💧 Chapter 7 – Properties of Bulk Matter

🌊 1. Introduction

So far, we treated matter as rigid. But real materials deform under forces, flow as liquids, or exist as gases.
This chapter covers elasticity, fluid mechanics, and surface phenomena — essential for understanding real-world physics.

⚙️ 2. Elasticity

When you stretch a spring, it returns. That restoring property is elasticity.

Hooke's Law:

Stress∝Strain(withinelasticlimit)\text{Stress} ∝ \text{Strain} \quad (within elastic limit)Stress∝Strain(withinelasticlimit) Stress=E×Strain\text{Stress} = E × \text{Strain}Stress=E×Strain

Type	Formula	Example
Young's modulus	$Y = (F/A)/(\Delta L/L)$	Wire stretch
Bulk modulus	$K = (-\Delta P)/(\Delta V/V)$	Pressure on fluid
Shear modulus	$\eta = (F/A)/(\Delta x/L)$	Shearing metal block

Unit: N/m^2 (Pascal).
Elastic limit → beyond it, permanent deformation occurs.

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3. Fluid Pressure and Pascal's Law

Pressure = Force/Area.
Pascal's Law: External pressure applied on fluid transmits equally in all directions.

Applications:

- Hydraulic lift, brakes, press.

⚖️ 4. Archimedes' Principle

A body submerged in fluid experiences upthrust equal to weight of displaced fluid.

FB=ρfVgF_B = ρ_f V gFB=ρfVg

Explains floating and sinking.

Condition for floatation: ρ_body ≤ ρ_fluid.

Used in ships, hydrometers, submarines.

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5. Viscosity

Viscosity = internal friction in fluids.
For laminar flow, Newton's law of viscosity:

F=ηAdvdyF = η A \frac{dv}{dy}F=ηAdydv

Unit: Pa·s.

Stoke's Law (sphere in fluid):

F=6πηrvF = 6π η r vF=6πηrv

Terminal velocity:

vt=2r2(ρs−ρf)g9ηv_t = \frac{2r^2(ρ_s - ρ_f)g}{9η}vt=9η2r2(ρs−ρf)g

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6. Streamline and Turbulent Flow

- Streamline (laminar): smooth, layers slide without mixing.
- Turbulent: irregular, eddy currents form.

Reynolds number:

Re=ρvDηR_e = \frac{ρvD}{η}Re=ηρvD

If R_e < 2000 → laminar; > 4000 → turbulent.

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7. Surface Tension

Cohesive forces at surface create tension acting along the surface.

T=FLT = \frac{F}{L}T=LF

Unit: N/m.

Surface energy = T × increase in area.

Applications: capillarity, soap bubbles, insects walking on water.

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8. Capillary Rise

Liquid rises or falls in a narrow tube due to surface tension:

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

Water ($\theta < 90°$) → rise, Mercury ($\theta > 90°$) → fall.

🔥 9. Viscosity and Flow of Blood

Blood viscosity helps maintain uniform flow; too high → heart strain, too low → uncontrolled bleeding.
Thus, physics directly connects to physiology here.

📃 10. Summary

1. **Stress/strain describe deformation.**
2. **Elastic moduli: Y, K, η.**
3. **Pascal's law governs hydraulics.**
4. **Archimedes' principle explains buoyancy.**
5. **Viscosity controls flow; Reynolds number predicts turbulence.**
6. **Surface tension causes capillarity and drop formation.**