Crack Notes [Physics 5]
Fluids & Solids

Fluids
- Molecules have high kinetic energy
- Intermolecular bonds break & reform rapidly
- Exerts pressure/force on wall of container

Density
- $\rho = m/V$, density of water is $\rho_{water} = 1000\ kg/m^3 = 1\ g/cm^3$
- Intensive property (doesn't depend on amount)
- Compression can change density but we can assume liquids/solids are incompressible
- Specific gravity: $SG = \rho_{substance}/\rho_{water}$ ($SG > 1$ means heavier than water, < 1 means lighter)

Pressure
- Caused by molecular collisions
- $P = F/A$
- Fluid at rest (nonmoving): $P = \rho g y$ where y is depth
  - For multiple layers of fluid, you can add pressures
  - If container is open, must also add atmospheric pressure = $101\ kPa$
- Pascal's principle: if you add pressure anywhere, it'll be spread out everywhere – assumes incompressible
  - *Hydraulic lift*: $F_1 d_1 = F_2 d_2$, $\frac{F_1}{A_1} = \frac{F_2}{A_2}$, $A_1 d_1 = A_2 d_2$

Force
- Archimedes' principle: object inside water has buoyant force due to difference in pressures
- Buoyant force equal to weight of displaced fluid, $F = \rho_{fluid} V_{submerged} g$
  - V is volume of object that's submerged in water = m_{object}/ρ_{object}
  - If object isn't completely in the water, only consider V that's in the water
  - Floating object: fraction submerged = $\rho_{object}/\rho_{water}$ = specific gravity of object
- Center of buoyancy is always physical center of object, if center of mass isn't physical center then a torque is created

Motion
- Random translational motion: contributes to fluid pressure
- Uniform translational motion: motion of fluid as a whole, doesn't contribute to pressure

Ideal fluid
- No viscosity (resistance to flow, how "syrupy" fluid is)
- Incompressible (uniform density)
- Flows without turbulence (all points flow at same speed)
  - Volume flow rate $Q = Av$, A is cross sectional area, v is velocity of all fluid particles
  - Pipe that changes cross sectional area: $A_1 v_1 = A_2 v_2$

Nonideal fluid
- Drag/viscosity will decrease flow velocity

Crack the OAT

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Bernoulli's equation:

$$P + \rho gh + \frac{1}{2}\rho v^2 = constant$$

- h is height of fluid above ground
- Random motion KE + gravitational PE + uniform motion KE = constant

Applications:
(1) Hole in bottle of fluid, distance h below surface of water: $v = \sqrt{2gh}$
(2) Velocity increases when pressure decreases, so in a pipe, wider = more pressure

Intermolecular forces create surface tension, cohesion/adhesion

Solids

- *Stress* = force applied / area where it's applied
- *Strain* = change in shape / original shape
- Young's modulus: tensile (squishing/pulling), $E = \frac{F/A}{\Delta h/h_0}$
- Shear modulus: shear (tearing), $G = \frac{F/A}{\Delta x/h_0}$
- Bulk modulus: compression/expansion, $B = \frac{\Delta P}{\Delta V/V_0}$