1. Find the *name*s of suppliers who supply a red part.

$\pi_{sname}(\pi_{sid}((\pi_{pid}\,\sigma_{color='red'}\,Parts) \bowtie Catalog) \bowtie Suppliers)$

```
SELECT S.sname
FROM Suppliers AS S NATURAL JOIN Catalog AS C NATURAL JOIN Parts AS P
WHERE P.color='red' GROUP BY S.sname;
```

2. Find the *sid*s of suppliers who supply some red or green part.

$\pi_{sid}(\pi_{pid}(\sigma_{color='red' \vee color='green'}\,Parts) \bowtie catalog)$

```
SELECT C.sid
FROM Catalog C JOIN Parts P ON P.pid = C.pid
WHERE                    (P.color = 'red' OR P.color ='green') GROUP BY C.sid;
```

3. Find the *sid*s of suppliers who supply some red part or are at 221 Packer Street.

R1 ← $\pi_{sid}((\pi_{pid}\sigma_{color=\,red}\,Parts) \bowtie Catalog)$
(RENAME with the arrow or by using ρ)

$\rho(R2,\ \pi_{sid}\,\sigma_{address='221Packer\ Street'}\,Suppliers)$

can also be written as

$\rho_{R2}\ (\ \pi_{sid}\,\sigma_{address='221Packer\ Street'}\,Suppliers)$

$R1 \cup R2$

```
SELECT S.sid
FROM   Suppliers S
WHERE  S.address = '221 Packer street'
       OR S.sid IN ( SELECT C.sid
         FROM    Parts P JOIN Catalog C ON P.pid =C.pid
         WHERE   P.color='red' )
```

4. Find the *sid*s of suppliers who supply some red part and some green part

$\rho(R1,\ \pi_{sid}((\pi_{pid}\,\sigma_{color=\,red}\,Parts) \bowtie Catalog))$
$\rho(R2,\ \pi_{sid}((\pi_{pid}\,\sigma_{color=\,green}\,Parts) \bowtie Catalog))$
$R1 \cap R$

```
SELECT sid FROM (
    SELECT DISTINCT sid FROM Catalog NATURAL JOIN Parts WHERE color = red ) AS T1
    NATURAL JOIN
    SELECT DISTINCT sid FROM Catalog NATURAL JOIN Parts WHERE color = red ) AS T2 ) AS T3
```

```
SELECT C.sid
        FROM Parts P JOIN Catalog C ON P.pid = C.pid
          WHERE P.color = 'red'
            AND EXISTS ( SELECT P2.pid
```

```
FROM Parts P2, Catalog C2
WHERE P2.color = 'green' AND C2.sid = C.sid
AND  P2.pid = C2.pid )
        GROUP BY C.sid;
```

5. Find the *sid*s of suppliers who supply every part.

$(\pi_{sid,pid} Catalog) / (\pi_{pid} Parts)$

```
SELECT C.sid
    FROM  Catalog C
      WHERE NOT EXISTS (SELECT P.pid
                        FROM  Parts P
                          WHERE NOT EXISTS (SELECT C1.sid
                                            FROM    Catalog C1
                                            WHERE   C1.sid = C.sid
                                                    AND C1.pid = P.pid))
                        GROUP BY C.sid;
```

6. Find the *sid*s, *snames* and number of parts supplied by every supplier.

$T1 \leftarrow \pi_{s.sid,sname,pid}$ (*Suppliers* $\bowtie$ *Catalog*))

$_{Sid,sname}\mathcal{F}_{COUNT\ pid}$(T1)

```
SELECT sid, sname, COUNT(pid) FROM Suppliers AS s  LEFT JOIN Catalog AS c ON c.sid = s.sid
    GROUP BY sid, sname;
```

OR

```
SELECT sid, sname, COUNT(pid)    FROM (
      SELECT s.sid, sname, pid FROM Suppliers AS s
            LEFT  JOIN catalog AS c ON c.sid = s.sid ) as T1
  GROUP BY sid, sname;
```

7. Find the *sid*s of suppliers who supply every red part or a supplier that supply every green part.

$\rho(R1, ((\pi_{sid,pid} Catalog) / (\pi_{pid} \sigma_{color = red}\ Parts)))$
$\rho(R2, ((\pi_{sid,pid} Catalog) / (\pi_{pid} \sigma_{color = green}\ Parts)))$
$R1 \cup R2$

```
SELECT C.sid
   FROM   Catalog C
   WHERE    (NOT EXISTS (SELECT P.pid
                         FROM Parts P
                          WHERE P.color = 'red' AND
                           (NOT EXISTS (SELECT C1.sid
                                        FROM Catalog C1
                                          WHERE C1.sid = C.sid AND
                                          C1.pid = P.pid))))
            OR ( NOT EXISTS (SELECT P1.pid
                             FROM Parts P1
                              WHERE  P1.color = 'green' AND
                              (NOT  EXISTS  (SELECT C2.sid
                                             FROM Catalog C2
```

```
                                        WHERE C2.sid = C.sid AND
                                              C2.pid = P1.pid))))
GROUP BY C.sid;
```

8. Find pairs of *sid*s such that the supplier with the first *sid* charges more for some part than the supplier with the second *sid*

$\rho(R1, Catalog)$
$\rho(R2, Catalog)$
$\pi_{R1.sid,R2.sid}(\sigma_{R1.pid=R2.pid \wedge R1.sid/=R2.sid \wedge R1.cost>R2.cost}(R1 \times R2))$

SQL

```
SELECT C1.sid, C2.sid
FROM Catalog C1 JOIN Catalog C2 ON C1.pid = C2.pid
WHERE C1.sid <> C2.sid
      AND C1.cost > C2.cost
```

9. Find the *pid*s of parts supplied by at least two different suppliers.

$\rho(R1, Catalog)$
$\rho(R2, Catalog)$
$\pi_{R1.pid}\sigma_{R1.pid=R2.pid \wedge R1.siS|=R2.sid}(R1 \times R2)$

SQL

```
SELECT C.pid
FROM Catalog C
WHERE EXISTS (SELECT C1.sid
                FROM Catalog C1
                WHERE C1.pid = C.pid AND C1.sid <> C.sid )
GROUP BY C.pid;
```

10. Find the *pid*s of the most expensive parts supplied by suppliers named Yosemite Sham. (Assume multiple suppliers with the name 'Yosemite Sham'

WITHOUT THE AGGREGATE RELATIONAL OPERATOR

$\rho(R1, \pi_{sid}\sigma_{sname='YosemiteSham'}Suppliers)$
$\rho(R2, R1 \bowtie Catalog)$
$\rho(R3, R2)$
$\rho(R4(1 \rightarrow sid, 2 \rightarrow pid, 3 \rightarrow cost), \sigma_{R3.cost<R2.cost}(R3 \times R2))$
$\pi_{pid}(R2 - \pi_{sid,pid,cost}R4)$

WITH THE AGGREGATE RELATIONAL OPERATOR

$R1 \leftarrow (\pi_{sid}\sigma_{sname='YosemiteSham'}Suppliers)$
$R2 \leftarrow (R1 \bowtie Catalog)$
$Sid\ \mathcal{F}_{MAX\ cost}(R2)$

```
SELECT C.pid
FROM   Catalog C, Suppliers S
WHERE S.sname = 'Yosemite Sham' AND C.sid = S.sid
      AND C.cost ≥ ALL (Select C2.cost
                        FROM Catalog C2 JOIN Suppliers S2 ON C2.sid = S2.sid
WHERE S2.sname = 'Yosemite Sham') GROUP BY C.pid;
```

11. Find the *pid*s of parts supplied by every supplier at less than $200. (If any supplier either does not supply the part or charges more than $200 for it, the part is not selected.)

$(\pi_{sid,pid}\ \sigma_{cost < 200}\ Catalog) / (\pi_{sid} Supplier)$

```
SELECT C.pid
        FROM  Catalog C
          WHERE NOT EXISTS (SELECT S.sid
                                  FROM  Supplier S
                                       WHERE NOT EXISTS (SELECT C1.sid
                                                                FROM       Catalog C1
                                                                WHERE      C1.pid = C.pid AND
                                                                C.sid = s.sid
                                                       AND C1.sid = S.sid and C1.cost < 200))
         GROUP BY C.pid;
```

12. Find the pids of parts and the number of suppliers that provide that pid.

pid $\mathfrak{F}$ COUNT sid (catalog)

SELECT pid, COUNT(sid) FROM catalog GROUP by pid;