Write your name, date of birth (if you have not registered your social security number), the name of the course, date of the exam and your signature on each answer sheet

1. Let's consider the relations A($\underline{a}$,b,c,d) (n>0 tuples) and B($\underline{a \rightarrow A,k}$,e,d) (m>0 tuples).. Notations:
   π projection, $\times$ cross product, $|\times|$ join, σ selection, * natural join
   a) List the attributes of A * B .

      a,b,c,d,k,e

   b) What is the join condition in A * B.

      A.a=B.a and A.d=B.d

   c) How many tuples A $|\times|_{A.a=B.a}$ B has?
      As many as B (m tuples)

   d) What is the relation between the cardinalities (number of tuples) of $\pi_a(A)$ and $\pi_{a,b}(A)$?
      They have the same number of rows
   e) If $\sigma_{a = 's'}(A)$ has the same cardinality as $\sigma_{a = 's'}(B)$, what is this cardinality ? (15p)
      0 or 1 because a is the key of A

Consider the following library tables
```
person(pId, name, address)
title(titleId, name, yearPublished)
item(itemNumber, title →title, dateAcquired, pricePaid)
borrowing(book→item, dateBorrowed, borrower → person, dateReturned, penalty)
    This table contains data about current and past borrowings. If the book is
    not returned dateReturned is empty. Penalty contains the fine paid if the
    book was not returned in time. It is 0 (zero) if there was no penalty.
biggestItemNumber(itemNumber)
    biggest item number in use
```

2. Express the following queries in SQL. Specify the proper order for the resulting rows.
   a) List the titles acquired during year 1999 in alphabetic order.

      ```
      select name, titleid
      from title where
      yearpublished=1999
      order by name;
      ```

   b) List the persons that currently have books borrowed.

      ```
      select distinct name, pid
      from person, borrowing
      where pid=borrower and datereturned is null
      order by nimi;
      ```

   c) List the persons that have not borrowed any books in year 1999. (12p)

```
select distinct name, pid
from person
where pid not in
    (select borrower
     from borrowing
     where dateborrowed between '1.1.1999' and '31.12.1999';
order by name;
```

3. Express the following queries in SQL. Specify the proper order for the resulting rows.

a)   How many items there are of the title 'Introduction to Horse Care'?

```
select count(*)
   from item
  where title in
          (select titleid
           from title where nimi='Introduction to Horse Care');
```

b)   How much money was used for acquiring books in 1999?

```
select sum(pricepaid)
from item
where dateaquired between '1.1.1999' and '31.12.1999';
```

c)   What has been the yearly income of penalties?

```
select yearOf(datereturned), sum(penalty)
from borrowing
where group by yearOf(datereturned);
```

d)   For which items the penalty income has exceeded the price of the item. (16p)

```
select name, itemnumber
from title, item
where item.title=titleid and
pricepaid<
   (select sum(penalty) from borrowing
where book=itemnumber)
order by name, itemnumber;
```

4. When a new item arrives in the library it will obtain an item number that is next in sequence to the currently biggest item number. The biggest item number is also increased by one. Give the SQL-statements needed for registering a new item. You may give the title, the date acquired and the price as constants. (8p)

```
commit;

insert into item
select itemnumber+1,2345, '5.6.2000',300)
from biggestitemnumber;

update biggestitemnumber
set itemnumber=itemnumber+1;
```

commit;

5. Explain briefly what elements make up a www-based database application. (9p)