Exercise 12 - Solutions

1. (a) $\pi_{NAME}\ \sigma_{GRADE='F'}\ (Student \bowtie Enroll)$

In SQL:

SELECT Name FROM Student, Enroll WHERE Student.SNO = Enroll.SNO AND
Enroll.Grade = 'F'

(b) $\pi_{NAME}\ \sigma_{DEPT='MATH'}\ (Student \bowtie Enroll \bowtie Course)$

In SQL:

SELECT Name FROM Student, Enroll, Course WHERE
Student.SNO = Enroll.SNO AND Enroll.CNO = Course.CNO AND Course.DEPT = 'MATH'

(Note: SQL also has a JOIN, not covered in class, which allows expressing the relational algebra natural join more directly.)

2. (a)

Type
Checking
Savings

(b)

AccountNumber	CustomerID	BranchID	Balance	Type
A0001	001	B01	$ 5,000	Checking
A0003	003	B01	$ 2,500	Savings
A0004	003	B01	$ 3,500	Checking

(c)

Customer ID	Name	Address	Phone	AccountNo	Branch ID	Balance	Type
001	John Doe	123 Elm Street	555-1234	A0001	B01	$5,000	Checking
002	Jane Smith	456 Pine Street	555-5678	A0002	B02	$8,000	Savings
003	Bob Brown	789 Oak Street	555-9012	A0003	B01	$2,500	Savings
003	Bob Brown	789 Oak Street	555-9012	A0004	B01	$3,500	Checking

(d)

Name	Branch Name
John Doe	Downtown
Jane Smith	Uptown
Bob Brown	Downtown

3. (a) Recall the formal definition of the natural join: For $r(R)$, $s(S)$,

$r \bowtie s$ is a relation over $R \cup S$ and

$$r \bowtie s = \{ t \in \text{domain}(R \cup S) : \pi_R(t) \in r \text{ and } \pi_S(t) \in s \}$$

So $r \bowtie (s \bowtie t)$ is a relation over $R \cup (S \cup T) = (R \cup S) \cup T$ with

$$r \bowtie (s \bowtie t) = \{ x \in \text{domain}(R \cup (S \cup T)) : \pi_R(x) \in r \text{ and } \pi_{S \cup T}(x) = \{ y : \pi_S(y) \in s \text{ and } \pi_T(y) \in t \} \}$$

$$= \{ x \in \text{domain}(R \cup S \cup T) : \pi_R(x) \in r \text{ and } \pi_S(x) \in s \text{ and } \pi_T(x) \in t \}$$

$$= \{ x \in \text{domain}((R \cup S) \cup T) : \pi_{R \cup S}(x) = \{ y : \pi_R(y) \in r \text{ and } \pi_S(y) \in s \} \text{ and } \pi_T(x) \in t \}$$

$$= r \bowtie (s \bowtie t)$$

(b) Recall: $\sigma_{r.M = r.M}(R)$ is a relation over R with

$$\sigma_{r.M = r.M}(R) = \{ t : t \in r \text{ and } t.M = t.N \}$$

So $\sigma_{M=N}(r \bowtie s)$ is a relation over $R \cup S$ with

$$\sigma_{M=N}(r \bowtie s) = \{ t : t \in r \bowtie s \text{ and } t.M = t.N \}$$

$$= \{ t \in \text{domain}(R \cup S) : \pi_R(t) \in r \text{ and } \pi_S(t) \in s \text{ and } t.M = t.N \}$$

$$= \{ t \in \text{domain}(R \cup S) : (\pi_R(t) \in r \text{ and } \pi_R(t).M = \pi_R(t).N) \text{ and } \pi_S(t) \in s \}$$

$$= \sigma_{M=N}(r) \bowtie s$$