Determination of Avogadro's Number

The Brownian Particles from a gas in equilibrium. The concentration of the particles in a vertical column decreases with height due to gravity.

Consider two layers of the particles at heights h and $h+dh$

Let P and $P+dP$ be the pressure respectively

The force due to gravity acting on particles

$$= (1 \times dh)\rho g = \rho g dh$$

Net force, $= (P+dP) - P + [\rho g dh]$

At equilibrium state, net force is equals to zero

$$(P+dP) - P + (\rho g dh) = 0$$

$$dP = -\rho g dh$$

for perfect gas

$$P = nKT$$

$$dP = KT dn \Rightarrow \rho = mn$$

$$KT dn = -mng dh$$

$$\frac{dn}{n} = -\left(\frac{mg}{KT}\right) dh$$

$$\log n = -\left(\frac{Nmg}{RT}\right) h + k' \quad \left[\frac{N}{R} = \frac{1}{K}\right] \quad -(1)$$

At $h = h_0$ & $n = n_0$

$$\log n_0 = -\left(\frac{Nmg}{RT}\right) h_0 + K$$

$$K = \log n_0 + \left(\frac{Nmg}{RT}\right) h_0 \quad -(2)$$

from (1) & (2)

$$\log n = -\left(\frac{Nmg}{RT}\right) h + \left(\frac{Nmg}{RT}\right) h_0 + \log n_0$$

$$\log\left(\frac{n}{n_0}\right) = -\left(\frac{Nmg}{RT}\right)(h - h_0) \quad -(3)$$

$$N = \frac{RT \log(n_0/n)}{mg(h-h_0)}$$

The effective mass of the suspended particle,

$$m = \frac{4}{3}\pi a^3 (d_1 - d_2)$$

and

$$N = \frac{3RT \log(n_0/n)}{4\pi a^3 g (d_1-d_2)(h-h_0)}$$

Determination of d_1

The density (d_1) can be calculated as:
Let m_1 and m_2 be the masses of water and emulsion filling specific gravity and m_3 be the mass of particles left over after desiccation in an oven.

volume of granules; $= \left(\frac{m_1}{d}\right) - \left(\frac{m_2 - m_3}{d}\right)$

Density of granules;

$$d_1 = \frac{m_3}{\left(\frac{m_1}{d}\right) - \left(\frac{m_2-m_3}{d}\right)}$$

$$d_1 = \frac{m_3 d}{(m_1 + m_3 - m_2)}$$

Determination of a

The radius of the particle is determined by Stoke's formula.

$$6\pi\eta a v = \frac{4}{3}\pi a^3 (d_1 - d_2) g$$

$$a = \left[\frac{9\eta v}{2(d_1-d_2)g}\right]^{1/2}$$

By substituting the value of d_1 & a, we can get the value of Avagadro's Number.

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