A liquid solution of methyl alcohol (CH3OH, MW = 32.03 g/mol) and water (H2O, MW = 18.02 g/mol) is 16.35 % by mass methyl alcohol. The density of the solution (at T = 20.0 °C) is D = 0.9721 g/cm3. What are the molarity, molality, and mole fraction of methyl alcohol in the solution?

Solution:

1.$\frac{p\times V}{T}=\frac{p_0\times V_0}{T_0}$;

p and p_0= 1 atm;

T_0=273K;

T=293K;

V_0=22.4$\frac{L}{mol}$;

V-x$\frac{L}{mol}$

$\frac{1\times x}{293}=\frac{1\times 22.4}{273}$;

x=24.04

V=24.04$\frac{L}{mol}$

2.ρ=$\frac{M}{V}$;

M=ρ×V;

M=0.9721×24.04=23.37.It is average molar mass.

3.M(average)=$\varphi_1\times M_1+\varphi_2\times M_2$;$\varphi(CH_3OH)$=x,$\varphi(H_2O)$=1-x

$M(CH_3OH+H_2O)$=x×32.03+(1-x)×18.02

23.37= x×32.03+(1-x)×18.02

x=0.38

$\varphi(CH_3OH)$=0.38;

$\varphi(CH_3OH)=\chi(CH_3OH)$=0.38.

4. let the mass CH_3OH and H_2O equal 100 grams.

$\omega(CH3OH)$=$\frac{m(CH_3OH)}{m(CH_3OH+H_2O)}$×100%

$m(CH_3OH) = \frac{\omega(CH_3OH) \times m(CH_3OH + H_2O)}{100\%}$;

m(CH_3OH)=$\frac{16.35 \times 100}{1,kl;00} = 16.35\ g$;

5.n=$\frac{m}{M}$;

n(CH_3OH)=$\frac{16.35}{32.03} = 0.51\ mol.$

Answer:0.51 mol;0.38.