1: Answers: FFFFTFFFTT

2: Answers: FTFTTTTTF

3:

```
CREATE TABLE Product (maker     VARCHAR(30),
                      model     INT NOT NULL PRIMARY KEY,
                      category  VARCHAR(20) CHECK ((category = 'PC') OR
                                                   (category = 'laptop') OR
                                                   (category = 'printer'))
                      )



CREATE TABLE PC (model  INT NOT NULL PRIMARY KEY,
                 speed  VARCHAR(20),
                 ram    VARCHAR(20),
                 hd     VARCHAR(20),
                 price  NUM(10,2),
                 FOREIGN KEY (model) REFERENCES Product(model) )
                 )


CREATE TABLE Laptop (model  INT NOT NULL PRIMARY KEY,
                 speed  VARCHAR(20),
                 ram    VARCHAR(20),
                 hd     VARCHAR(20),
                 screen VARCHAR(20),
                 price  NUM(10,2),
                 FOREIGN KEY (model) REFERENCES Product(model) )
                 )

CREATE TABLE Printer (model  INT NOT NULL PRIMARY KEY,
                 color  VARCHAR(20),
                 ptype  VARCHAR(20) CHECK ((ptype = 'laser') OR
                                           (ptype = 'inkjet')),
                 price  NUM(10,2),
                 FOREIGN KEY (model) REFERENCES Product(model) )
                 )


CREATE ASSERTION A1 CHECK
     ( NOT EXISTS (
```

```
                        ((SELECT model FROM PC)
                          INTERSECT
                        (SELECT model FROM Laptop))
                          UNION
                         ((SELECT model from PC)
                          Intersect
                          (SELECT model from Printer))
                         UNION
                         ((SELECT model from Laptop)
                           Intersect
                          (SELECT model from Printer))
                         ))


CREATE ASSERTION A2 CHECK
    ( NOT EXISTS (SELECT *
                  FROM PC, Product PCP
                  WHERE PC.model = PCP.model
                  AND ((NOT EXISTS (SELECT *
                                    FROM Printer, Product PrP
                                    WHERE PrP.maker = PCP.maker
                                       AND Printer.type = 'ink-jet') )
                                       AND Printer.color = 'yes') )

                       OR
                       (NOT EXISTS (SELECT *
                                    FROM Printer, Product PrP
                                    WHERE PrP.maker = PCP.maker
                                    AND Printer.type = 'laser') )
                       ) ) )
```

4:

```
SELECT ppc.maker
FROM   product ppc,
       product pla,
       product ppr,
       pc pc,
       laptop la,
       printer pr
WHERE  pr.type = 'laser' AND
       ppc.model = pc.model AND
       pla.model = la.model AND
       ppr.model = pr.model AND
       pla.maker = ppc.maker AND
       ppc.maker = ppr.maker AND
       (pc.price + pr.price +la.price) < 2000;
```

5:

```
  SELECT P.model
  FROM   PC P, PRODUCT P1
  WHERE  P.model = P1.model
    AND  P.speed >= ALL ( SELECT L1.speed
  FROM   LAPTOP L1, PRODUCT P2
  WHERE  P2.model = L1.model
      AND  P2.maker = P1.maker )
    AND  P.ram   >= ALL ( SELECT L2.ram
  FROM   LAPTOP L2, PRODUCT P3
    WHERE  P3.model = L2.model
    AND  P3.maker = P1.maker )
```

$$\pi_{model}(PC) - \pi_{model}\Big((\pi_{model,ram,maker}(PC \bowtie Product)\Big) \bowtie_{maker=lmaker,ram<lram}$$
$$\Big(\rho_{lmaker \leftarrow maker,lram \leftarrow ram,lmodel \leftarrow model}(\pi_{model,ram,maker}(Laptop \bowtie Product))\Big)$$
$$- \pi_{model}\Big((\pi_{model,speed,maker}(PC \bowtie Product)\Big) \bowtie_{maker=rmaker,speed<rspeed}$$
$$\Big(\rho_{rmaker \leftarrow maker,rspeed \leftarrow speed,rmodel \leftarrow model}(\pi_{model,speed,maker}(Laptop \bowtie Product))\Big)$$

6:

```
SELECT maker
FROM   product
WHERE  maker NOT IN
       (SELECT maker
        FROM   product p,
               laptop l
        where  l.model = p.model AND NOT EXISTS
               (SELECT p2.maker
                FROM   product p2,
                       laptop l2,
                WHERE  p2.model = l2.model AND
                       p2.maker <> p.maker AND
                       l2.speed > l.speed AND
                       l2.ram > l.ram AND
                       l2.monitor > l.monitor AND
                       l2.price < l.price))
```

$$\pi_{maker} PRODUCT - \pi_{maker}((\pi_{maker,ram,monitor,speed}(PRODUCT \bowtie LAPTOP)) \bowtie_{ram>oram AND monitor>omonitor AND speed>ospeed AND omodel>model} (\rho_{omaker \leftarrow maker, oram \leftarrow ram, omonitor \leftarrow monitor, ospeed \leftarrow speed, omodel \leftarrow model} \pi_{maker,ram,monitor,speed,model}(PRODUCT \bowtie LAPTOP)))$$

7:

```
  SELECT T.maker, MIN(T.pr), MAX(T.pr), AVG(T.pr)
  FROM   ( SELECT P1.maker, (L.price+P.price) AS pr
   FROM   Product P1, Product P2, Printer P, Laptop L
   WHERE  P1.model = P.model AND P2.model = L.model
     AND  L.type = 'ink-jet' AND L.color = 'yes'
     AND  P1.maker = P2.maker
) AS T
  GROUP BY T.maker
```

8:

a: No. Any decomposition would lose the FD $BC \rightarrow A$, and the schema itself is not in BCNF.

b: Lossless BCNF decomposition: AB, BCE, DE.