Part 1

Given the following relations:

TABLE T1

P	Q	R
10	a	5
15	b	8
25	a	6

TABLE T2

A	B	C
10	b	6
25	c	3
10	b	5

1. Show the results of the following operations:

a. $T1 \bowtie_{T1.P = T2.A} T2$

b. $T1 \bowtie_{T1.Q = T2.B} T2$

c. $T1 \bowtie_{T1.P = T2.A} T2$

d. $T1 \bowtie_{T1.Q = T2.B} T2$

e. $T1 \cup T2$

f. $T1 \bowtie_{(T1.P = T2.A \text{ AND } T1.R = T2.C)} T2$

Part 2

Given the following database schema for a University:

classroom(*building*, *room_number*, *capacity*)
department(*dept_name*, *building*, *budget*)
course(*course_id*, *title*, *dept_name*, *credits*)
instructor(*ID*, *name*, *dept_name*, *salary*)
section(*course_id*, *sec_id*, *semester*, *year*, *building*, *room_number*, *time_slot_id*)
teaches(*ID*, *course_id*, *sec_id*, *semester*, *year*)
student(*ID*, *name*, *dept_name*, *tot_cred*)
takes(*ID*, *course_id*, *sec_id*, *semester*, *year*, *grade*)
advisor(*s_ID*, *i_ID*)
time_slot(*time_slot_id*, *day*, *start_time*, *end_time*)
prereq(*course_id*, *prereq_id*)

1. Write the following queries in relational algebra:

a. Find the titles of courses in the Comp. Sci. department that have 3 credits.
b. Find the IDs of all students who were taught by an instructor named Einstein; make sure there are no duplicates in the result.
c. Find the highest salary of any instructor.
d. Find all instructors earning the highest salary (there may be more than one with the same salary)

e. Find the enrollment of each section that was offered in Autumn 2009.
f. Find the maximum enrollment, across all sections, in Autumn 2009.
g. Find the sections that had the maximum enrollment in Autumn 2009.

2. Write the following queries in relational algebra:

a. Find the names of all students who have taken at least one Comp. Sci. course.
b. Find the IDs and names of all students who have not taken any course offering before Spring 2009.
c. For each department, find the maximum salary of instructors in that department. You may assume that every department has at least one instructor.
d. Find the lowest, across all departments, of the per-department maximum salary computed by the preceding query

3. write relational-algebra queries to find the course sections taught by more than one instructor in the following ways:
a. Using an aggregate function.
b. Without using any aggregate functions.

Part 3

Given the following database schema:

employee (*person_name*, *street*, *city*)
works (*person_name*, *company_name*, *salary*)
company (*company_name*, *city*)
manages (*person_name*, *manager_name*)

1. Write the following queries in relational algebra:

a. Find the names of all employees who live in the same city and on the same street as do their managers.

b. Find the names of all employees in this database who do not work for “First Bank Corporation”.

c. Find the names of all employees who earn more than every employee of “Small Bank Corporation”

2. Write the following queries in relational algebra:

d. Find all employees who work directly for “Jones”

e. Find all cities of residence of all employees who work directly for “Jones.

f. Find the name of the manager of the manager of “Jones.”

g. Find those employees who earn more than all employees living in the city “Mumbai”.

3. Write the following queries in relational algebra:

a. Find the names of all employees who work for “First Bank Corporation”.
b. Find the names and cities of residence of all employees who work for “First Bank Corporation”.
c. Find the names, street addresses, and cities of residence of all employees who work for “First Bank Corporation” and earn more than $10,000.
d. Find the names of all employees in this database who live in the same city as the company for which they work.

e. Assume the companies may be located in several cities. Find all companies located in every city in which “Small Bank Corporation” is
located.

4. Write the following queries in relational algebra:

a. Find the company with the most employees.
b. Find the company with the smallest payroll.
c. Find those companies whose employees earn a higher salary, on average, than the average salary at First Bank Corporation.

Part 4:

Given the following database schema for a library:

member(*memb_no*, *name*, *dob*)
books(*isbn*, *title*, *authors*, *publisher*)
borrowed(*memb_no*, *isbn*, *date*)

1. Write the following queries in relational algebra:

a. Find the names of members who have borrowed any book published by “McGraw-Hill”.
b. Find the name of members who have borrowed all books published by “McGraw-Hill”.
c. Find the name and membership number of members who have borrowed more than five different books published by “McGraw-Hill”.
d. For each publisher, find the name and membership number of members who have borrowed more than five books of that publisher.
e. Find the average number of books borrowed per member. Take into account that if an member does not borrow any books, then that member does not appear in the *borrowed* relation at all.