Exercise 6.4.1: Write each of the queries in Exercise 2.4.1 in SQL, making sure that duplicates are eliminated.

Exercise 6.4.2: Write each of the queries in Exercise 2.4.3 in SQL, making sure that duplicates are eliminated.

Exercise 2.4.1: This exercise builds upon the products schema of Exercise 2.3.1. Recall that the database schema consists of four relations, whose schemas are:

```
Product(maker, model, type)
PC(model, speed, ram, hd, price)
Laptop(model, speed, ram, hd, screen, price)
Printer(model, color, type, price)
```

Some sample data for the relation `Product` is shown in Fig. 2.20. Sample data for the other three relations is shown in Fig. 2.21. Manufacturers and model numbers have been "sanitized," but the data is typical of products on sale at the beginning of 2007.

Write expressions of relational algebra to answer the following queries. You may use the linear notation of Section 2.4.13 if you wish. For the data of Figs. 2.20 and 2.21, show the result of your query. However, your answer should work for arbitrary data, not just the data of these figures.

a) What PC models have a speed of at least 3.00?

b) Which manufacturers make laptops with a hard disk of at least 100GB?

c) Find the model number and price of all products (of any type) made by manufacturer B.

!! h) Find those manufacturers of at least two different computers (PC's or laptops) with speeds of at least 2.80.

Exercise 2.4.3: This exercise builds upon Exercise 2.3.2 concerning World War II capital ships. Recall it involves the following relations:

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

Figures 2.22 and 2.23 give some sample data for these four relations.[4] Note that, unlike the data for Exercise 2.4.1, there are some "dangling tuples" in this data, e.g., ships mentioned in `Outcomes` that are not mentioned in `Ships`.

Write expressions of relational algebra to answer the following queries. You may use the linear notation of Section 2.4.13 if you wish. For the data of Figs. 2.22 and 2.23, show the result of your query. However, your answer should work for arbitrary data, not just the data of these figures.

! g) Find the classes that had only one ship as a member of that class.

Exercise 6.4.6: Write the following queries, based on the database schema

```
Product(maker, model, type)
PC(model, speed, ram, hd, price)
Laptop(model, speed, ram, hd, screen, price)
Printer(model, color, type, price)
```

of Exercise 2.4.1, and evaluate your queries using the data of that exercise.

a) Find the average speed of PC's.

b) Find the average speed of laptops costing over $1000.

c) Find the average price of PC's made by manufacturer "A."

! d) Find the average price of PC's and laptops made by manufacturer "D."

e) Find, for each different speed, the average price of a PC.

! f) Find for each manufacturer, the average screen size of its laptops.

! g) Find the manufacturers that make at least three different models of PC.

! h) Find for each manufacturer who sells PC's the maximum price of a PC.

! i) Find, for each speed of PC above 2.0, the average price.

!! j) Find the average hard disk size of a PC for all those manufacturers that make printers.

Exercise 6.4.7: Write the following queries, based on the database schema

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

of Exercise 2.4.3, and evaluate your queries using the data of that exercise.

a) Find the number of battleship classes.

b) Find the average number of guns of battleship classes.

! c) Find the average number of guns of battleships. Note the difference between (b) and (c); do we weight a class by the number of ships of that class or not?

! d) Find for each class the year in which the first ship of that class was launched.

! e) Find for each class the number of ships of that class sunk in battle.

Exercise 6.5.1: Write the following database modifications, based on the database schema

```
Product(maker, model, type)
PC(model, speed, ram, hd, price)
Laptop(model, speed, ram, hd, screen, price)
Printer(model, color, type, price)
```

of Exercise 2.4.1. Describe the effect of the modifications on the data of that exercise.

a) Using two `INSERT` statements, store in the database the fact that PC model 1100 is made by manufacturer C, has speed 3.2, RAM 1024, hard disk 180, and sells for $2499.

! b) Insert the facts that for every PC there is a laptop with the same manufacturer, speed, RAM, and hard disk, a 17-inch screen, a model number 1100 greater, and a price $500 more.

c) Delete all PC's with less than 100 gigabytes of hard disk.

d) Delete all laptops made by a manufacturer that doesn't make printers.

e) Manufacturer A buys manufacturer B. Change all products made by B so they are now made by A.

f) For each PC, double the amount of RAM and add 60 gigabytes to the amount of hard disk. (Remember that several attributes can be changed by one `UPDATE` statement.)

! g) For each laptop made by manufacturer B, add one inch to the screen size and subtract $100 from the price.