

## Fundamentals of Database Systems | (5th Edition)

Chapter 6, Problem 16E

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Step-by-step solution

Step 1 of 10

The following symbols are used to write a relation algebra query:

Symbol	Operation
$\sigma$	SELECT
$\pi$	PROJECT
$\bowtie$	EQUI-JOIN
$*$	NATURAL JOIN
$\cup$	FUNCTION
$\div$	DIVISION
-	SET DIFFERENCE

a. Following is the query to find the names of all employees in department 5 who work on the project ProductX for more than 10 hours per week:  
$$R1 \leftarrow (\sigma_{FNAME = 'ProductX'}(PROJECT))$$
$$R2 \leftarrow (R1) \bowtie_{PNUMBER = PNO} (WORKS\_ON)$$
$$R3 \leftarrow (EMPLOYEE) *_{SSN=ESSN} (\sigma_{HOURS > 10} (R2))$$
$$Result \leftarrow \pi_{FNAME, LNAME} (\sigma_{DNO=5} (R3))$$
  
Result of query:

LNAME	FNAME
Smith	John
English	Joyce

  
**Explanation:**

- R1 will give the details of the project whose Pname is 'ProductX'. The details of ProductX will be the output.
- R2 will check the table works\_on for Pno=1. It will give Essn, Pno and hours of the project whose Pnumber is 1.
- R3 will give the employee details from EMPLOYEE table whose Ssn number is same as the Essn number of result R2. The details of the employee with Ssn 123456789 and 453453453 will be displayed.
- Result will display only the Fname and Lname of the output obtained from R3.

Comment

Step 2 of 10

b. Following is the query that displays the names of the employee whose first name and dependent first name is same:  
$$R1 \leftarrow (EMPLOYEE) \bowtie_{(SSN=ESSN) \text{ AND } (FNAME=DEPENDENT\_NAME)} (DEPENDENT)$$
$$Result \leftarrow \pi_{FNAME, LNAME} (R1)$$
  
Result of query: Empty

FNAME	LNAME
-------	-------

  
**Explanation:**

- R1 will retrieve the details of the employees whose SSN of EMPLOYEE table is same as the ESSN of DEPENDENT table and whose FNAME of EMPLOYEE table is same as the DEPENDENT\_NAME of DEPENDENT table.
- Result will display only the Fname and Lname of the output obtained from R1.

Comment

Step 3 of 10

c. Following is the query that displays the names of the employees whose is supervised by Frankin Wong:  
$$R1 \leftarrow \pi_{SSN} (\sigma_{FNAME = 'Frankin' \text{ AND } LNAME = 'Wong'} (EMPLOYEE))$$
$$R2 \leftarrow (EMPLOYEE) \bowtie_{SUPERSSN = SSN} (R1)$$
$$Result \leftarrow \pi_{FNAME, LNAME} (R2)$$
  
Result of query:

FNAME	LNAME
John	Smith
Ramesh	Narayan
Joyce	English

  
**Explanation:**

- R1 will give the SSN of the employee in EMPLOYEE table whose FNAME = 'Frankin' and LNAME = 'Wong'. The output will be 333445555.
- R2 will give the details of the employees in EMPLOYEE table whose SUPERSSN=333445555.
- Result will display only the Fname and Lname of the output obtained from R2.

Comment

Step 4 of 10

d. Following is the query that displays the project name and total hours per week spent one each project:  
$$R1 (PNO, TOT\_HRS) \leftarrow \pi_{PNO, \sum HOURS} (WORKS\_ON)$$
$$Result \leftarrow \pi_{FNAME, TOT\_HRS} ((R1) \bowtie_{PNO= PNUMBER} (PROJECT))$$
  
Result of query:

PNAME	TOT HRS
ProductX	52.5
ProductY	37.5
ProductZ	50.0
Computerization	55.0
Reorganization	25.0
NewBenefits	55.0

  
**Explanation:**

- R1 will give the PNO and sum of Hours from WORKS\_ON table.
- Result will give the PNAME and total of Hours by performing a equijoin between WORKS\_ON table and PROJECT table. A equijoin is performed by matching the PNO of WORKS\_ON table with PNUMBER of PROJECT table.

Comment

Step 5 of 10

e. Following is the query that displays the names of the employees who work on every project:  
$$R1 (PNO, SSN) \leftarrow \pi_{PNO, SSN} (WORKS\_ON)$$
$$R2 (PNO) \leftarrow \pi_{PNUMBER} (PROJECT)$$
$$R3 \leftarrow \pi_{FNAME, LNAME} (R1 \div R2)$$
$$Result \leftarrow \pi_{FNAME, LNAME} (EMPLOYEE * R3)$$
  
Result of query:

FNAME	LNAME
-------	-------

  
**Explanation:**

- R1 will output the PNO and SSN from WORKS\_ON table.
- R2 will output the PNUMBER from PROJECT table.
- R3 will output the FNAME and LNAME after performing R1 ÷ R2.
- Result will output the FNAME and LNAME after performing natural join on EMPLOYEE and R3.

Comment

Step 6 of 10

f. Following is the query that displays the names of the employees who do not work on any project:  
$$R1 \leftarrow \pi_{SSN} (EMPLOYEE)$$
$$R2 (SSN) \leftarrow \pi_{ESSN} (WORKS\_ON)$$
$$R3 \leftarrow R1 - R2$$
$$Result \leftarrow \pi_{FNAME, LNAME} (EMPLOYEE * R3)$$
  
Result of query:

FNAME	LNAME
-------	-------

  
**Explanation:**

- R1 will output the SSN of all employees from EMPLOYEE table.
- R2 will output the ESSN from WORKS\_ON table.
- R3 will perform the difference of result obtained from R1 and R2.
- Result will output the FNAME and LNAME after performing natural join on EMPLOYEE and R3.

Comment

Step 7 of 10

g. Following is the query that displays department name and department's average salary:  
$$R1 (DNUMBER, AVG\_SAL) \leftarrow \pi_{DNO, \sum AVG\_SALARY} (EMPLOYEE)$$
$$Result \leftarrow \pi_{DNUMBER, AVG\_SAL} (R1 \div DEPARTMENT)$$
  
Result of query:

DNUMBER	AVG SAL
Research	33250
Administration	31000
Headquarters	55000

  
**Explanation:**

- R1 will output the average salary of each department from EMPLOYEE table.
- Result will output the average salary of each department after performing the natural join of R1 and DEPARTMENT.

Comment

Step 8 of 10

h. Following is the query that displays average salary of female employees:  
$$Result (AVG\_F\_SAL) \leftarrow \sum_{AVG\_SALARY} (\sigma_{SEX = 'F'} (EMPLOYEE))$$
  
Result of query:

AVG F SAL
31000

  
**Explanation:**

- ( $\sigma_{SEX = 'F'}$  (EMPLOYEE)) will output the details of female employees.
- $\sum_{AVG\_SALARY}$  will perform the average of Salary of result obtained from ( $\sigma_{SEX = 'F'}$  (EMPLOYEE)).

Comment

Step 9 of 10

i. Following is the query that displays names and addresses of employees who work on a project at Houston and whose department has no location Houston:  
$$R1(SSN) \leftarrow \pi_{ESSN} ((WORKS\_ON) \bowtie_{PNO=PNUMBER} (\sigma_{LOCATION='Houston'} (PROJECT)))$$
$$R2 \leftarrow \pi_{DNUMBER} (DEPARTMENT) - \pi_{DNUMBER} (\sigma_{LOCATION='Houston'} (DEPARTMENT))$$
$$R3 \leftarrow \pi_{SSN} (EMPLOYEE) \bowtie_{DNO=DNUMBER} (R2)$$
$$R4 \leftarrow R1 - R3$$
$$Result \leftarrow \pi_{FNAME, LNAME, ADDRESS} (EMPLOYEE * R4)$$
  
Result of query:

FNAME	LNAME	ADDRESS
Jennifer	Wallace	291 Berry, Bellaire, TX

  
**Explanation:**

- R1 will give the ESSNs from WORKS\_ON table whose Project location is in Houston. To know the Project location, PNUMBER of PROJECT table is equijoin with the PNO of WORKS\_ON table.
- R2 will give the DNUMBER of departments that has no location in Houston.
- R3 will give the SSN from EMPLOYEE table whose DNO is equal to the DNUMBER obtained from R2.
- R4 will give the differences of R1 and R3.
- Result will output the FNAME, LNAME and ADDRESS after performing natural join on EMPLOYEE and R4.

Comment

Step 10 of 10

j. Following is the query that displays the last name of managers who have no dependents:  
$$R1 (SSN) \leftarrow \pi_{MGRSSN} (DEPARTMENT)$$
$$R2 (SSN) \leftarrow \pi_{ESSN} (DEPENDANT)$$
$$R3 \leftarrow R1 - R2$$
$$Result \leftarrow \pi_{FNAME, LNAME} (EMPLOYEE * R3)$$
  
Result of query:

FNAME	LNAME
James	Borg

  
**Explanation:**

- R1 will give the MGRSSN from DEPARTMENT table.
- R2 will give the ESSN from DEPENDANT table.
- R3 will give the difference of R1-R2.
- Result will output the FNAME and LNAME after performing natural join on EMPLOYEE and R3.

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