2-3-1 The lever rule:

The relative amounts of the two phases present in the two-phase area can be determined by use of a lever relation.

Lever rule: the fractional amounts of two phases are inversely proportional to their distances along the tie line (isotherm) from the bulk composition axis.

For example, Point $\mathbf{X_2}$ in fig.(10) is the fulcrum of a lever. One lever arm is $\mathbf{A_2X_2}$, the distance from point $\mathbf{A_2}$ to point $\mathbf{X_2}$. The other lever arm is $\mathbf{X_2M_2}$. The relative amount of crystals A is given by the lever arm $\mathbf{X_2M_2}$ divided by the sum of the lever arms, $\mathbf{A_2M_2}$. Thus, the percentage of phases at point $\mathbf{X_2}$ is given by:

$$\%\ \textbf{of crystals A} = \frac{X2M2}{A2M2} \times 100 = \frac{C_{M2}-C_X}{C_{M2}} \times 100 = \frac{45-30}{45} \times 100 = \frac{15}{45} \times 100 = 33\%$$

$$\%\ \textbf{of melt} = \frac{A2X2}{A2M2} \times 100 = \frac{C_X}{C_{M2}} \times 100 = \frac{30}{45} \times 100 = 67\%$$

The composition of the **melt** at point $\mathbf{M_2}$ is **45% B** and **55% A.**

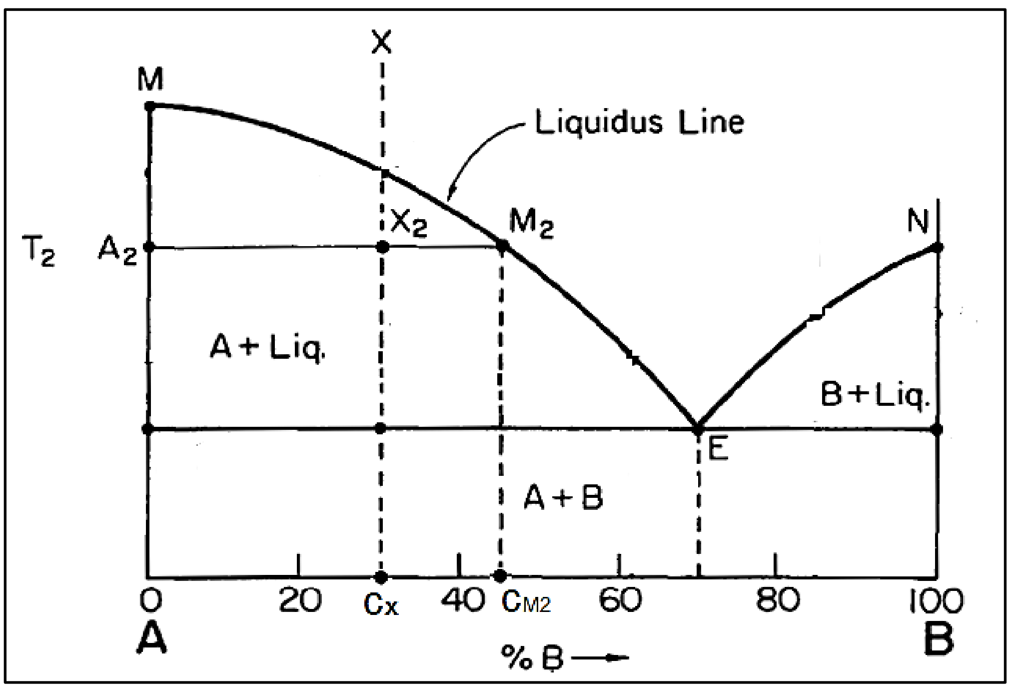

Fig.(10) Hypothetical phase diagram to explain the lever rule

The calculations on a cooling melt at point X with composition (70% A + 30% B) in fig.(11) are explained in table (1), isoplethal study.

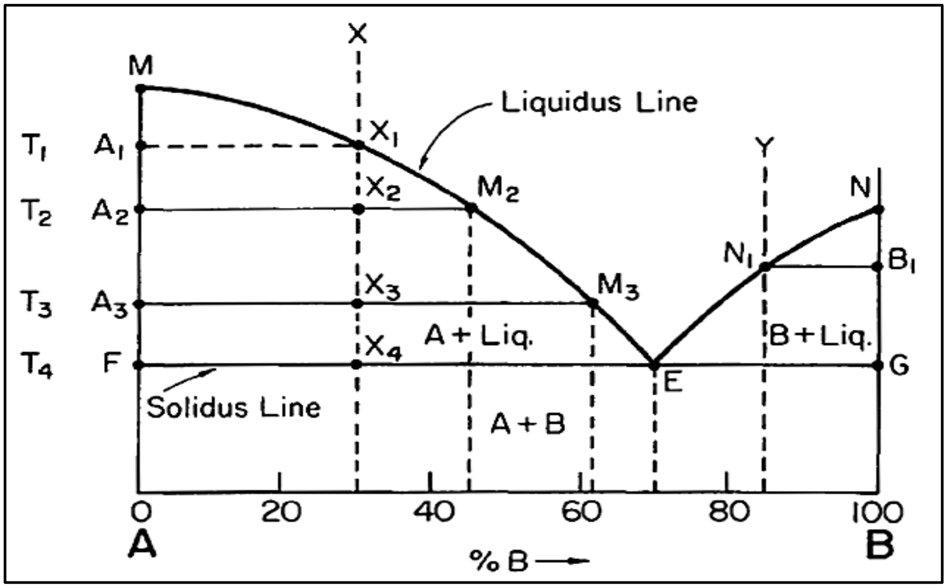

Fig.(11) Hypothetical phase diagram for binary system.

Table (1) Isoplethal study at point X with composition (70% A + 30% B).

Temp (°C)	Proportions (phases)	% (Phases)	% Composition of phases (in terms of components)
T_1	30 units melt	100	A = 70, B = 30
	ε units crystals (A)	ε†	A = 100
T_2	30 units melt	67	A = 55, B = 45
	15 units crystals (A)	33	A = 100
	45		
T_3	30 units melt	48	A = 37.5, B = 62.5
	32.5 units crystals (A)	52	A = 100
	62.5		
T_4^+	30 units melt	43	A = 30, B = 70
	40 units crystals (A)	57	A = 100
	70		
	Melt solidifies to form eutectic microstructure		
T_4^-	30 units eutectic xtals	43	A = 30, B = 70
	40 units crystals (A)	57	A = 100
	70		

2-3-2 The Binary Eutectic :

The **eutectic reaction** is an isothermal three-phase reaction in which a liquid is in equilibrium with two crystalline phases.

$$\text{Melt } C_E \text{ (L)} \overset{\text{cooling}}{\Longleftrightarrow} \text{crystals A + crystals B}$$

This reaction involving a liquid changing to two crystalline phases at the eutectic point which is **point E**. The eutectic point E, which formed by the intersection of the two liquidus lines, represents the composition of the lowest melting mixture in this system. As shown in fig.(12). If a microscope were arranged so as to view melt ***X*** at the various stages of crystallization at cooling, the phases might appear as shown schematically in fig.(13).

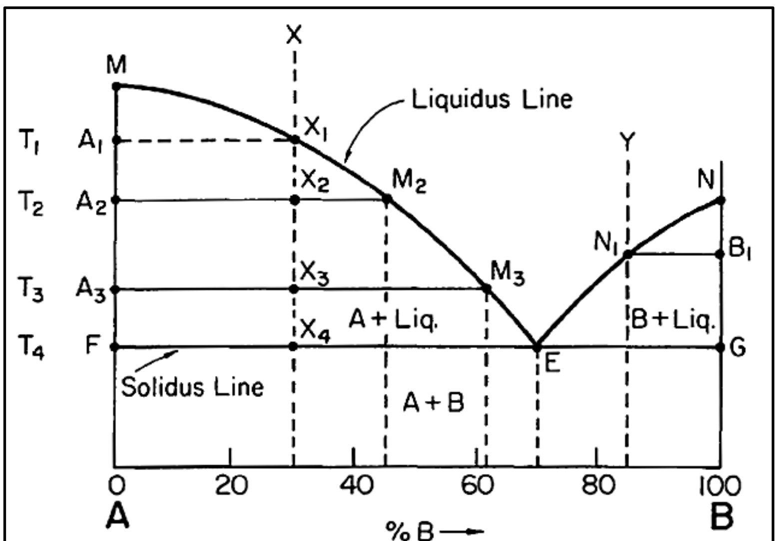

Fig.(12) Binary system containing one eutectic.

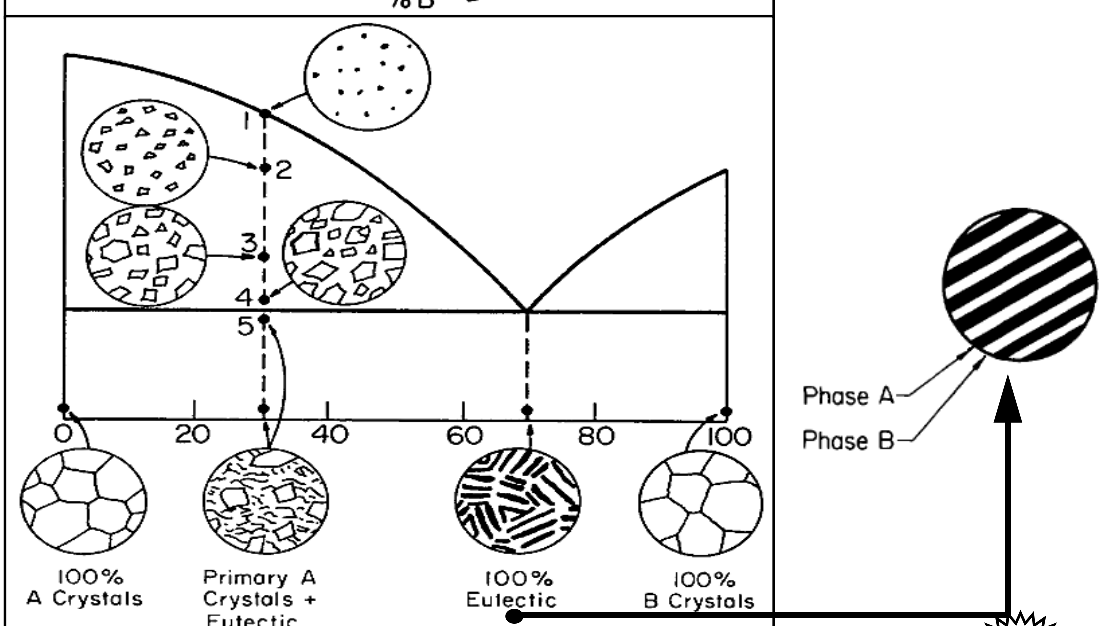

Fig.(13) Microstructure of phases in binary system containing one eutectic.