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Title: Properties of Solids & Liquids

Properties of Solids and Liquids

Elasticity and Stress-Strain Relations

Stress: Force per unit area experienced by a body under deformation.

$$\text{Stress} = \frac{\text{Force}}{\text{Area}}$$

SI unit: Pascal (Pa).

Strain: Relative change in shape or size.

$$\text{Strain} = \frac{\text{Change in Dimension}}{\text{Original Dimension}}$$

Dimensionless.

Elastic Moduli: Ratio of stress to strain.

Young's Modulus (Y)

$$Y = \frac{FL}{A\Delta L}$$

Describes resistance to longitudinal deformation.

Shear Modulus (G)

$$G = \frac{F}{A \cdot \theta} \quad (\text{for small angle } \theta)$$

Measures response to tangential forces.

Bulk Modulus (K)

$$K = -V \frac{dP}{dV}$$

Describes response to uniform pressure.

Compressibility:

$$\text{Compressibility} = \frac{1}{K}$$

Poisson's Ratio (σ):

$$\sigma = -\frac{\text{Lateral Strain}}{\text{Longitudinal Strain}}$$

Fluid Mechanics

Pressure in Liquids

$$P = P_0 + \rho gh$$

Pascal's Law

Pressure applied is transmitted equally.

Archimedes' Principle

$$F_B = V \rho g$$

Upthrust equals weight of displaced fluid.

Fluid Flow Types

- Streamline: Predictable paths.

- Turbulent: Irregular, random paths.

Continuity Equation

$$A_1 v_1 = A_2 v_2$$

Conservation of mass.

Bernoulli's Equation

$$P + \frac{1}{2} \rho v^2 + \rho g h = \text{constant}$$

Energy conservation in fluid flow.

Viscosity

$$F = -\eta A \frac{dv}{dz}$$

Internal fluid friction.

Stokes' Law and Terminal Velocity

$$F = 6\pi\eta r v \quad ; \quad v_t = \frac{2r^2(\rho - \sigma)g}{9\eta}$$

Surface Tension and Related Concepts

$$\Delta P_{\text{drop}} = \frac{2T}{R} \quad ; \quad \Delta P_{\text{bubble}} = \frac{4T}{R}$$

$$h = \frac{2T \cos \theta}{\rho g r}$$

Thermal Properties of Matter

Modes of Heat Transfer

Conduction, convection, and radiation.

Thermal Conductivity

$$\frac{dQ}{dt} = -K A \frac{dT}{dx}$$

Blackbody and Radiation Laws

Stefan's Law:

$$E = \sigma T^4 \quad ; \quad E = e\sigma T^4$$

Kirchhoff's Law:

$$\frac{e}{a} = E_{\text{black body}}$$

Newton's Law of Cooling

$$-\frac{dT}{dt} \propto (T - T_s)$$