1)

In this problem we had combined unit shipping cost and unit production cost to get the minimum objective function.

Here, we have to create a dummy variable in demand of 10 because to make supply and demand equal to 220.

So, we get 2 new dummy variables.

Objective Function:

Z min = 622 X11 + 614 X12 + 630 X13 + 0 X14 + 641 X21 + 645 X22 + 649 X23 + 0 X24;

In the objective function we have 6 decision variables and 2 dummy variables names X14 and X24.

Constraints:

Supply Constraints

X11 + X12 + X13 + X14 = 100
X21 + X22 + X23 + X24 = 120

Demand Constraints

X11 + X21 = 80
X12 + X22 = 60
X13 + X23 = 70
X14 + X24 = 10

Where, Xpq >=0 (p=1,2 and q=1,2,3,4 Here p=plant and q=warehouses)

2a)

In this problem the supply is 276 TBD and demand is 274 TBD as demand is not equal to supply we create a dummy variable in demand side of 2 TBD to make sure that the demand is equal to the supply.

Objective Function:

$Z_{min} = 1.52\,X_{AP} + 1.60\,X_{AQ} + 1.40\,X_{AR} + 1.70\,X_{BP} + 1.63\,X_{BQ} + 1.55\,X_{BR} + 1.45\,X_{CP} + 1.57\,X_{CQ} + 1.30\,X_{CR} + 5.15\,X_{P1} + 5.69\,X_{P2} + 6.13\,X_{P3} + 5.63\,X_{P4} + 5.80\,X_{P5} + 0\,X_{P6} + 5.12\,X_{Q1} + 5.47\,X_{Q2} + 6.05\,X_{Q3} + 6.12\,X_{Q4} + 5.71\,X_{Q5} + 0X_{Q6} + 5.32X_{R1} + 6.16\,X_{R2} + 6.25\,X_{R3} + 6.17\,X_{R4} + 5.87\,X_{R5} + 0\,X_{R6}$;

Constraints:

Supply Constraints:

$X_{AP} + X_{AQ} + X_{AR}=93$

$X_{BP} + X_{BQ} + X_{BR}=88$

$X_{CP} + X_{CQ} + X_{CR}=95$

Demand Constraints:

$X_{P1}+X_{Q1}+X_{R1}=30$

$X_{P2}+X_{Q2}+X_{R2}=57$

$X_{P3}+X_{Q3}+X_{R3}=48$

$X_{P4}+X_{Q4}+X_{R4}=91$

$X_{P5}+X_{Q5}+X_{R5}=48$

$X_{P6}+X_{Q6}+X_{R6}=2$

Constraints from pumps to the refineries:

$X_{AP} + X_{BP} + X_{CP} = X_{P1} + X_{P2} + X_{P3} + X_{P4} + X_{P5} + X_{P6}$

$X_{AQ}+ X_{BQ} + X_{CQ} = X_{Q1} + X_{Q2} + X_{Q3} + X_{Q4} + X_{Q5} + X_{Q6}$

$X_{AR} + X_{BR} + X_{CR} = X_{R1} + X_{R2} + X_{R3}+ X_{R4} + X_{R5} + X_{R6}$

Where $X_{ij}>=0$; (wells=A,B,C and pumps=P,Q,R and refineries=1,2,3,4,5,6).

The optimal solution for the above formulation is 1966.68.

Well 3 is used to the capacity in the optimal schedule.

2b)

Network Diagram for the above problem:
Here wells: A,B,C
Pumps: P,Q,R
Refineries: 1,2,3,4,5