Classes

class	type	country	numGuns	bore	displacement
Bismarck	Bb	Germany	6	15	40000
Iowa	Bb	USA	6	14	38000
Kongo	Bb	Japan	10	16	74000
North Carolina	Bc	USA	8	15	32000
Renown	Bb	GB	12	14	41000
Revenge	Bc	GB	22	16	28000
Tennessee	Bb	USA	4	18	20000
Yamato	Bc	Japan	16	15	37000

Ships

name	class	launched
California	Tennessee	1926
Haruna	Kongo	1910
Hiei	Kongo	1942
Iowa	Iowa	1938
Kirishima	Yamato	1944
Kongo	Yamato	1906
Royal Oak	Revenge	1894
Musashi	Yamato	1922

Battles

name	date
Denmark Strait	04-15-1939
Guadalcanal	04-02-1945
North Cape	09-28-1941
Surigao Strait	02-17-1943
Battle of Midway	03-08-1939

Battle of Stalingrad	07-16-1945
Normandy Landing	01-27-1941
Operation Overlord	02-28-1943

Outcomes

ship	battle	result
California	Pearl Harbor	sunk
Haruna	Pearl Harbor	sunk
Hiei	Pearl Harbor	ok
Iowa	Denmark Strait	sunk
Kirishima	Denmark Strait	damaged
Kongo	Denmark Strait	damaged
Royal Oak	Guadalcanal	sunk
Musashi	Guadalcanal	ok

Exercise 2.4.3

As part of this problem, I want you to create an instance of your WW II ships database with at least eight tuples/relation they give. I.e, use the relation names they have, but don't use the instances they provide in the text, make up your own tuples, and make sure you make up at least 8 tuples/relation. As part of your solution to each part show how the relational algebra query you gave would evaluate its result on the tuples you listed. By show, I mean show at least some intermediate calculations for the query based on relational algebra expression you gave.

a. Give the class names and countries of the classes that carried guns of at least 16-inch bore.

$\sigma_{bore \geq 16}(\text{Classes})$

class	type	country	numGuns	bore	displacement
Kongo	Bb	Japan	10	16	74000
Revenge	Bc	GB	22	16	28000
Tennessee	Bb	USA	4	18	26000

$\pi_{class,country}(\sigma_{bore \geq 16}(Classes))$

class	country
Kongo	Japan
Revenge	GB
Tennessee	USA

b. Find the ships launched prior to 1921

$\sigma_{launched<1921}(Ships)$

name	class	launched
Haruna	Kongo	1910
Kongo	Yamato	1906
Royal Oak	Revenge	1894

$\pi_{name}(\sigma_{launched<1921}(Ships))$

name
Haruna
Kongo
Royal Oak

c. Find the ships sunk in the battle of Denmark Strait.

$\sigma_{battle='Denmark\ Strait'\ AND\ result='sunk'}(Outcomes)$

ship	battle	result
Iowa	Denmark Strait	sunk

$\pi_{ship}(\sigma_{battle='Denmark\ Strait'\ AND\ result='sunk'}(Outcomes))$

Name
Iowa

d. The treaty of Washington in 1921 prohibited capital ships heavier than 35,000 tons. List the ships that violated the treaty of Washington.

$\sigma_{\text{launched>1921 AND displacement>35000}}(\text{Classes}\bowtie\text{Ships})$

name	class	Launched	type	country	numGuns	bore	displacement
Hiei	Kongo	1942	Bb	Japan	10	16	74000
Iowa	Iowa	1938	Bc	USA	8	15	32000
Kirishima	Yamato	1944	Bb	GB	12	14	41000
Musashi	Yamato	1922	Bc	Japan	16	15	37000

$\pi_{\text{name}}(\sigma_{\text{launched>1921 AND displacement>35000}}(\text{Classes}\bowtie\text{Ships}))$

name
Hiei
Iowa
Kirishima
Musashi

e. List the name, displacement, and number of guns of the ships engaged in the battle of Guadalcanal

$\sigma_{\text{battle='Guadalcanal'}}(\text{Outcomes})$

name	class	Launched
Royal Oak	Guadalcanal	sunk
Musashi	Guadalcanal	ok

$\text{Ships}\bowtie_{\text{(ship=name)}}\sigma_{\text{battle='Guadalcanal'}}(\text{Outcomes})\bowtie\text{Classes}$

name	battle	result	class	launched	type	country	numGuns	bore	displacement
Royal Oak	Guadalcanal	sunk	Revenge	1894	Bc	GB	22	16	28000
Musashi	Guadalcanal	ok	Yamato	1922	Bc	Japan	16	15	37000

$\pi_{\text{name,displacement,numGuns}}(\text{Ships}\bowtie_{\text{(ship=name)}}\sigma_{\text{battle='Guadalcanal'}}(\text{Outcomes})\bowtie\text{Classes})$

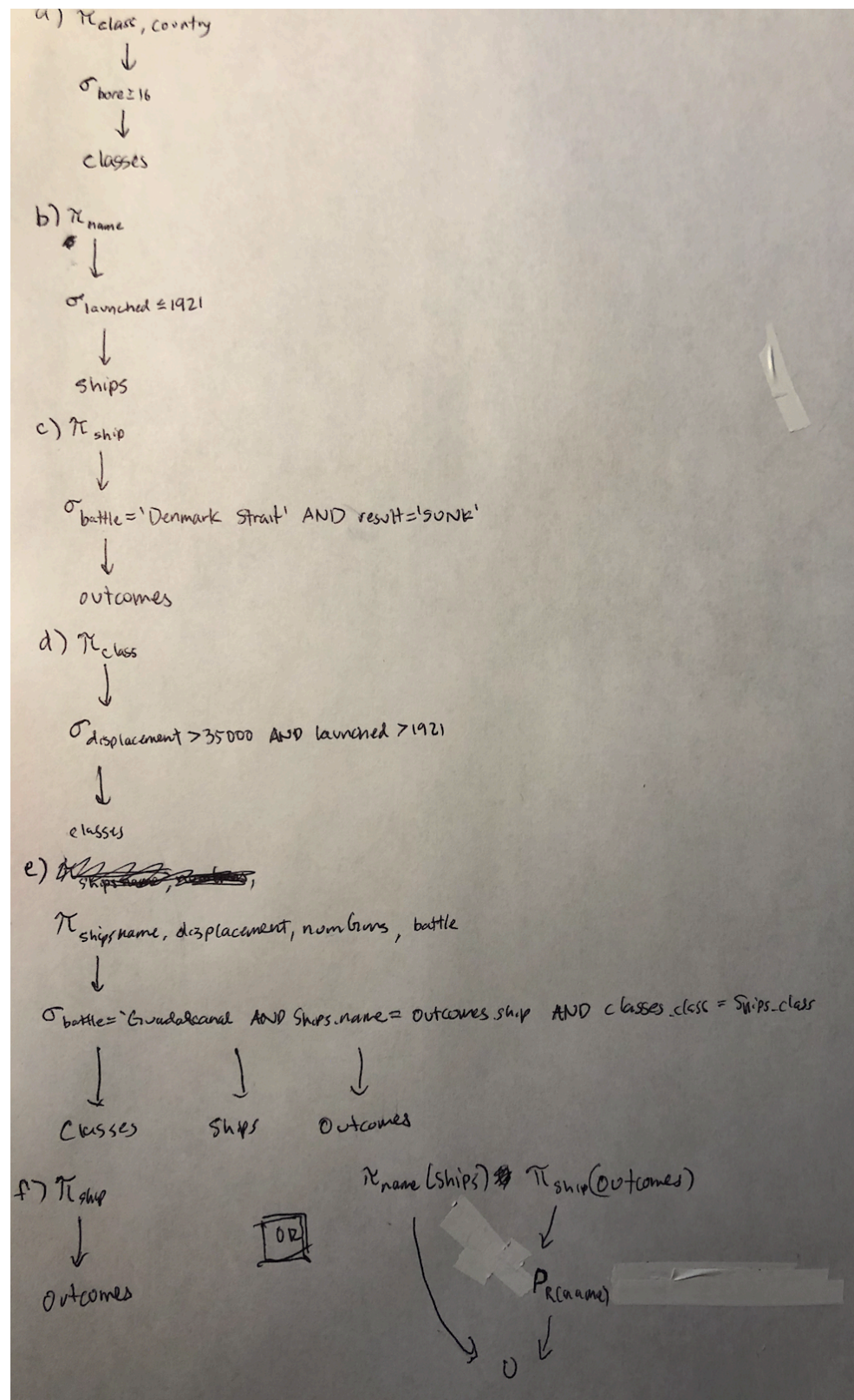| name	displacement	numGuns
Royal Oak	28000	22

Musashi	37000	16

f. List all the capital ships mentioned in the database.

$\pi_{name}(\text{Ships}) \cup \rho_{R(name)}(\pi_{ship}(\text{Outcomes}))$

ship
California
Haruna
Hiei
Iowa
Kirishima
Kongo
Royal Oak
Musashi

Exercise 2.4.4

a) $\pi_{class, country}$
$\downarrow$
$\sigma_{bore \geq 16}$
$\downarrow$
classes

b) π_{name}
$\downarrow$
$\sigma_{launched \leq 1921}$
$\downarrow$
ships

c) π_{ship}
$\downarrow$
$\sigma_{battle = 'Denmark\ Strait'\ AND\ result = 'SUNK'}$
$\downarrow$
outcomes

d) π_{class}
$\downarrow$
$\sigma_{displacement > 35000\ AND\ launched > 1921}$
$\downarrow$
classes

e) ~~ships name, classes,~~

$\pi_{ships\ name,\ displacement,\ numGuns,\ battle}$
$\downarrow$
$\sigma_{battle = 'Guadalcanal'\ AND\ Ships.name = Outcomes.ship\ AND\ classes.class = Ships.class}$
$\downarrow$ $\downarrow$ $\downarrow$
Classes   Ships   Outcomes

f) π_{ship}
$\downarrow$
outcomes

$\boxed{OR}$

$\pi_{name}(Ships) \not{\#} \pi_{ship}(Outcomes)$
$\downarrow$
$\rho_{R(name)}$
$\downarrow$
$\cup$

Exercise 2.5.2

Modify (a) so that the bore must also be at least 10 inches. For (b) change 9 to 7 and 14 to 12. Do the problem with respect to your data above not the book's data.

Express the following constraints in relational algebra. The constraints are based on the relations of Exercise 2.3.2:

Classes(class, type, country, numGuns, bore, displacement)
Ships(name, class, launched)
Battles(name, date)
Outcomes(ship, battle, result)

You may write your constraints either as containments or by equating an expression to the empty set. For the data of Exercise 2.4.3, indicate any violations to your constraints.

a. No class of ships may have guns with larger than 16-inch bore (and at least 10 inches).

$$\pi_{class}(\sigma_{bore>16 \text{ AND } bore<10}(Classes)) = \varnothing$$

b. If a class of ships has more than (7) guns, then their bore must be no larger than (12) inches.

$$\pi_{class}(\sigma_{numGuns>7}(Classes) \cap \sigma_{bore>12}(Classes)) = \varnothing$$

Exercise 3.1.2

Consider a relation representing the present position of molecules in a closed container. The attributes are an ID for the molecule, the x, y, and z coordinates of the molecule, and its velocity in the x, y, and z dimensions. What FD's would you expect to hold? What are the keys?

Molecule:

Mulecule ID –> Coord(X,Y,Z), Velocity(X,Y,Z)

MoleculeID would be a vaild key, because there would not be more than one molecule ID.

Transcript.txt

Create these files first:

--classes.dat
Bismarck|Bb|Germany|6|15|40000
Iowa|Bb|USA|6|14|38000
Kongo|Bb|Japan|10|16|74000
North Carolina| Bc|USA|8|15|32000
Renown|Bb|GB|6|14|41000
Revenge|Bc|GB|6|16|28000
Tennessee|Bb|USA|4|18|20000
Yamato|Bc|Japan|16|15|37000

--ships.dat
California|Tennessee|1926
Haruna|Kongo|1910
Hiei|Kongo|1942
Iowa|Iowa|1938
Kirishima|Yamato|1944
Kongo|Yamato|1906
Royal Oak|Revenge|1894
Musashi|Yamato|1922

--battles.dat
Denmark Strait|04-15-1939
Guadalcanal|04-02-1945
North Cape|09-28-1941
Surigao Strait|02-17-1943
Battle of Midway|03-08-1939
Battle of Stalingrad|07-16-1945
Normandy Landing|01-27-1941
Operation Overlord|02-28-1943

--outcomes.dat
California|Pearl Harbor|sunk
Haruna|Pearl Harbor|sunk
Hiei|Pearl Harbor|ok
Iowa|Denmark Strait|sunk
Kirishima|Denmark Strait|damaged
Kongo|Denmark Strait|damaged
Royal Oak|Guadalcanal|sunk
Musashi|Guadalcanal|ok

Then run these commands:

sqlite3 WW2.db

```
CREATE TABLE Classes(class VARCHCAR(16),
                     type CHAR(2),
                     country VARCHAR(16),
                     numGuns SMALLINT,
                     bore SMALLINT,
                     displacement INT,
                     PRIMARY KEY(class, country));

CREATE TABLE Ships(name VARCHAR(32),
                   class VARCHAR(16),
                   launched SMALLINT,
                   PRIMARY KEY(name, class));

CREATE TABLE Battles(name VARCHAR(32),
                     date DATE,
                     PRIMARY KEY(name));

CREATE TABLE Outcomes(ship VARCHAR(32),
                      battle VARCHAR(32),
                      result VARCHAR(16),
```

```
                        PRIMARY KEY(ship, battle));


.import classes.dat Classes
.import ships.dat Ships
.import battles.dat Battles
.import outcomes.dat Outcomes
```