1. [6] In one or two words each, identify the operation performed by each of these relational algebra operators.
   a. π
   b. σ
   c. ρ
   d. ∪
   e. ×
   f. ⋈

2. [6] Write relational algebra expressions to answer the following questions.
   You copy these operators into your answers as needed:
   π σ ρ ∪ ∩ − × ⋈

   a. List the name and country of origin of all classes that carried guns of at least 16-inch bore.

   b. Find the ships that were sunk during the battle named 'Denmark Strait'.

3. [6] In one sentence each, describe the result produced by these relational algebra expressions.

   a. π name
      (σ launched > 1921 AND displacement > 35000
         (Class ⋈ Ship))

   b. π name (Ship)
      ∪
      ρ Result(name) (π ship (Outcome))

4. [8] Write SQL queries to answer the following questions.

   a. Find the name and country for all classes with at least 10 guns.

   b. List the name of the ships sunk in battle with the name of the battle in which they were sunk.

5. [6] In one sentence each, describe the result produced by these SQL queries.

   a.
```
SELECT  name
FROM    Ships
WHERE   yearLaunched < 1918 AND name = nameOfClass;
```

   b.
```
SELECT  name AS shipName
FROM    Ships
WHERE   name LIKE 'R%';
```

6. [8] Write an SQL query over multiple relations to answer each of the following questions.

   a. Find the ships heavier than 35,000 tons.

   b. List the name, displacement, and number of guns for all the ships engaged in the battle of Guadalcanal.

7. [8] Write SQL queries with aggregations to answer each of the following questions.

   a. Find the average number of guns on battleships.

   b. Find the year that the first ship of each class was launched.

8. [3] Choose *one* of the following questions.
   Write an SQL query to answer it.

   a. List all the ships mentioned in the database. Note that not all of the ships may appear in the Ship relation.

   b. Find the countries that have both a battleship and a battlecruiser.

9. [3] Write an SQL query to answer the following question.
   Use a subquery in your solution.

   Find the countries whose ships have the maximum number of guns.

10. [3] Convert this relational algebra query to SQL:

    π a, b (σ c < d (R))

11. [3] Consider this query:

```
SELECT name, year FROM Kurt
WHERE length < (SELECT AVG(length) FROM Alice
                WHERE Alice.genre = Kurt.genre);
```

    against the movie relations that had these schema:
      Alice(name, year, length, genre)
      Kurt (name, year, length, genre)

    In the subquery, why do we have to qualify the name Kurt.genre but not length or Alice.genre?