**Practice Problems Worksheet Answer Key**

**Show complete solutions to the following problems and box final answers with units.**

1. **A sample of an unknown material weighs 300 N in air and 200 N when submerged in an alcohol solution with a density of 0.70 x 103 kg/m3. What is the density of the material?**

Given:

Fg(air) = 300 N

Fg(alcohol) = 200 N

ρalcohol = 0.7 x 103 kg/m3

Unknown:

ρmaterial or ρo

Solution:

FB = Fg(air) – Fg(alcohol) = 300 N – 200N

**FB = 100 N**

Fg(air) / FB = ρo / ρalcohol

ρo = Fg(air) / FB \* ρalcohol = (300 N / 100 N) \* 0.7 x 103 kg/m3

**ρo = 2.1 x 103 kg/m3**

1. **A 40-cm tall glass is filled with water to a depth of 30 cm.**
   1. **What is the gauge pressure at the bottom of the glass?**
   2. **What is the absolute pressure at the bottom of the glass?**

Given:

h = 30 cm = 0.3 m

g = 9.81 m/s2

ρwater = 1.0 x 103 kg/m3

Uknown:

1. Pgauge
2. Pabsolute

Solution:

1. Pgauge = ρgh = (1.0 x 103 kg/m3) (9.81 m/s2) (0.3 m)

**Pgauge = 2.9 x 103 kg/m3 Pa**

1. Pabsolute = Patm + Pgauge

Pabsolute = 1.01 x 105 Pa + 2.9 x 103 kg/m3 Pa

**Pabsolute = 1.04 x 105 Pa**

1. **Water circulates throughout a house in a hot water heating system. If the water is pumped at a speed of 0.50 m/s through a 4.0-cm diameter pipe in the basement under a pressure of 3.03x105 Pa, what will be the velocity and pressure in a 2.6-cm diameter pipe on the second floor 5.0 m above?**

Given:

v1 = 0.50 m/s v2 = ?

h1 = 0 m (basement) h2 = 5.0 m

d1 = 0.04 m d2 = 0.026 m

A1 = π (d1 / 2)2 = 0.0004π A2 = π (d2 / 2)2 = 1.69 x 10-4π

P1 = 3.03 x 105 Pa P2 = ?

Unknown:

v2

P2

Solution:

A1 v1 = A2 v2

v2 = A1 v1 / A2 = (0.0004π \* 0.50 m/s) / 1.69 x 10-4π

**v2 = 11.83 m/s**

P1 + ½ ρ v12 + ρgh1 = P2 + ½ ρ v22 + ρgh2

P2 = P1 + ½ ρ (v12 - v22) - ρgh2

P2 = (3.03 x105 Pa) + ½ (1.0 x 103 kg/m3) [(0.50 m/s)2 – (11.83 m/s)2] – (1.0 x 103 kg/m3) (9.81 m/s2) (5.0 m)

**P2 = 1.84 x 105 Pa**

1. **The small piston of a hydraulic lift has an area of 0.20 m2. A car weighing 1.2 x 104 N sits on a rack mounted on the large piston. The large piston has an area of 0.90 m2. How large force must be applied to the small piston to support the car?**

Given:

A1 = 0.20 m2 A2 = 0.90 m2

F1 = ? F2 = 1.2 x 104 N

Unknown:

F1

Solution:

F1 / A1 = F2 / A2

F1 = F2 / A2 (A1) = (1.2 x 104 N / 0.90 m2) \* 0.20 m2

**F1 = 2.7 x 103 N**

1. **Calculate the absolute pressure at an ocean depth of 1.0 x 103 m. Assume that the density of the water is 1.025 x 103 kg/m3 and that P0 = 1.01 x 105 Pa.**

Given:

h = 1.0 x 103 m

ρ = 1.025 x 103 kg/m3

Patm or Po = 1.01 x 105 Pa

Unknown:

Pabsolute

Solution:

Pabsolute = Patm + Pgauge

Pabsolute = Patm + ρgh = 1.01 x 105 Pa + (1.025 x 103 kg/m3) (9.81 m/s2) (1.0 x 103 m)

**Pabsolute = 1.01 x 107 Pa**

1. **A water tank has a spigot near its bottom. If the top of the tank is open to the atmosphere, determine the speed at which the water leaves the spigot when the water level is 0.5 m above the spigot.**

Given:

P1 = Patm = 1.01 x 105 Pa = P2 (both are open to atmosphere)

v1 = 0 (negligible)

h1 = 0.5 m

h2 = 0 m

Unknown:

v2

Solution:

P1 + ½ ρ v12 + ρgh1 = P2 + ½ ρ v22 + ρgh2

P1 + ρgh1 = P2 + ρgh2

v2 = sqrt(2gh1)

v2 = sqrt(2 (9.81 m/s2) (0.5m))

**v2 = 3.13 m/s**