Homework #1

Notice: Please use only MySQL syntax for this assignment.

Name: Student ID: Assigned Date: 2025-03-13

1. In this problem set, we introduce one of our running examples of a relational database schema. The database schema comprises four relations with the following schemas:

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

The Product relation gives the manufacturer, model number and type (PC, laptop, or printer) of various products. We assume for convenience that model numbers are unique over all manufacturers and product types; that assumption is not realistic, and a real database would include a code for the manufacturer as part of the model number. The PC relation gives for each model number that is a PC the speed (of the processor, in gigahertz), the amount of RAM (in megabytes), the size of the hard disk (in gigabytes), and the price. The Laptop relation is similar, except that the screen size (in inches) is also included. The Printer relation records for each printer model whether the printer produces color output (true, if so), the process type (laser or ink-jet, typically), and the price. Please write the following declarations in SQL:

(a) A suitable schema for relation Product. (17%)

(b) A suitable schema for relation Laptop. (17%)

(c) A suitable schema for relation Printer. (17%)

2. This problem set builds upon the products schema of Problem Set 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. 1. Sample data for the other three relations is shown in Fig. 2. Manufacturers and model numbers have been "sanitized", but the data is typical of products on sale at the beginning of 2025.

Write expressions of relational algebra to answer the following queries. Using the linear notation (e.g., π, σ, etc.). For the data of Figs. 1 and 2, 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 processor speed of less than 2.95? (6%)

(b) Which manufacturers make laptops with a hard disk of at least 120 GB? (6%)

(c) Find the model number and price of all products (of any type) made by manufacturer A. (6%)

(d) Find those manufacturers that sell Printers, but not PC's. (6%)

maker	*model*	*type*
A	1001	pc
A	1002	pc
A	1003	pc
A	2004	laptop
A	2005	laptop
A	2006	laptop
B	1004	pc
B	1005	pc
B	1006	pc
B	2007	laptop
C	1007	pc
D	1008	pc
D	1009	pc
D	1010	pc
D	3004	printer
D	3005	printer
E	1011	pc
E	1012	pc
E	1013	pc
E	2001	laptop
E	2002	laptop
E	2003	laptop
E	3001	printer
E	3002	printer
E	3003	printer
F	2008	laptop
F	2009	laptop
G	2010	laptop
H	3006	printer
H	3007	printer

Figure 1: Sample data for Product

model	*speed*	*ram*	*hd*	*price*
1001	2.66	1024	250	2114
1002	2.10	512	250	995
1003	1.42	512	80	478
1004	2.80	1024	250	649
1005	3.20	512	250	630
1006	3.20	1024	320	1049
1007	2.20	1024	200	510
1008	2.20	2048	250	770
1009	2.00	1024	250	650
1010	2.80	2048	300	770
1011	1.86	2048	160	959
1012	2.80	1024	160	649
1013	3.06	512	80	529

(a) Sample data for relation PC

model	*speed*	*ram*	*hd*	*screen*	*price*
2001	2.00	2048	240	20.1	3673
2002	1.73	1024	80	17.0	949
2003	1.80	512	60	15.4	549
2004	2.00	512	60	13.3	1150
2005	2.16	1024	120	17.0	2500
2006	2.00	2048	80	15.4	1700
2007	1.83	1024	120	13.3	1429
2008	1.60	1024	100	15.4	900
2009	1.60	512	80	14.1	680
2010	2.00	2048	160	15.4	2300

(b) Sample data for relation Laptop

model	*color*	*type*	*price*
3001	true	ink-jet	99
3002	false	laser	239
3003	true	laser	899
3004	true	ink-jet	120
3005	false	laser	120
3006	true	ink-jet	100
3007	true	laser	200

(c) Sample data for relation Printer

Figure 2: Sample data for relations of Problem Set 2

3. Express the following constraints for the relations from Problem Set 1, which are reproduced here:

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

Please write your constraints by equating an expression of relational algebra to the empty set. For the data of Problem Set 2, indicate the model numbers if there are any violations to your constraints.

(a) A PC with a processor speed less than 2.20 must not sell for more than $950. (9%)

(b) A laptop with a screen size more than 15.5 inches must have at least a 100 gigabyte hard disk or have a processor speed more than 1.70. (8%)

(c) No manufacturer of PC's may also make laptops. (8%)