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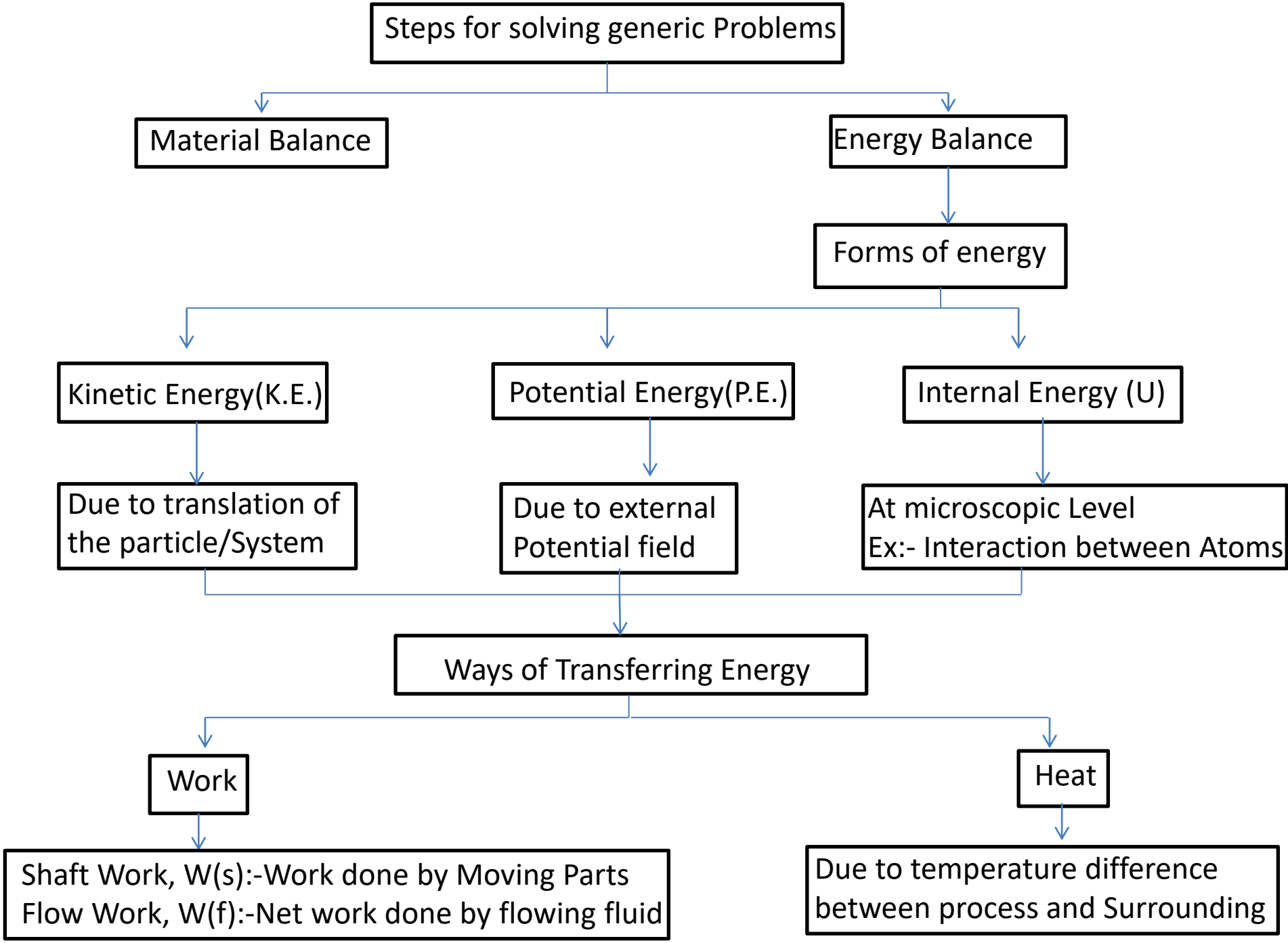
CL 201
ASSN10


Steps for solving generic Problems
Material Balance
Energy Balance
Forms of energy
Kinetic Energy(K.E.)
Potential Energy(P.E.)
Internal Energy (U)
Due to translation of the particle/System
Due to external Potential field
At microscopic Level
Ex:- Interaction between Atoms
Ways of Transferring Energy
Work
Heat
Shaft Work, W(s):-Work done by Moving Parts
Flow Work, W(f):-Net work done by flowing fluid
Due to temperature difference between process and Surrounding

Conservation of Energy and Mass

Input + Generation – output – Consumption = Accumulation -- 1

If no nuclear reaction is taking place then **Generation = Consumption = 0**

In case of Steady State **Accumulation = 0**

Equation 1 can be integrated(to get Rate of energy) and can be differentiated

Energy Balance

e = K.E.+ P.E. + U + W(s) + W(f)

= K.E.+ P.E. + H(enthalpy) + W(s), where H = U + W(f)

Enthalpy is always calculated w.r.t. reference

$\Delta H = mh$, h = specific enthalpy, m=mass of the component

If the data to calculate K.E. and P.E. is not given then it can be taken as zero.

Enthalpy

(In the System of multiple components enthalpy is not the sum of individual components)

When Explicit Information is given

$$\Delta h(T_f) = \Delta h(T_{ref}) + \int_{T(ref)}^{T(f)} C_p dT$$

(for gas only)

$$\Delta h(T_f) = \Delta h(T_{ref}) + \int_{T(ref)}^{T(f)} C_p dT + (P_1 - P_{ref})V$$

(for solid and liquid)

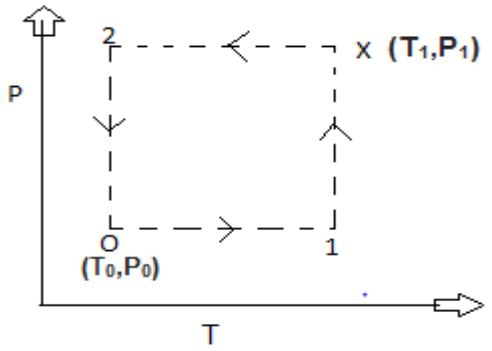
When explicit information is unavailable

$F = C - P + 2$

Where F = minimum intensive variable required to explain a particular state

C = Number of Components

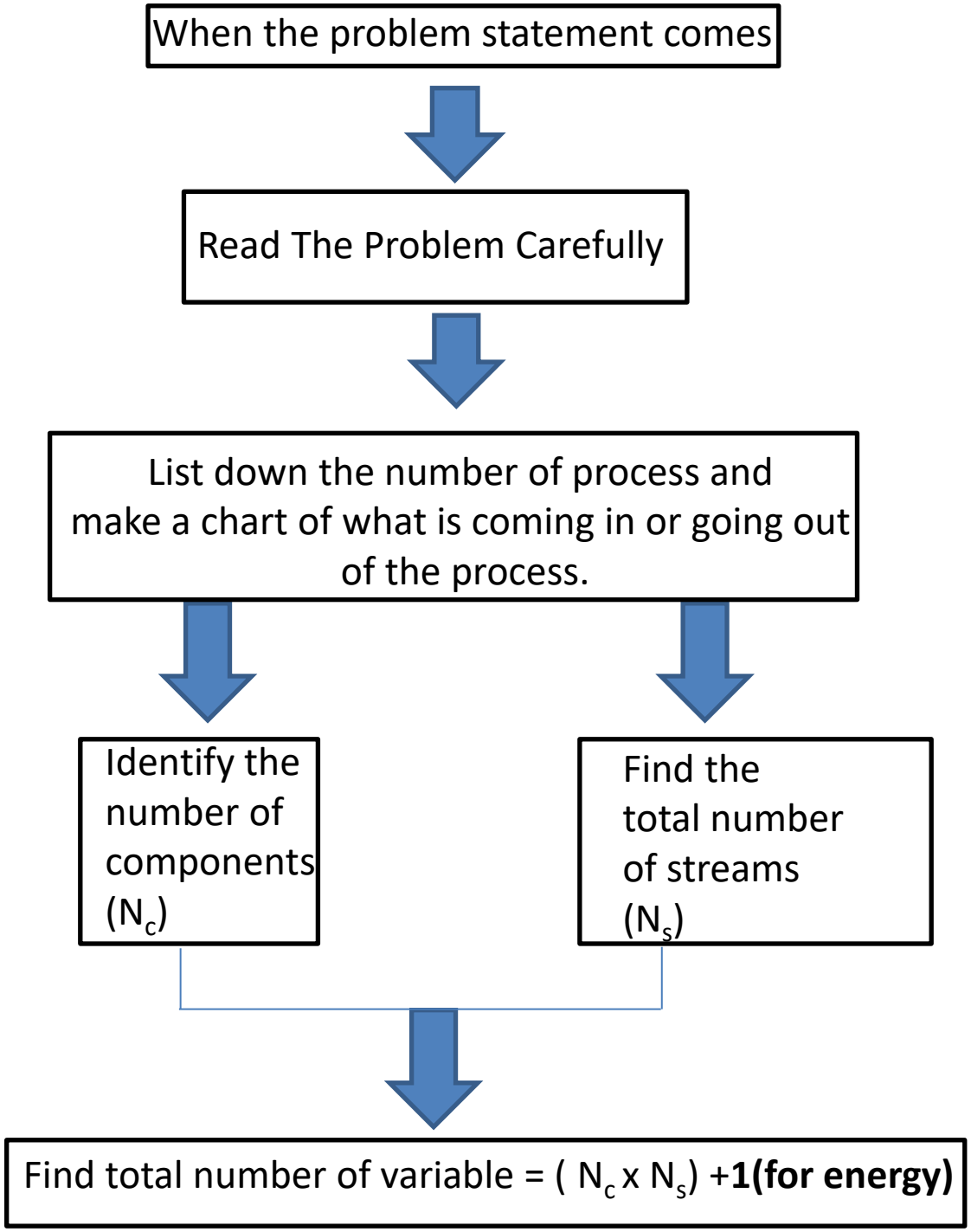
P = Number of Phase

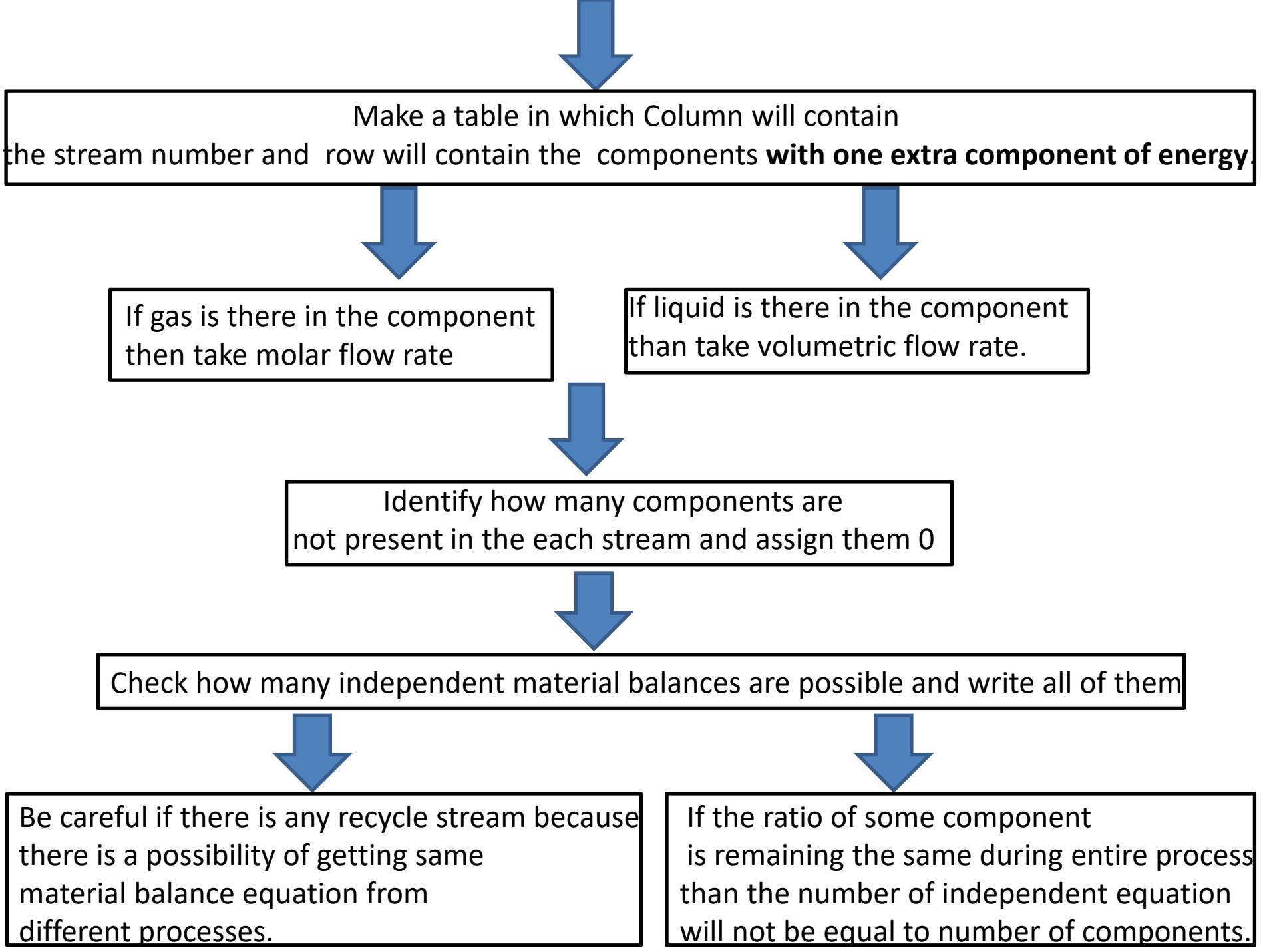


If We Know the Enthalpy at O then we can find Enthalpy at X taking anyone simple path as shown

$$h(T_1,P_1) = h(T_0,P_0) + \int_{T(ref)}^{T(f)} Cp(P_0)dT + \int_{P0}^{P1} dpv\ (T=T_1)$$

and if phase of the component is changing between O and X then one extra term must be added to the left side of the equation which will be either heat of fusion or heat of vaporization depending on the phase change


When the problem statement comes
Read The Problem Carefully
List down the number of process and make a chart of what is coming in or going out of the process.
Identify the number of components (N_c)
Find the total number of streams (N_s)
Find total number of variable = (N_c x N_s) +**1(for energy)**


Make a table in which Column will contain
the stream number and row will contain the components **with one extra component of energy.**
If gas is there in the component then take molar flow rate
If liquid is there in the component than take volumetric flow rate.
Identify how many components are not present in the each stream and assign them 0
Check how many independent material balances are possible and write all of them
Be careful if there is any recycle stream because there is a possibility of getting same material balance equation from different processes.
If the ratio of some component is remaining the same during entire process than the number of independent equation will not be equal to number of components.

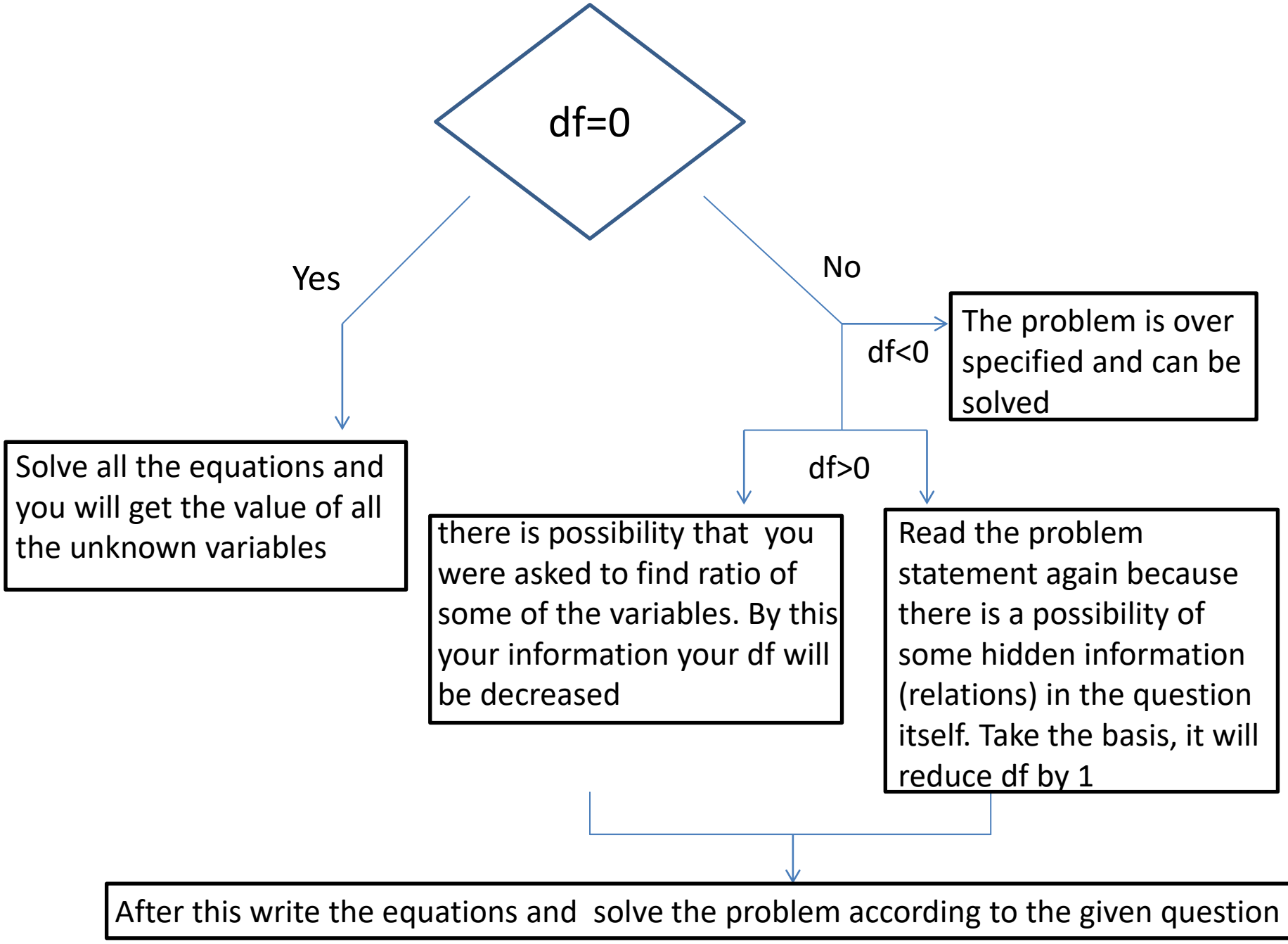
Search out the relation given in the question and calculate degree of freedom as follows (If any reaction is taking place then one unknown variable will be introduced that is 'extent of reaction'.)

df = (Total Variables)–(Known Variables)–(Independent Material Balance) -- (Independent Energy Balance) –(Number of relations)+(Number of reactions)

If you have to find the variables which are involved only in one of the process and than focus on that process and calculate the df and solve the question.

If you are asked the most of the things then do the df analysis

If you are asked only about End product than (Combined all the process) and calculate df.


df=0
Yes
No
Solve all the equations and you will get the value of all the unknown variables
df<0
The problem is over specified and can be solved
df>0
there is possibility that you were asked to find ratio of some of the variables. By this your information your df will be decreased
Read the problem statement again because there is a possibility of some hidden information (relations) in the question itself. Take the basis, it will reduce df by 1
After this write the equations and solve the problem according to the given question