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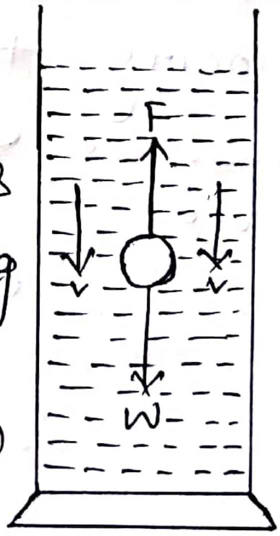
B.Sc (part-1) Hons

Paper-1

Stoke's Formula for the velocity of a small sphere falling through very viscous liquid.

Stoke showed that if a small sphere of a radius r be moving slowly with a terminal velocity v through a perfectly homogenous fluid of infinite extension and having a viscosity co-efficient η, the viscous force exerted upon the sphere will be given by

$$F = 6\pi\eta r v \quad \text{--- (1)}$$



Let us suppose that a small sphere of radius r and density ρ is falling frelly from rest under gravity throug a liquid of density σ and co-efficient of viscosity η. When it acquires the terminal velocity v, the various forces acting up on it are, Downward force due to gravity

$$= \frac{4}{3}\pi r^3 \rho g$$

upward thurst due to ~~buoy~~ buoyancy

$$= \frac{4}{3}\pi r^3 \sigma g$$

Retarding viscous force $= 6\pi\eta r v$

Hence the resultant downward driving force is

$$F = \frac{4}{3}\pi r^3 \rho g - \frac{4}{3}\pi r^3 \sigma g$$

$$= \frac{4}{3}\pi r^3 (\rho - \sigma) g$$

$$\therefore F = \frac{4}{3}\pi r^3 (\rho - \sigma) g$$

Since the sphere has attained a constant velocity the resultant driving force must be equal to the retarding viscous force

$$\therefore 6\pi\eta r v = \frac{4}{3}\pi r^3 (\rho - \sigma) g$$

$$\therefore \eta = \frac{4\pi r^3 (\rho - \sigma) g}{6 \times 3 \pi r v}$$

$$\therefore \boxed{\eta = \frac{2}{9}\frac{r^2}{v}(\rho - \sigma) g}$$

This is the required stoke's formula.