1.

(a)

SELECT DISTINCT c.cid, c.cname

FROM Purchase b JOIN Customer c USING(cid)

WHERE NOT EXISTS (SELECT p.cid FROM Product a, Purchase p

WHERE p.pid = a.pid AND c.cid = p.cid AND p.price < a.msrp) ;

(b)

SELECT cid, pid

FROM Purchase

GROUP BY cid, pid

HAVING COUNT(\*) = 2;

(c)

SELECT pid, MIN(price) AS lowest\_price

FROM Purchase

GROUP BY pid;

(d)

SELECT c.cid, c.cname, 0 AS count

FROM Customer c

WHERE NOT EXISTS (SELECT \* FROM Purchase p WHERE p.cid = c.cid)

UNION

SELECT c.cid, c.cname, COUNT(c.cid) AS count

FROM Customer c, Purchase p

WHERE c.cid = p.cid

GROUP BY c.cid, c.cname;

(e)

SELECT ca, cb, COALESCE((intersect / (seta + setb-intersect)),0) AS Jaccard

FROM (SELECT t.ca AS ca, t.cb AS cb, COUNT(DISTINCT t.pa) AS seta, COUNT(DISTINCT t.pb) AS setb

FROM (SELECT DISTINCT p1.cid AS ca, p2.cid AS cb, p1.pid AS pa, p2.pid AS pb

FROM purchase p1, purchase p2 WHERE p1.cid < p2.cid) AS t

GROUP BY t.ca, t.cb) AS a LEFT OUTER JOIN

(SELECT DISTINCT t.ca AS ca, t.cb AS cb, COUNT(\*) as intersect

FROM (SELECT DISTINCT p1.cid AS ca, p2.cid AS cb, p1.pid AS pa, p2.pid AS pb

FROM purchase p1, purchase p2

WHERE p1.cid < p2.cid AND p1.pid = p2.pid) AS t

GROUP BY t.ca, t.cb) AS b USING (ca, cb)

ORDER BY Jaccard DESC;

(f)

(g)

(h)

2.

(a) True

First, prove that δ(σc(R)) ⊆ σc(δ(R)) for arbitrary R.

Fix an arbitrary R and suppose t:k ∈ δ(σc(R)). From the assumption, we know that t:k is in R and that C holds on t after duplicate elimination. So, there should be at least one t in σc(R), which means t satisfies C and there is at least one t in R. Since there is at least one t in R, there is one t in δ(R). Since t satisfies C, t:k ∈ σc(δ(R)). So, δ(σc(R)) ⊆ σc(δ(R)) is proved to be true.

Next, prove that σc(δ(R)) ⊆ δ(σc(R)) for arbitrary R.

Fix an arbitrary R and suppose t:k ∈ σc(δ(R)). From the assumption, we know that t:k is in δ(R) and that C holds on t. Since t:k is in δ(R), there is at least one t in R. t satisfies C and t is in R, so there is at least one t σc(R). Then t:k is in the result of δ(σc(R)), t:k ∈ δ(σc(R)). So, is proved to be true.

As result, the statement δ(σc(R)) ≡ σc(δ(R)) is true.

(b) True

First, prove that δ(πA(R)) ⊆ πA(δ(R)) for arbitrary R.

Fix an arbitrary R and suppose t:k ∈ δ(πA(R)). From the assumption, we know that there is at least one tuple containing attribution A of t. δ(R) eliminates duplicates, but there is still one tuple containing attribution A of t. After projection of A on δ(R), one t is still there, t:k ∈ πA(δ(R)). So, δ(πA(R)) ⊆ πA(δ(R)) is proved to be true.

Next, prove that πA(δ(R)) ⊆ δ(πA(R)) for arbitrary R.

Fix arbitrary R and suppose t:k ∈ πA(δ(R)). From the assumption, we know that t with attribution A is in the duplicate-eliminated R, which means there is at least one tuple containing attribution A of t in R. So, t satisfies πA(R). After duplicate elimination, t is still in the relation δ(πA(R)), which means t:k ∈ δ(πA(R)). So πA(δ(R)) ⊆ δ(πA(R)) is proved to be true.

As result, the statement δ(πA(R)) ≡ πA(δ(R) is true.

(c) True

First, prove that δ(R×S) ⊆ δ(R)×δ(S)  for arbitrary R.

Fix an arbitrary R and suppose t:k ∈ δ(R×S). From the assumption, we know that there is at least one t in the cross product of R and S, t:k ∈ R×S. So, the entries of t can be found in R and S, which means the entries in t appears in δ(R) and δ(S). When doing cross join between δ(R) and δ(S), t should in the cross product of it, t:k ∈ δ(R)×δ(S). So, δ(R×S) ⊆ δ(R)×δ(S) is proved to be true.

Next, prove that δ(R)×δ(S) ⊆ δ(R×S) for arbitrary R.

Fix an arbitrary R and suppose t:k ∈ δ(R)×δ(S). From the assumption, we know that t is in the cross product of duplicate-eliminated R and S. Let a and b be the entries of t from R and S that means (a, b) denotes t. There is at least one a in R and one b in S. Based on this, when doing cross join between R and S, (a, b) is in R × S, which mean t satisfies R × S. Since t ∈ R×S, t also satisfies δ(R×S). So, δ(R)×δ(S) ⊆ δ(R×S) is proved to be true.

As result, the statement δ(R×S) ≡ δ(R)×δ(S) is true.

(d) True

First, prove that δ(R c S) ⊆ δ(R) c δ(S).

Fix an arbitrary R and suppose t:k ∈ δ(R c S). From the assumption, we know that t satisfies C and t ∈ δ(R c S). So, t ∈ R c S. Let a be the entries in t that correspond to attributes of R, and b be the entries in t that correspond to attributes of S. So a and b satisfy C, and a ∈ R and b ∈S. Also, a ∈ δ(R) and b ∈ δ(S). If join δ(R) and δ(S) under condition C, the tuple containing a and b should in the relation, which is t:k ∈ δ(R) c δ(S). Therefore, δ(R c S) ⊆ δ(R) c δ(S) is proved to be true;

Next, prove that δ(R) c δ(S) ⊆ δ(R c S).

Fix an arbitrary R and suppose t:k ∈ δ(R) c δ(S). Let a be the entries in t that correspond to attributes of R, and b be the entries in t that correspond to attributes of S. So a ∈ δ(R) and b ∈ δ(S), and a and b satisfy C, then we have a ∈ R and b ∈ S, and a and b satisfy C. Then, since a and b are the entries of t, t should be in the relation of R c S. So, t is also in δ(R c S), which is t ∈ δ(R c S). Therefore, δ(R c S) ⊆ δ(R) c δ(S) is proved to be true.

As result, the statement δ(R c S) ≡ δ(R) c δ(S) is true.

(e) False

First, prove that δ(R) ∪B δ(S) ⊆ δ(R ∪B S).

Fix an arbitrary R and suppose t:k ∈ δ(R) ∪B δ(S). Let a be the entries of t that corresponds to attributes of R and S in common. So a ∈ δ(R) and a ∈ δ(S). When bag union δ(R) and δ(S), there will two a appear in the processed relation, t:2 ∈ δ(R) ∪B δ(S). For δ(R ∪B S), no matter how many a is in R ∪B S, after duplicate elimination, there is only one a in δ(R ∪B S). So, t:1 ∈ δ(R ∪B S). Since the set of δ(R) ∪B δ(S) is bigger than that of δ(R ∪B S), δ(R) ∪B δ(S) ⊆ δ(R ∪B S) is proved to be false.

Since the first condition fails, the statement δ(R) ∪B δ(S) ≡ δ(R ∪B S) is false.

(f) True

First, prove that δ(R∩B S) ⊆ δ(R)∩B δ(S).

Fix an arbitrary R and suppose t:k ∈ δ(R∩B S). From the assumption, we know that t:k ∈ R∩B S as well and there is only one t in δ(R∩B S). So, t is the tuple that R and S share in common, which means t ∈ R and t ∈ S. Then, we know t ∈ δ(R) and t ∈ δ(S). When performing bag intersection to δ(R) and δ(S), t should appear in the processed relation only once. So, δ(R∩B S) ⊆ δ(R)∩B δ(S) is proved to be true.

Next, prove that δ(R)∩B δ(S) ⊆ δ(R∩B S).

Fix an arbitrary R and suppose t:k ∈ δ(R)∩B δ(S). From the assumption, we know that there is only one t in δ(R)∩B δ(S), t ∈ δ(R), and t ∈ δ(S). Then t ∈ R and t ∈ S. So, there is at least one t in R∩B S. After duplicate elimination, no matter how many t is in R∩B S, there is only one t in δ(R∩B S). So, δ(R)∩B δ(S) ⊆ δ(R∩B S) is proved to be true.

As result, the statement δ(R∩B S) ≡ δ(R)∩B δ(S) is true.

(g) False

First, prove that δ(R −B S) ⊆ δ(R) −B δ(S).

Fix an arbitrary R and suppose t:k ∈ δ(R −B S). Let t be the tuple appears n + 1 times in R and n times in S where n ≠ 0. So t ∈ R and t ∈ S. In the case of δ(R −B S), when performing R −B S, there is one (n + 1 – n = 1) t remaining in the relation, so there is one t in δ(R −B S) as well. However, in the case of δ(R) −B δ(S), there is only one t in both δ(R) and δ(S). After perfoming bag difference to δ(R) and δ(S), t is no longer in the processed relation. So, δ(R −B S) ⊆ δ(R) −B δ(S) is proved to be false.

Since the first condition fails, the statement δ(R −B S) ≡ δ(R) −B δ(S) is false.