Relational Algebra Answers

Use the schema below

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

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 2.20: 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

1. Write expressions of relational algebra to answer the following queries. You may use the linear notation.

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

$R1 := \sigma_{speed \geq 3.00} (PC)$
$R2 := \pi_{model}(R1)$

model
1005
1006
1013

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

$R1 := \sigma_{hd \geq 100} (Laptop)$
$R2 := Product \bowtie (R1)$
$R3 := \pi_{maker} (R2)$

maker
E
A
B
F
G

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

$R1 := \sigma_{maker=B} (Product \bowtie PC)$
$R2 := \sigma_{maker=B} (Product \bowtie Laptop)$
$R3 := \sigma_{maker=B} (Product \bowtie Printer)$
$R4 := \pi_{model,price} (R1)$
$R5 := \pi_{model,price} (R2)$
$R6: = \pi_{model,price} (R3)$
$R7 := R4 \cup R5 \cup R6$

model	price
1004	649
1005	630
1006	1049
2007	1429

d) Find the model numbers of all color laser printers .

$R1 := \sigma_{color = true \text{ AND } type = laser} (\text{Printer})$
$R2 := \pi_{model} (R1)$

model
3003
3007

e) Find those manufacturers that sell Laptops , but not PC ' s .

$R1 := \sigma_{type=laptop} (\text{Product})$
$R2 := \sigma_{type=PC}(\text{Product})$
$R3 := \pi_{maker}(R1)$
$R4 := \pi_{maker}(R2)$
$R5 := R3 - R4$

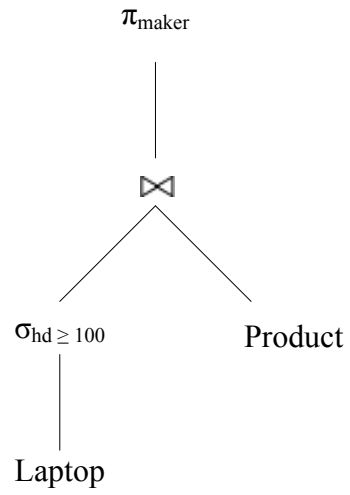| maker |
|-------|
| F |
| G |

2. Draw expression trees for each of your expressions.

a)

$$\pi_{model}$$

$$\sigma_{speed \geq 3.00}$$

PC

b)

π_{maker}

⋈

$\sigma_{hd \geq 100}$ Product

Laptop

c)

∪

$\pi_{model,price}$ $\pi_{model,price}$ $\pi_{model,price}$

$\sigma_{maker=B}$ $\sigma_{maker=B}$ $\sigma_{maker=B}$

⋈   ⋈   ⋈

Printer   Product   Laptop   Product   PC   Product

d)

π_{model}

|

$\sigma_{\text{color = true AND type = laser}}$

|

Printer

e)

$-$

π_{maker} π_{maker}

| |

$\sigma_{\text{type=PC}}$ $\sigma_{\text{type=laptop}}$
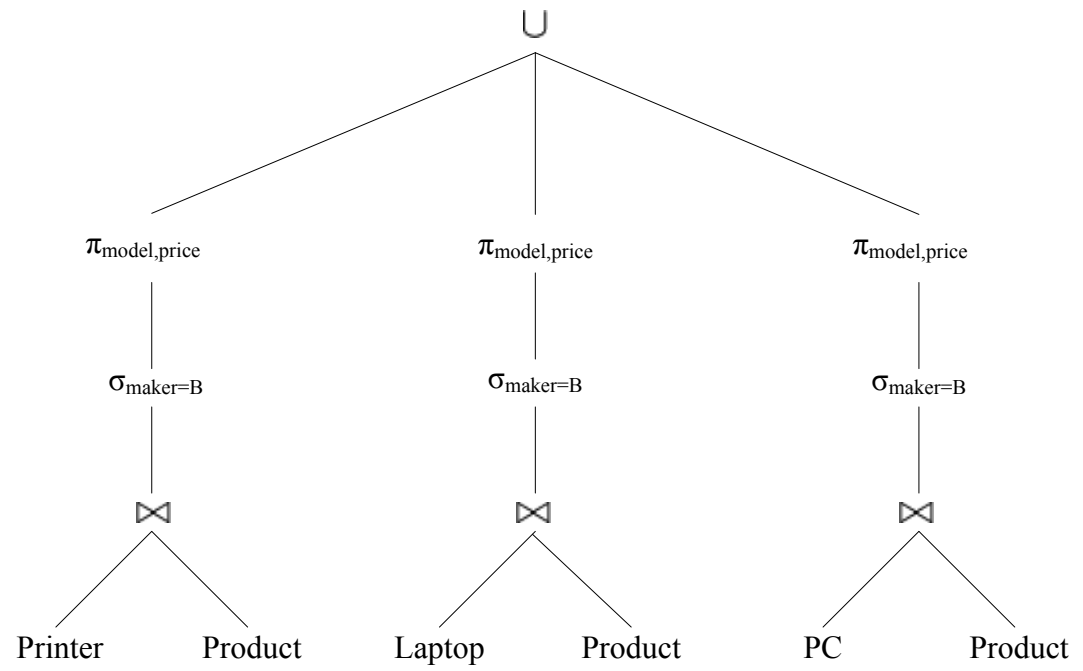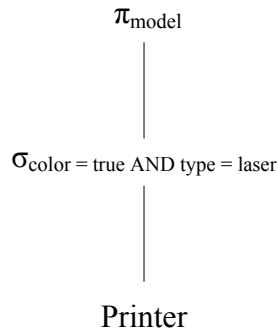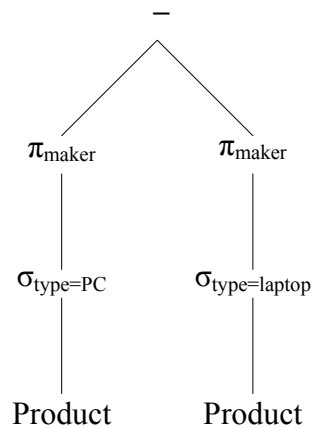
| |

Product   Product
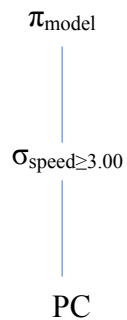
3. This exercise is similar to 1 concerning World War II capital ships. Ships are built in "classes " from the same design , and the class is usually named for the first ship of that class . The relation **Classes** records the name of the class , the type (' bb ' for battleship or ' bc ' for battlecruiser) , the country that built the ship , the number of main guns , the bore (diameter of the gun barrel , in inches) of the main guns , and the displacement (weight , in tons) . Relation **Ships** records the name of the ship , the name of its class , and the year in which the ship was launched . Relation **Battles** gives the name and date of battles involving these ships , and relation **Outcomes** gives the result (sunk , damaged , or ok) for each ship in each battle . It involves the following relations :

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

class	type	country	numGuns	bore	displacement
Bismarck	bb	Germany	8	15	42000
Iowa	bb	USA	9	16	46000
Kongo	bc	Japan	8	14	32000
North Carolina	bb	USA	9	16	37000
Renown	bc	Gt. Britain	6	15	32000
Revenge	bb	Gt. Britain	8	15	29000
Tennessee	bb	USA	12	14	32000
Yamato	bb	Japan	9	18	65000

(a) Sample data for relation Classes

name	date
Denmark Strait	5/24-27/41
Guadalcanal	11/15/42
North Cape	12/26/43
Surigao Strait	10/25/44

(b) Sample data for relation Battles

ship	battle	result
Arizona	Pearl Harbor	sunk
Bismarck	Denmark Strait	sunk
California	Surigao Strait	ok
Duke of York	North Cape	ok
Fuso	Surigao Strait	sunk
Hood	Denmark Strait	sunk
King George V	Denmark Strait	ok
Kirishima	Guadalcanal	sunk
Prince of Wales	Denmark Strait	damaged
Rodney	Denmark Strait	ok
Scharnhorst	North Cape	sunk
South Dakota	Guadalcanal	damaged
Tennessee	Surigao Strait	ok
Washington	Guadalcanal	ok
West Virginia	Surigao Strait	ok
Yamashiro	Surigao Strait	sunk

(c) Sample data for relation Outcomes

name	class	launched
California	Tennessee	1921
Haruna	Kongo	1915
Hiei	Kongo	1914
Iowa	Iowa	1943
Kirishima	Kongo	1915
Kongo	Kongo	1913
Missouri	Iowa	1944
Musashi	Yamato	1942
New Jersey	Iowa	1943
North Carolina	North Carolina	1941
Ramillies	Revenge	1917
Renown	Renown	1916
Repulse	Renown	1916
Resolution	Revenge	1916
Revenge	Revenge	1916
Royal Oak	Revenge	1916
Royal Sovereign	Revenge	1916
Tennessee	Tennessee	1920
Washington	North Carolina	1941
Wisconsin	Iowa	1944
Yamato	Yamato	1941

Figure 2.23: Sample data for relation Ships

Figures above give some sample data for these four relations . Note that , unlike the data for previous problem, 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 . For the data above, show the result of your query

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

$R1 := \sigma_{bore \geq 16} (\text{Classes})$
$R2 := \pi_{class,country} (R1)$

class	country
Iowa	USA
North Carolina	USA
Yamato	Japan

b) Find the ships launched prior to 1921 .

$R1 := \sigma_{launched < 1921} (\text{Ships})$
$R2 := \pi_{name} (R1)$

name
Haruna
Hiei
Kirishima
Kongo
Ramillies
Renown
Repulse
Resolution
Revenge
Royal Oak
Royal Sovereign
Tennessee

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

$R1 := \sigma_{\text{battle=Denmark Strait AND result=sunk}}(\text{Outcomes})$

$R2 := \pi_{\text{ship}}(R1)$

ship
Bismarck
Hood

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

$R1 := \text{Classes} \bowtie \text{Ships}$

$R2 := \sigma_{\text{launched > 1921 AND displacement > 35000}}(R1)$

$R3 := \pi_{\text{name}}(R2)$

name
Iowa
Missouri
Musashi
New Jersey
North Carolina
Washington
Wisconsin
Yamato

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

$R1 := \sigma_{battle=Guadalcanal}(Outcomes)$
$R2 := Ships \bowtie_{(ship=name)} R1$
$R3 := Classes \bowtie R2$
$R4 := \pi_{name,displacement,numGuns}(R3)$

name	displacement	numGuns
Kirishima	32000	8
Washington	37000	9

f) List all the capital ships mentioned in the database . (Remember that all these ships may not appear in the Ships relation.)

$R1 := \pi_{name}(Ships)$
$R2 := \pi_{ship}(Outcomes)$
$R3 := \rho_{R3(name)}(R2)$
$R4 := R1 \cup R3$

name
California
Haruna
Hiei
Iowa
Kirishima
Kongo
Missouri
Musashi
New Jersey
North Carolina
Ramillies
Renown
Repulse
Resolution
Revenge
Royal Oak
Royal Sovereign
Tennessee
Washington
Wisconsin
Yamato
Arizona

Bismarck
Duke of York
Fuso
Hood
King George V
Prince of Wales
Rodney
Scharnhorst
South Dakota
West Virginia
Yamashiro