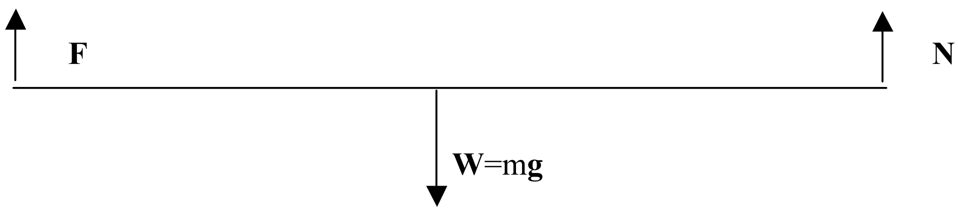
Problem 1

a) speed = volume rate / area of pipe = 6.37 m/s
b) using Bernoulli's equation and the fact that speeds are the same:
   $P_1 = P_2 - \rho g h = 1.84\times10^5$ Pa (184 kPa)
c) make all 3 statements for full credit:
   i) $A_1 v_1 = A_2 v_2$ (continuity equation)
   ii) radius constant in this region
   iii) water is not compressible
d) use continuity equation: v = 17.7 m/s

Problem 2

(the wording was slightly altered for Per 3. The result and method is the same)

a)

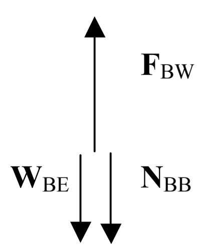


F = contact force on beam by left wall (or pier end, or whatever you called it)
N = Normal force on beam by buoy
W = Force of gravity on beam by Earth

b) $\Sigma\tau = 0$
   L = length to force

$\tau_{ccw} = \tau_{cw}$
$N\times L = L/2 \times mg$
N = 200 Newtons, up

c)



$\Sigma F = 0$

$\mathbf{F}_{BW}$ = Buoyant Force on buoy by water
$\mathbf{W}_{BE}$ = Weight on buoy by Earth = mg
$\mathbf{N}_{BB}$ = Normal (contact) force on buoy by beam

d) F_{BW} = mg + Normal
   = 100N + 200N
   = 300 N

e) Weight of displaced water = result from d, 300N. Mass of displaced water = 30 kg.
   thus, Volume submerged = 30kg/1000 kg/m^3 = .03 m^3
   divide volume submerged by volume of cylinder you get 26.5%

f) straight forward → % = density of buoy / density of water = 8.84%

g) part i) $1/2\rho v^2$ term in Bernoulli's equation & mention a drop in fluid pressure makes it sink
   part ii) go up since less torque making it go clockwise: mass distribution more to center

Problem 3 (tests were unique. Method all the same)

Part a)
$PV = nRT$
$V = AH$
$PAH = nRT$
Thus, $H = nRT / PA$

Part b)
Label axis with appropriate units & scales (make sure to graph ONLY range of given value, and do not have 0,0 show up on this graph!

Part c)
Slope of your line should be set equal to nR / PA . I got my slope to be about 0.36 / 105 K

Thus n = number of moles = PA / R times the slope

$n = (1x10^5 \text{ Pa}) (0.035 \text{ m}^2) / 8.31 \text{ J/(mol K)}$ all times slope (0.36 / 105 K)

n = 1.44 moles

Problem 4 (The values given varied for each test, the problems were the same)

Part a)
2 times, t_1 and t_2 . Add them when we are done. First part, veetax until it goes with constant speed called "v" , then use distance = rate times time for the remaining part
$v = a\, t_1 \rightarrow t_1 = v / a = 6 \text{ m/s} / 0.2 \text{ m/s}^2 = 30 \text{ s}$
how far down did it go? $h = 1/2at^2 = ½(0.2 \text{ m/s}^2)(30\text{s})^2 = 90$ meters
Now, how much time for remaining 60 meters (150 m – 90 m = 60 m)
$h = v\, t_2 \rightarrow t_2 = h / v = 60 \text{ m} / 6 \text{ m/s} = 10 \text{ s}$

Total time = 40 seconds

Part b)
weight = m g, so we need to find total mass. density = mass / volume
Thus, mass = density × volume
Volume of cylinder above = top area of bell time times height = $9\text{m}^2 \times 150 \text{ m} = 1.35\times10^3\text{m}^3$
mass = density × volume = $1025 \text{ kg/m}^3 \times 1350 \text{ m}^3 = 1.38 \times 10^6 \text{ kg}$
weight = mg = 1.38×10^7 N

Part c)
$P = P_o + \rho gh = 1.0\times10^5 \text{ Pa} + (1025 \text{ kg/m}^3)(10 \text{ m/s}^2)(150 \text{ m}) = 1.63\times10^6 \text{ Pa}$

Part d)

Force on hatch = Pressure × area of hatch

Area of hatch = πr^2 (where r = .3 m)

Since there is one atm inside the bell, the net pressure corresponding to the minimum applied force from the water only:

$F_{min} = \rho g h \times \pi r^2 = (1025\ kg/m^3)(10\ m/s^2)(150\ m) \times \pi\ (0.3 m)^2 = 4.35\times 10^5\ N$

Part e)

Examples include –

Increase pressure inside diving bell (less pressure difference means less required force)

Reduce the size of the hatch (since force is due to surface area)

Use a tool that gives a mechanical advantage (lever arm & torque)

Allow hatch to open inwards