Fields (continued)



TAL Distributors : Database- C:\C\Conc 8\Data\Chapter 2\TAL...

Customer: *, CustomerNum, CustomerName, Street, City, State, PostalCode, Balance, CreditLimit, RepNum

AvailableCredit:CreditLimit-Balance

Field:	CustomerNum	CustomerName						
Table:	Customer	Customer						
Sort:								
Show:	✓	✓	☐	☐	☐	☐	☐	☐
Criteria:								
or:								

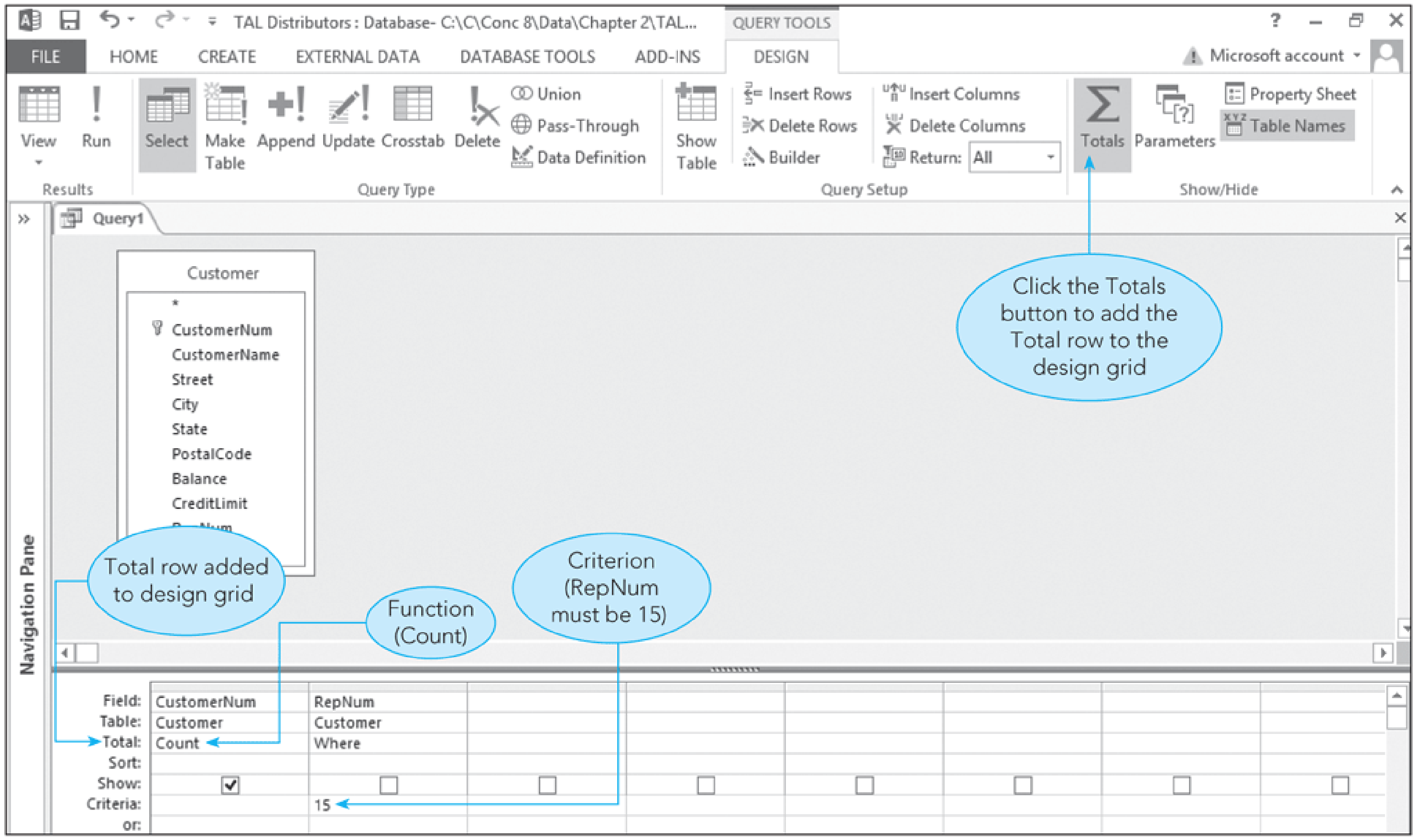
FIGURE 2-15: Query that uses a computed field

Functions

- Built-in **functions**
  - Called **aggregate functions** in Access

- Count
- Sum
- Avg (average)
- Max (largest value)
- Min (smallest value)
- StDev (standard deviation)
- Var (variance)
- First
- Last

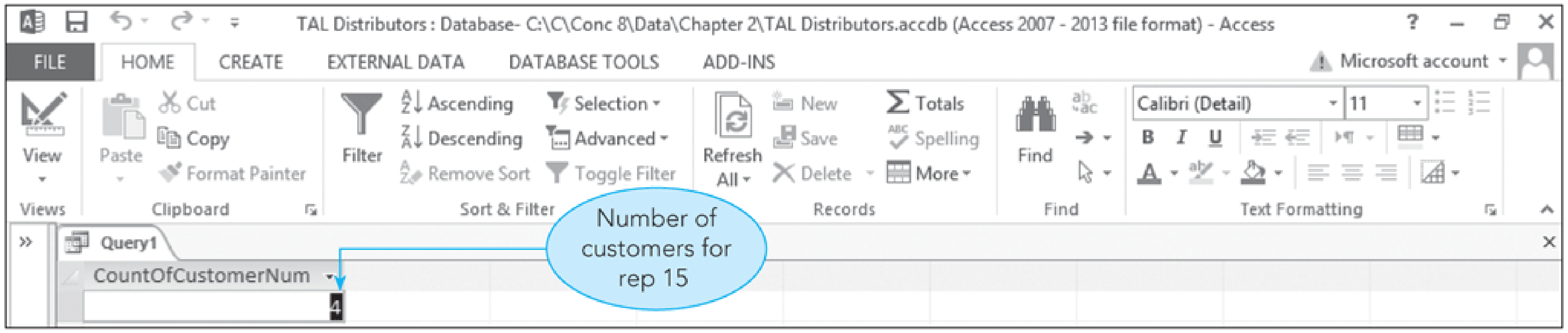
Functions (continued)


Click the Totals button to add the Total row to the design grid
Total row added to design grid
Function (Count)
Criterion (RepNum must be 15)
Customer
*
CustomerNum
CustomerName
Street
City
State
PostalCode
Balance
CreditLimit
Totals
Query1

Field:	CustomerNum	RepNum
Table:	Customer	Customer
Total:	Count	Where
Sort:		
Show:	✓	☐
Criteria:		15
or:		

FIGURE 2-17: Query to count records

Functions (continued)



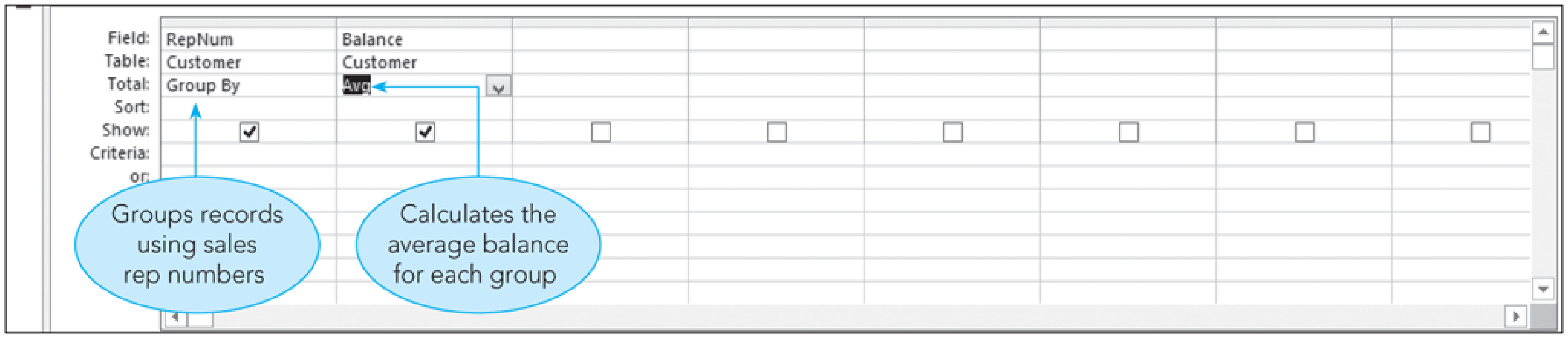
CountOfCustomerNum
4

FIGURE 2-18: Query results

Grouping

- **Grouping**: creating groups of records that share some common characteristic
- To group records in Access:
  - Select Group By operator in the Total row for the field on which to group

Grouping (continued)



Field:	RepNum	Balance
Table:	Customer	Customer
Total:	Group By	Avg
Sort:		
Show:	✓	✓
Criteria:		
or:		

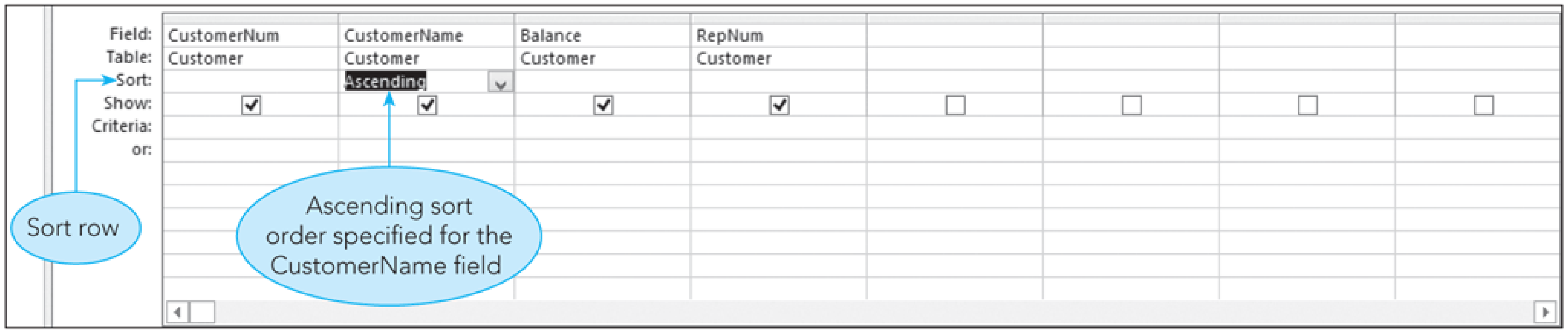
Groups records using sales rep numbers
Calculates the average balance for each group

FIGURE 2-21: Query to group records

Sorting

- **Sorting**: listing records in query results in an ordered way
- **Sort key**: field on which records are sorted
- **Major sort key**
  - Also called the **primary sort key**
  - First sort field, when sorting records by more than one field
- **Minor sort key**
  - Also called the **secondary sort key**
  - Second sort field, when sorting records by more than one field

Sorting (continued)



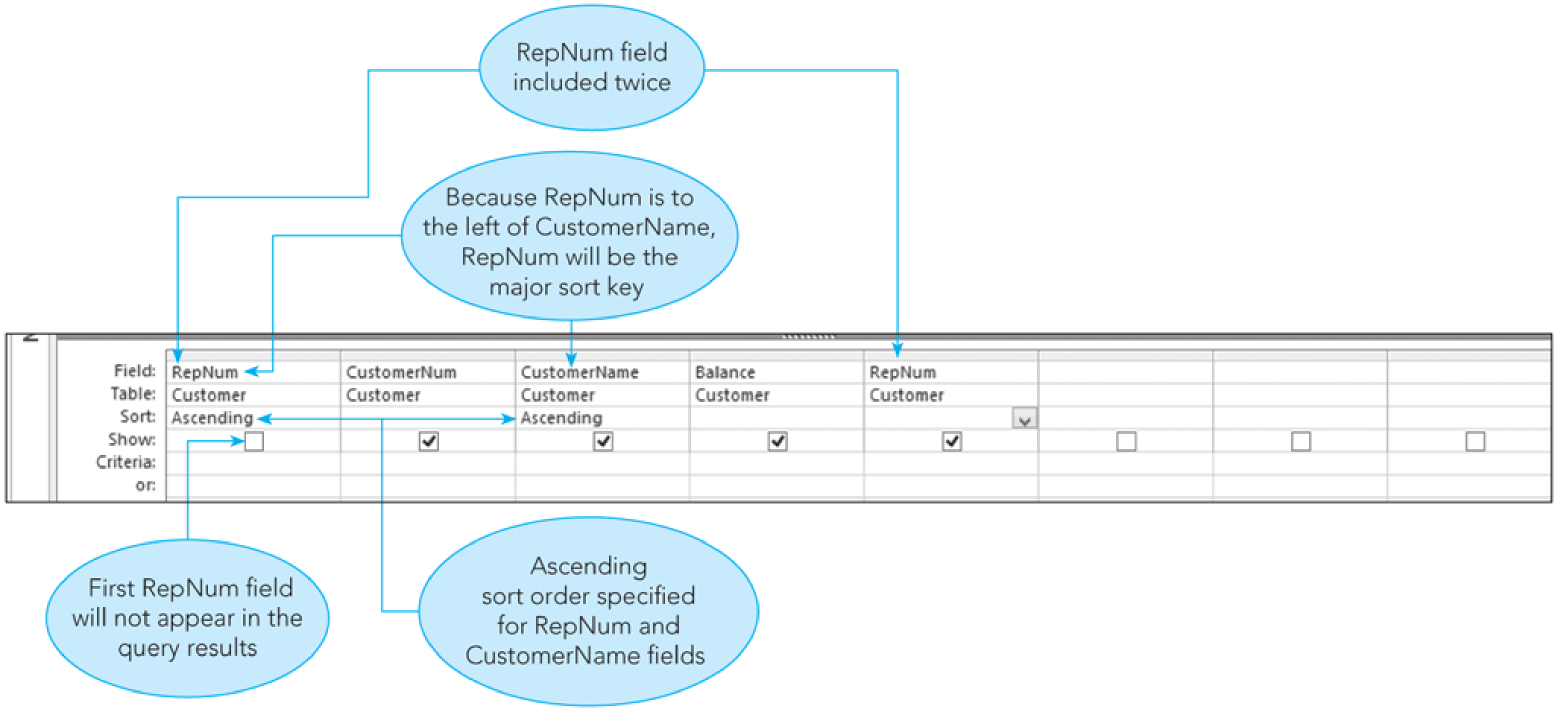
Field:	CustomerNum	CustomerName	Balance	RepNum				
Table:	Customer	Customer	Customer	Customer				
Sort:		Ascending						
Show:	✓	✓	✓	✓	☐	☐	☐	☐
Criteria:								
or:								

FIGURE 2-23: Query to sort records

Sorting on Multiple Keys

- Specifying more than one sort key in a query
- Major (primary) sort key
  - Sort key on the left in the design grid
- Minor (secondary) sort key
  - Sort key on the right in the design grid

Sorting on Multiple Keys (continued)



Field:	RepNum	CustomerNum	CustomerName	Balance	RepNum			
Table:	Customer	Customer	Customer	Customer	Customer			
Sort:	Ascending		Ascending					
Show:	☐	✓	✓	✓	✓	☐	☐	☐
Criteria:								
or:								

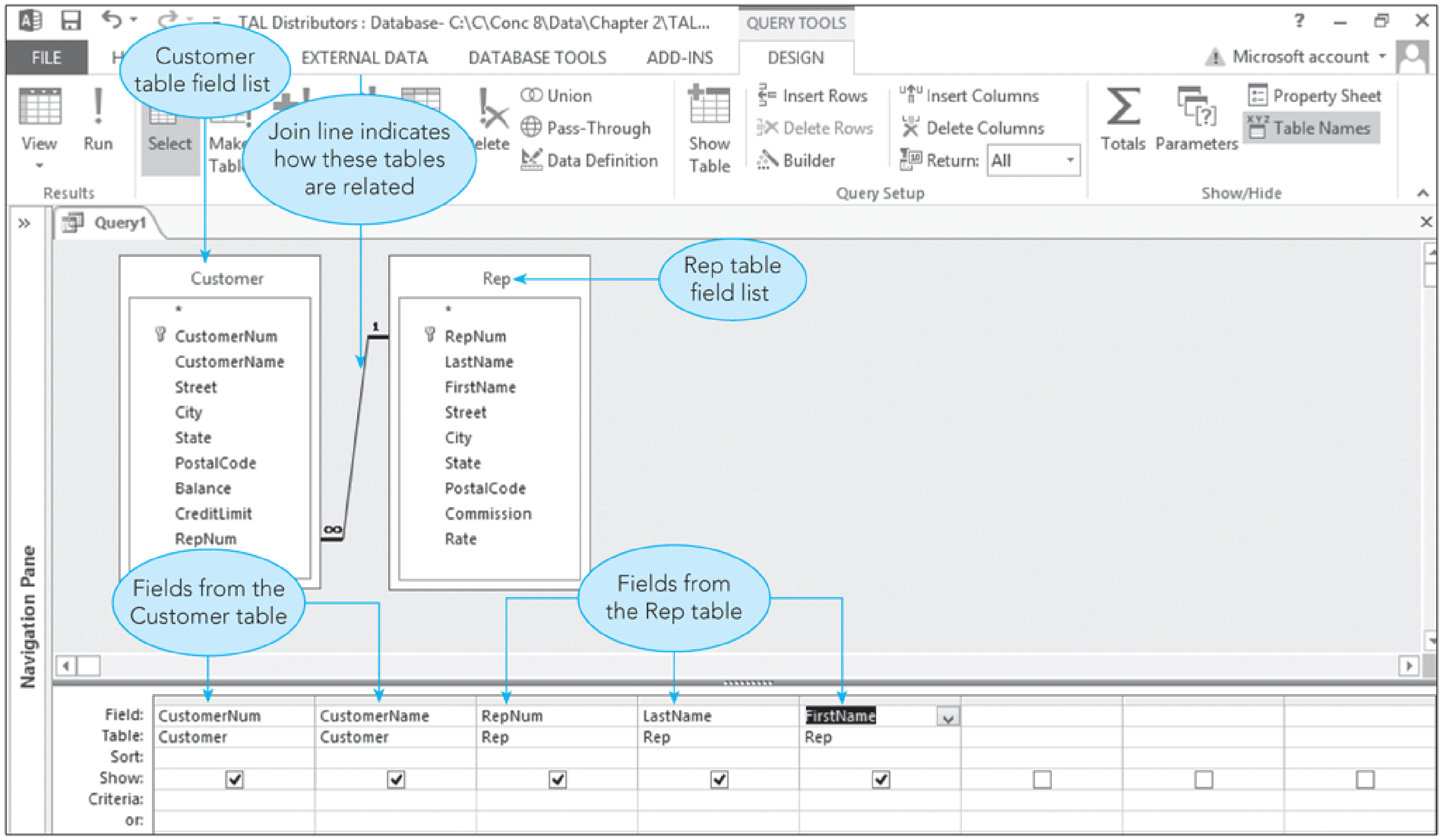
RepNum field included twice
Because RepNum is to the left of CustomerName, RepNum will be the major sort key
First RepNum field will not appear in the query results
Ascending sort order specified for RepNum and CustomerName fields

FIGURE 2-27: Correct query design to sort by RepNum and then by CustomerName

Joining Tables

- Queries to select data from more than one table
- **Join** the tables based on matching fields in corresponding columns
- **Join line**
  - Line drawn by Access between matching fields in the two tables
  - Indicates that the tables are related

Joining Tables (continued)



Field:	CustomerNum	CustomerName	RepNum	LastName	FirstName
Table:	Customer	Customer	Rep	Rep	Rep
Sort:					
Show:	✓	✓	✓	✓	✓
Criteria:					
or:					

FIGURE 2-29: Query design to join two tables

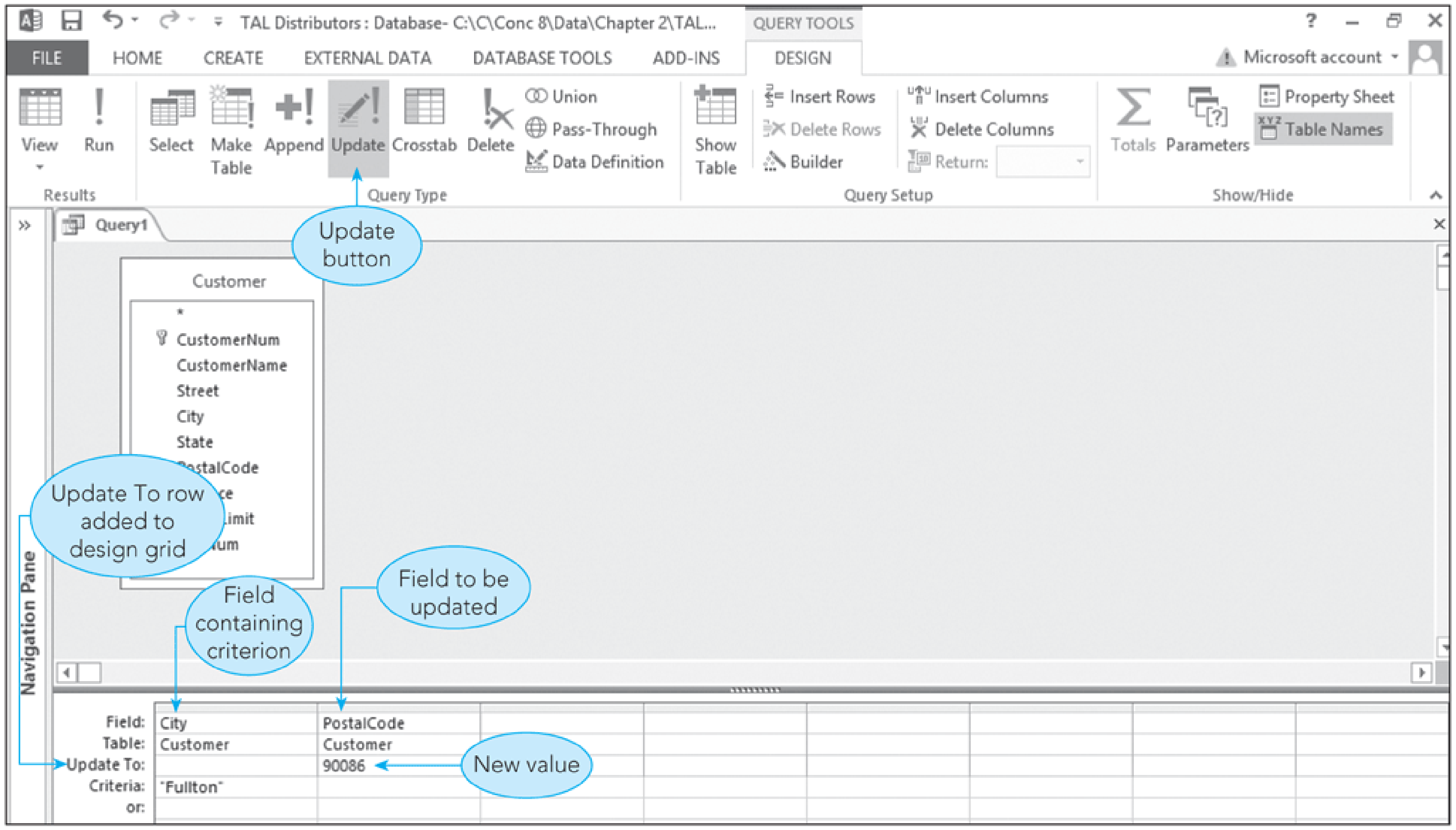
Joining Multiple Tables

- Joining three or more tables is similar to joining two tables
- To join three or more tables:
  - Add the field lists for all tables in the join to upper pane
  - Add the fields to appear in query results to design grid in the desired order

Using an Update Query

- **Update query**: a query that changes data
  - Makes a specified change to all records satisfying the criteria in the query
- To change a query to an update query:
  - Click Update button in the Query Type group on the QUERY TOOLS DESIGN tab
- Update To row is added when an update query is created
  - Used to indicate how to update data selected by the query

Using an Update Query (continued)



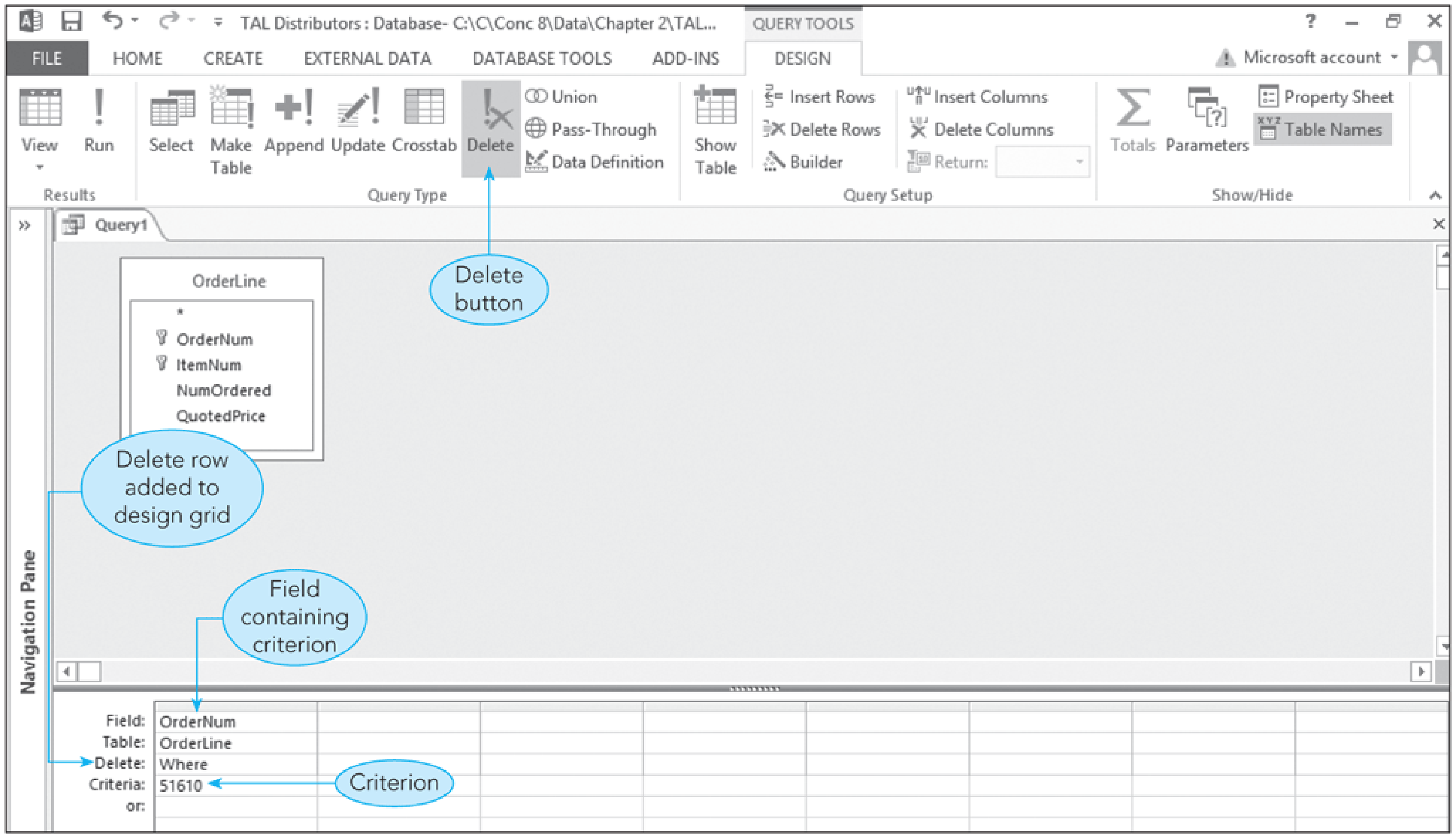
Field:	City	PostalCode
Table:	Customer	Customer
Update To:		90086
Criteria:	"Fullton"	
or:		

FIGURE 2-35: Query design to update data

Using a Delete Query

- **Delete query**: permanently deletes all records satisfying the criteria entered in the query
- To change query type to a delete query:
  - Click Delete button in the Query Type group on the QUERY TOOLS DESIGN tab
- Delete row is added
  - Indicates this is a delete query

Using a Delete Query (continued)



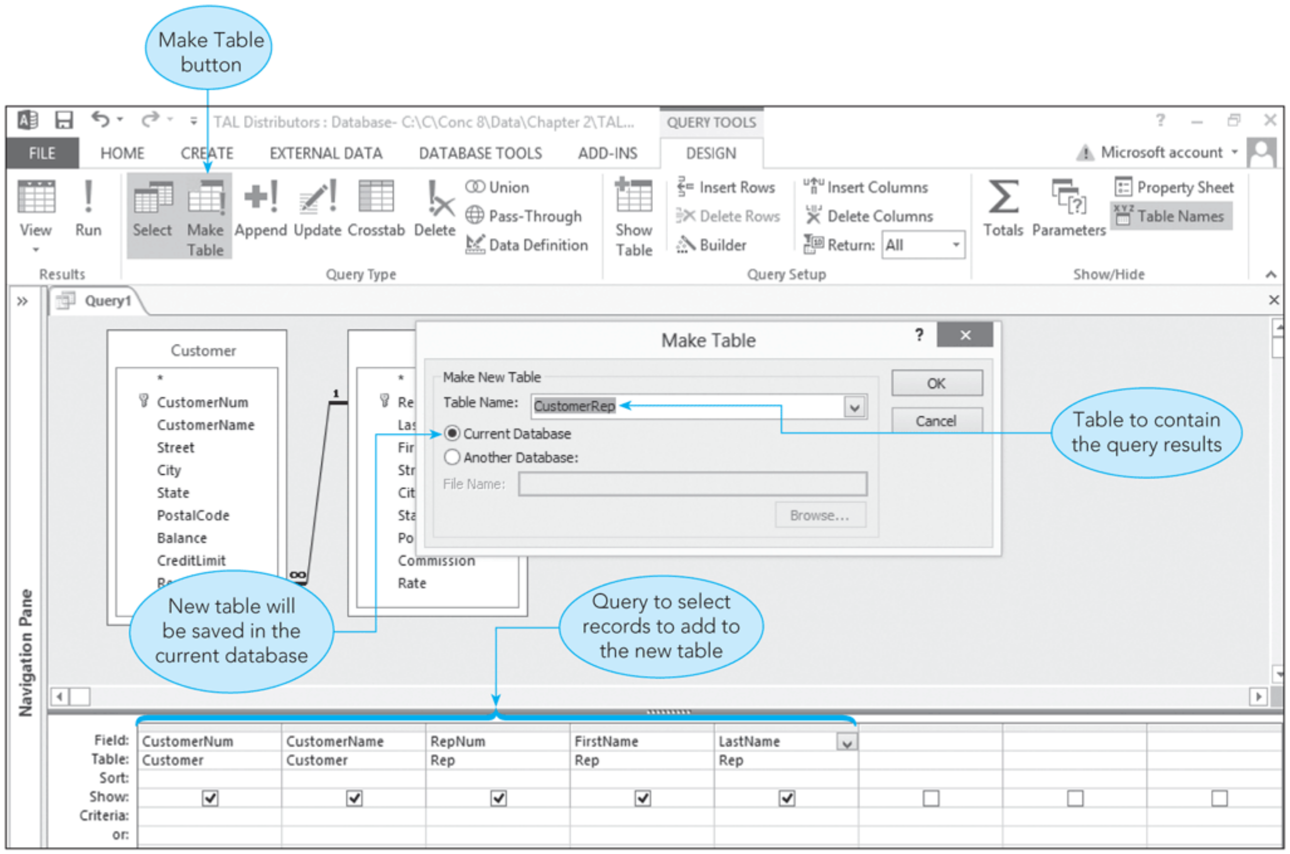
Field:	OrderNum
Table:	OrderLine
Delete:	Where
Criteria:	51610
or:	

FIGURE 2-36: Query design to delete records

Using a Make-Table Query

- **Make-table query**: creates a new table using results of a query
- Records added to new table are separate from the original table
- To change the query type to a make-table query:
  - Click Make Table button in the Query Type group on the QUERY TOOLS DESIGN tab
  - In Make Table dialog box, enter the new table's name and choose where to create it

Using a Make-Table Query (continued)



Make Table

Make New Table

Table Name: CustomerRep

Current Database [✓]

Another Database:

File Name:

Browse...

OK

Cancel

Customer: *, CustomerNum, CustomerName, Street, City, State, PostalCode, Balance, CreditLimit

Rep: *, RepNum, LastName, FirstName, Street, City, State, PostalCode, Commission, Rate

Field:	CustomerNum	CustomerName	RepNum	FirstName	LastName			
Table:	Customer	Customer	Rep	Rep	Rep			
Sort:								
Show:	✓	✓	✓	✓	✓	☐	☐	☐
Criteria:								
or:								

FIGURE 2-38: Make Table dialog box

Relational Algebra

- Theoretical way of manipulating a relational database
- Includes operations that act on existing tables to produce new tables
- Each command ends with a GIVING clause, followed by a table name
  - Clause requests the result of the command to be placed in a temporary table with the specified name

Select

- Takes a horizontal subset of a table
- Retrieves certain rows from an existing table (based on criteria) and saves them as a new table
- Includes the word *WHERE* followed by a condition
- Example:

```
SELECT Customer WHERE CustomerNum=586
     GIVING Answer
```

Project

- Takes a vertical subset of a table
- Causes only certain columns to be included in the new table
- Includes the word *OVER* followed by a list of the columns to be included
- Example:

```
PROJECT Customer OVER (CustomerNum, CustomerName)
     GIVING Answer
```

Join

- Allows extraction of data from more than one table
- Two tables being joined
  - **Join column**: common column on which two tables are joined
  - Rows in new table will be the **concatenation** (combination) of rows from each original table
- **Natural join**: joins records from each original table that is common to both tables
- **Outer join**: joins records from each original table including records not common to both tables

Normal Set Operations

- **Union** of tables A and B
  - Table containing all rows that are in either table A or table B or in both table A and table B
- **Intersection** of tables A and B
  - Table containing all rows that are common in both table A and table B
- **Difference** of tables A and B
  - Referred to as A minus B
  - Set of all rows that are in table A but that are not in table B

Union

- Two tables are **union compatible** when:
  - They have the same number of columns
  - Corresponding columns represent the same type of data

```
JOIN Orders, Customer
     WHERE Orders.CustomerNum=Customer.CustomerNum
     GIVING Temp1
PROJECT Temp1 OVER CustomerNum, CustomerName
     GIVING Temp2
SELECT Customer WHERE RepNum=‘30'
     GIVING Temp3
PROJECT Temp3 OVER CustomerNum, CustomerName
     GIVING Temp4
UNION Temp2 WITH Temp4 GIVING Answer
```

Intersection

- Performed by the **INTERSECT** command

```
JOIN Orders, Customer
     WHERE Orders.CustomerNum=Customer.CustomerNum
     GIVING Temp1
PROJECT Temp1 OVER CustomerNum, CustomerName
     GIVING Temp2
SELECT Customer WHERE RepNum=‘30'
     GIVING Temp3
PROJECT Temp3 OVER CustomerNum, CustomerName
     GIVING Temp4
INTERSECT Temp2 WITH Temp4 GIVING Answer
```

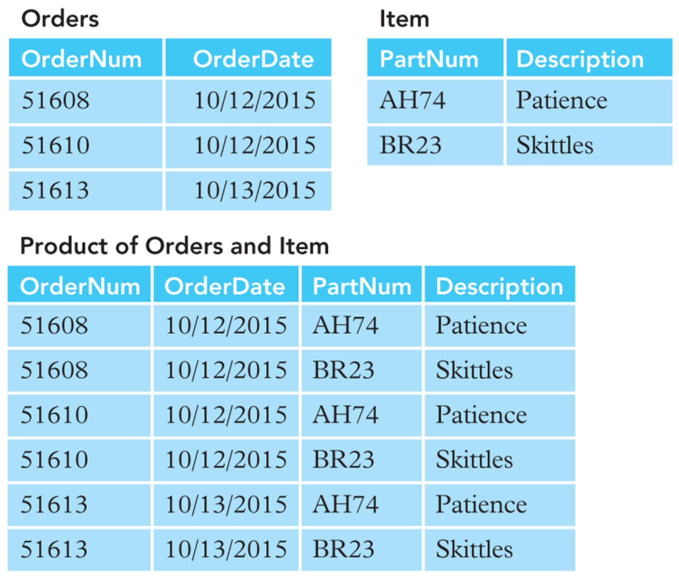
Difference

- Performed by the **SUBTRACT** command

```
JOIN Orders, Customer
     WHERE Orders.CustomerNum=Customer.CustomerNum
     GIVING Temp1
PROJECT Temp1 OVER CustomerNum, CustomerName
     GIVING Temp2
SELECT Customer WHERE RepNum=‘30'
     GIVING Temp3
PROJECT Temp3 OVER CustomerNum, CustomerName
     GIVING Temp4
SUBTRACT Temp4 FROM Temp2 GIVING Answer
```

Product

- Mathematically called the Cartesian product
- Table obtained by concatenating every row in first table with every row in second table



Orders

OrderNum	OrderDate
51608	10/12/2015
51610	10/12/2015
51613	10/13/2015

Item

PartNum	Description
AH74	Patience
BR23	Skittles

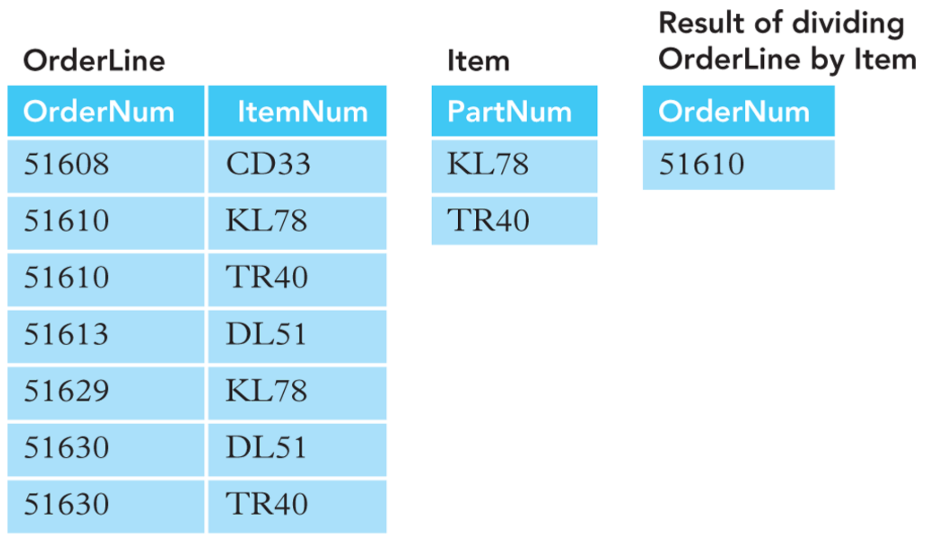
Product of Orders and Item

OrderNum	OrderDate	PartNum	Description
51608	10/12/2015	AH74	Patience
51608	10/12/2015	BR23	Skittles
51610	10/12/2015	AH74	Patience
51610	10/12/2015	BR23	Skittles
51613	10/13/2015	AH74	Patience
51613	10/13/2015	BR23	Skittles

FIGURE 2-43: Product of two tables

Division

- Best illustrated by considering division of a table with two columns by a table with a single column
- Result contains quotient



OrderLine

OrderNum	ItemNum
51608	CD33
51610	KL78
51610	TR40
51613	DL51
51629	KL78
51630	DL51
51630	TR40

Item

PartNum
KL78
TR40

Result of dividing OrderLine by Item

OrderNum
51610

FIGURE 2-44: Dividing one table by another