1. Flights (*flno*: integer, *from*: string, *to*: string, *distance*: integer, *departs*: time, *arrives*: time)
   Aircraft (*aid*: integer, *aname*: string, *cruisingrange*: integer)
   Certified (*eid*: integer, *aid*: integer)
   Employees (*eid*: integer, *ename*: string, *salary*: integer)

   a. Find the *eids* of pilots certified for some Boeing aircraft.

   $$\pi_{eid}(\sigma_{aname='Boeing'}(Aircraft \bowtie Certified))$$

   b. Find the *names* of pilots certified for some Boeing aircraft.

   $$\pi_{ename}(\sigma_{aname='Boeing'}(Aircraft \bowtie Certified \bowtie Employees))$$

   c. Find the *aids* of all aircraft that can be used on non-stop flights from Bonn to Madrid.

   $$\pi_{aid}(\sigma_{crusingrange > distance}(Aircraft \times \sigma_{from='Bonn' \wedge to='Madrid'}(Flights)))$$

   d. Identify the flights that can be piloted by every pilot whose salary is more than \$100,000.

   $$\pi_{flno}(\sigma_{distance < cruisingrange \wedge salary > 100,000}(Flights \bowtie Aircraft \bowtie Certified \bowtie Employees))$$

   e. Find the *names* of pilots who can operate planes with a range greater than 3,000 miles but are not certified on any Boeing aircraft.

   $$\rho(R, \ \pi_{eid}(\sigma_{cruisingrange > 3000}(Aircraft \bowtie Certified)))$$

   $$\pi_{ename}(Employees \bowtie (X - \pi_{eid}(\sigma_{aname='Boeing'}(Aircraft \bowtie Certified))))$$

   f. Find the *eids* of employees who make the highest salary.

   $$\rho(E1, Employees)$$

   $$\rho(E2, Employees)$$

   $$\rho(T1, \pi_{E2.eid}(E1 \bowtie_{E1.salary > E2.salary} E2)$$

   $$(\pi_{eid}E1) - E3$$

   g. Find the *eids* of employees who make the second highest salary.

   $$\rho(E1, Employees)$$

   $$\rho(E2, Employees)$$

   $$\rho(T1, \pi_{E2.eid}(E1 \bowtie_{E1.salary > E2.salary} E2))$$

   $$\rho(T2, E2 \bowtie E3)$$

   $$\rho(T3, E2 \bowtie E3)$$

   $$\rho(T4, \pi_{T3.eid}(T2 \bowtie_{E1.salary > T3.salary} E5))$$

   $$(\pi_{eid} T1) - T4$$

   h. Find the *eids* of employees who are certified for the largest number of aircraft.

   $$_{Cerified.eid}G_{cnt.aid}(Certified) \rightarrow T1$$

   $$\pi_{eid}\sigma_{max(cnt.aid)}(T1)$$

   i. Find the *eids* of employees who are certified for exactly three aircraft.

   $$_{Cerified.eid}G_{cnt.aid}(Certified) \rightarrow T1$$

   $$\pi_{eid}\sigma_{cnt.aid = 3}(T1)$$

    j.   Find the total amount paid to employees as salaries.

$$G_{sum(Employees.salary)}(Employees)$$

2. Consider the following relations:

Relation r

B	C	D
a	15	b
b	6	a
c	25	b
a	15	c

Relation s

D	E	F
b	10	6
c	25	3
b	10	15

Show the results of the following relational algebraic operations. Give $\varnothing$ as your answer   if you think the operation makes no sense. However,   if you believe an operation makes sense but   no tuples should be returned, you should still draw the schema of the resulting table.

    a. $\pi_D(\sigma_{E\leq 15}(S)) =$

s_D
b

    b. $r \times s =$

r_B	r_C	r_D	s_D	s_E	s_F
a	15	b	b	10	6
a	15	b	c	25	3
a	15	b	b	10	15
b	6	a	b	10	6
b	6	a	c	25	3
b	6	a	b	10	15
c	25	b	b	10	6
c	25	b	c	25	3
c	25	b	b	10	15
a	15	c	b	10	6
a	15	c	c	25	3
a	15	c	b	10	15

c. $r \bowtie s =$

r_B	r_C	r_D	s_E	s_F
a	15	b	10	6
a	15	b	10	15
c	25	b	10	6
c	25	b	10	15
a	15	c	25	3

d. $r \bowtie_{r.C=s.F} s =$

r_B	r_C	r_D	s_D	s_E	s_F
a	15	b	b	10	15
b	6	a	b	10	6
a	15	c	b	10	15

e. $r \bowtie_{r.B = s.D \text{ AND } r.C > s.F} s =$

r_B	r_C	r_D	s_D	s_E	s_F
c	25	b	c	25	3

f. $r \div (\pi_D(s))$

r_B	r_C
a	15

g. $r \cup \pi_D(s) = \varnothing$

h. $r \cap s = \varnothing$

i. $\pi_{B, C}(r) - \pi_{D, F}(s) =$

r_B	r_C
a	15
c	25