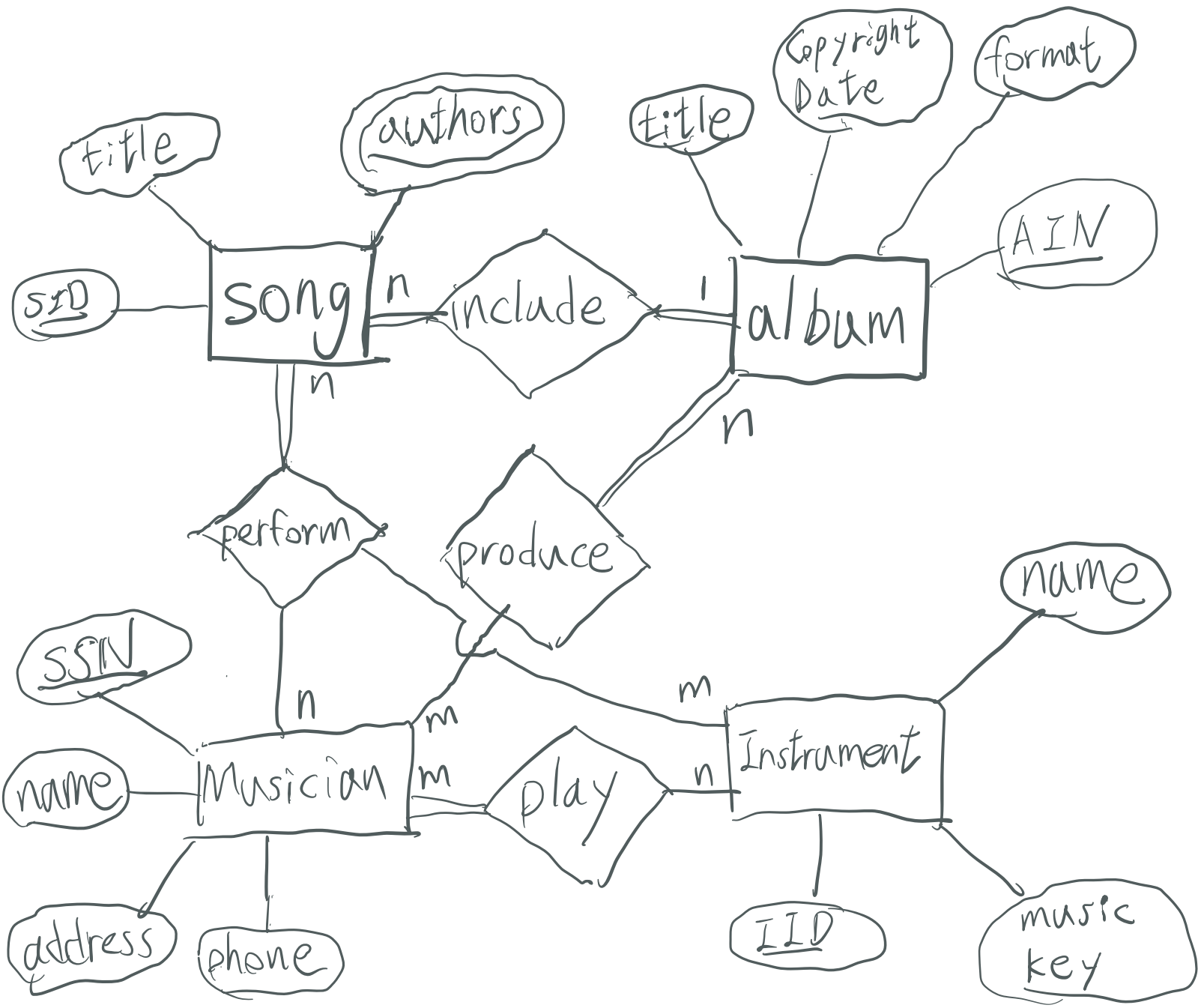
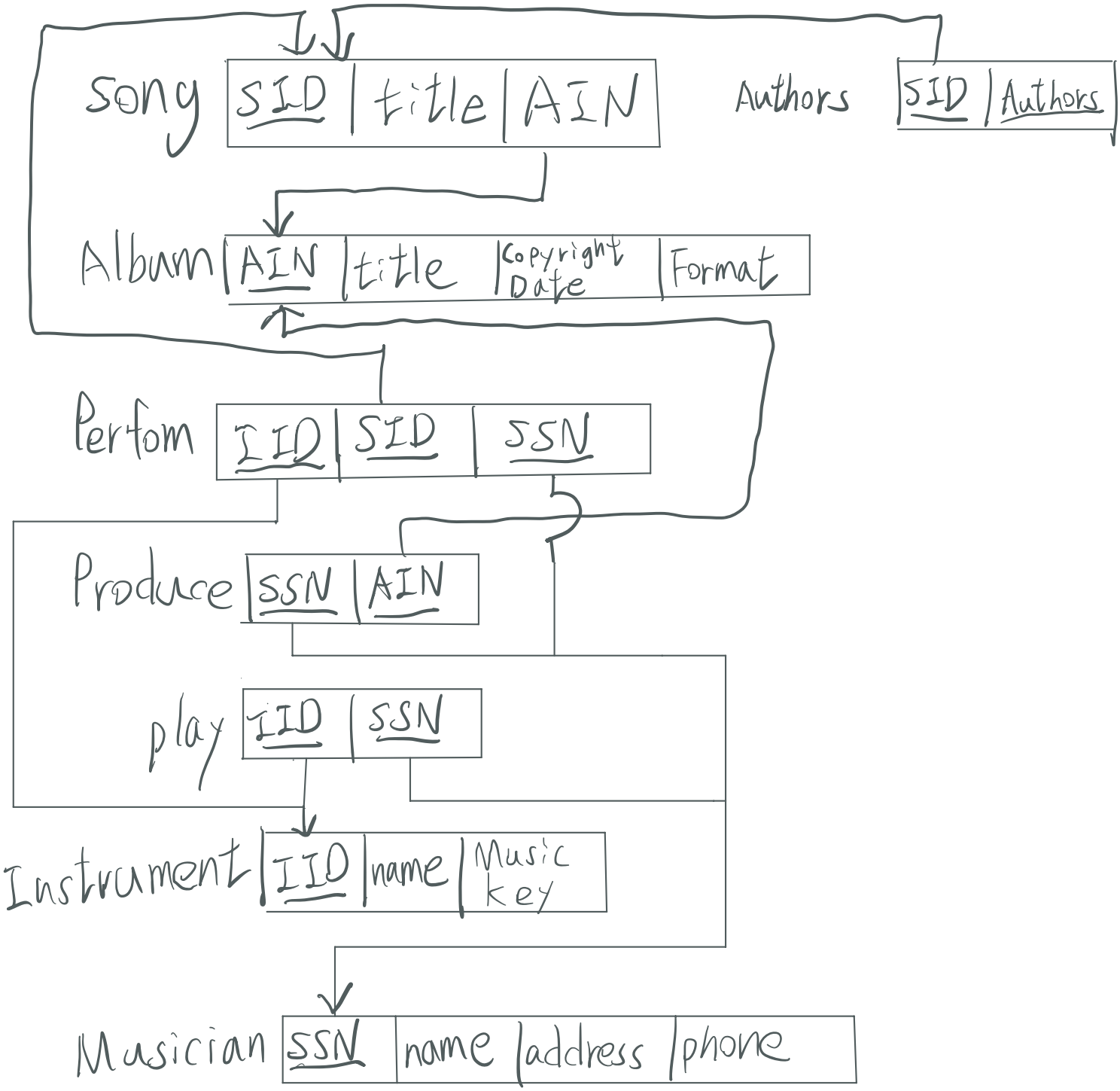
1. (a)

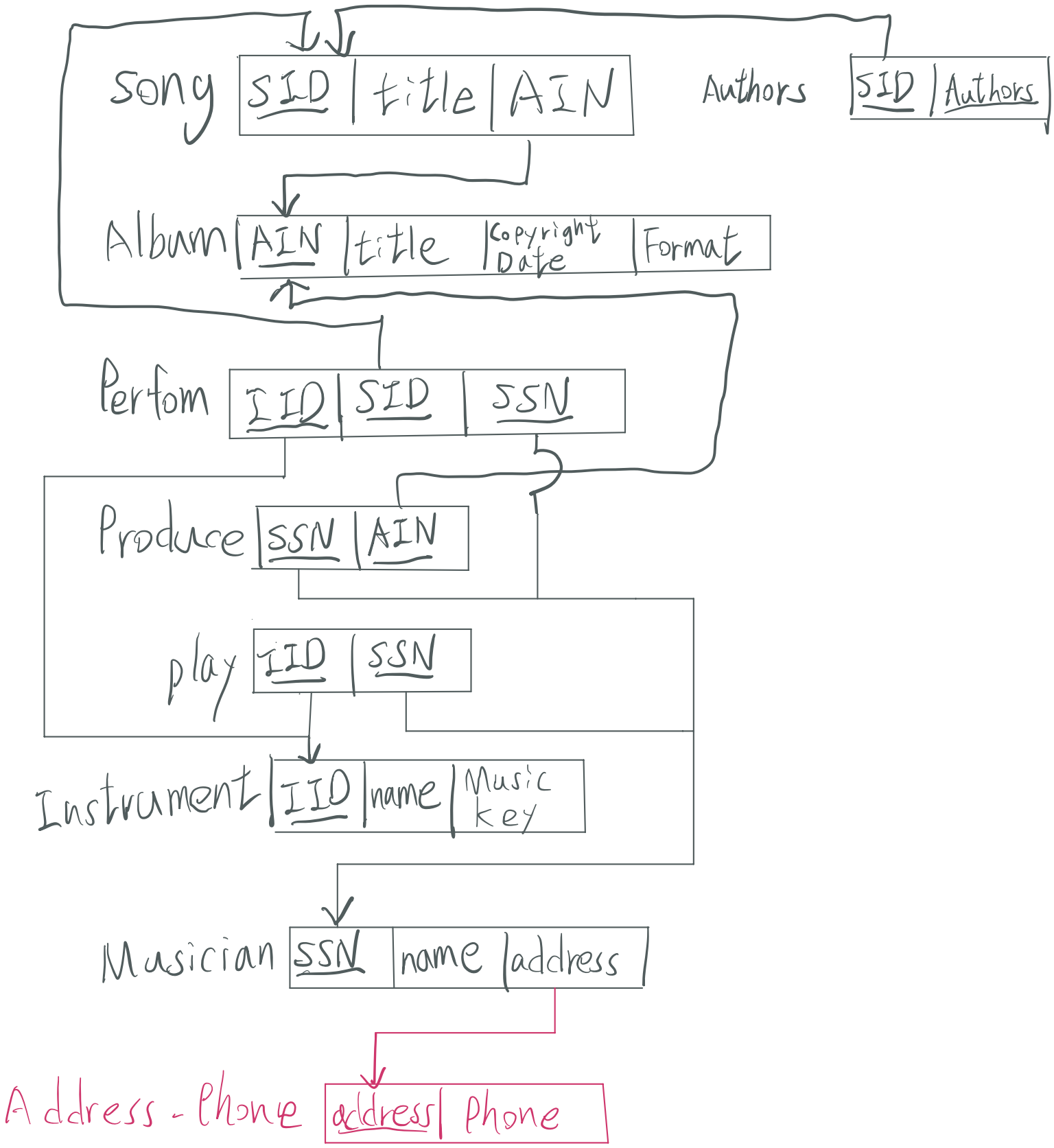

title
authors
SID
song
n
include
1
album
Copyright Date
format
title
AIN
n
n
perform
produce
SSN
name
n
m
m
n
name
Musician
m
play
n
Instrument
address
phone
IID
music key

1. (b) SID: Song ID AIN: Album identification number

SSN: Social security number IID: Instrument ID



1. (C)


Song
SID | title | AIN
Authors
SID | Authors
Album
AIN | title | Copyright Date | Format
Perfom
IID | SID | SSN
Produce
SSN | AIN
play
IID | SSN
Instrument
IID | name | Music key
Musician
SSN | name | address
Address - Phone
address | phone

1. (d)

S = Song , A = Album

I = Instrument , P = Perform

① relational algebra :

$$Result \leftarrow \pi_{(title)}(A \bowtie (S \bowtie (P \bowtie (\sigma_{(name = "violin" \text{ and } musickey = "C\text{-}Sharp")}(I)))))$$

② tuple relational calculus :

$$\{A.title \mid Album(A) \text{ and } (\exists S)((Song(S) \text{ and } S.AIN = A.AIN) \text{ and } (\exists P)((Perform(P) \text{ and } P.SID = S.SID) \text{ and } (\exists I)((Instrument(I) \text{ and } I.IID = P.IID) \text{ and } I.name = "violin" \text{ and } I.musickey = "C\text{-}Sharp"))) \}$$

1. (d)

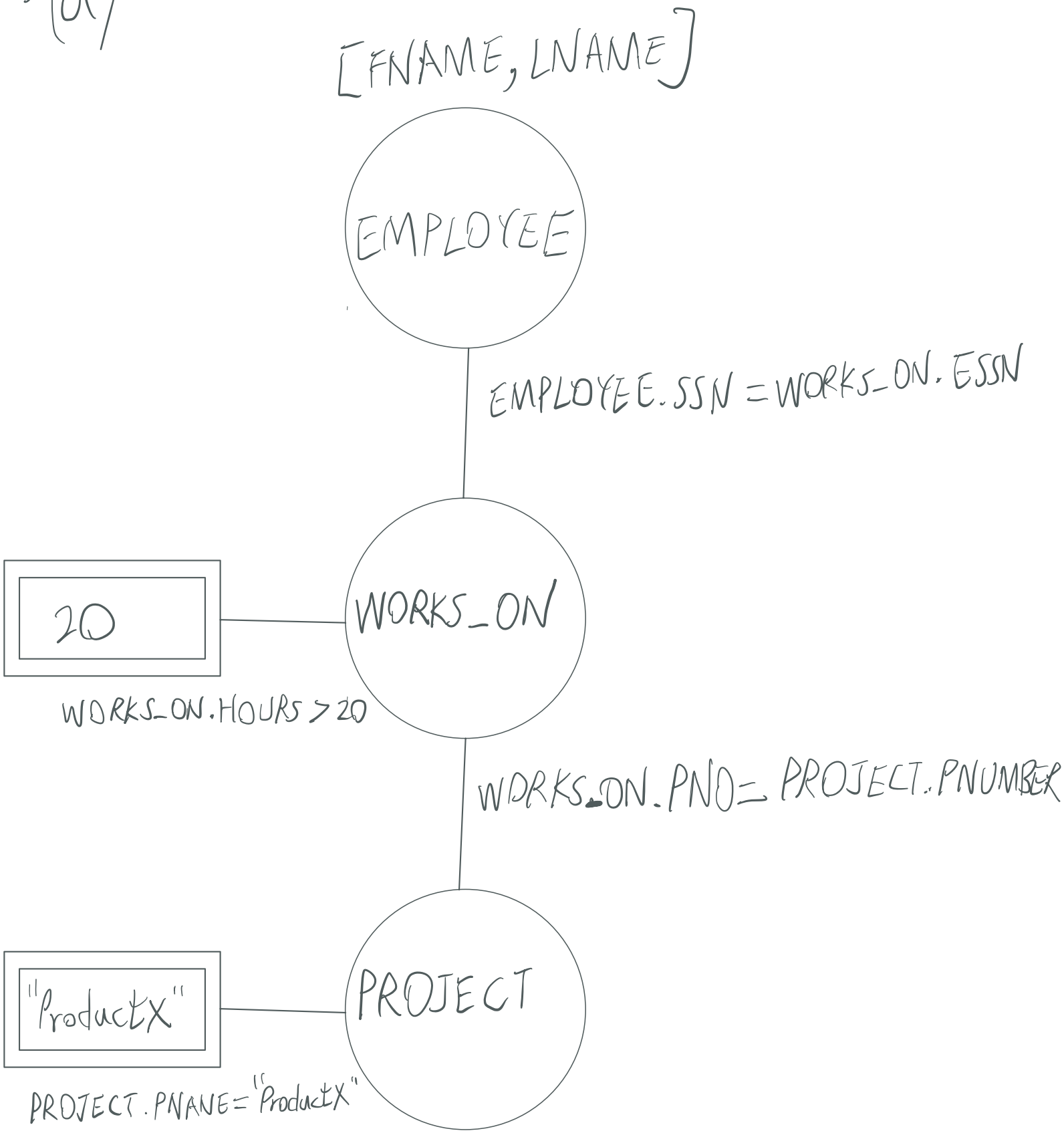
③ domain relational calculus:

$\{A_2 \mid (\exists A_1)(Album(A_1 A_2 A_3 A_4))$
and $(\exists S_1)(\exists S_3)((Song(S_1 S_2 S_3)$ and $S_3 = A_1)$
and $(\exists P_1)(\exists P_2)((Perform(P_1 P_2 P_3)$ and $P_2 = S_1)$
and $(\exists I_1)(\exists I_2)(\exists I_3)((Instrument(I_1 I_2 I_3)$ an $I_1 = P_1)$
and $I_2 =$ "violin" and $I_3 =$ "C-sharp"))) $\}$

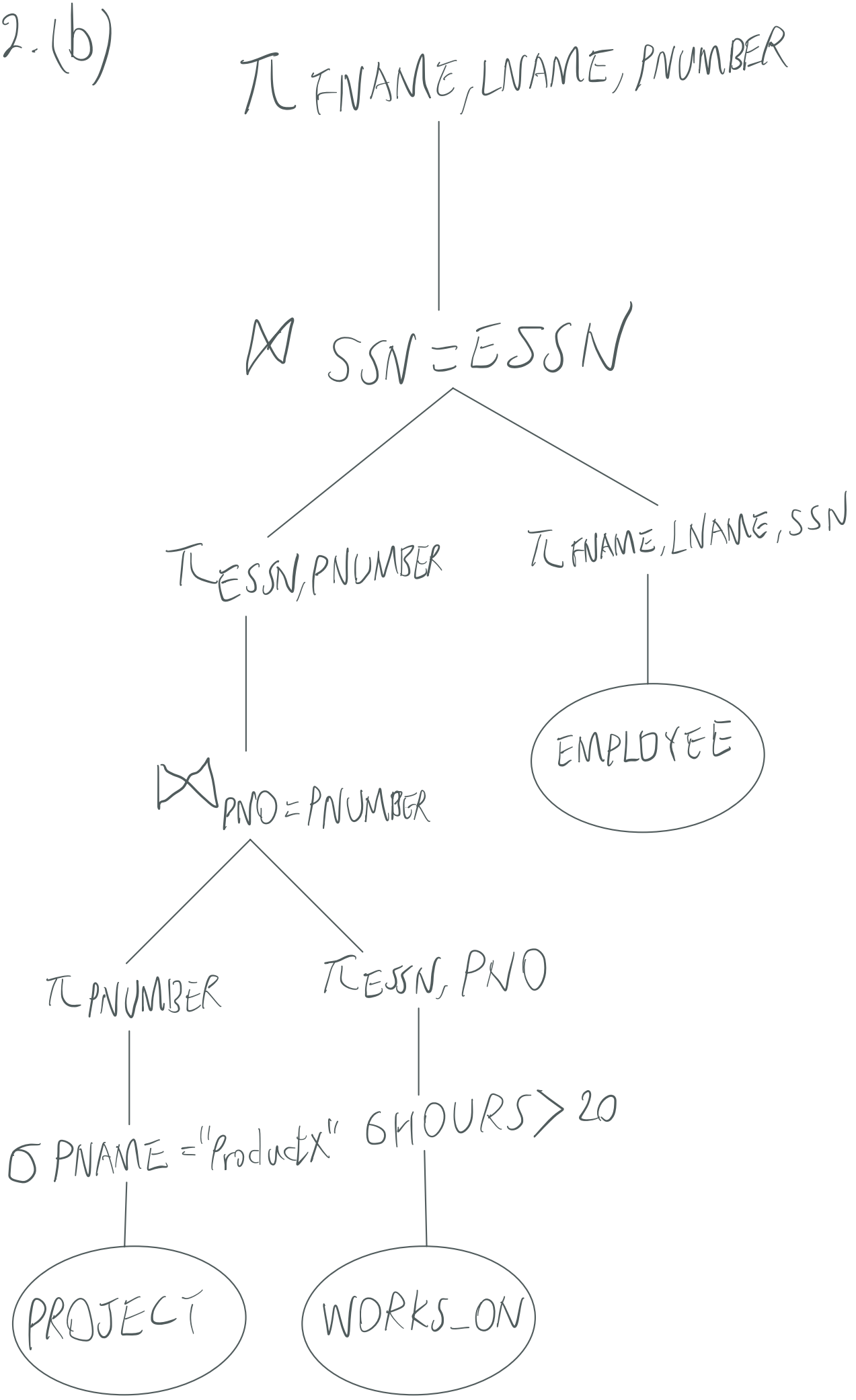
④ SQL:

```
SELECT DISTINCT A.title
FROM Album AS A, Song AS S, Perform AS P
Instrument AS I
WHERE A.AIN = S.AIN AND S.SID = P.SID
AND P.IID = I.IID AND I.nam = "violin"
AND I.musickey = "C-Sharp";
```

2. (a)


[FNAME, LNAME]
EMPLOYEE
EMPLOYEE.SSN = WORKS_ON.ESSN
20
WORKS_ON
WORKS_ON.HOURS > 20
WORKS_ON.PNO = PROJECT.PNUMBER
"ProductX"
PROJECT
PROJECT.PNAME = "ProductX"

2. (b)


π FNAME, LNAME, PNUMBER
⋈ SSN = ESSN
π ESSN, PNUMBER
π FNAME, LNAME, SSN
EMPLOYEE
⋈ PNO = PNUMBER
π PNUMBER
π ESSN, PNO
σ PNAME = "ProductX"
σ HOURS > 20
PROJECT
WORKS_ON