Q1.

a)

$$\pi_{dname}\Big(\Big(\pi_{did}Dishes - \pi_{did}\left(\sigma_{iname='sugar' OR\ iname='butter'\ OR\ iname='starch}(Recipes \bowtie Ingredients)\right)\Big) \bowtie Dishes\Big)$$

b)

$$\pi_{iname}((\sigma_{unitprice\geq 10}Ingredients) \bowtie Recipes \bowtie (\sigma_{popularity>10000}Dishes))$$

c)

$$\pi_{origin}((\sigma_{iname='saffron'}Ingredients) \bowtie \left(\sigma_{quantity\geq 1}Recipes\right) \bowtie Dishes)$$

d)

$$\pi_{popularity}((\pi_{did}Dishes - \pi_{did}\left(\left(\sigma_{unitprice<50}Ingredients\right) \bowtie Recipes\right)) \bowtie Dishes)$$

e)

$$\rho(TMP1, Recipes)$$

$$\rho(TMP2, Recipes)$$

$$\rho(TMP3, \pi_{iid}Recipes - \pi_{iid}(TMP1 \bowtie_{(TMP1.iid=TMP2.iid)\hat{}(TMP1.did<>TMP2.did)} TMP2))$$

$$\pi_{iname,unitprice}(TMP3 \bowtie Ingredients)$$

Q2.

a)
```
CREATE TABLE RECIPES (
        iid integer,
        did integer,
        quantity integer,
        PRIMARY KEY (iid,did),
        FOREIGN KEY (iid) REFERENCES Ingredients,
        FOREIGN KEY (did) REFERENCES Dishes);
```

b)
```
SELECT  I.iname
FROM Ingredients I WHERE NOT EXISTS(
    SELECT D.did FROM Dishes D, Recipes R
    WHERE D.did=R.did and D.origin='Scandinavia'
    MINUS
    SELECT R1.did FROM Recipes R1
    WHERE R1.iid=I.iid
    )
```

c)
```
SELECT I.iname
FROM Ingredients I, Recipes R
WHERE I.iid = R.iid AND I.iid NOT IN (
    SELECT R1.iid
    FROM Recipes R1, Dishes D
    WHERE R1.did=D.did AND D.origin <> 'Caribbean'
    )
```

d)

```
SELECT D.origin
FROM Dishes D, Recipes R, Ingredients I
WHERE D.did=R.did and R.iid=I.iid and I.iname LIKE “%sour%” and R.quantiy >=3
```

e)

```
SELECT D.did, D.dname
FROM Dishes D, Recipes R, Ingredients I
WHERE D.did=R.did and R.iid=I.iid
GROUP BY D.did, D.dname
HAVING 100 <= SUM( R.quantity * I.unitprice ) AND ANY (I.unitprice<=10)
```

f)

```
SELECT D.origin
FROM Dishes D, Recipes R, Ingredients I
WHERE D.did=R.did and R.iid=I.iid and I.unitprice =
    (SELECT MAX(unitprice)
    FROM Ingredients)
```

g)

```
SELECT  TMP.iname
FROM        (SELECT I.iname, AVERAGE (D.popularity) as AvgPop
            FROM Dishes D, Recipes R, Ingredients I
            WHERE D.did=R.did and R.iid=I.iid
            GROUP BY I.iid, I.iname
            ) TMP
WHERE TMP.AvgPop = (SELECT MAX(AvgPop) FROM TMP)
```