PRESSURE/FLIGHT UNIT SOME NOTES… ALL stuff we know already!!

Density is Mass /Vol (in $Kg/^3$) for Physics
So Mass = Dens * Volume, Since Weight = Mass *g, Weight=Dens*Vol*g

Pressure is Force/Area in Newtons/ square meter

$1\ N/m^2$ = 1 Pascal of Pressure, Sea Level = 101320 Pascals

Since Energy is Force * Distance = Work

Pressure = (Force/Area * Distance/Distance)
= (Force * Distance) / (Area*Distance)
Pressure = Work / Volume = Energy/Volume

For an object in a fluid the pressure on top of it is:

Δ Pressure = Force/Area = Weight/Area
= (Dens * Vol*g)/ Area
= Dens * g * Vol/Area
Δ Pressure = Dens*g*Height
That's the same as saying that ΔWork/Volume = mgh /Volume !

In fact the conservation of energy for a fluid is:

ΔWork + Δ GPE + Δ KE = 0 (with no heat) but dividing by volume (Mass/Vol = Dens)

$F*dist/Vol + mgh/Vol + ½\ m\ vel^2 / Vol = F*dist/Vol + mgh/Vol + ½\ m\ vel^2 / Vol$

$Pressure_1 + Dens*g*h_1 + ½\ Dens*Vel_1^2 = Pressure_2 + Dens*g*h_2 + ½\ Dens*Vel_2^2$

This is called Bernoulli's Principle, and is just a restatement of conservation of energy that relates Pressure (instead of work), Height and Velocity for a fluid.

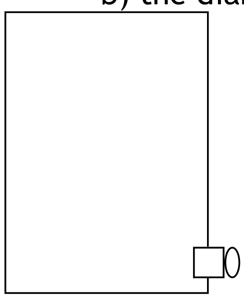
If velocity stays the same, then pressure changes depending on density and height.
If height stays the same, then the faster the velocity, the lower the pressure!

Pg 337 #1

A large storage tank open to the atmosphere at the top and filled with water, develops a small hole at a point 16 m below the water. If the rate of flow of water from the leak is .0025 m^3 / min, determine the following:

a) the speed at which the water leaves the hole.

b) the diameter of the hole (hint : Area = Volume/Dist= πr^2)



TOP:

Pressureair + $Dens_{water}$*g*h + ½ $Dens_{water}$* Vel^2

101320 Pascals + 1000 kg/m^3* 9.8 * 16m + 0 (large top means v≈ 0)

BOTTOM:

Pressureair + $Dens_{water}$*g*h + ½ $Dens_{water}$* Vel^2

101320 Pascals + 0 (h= 0!_ + ½ 1000 kg/m^3* Vel^2

SO:

Dens*g*h = ½ Dens * Vel^2

Vel^2 = 2(9.8)*16, Vel = 17.7 m/s

b) VOLUME/TIME = .0025 m^3/min = .000042 m^3/sec,

AREA = VOLUME/DISTANCE = (VOLUME/TIME) / (DISTANCE/TIME)= Flow Rate/Velocity

AREA = .000043 m^3/sec / 17.7 m/s = 0.00000235 m^2

AREA (circle) = πr^2 = .00000235 = 3.14159 * r^2 , r^2= .00000235 /3.14159

r = .000865 m so diameter = 2r= .00173 m = 0.173 cm

#2 Skip

#3 When a person inhales, air (Density is 1.29 kg/m^3) moves down the windpipe at 15 cm/s (.15 m/s) . The average flow speed doubles when passing through a constriction in the bronchus. Assuming incompressible flow, determine the pressure drop in the constriction

NO HEIGHT CHANGE (worth noting!)
SO
Pressureairin + ½ $Dens_{air}$* Vel^2 = Pressureairconstriction + ½ $Dens_{air}$* Vel^2

Pressureairin – Pressureairconstriction = ½* 1.29 * $.3^2$ – ½* 1.29 * $.15^2$

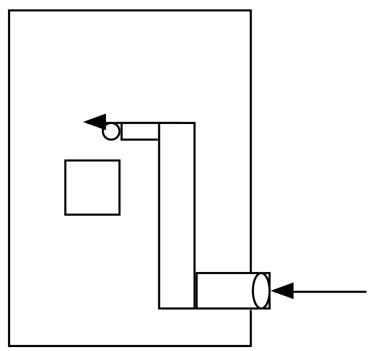
ΔP = - .0435375 Pascals (drop in pressure)

1) The time required to fill a bucket with water from a certain garden hose is 30 sec. If you cover part of the hose's nozzle with your thumb so that the speed of water leaving the nozzle doubles, how long does it take to fill the bucket?
Because water is treated as an incompressible fluid…
Volume stays the same so Vol/Time=Vol/Time or Area1*Vel1=Area2*Vel2
So if you double the flow speed, the area will be half
BUT the VOLUME/TIME stays the same…. So 30 seconds…

2) Skip

3) The water supply of a building is fed through a main entrance pipe that is 6 cm in DIAMETER. A 2 cm DIAMETER faucet tap positioned 2 m above the main pipe fills a 25 L (25 kg) container in 30 seconds. Water is 1000 kg/m^3

a) What is the speed at which water leaves the faucet?
b) What is the gauge pressure in the pipe? (Pressure compared to atmosphere)



TOP: Diameter = 2 cm = .02 m , Radius = .01 m
FLOW RATE = VOL/TIME = 25 L/30 Sec = .025 m^3 /30 sec = .0008333 m^3/sec
AREA = πr^2 = 3.14159* $(.01)^2$ = .000314159 m^2
VOL/TIME = AREA* DIST/TIME = AREA * VEL
.0008333 m^3/sec = .000314159 m^2 * VEL

VEL = 2.65258 m/s at top…

At bottom V1A1=V2A2

Area at bottom = AREA = πr^2 = 3.14159* $(.03)^2$ = 0.0028274 m^2
At bottom V1A1=V2A2
Vbottom=1/9th Vtop
2.65 (.000314) = .0028 (Vbottom)
Vbottom = .2947 m/s

We want gauge pressure (difference in pressure)

TOP:
Pressuretop + $Dens_{water}$*g*h + ½ $Dens_{water}$* Vel^2
P1 + 1000 kg/m^3* 9.8 * 2m + ½ 1000 kg/m^3* $(2.65\ m/s)^2$

BOTTOM:
Pressureair + $Dens_{water}$*g*h + ½ $Dens_{water}$* Vel^2
P2 + 0 (h= 0!_ + ½ 1000 kg/m^3* $(.2947\ m/s)^2$

P1-P2 = 1000 (9.8)*2 + ½*1000*2.65^2 - ½*1000*$.2947^2$
= 19600 + 3511.25 - 43.42405
ΔP = 23067.83 Pascals