What is Bernoulli's Principle?

Worksheet

Bernoulli's principle states that for an ideal, incompressible, non-viscous fluid flowing steadily, the sum of static pressure, dynamic pressure, and hydrostatic pressure is constant along a streamline - so as speed increases, pressure decreases.

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

Questions

1. As fluid speed increases in a horizontal pipe, what happens to pressure?
A) It increases
B) It decreases
C) It stays the same
D) It becomes zero

2. Bernoulli's equation assumes the fluid is...
A) Compressible and viscous
B) Incompressible and non-viscous
C) Always at rest
D) Always turbulent

3. In P + v + gh = constant, the term gh represents...
A) Dynamic pressure
B) Static pressure
C) Hydrostatic (potential) pressure
D) Viscous pressure

4. Why does an airplane wing generate lift?
A) Higher pressure below than above due to faster flow on top
B) Equal pressure above and below
C) Lower air density above the wing only
D) Gravity pulls air upward

5. Water flows through a horizontal pipe that narrows from a wide section (v1 = 2 m/s, P1 = 200,000 Pa) to a narrow section (v2 = 6 m/s). Find P2 (= 1000 kg/m).

6. Air flows over an airplane wing at 250 m/s on top and 200 m/s below. If P_below = 101,000 Pa and _air = 1.2 kg/m, find the pressure above.

7. A venturi meter has a wide section (v1 = 1 m/s) and throat (v2 = 4 m/s), both at the same height, water flowing (= 1000 kg/m). Find the pressure drop P1 P2.

8. Define: What does Bernoulli's principle state?

9. Define: What conditions does Bernoulli's equation assume?

10. Define: How does Bernoulli's principle explain lift?

Answer Key

1. B) It decreases - By Bernoulli's principle, P + v is constant, so higher v means lower P.

2. B) Incompressible and non-viscous - The ideal Bernoulli equation assumes steady, incompressible, non-viscous flow.

3. C) Hydrostatic (potential) pressure - gh is the pressure due to elevation - the hydrostatic term.

4. A) Higher pressure below than above due to faster flow on top - Faster flow over the curved top lowers pressure there, so higher pressure below pushes the wing up.

5. P1 + v1 = P2 + v2 200,000 + 0.510002 = P2 + 0.510006 200,000 + 2,000 = P2 + 18,000 P2 = 202,000 18,000 = 184,000 Pa

6. P_above = P_below + (v_below v_above) P_above = 101,000 + 0.51.2(200 250) P_above = 101,000 + 0.6(40,000 62,500) P_above = 101,000 + 0.6(22,500) = 101,000 13,500 = 87,500 Pa

7. P1 P2 = (v2 v1) P1 P2 = 0.51000(4 1) P1 P2 = 500(16 1) = 50015 = 7,500 Pa

8. Along a streamline, P + v + gh stays constant - faster flow means lower pressure.

9. Steady, incompressible, non-viscous (ideal) flow along a streamline.

10. Faster airflow over a curved wing top lowers pressure there, creating a net upward force.