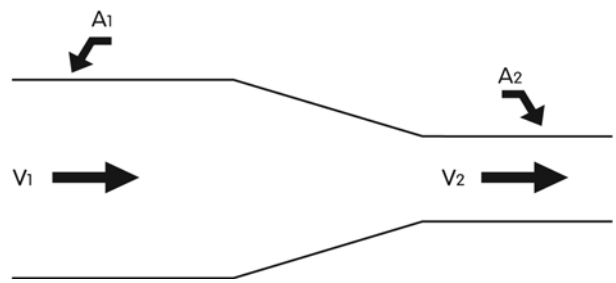
Skill Development Exercises for Chapter 1

1-1. In the figure below, Area A_1 = 2 ft^2, Area A_2 = 1.25 ft^2, and velocity V_1 = 1,000 fpm. Calculate V_2 (fpm).

a) 1,600 fpm b) 625 fpm c) 1,406 fpm d) 2,569 fpm



Answer: a, 1600 fpm. The volume flow remains constant as the duct cross-section reduces.

Volume = $(A_1 \times V_1) = (A_2 \times V_2)$, substituting $(2 \times 1000) = (1.25 \times V_2)$

V_2 = 1600 fpm

1-2. The total pressure at a certain point in a system is determined to be 5 in. wg, and the static pressure at that point is determined to be 2 in. wg. What is the velocity pressure (in. wg) at that point?

a) 21 in. wg b) 7 in. wg c) 3 in. wg d) 2 in. wg

Answer: c, 3 in. wg

Total pressure is the sum of static pressure plus velocity pressure.

Total pressure 5 in. wg = Static pressure 2 in. wg + Velocity pressure 3 in. wg

1-3. Which of the following is the most correct definition of *static pressure regain*?

a) As the velocity of an airstream decreases, the static pressure increases.

b) As the velocity of an enclosed airstream decreases due to friction, the static pressure increases.

c) Friction reduces static pressure while velocity pressure increases with reduction in duct size.

Answer: a

1-4. An air handling system is determined to have a 6 in. pressure drop through the system at a flow of 8,000 cfm. What is the system constant?

a) 1.5 b) 1,333 c) 3,265 d) 4,000

Answer: c, 3265

C_s is the system constant

$$\text{cfm} = C_s\sqrt{\Delta p_f}$$

$$8,000 = C_s\sqrt{6}$$

$$C_s = \frac{8,000}{\sqrt{6}} = \frac{8,000}{2.45} = 3,265$$

1-5. The product of fluid pressure and specific volume is _____?

a) Internal energy b) Reynolds number c) Kinetic energy
d) Flow work e) Viscosity

Answer: d, flow work

1-6. What does a water manometer measure?

a) Velocity b) Pressure c) Temperature d) All of the above

Answer: b, pressure

1-7. Fan pressures are typically indicated in what units?

a) in. wg b) in. Hg c) cfm d) None of the above

Answer: a, in. wg (inches of water column)

1-8. If the cross-sectional area of a duct decreases in size, the velocity of an airstream passing through the duct will increase.

a) True b) Cannot tell c) False

Answer: a, true

1-9. Air is passing through a length of inaccessible duct with a constant cross-sectional area. You suspect that there is a serious leak in the duct. The velocity pressure drops from 0.85 in. wg to 0.60 in. wg along the suspect section of duct. Approximately what percentage of air is being lost through the leak?

a) 50% b) 31% c) 16% d) 11%

Answer: c, 16%

The duct has a constant cross-section, so the volume flow is proportional to the velocity.

$$p_v = \left[\frac{V}{4005}\right]^2$$

Rearranging: $V = 4005\sqrt{p_v}$

$$V_{start} = 4005\sqrt{0.85} = 3692\text{fpm}$$

$$V_{end} = 4005\sqrt{0.6} = 3102\text{fpm}$$

Loss of velocity is 3692 – 3102 = 590 fpm.

Percentage loss: $\left(\frac{590}{3692}\right) \times 100 = 16\%$

1-10. In an air-conditioning system, 3000 cfm of outside air at 34°F is drawn in over a heater and delivered into the building at 74°F. What volume of air is delivered?

a) 6,529 cfm b) 1,378 cfm c) 2,775 cfm d) 3,243 cfm

Answer: d, 3243 cfm

Volume is proportional to absolute temperature when pressure remains constant. Bringing air into a building barely changes the pressure, so the 3000 cfm of outside air is increased in volume as it is heated from 34°F to 74°F.

$$3000 \times \left[\frac{460 + 74}{460 + 34}\right] = 3243\text{cfm}$$

1-11. In an air-conditioning system, 30,000 cfm of return air at 78°F is mixing with 4,600 cfm of outside air at 95°F. What is the approximate resulting volume and temperature?

a) 36,400 cfm, 79.2°F b) 36,400 cfm, 80.3°F

c) 34,600 cfm, 80.3°F d) 34,600 cfm, 79.2°F

Answer: c

The approximate answer is based on the volumes added together and the "sum of volume times temperature" in equals the "volume times temperature" out. Adding volumes : 30,000 + 4600 = 34,600 cfm

$$(V_1 \times t_1) + (V_2 \times t_2) = (V_m \times t_m)$$

$$(30,000 \times 78) + (4600 \times 95) = (34,600 \times t_m)$$

t_m = 80.3°F