Fluids Review Sheet

1. **Fluids**
   a. Definition – A fluid is a collection of molecules that are randomly arranged and held together by weak forces and forces exerted by the sides of the container
   b. Examples – liquids and gases
   c. Fluids conform to the shape of their container

2. **Pressure**
   a. **Pressure = Force/Area**
   b. Equivalent units of pressure: 1 atmosphere (atm) = 14.7 pounds per sq. inch (psi) = 760 mmHg = 101,300 Pascals (Pa) = 101.3 kiloPascals (kPa)
   c. Absolute pressure = Atmospheric pressure + Gauge pressure
   d. Pressure varies with depth in a fluid: $\mathbf{P_{in\ fluid} = P_{atm} + \rho gh}$

      Pressure below fluid = Atmospheric pressure + (Density of fluid)(gravity)(Depth)
   e. Pascal's Law: The change in the pressure of a fluid is transmitted equally to every point in the fluid and the walls of the container.

      Pressure $_1$ = Pressure $_2$, so $\dfrac{\text{Force}_1}{\text{Area}_1} = \dfrac{\text{Force}_2}{\text{Area}_2}$

3. **Buoyancy**
   a. Definition - The buoyant force is the upward force exerted by a fluid on any object immersed in the fluid.
   b. **Buoyant force = ρ_{fluid} g V**

      Buoyant force = (Density of fluid)(gravity)(Volume of object)
   c. If the weight of the object is greater than the buoyant force, it will sink.

      If the weight of the object is less than the buoyant force, it will float.

      Weight = Mass x Gravity **w = mg**

      Weight = Density x Volume x Gravity **w = ρVg**

4. **Fluid Dynamics**
   a. Characteristics of flow
      i. The fluid is nonviscous (not affected by friction).
      ii. The flow is steady (laminar), not turbulent.
      iii. The fluid is incompressible (constant density).
      iv. The flow is irrotational (velocity is the same everywhere).
   b. Flow rate: **Volume/Time = Area x Velocity**
   c. Continuity of flow: $\mathbf{Area_1 \times Velocity_1 = Area_2 \times Velocity_2}$

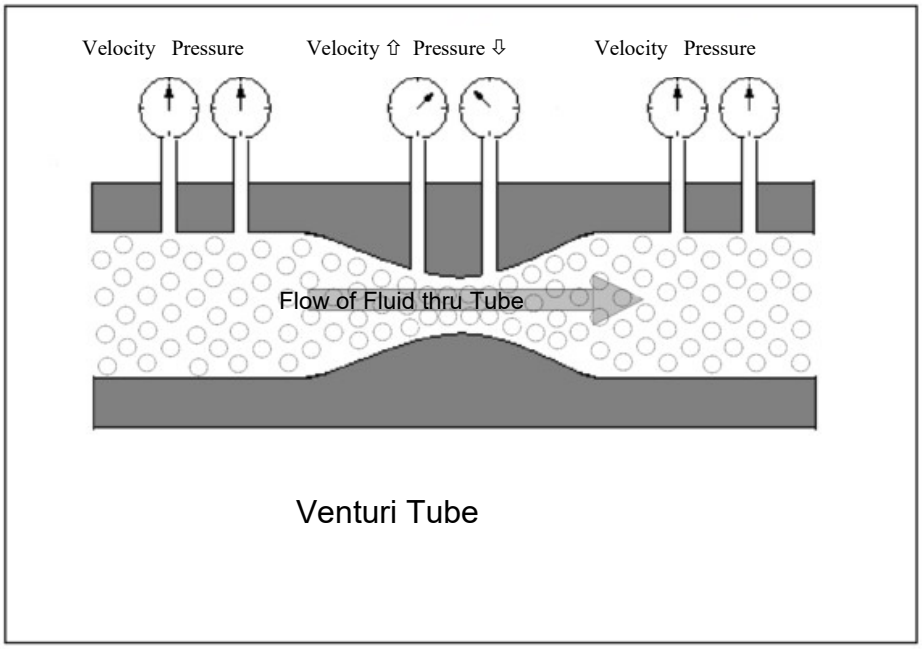
d. Bernoulli's Equation

i. Equation: $\mathbf{P_1 + \frac{1}{2}\rho v_1^2 + \rho g h_1 = P_2 + \frac{1}{2}\rho v_2^2 + \rho g h_2}$

$\text{Pressure}_1 + \frac{1}{2}(\text{Density})(\text{Velocity}_1)^2 + (\text{Density})(\text{gravity})(\text{Height}) = \text{Pressure}_2 + \frac{1}{2}(\text{Density})(\text{Velocity}_2)^2 + (\text{Density})(\text{gravity})(\text{Height})$

ii. Applications

1. Spray bottle
2. Flow of liquid from a tank
3. Flow measured by a Venturi tube
4. Affects path of a spinning ball

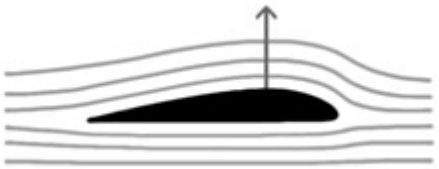


Venturi Tube

e. Coanda Effect – A flowing fluid tends to follow the contours of a curve

i. Application

1. Use for designing AC diffusers
2. Used for designing "leaf-free" gutters
3. Creates lift on an airplane wing



5. Real Fluids

a. Real fluids are viscous. Viscosity is the resistance to flow.
b. The flow in pipes and channels is affected by friction.
c. The flow velocity decreases where the fluid touches the sides.

Fluids Practice Problems

1. You use a tire gauge to measure the pressure in your bicycle tire. The gauge reads 16 psi. If the atmospheric pressure that day was 14.2 psi, what was the absolute pressure of the air in your tire?

2. Convert 45.0 psi to:
    a. atmospheres
    b. mmHg
    c. Pascals

3. A 600-Newton elephant sits on your lunch. If the elephant covers an area of 1.2 m^2 when it sits, what pressure is it exerting on your lunch?

4. A 90-pound person leans against a wall. If he exerts a pressure of 0.15 psi against the wall, what is his area of contact with the wall?

5. The density of silver is 10.490 g/cm^3. Find the mass of a bar of silver that is 45 cm long, 8 cm thick, and 20 cm wide.

6. The density of salt water is 1030 kg/m^3. What would be the fluid pressure 3 meters below the surface in a tank filled with salt water?

7. A hydraulic lift uses a 3 pound force to lift 60 pounds. If the area of the small piston is 1.5 in^2, what is the area of the large piston? What is the pressure in the hydraulic fluid?

8. A large ball has a volume of 0.7m^3 and a mass of 80 kg. The ball is thrown into a pool full of water (density 1000 kg/m^3).
    a. What is the buoyant force on the ball?
    b. Will the ball sink or float?
    c. If a string were tied to the bottom of the pool and to the ball, what would the tension of the string be?

9. A pipe has a radius of 2 inches. If the flow rate through the pipe is 50 cubic inches per minute, what is the velocity of the fluid in the pipe?

10. The pressure is measured at two points in a horizontal pipe. At the first point, the pressure is 150,000 Pascals and the fluid velocity is 10 m/s. At the second point, the pressure is 110,000 Pascals. The fluid's density is 920 kg/m^3.
    a. Did the velocity increase or decrease at the second point?
    b. Find the velocity at the second point.

11. Water flows out of a very large tank. The top of the tank is open so that the surface of the water is at atmospheric pressure. If the tank is 15 meters off the ground, how fast is the water coming out of the pipe when it reaches the ground?