Worksheet 10 Solutions

(1) $P = \frac{F}{A} \Rightarrow F = PA = 10^5 \cdot 0.1^2 = 10^3\ [N]$

(2) $F = PA = \int P(l)\, w \cdot dl = \frac{10^3}{10} + \int_0^{0.1} 10^3 x \cdot 0.01 \cdot dx = 100 + 0.05 = 100.05$

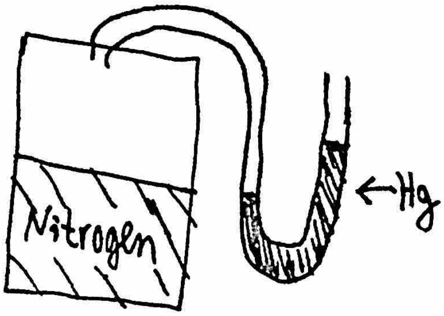
(3) $F = PA = \int P(x,y)\, dx\, dy = 10^3 + 10^3 \int_{-0.05}^{+0.05}\int_{-0.05}^{+0.05} \underbrace{\cos\left(\frac{2\pi x}{0.1}\right)}\underbrace{\cos\left(\frac{2\pi y}{0.1}\right)} = 10^3$

each go through exactly one period & so cancel

(4) $P = P_0 + \rho g h = 10^5 + 10^3 \cdot 10 \cdot 3 = 1.3 \times 10^5\ [Pa]$

(5) $\Rightarrow W = \int F \cdot dh = 3 \cdot 10^5 \cdot 10^{-4} + \int_0^{h=3} \overset{1 \leftarrow 10^4 \cdot 10^{-4} = 1}{10^4}\, h\, dh = 30 + 4.5 = 34.5\ [J]$

(6) (7)

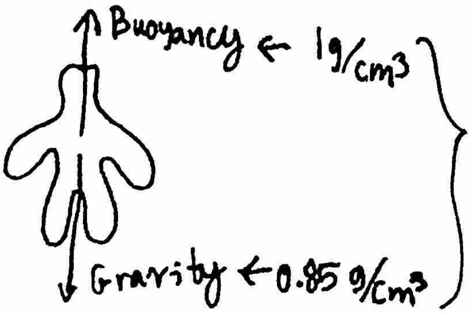


The pressure difference between heights is the atmosphere to dewar pressure difference,

which is $4.05 \times 10^5\ [Pa]$

So $4.05 \times 10^5 = \rho g h = \overset{\text{to } \frac{kg}{m^3}}{13.5 \cdot 1000} \cdot 10 \cdot h \Rightarrow h = 3\ [m]$

(8) (9)



Net is a force upwards of

0.15·g upwards

$20 = \frac{1}{2} \cdot 0.15\, g t^2 \Rightarrow t = 5.16s$

(10) $\pi \cdot 1^2 \cdot 10 = \pi \cdot 0.1^2 \cdot v \Rightarrow v = 10^3\ \left[\frac{m}{s}\right]$

(11) This is in general hard, so we assume the engine does all its speedup at $r = 0.5m$

$\rightarrow$ at 0.5 m $\rightarrow$ 40 m/s already $\rightarrow \frac{1}{2}(v_{new}^2 - 40^2) = 1000 \rightarrow v_{new} = 60 \rightarrow v_{exit} = \frac{60}{\left(\frac{0.1}{0.5}\right)^2} = 1.5 \times 10^3\ \left[\frac{m}{s}\right]$

(12) Find $\frac{\text{volumes}}{\text{second}}$:

$$1\,\frac{mol\,H_2O_2}{sec}\cdot\frac{0.084\,kg\,H_2O_2}{mol\,H_2O_2}\cdot\frac{1\,m^3\,H_2O_2}{1450\,kg\,H_2O_2} = 2.34\times10^{-5}\,\frac{m^3}{sec}$$

$$10\,\frac{mol\,H_2O}{sec}\cdot\frac{0.018\,kg\,H_2O}{mol\,H_2O}\cdot\frac{1\,m^3\,H_2O}{1000\,kg\,H_2O} = 18\times10^{-5}\,\frac{m^3}{sec}$$

Area $= 5.07\times10^{-4}\,m^2$

$$\Rightarrow v = \frac{\dot{V}}{A} = 0.4012\left[\frac{m}{s}\right]$$

(13) $12\,\frac{mol\,H_2O}{sec} \longrightarrow \longrightarrow 21.6\times10^{-5}\,\frac{m^3}{sec}$

$$\Rightarrow v = \frac{21.6\times10^{-5}}{5.07\times10^{-4}} = 0.4260\left[\frac{m}{s}\right]$$

(14) Use Bernoulli's Equation:

$$\cancel{P_i} + \underbrace{\rho}_{10^3}\underbrace{g}_{9.8}\underbrace{y_i}_{96} + \frac{1}{2}\underbrace{\rho}_{10^3}\underbrace{v_i^2}_{1} = \cancel{P_f} + \underbrace{\rho}_{10^3}\underbrace{g}_{9.8}\underbrace{y_f}_{0} + \frac{1}{2}\underbrace{\rho}_{10^3}\underbrace{v_f^2}_{?}$$

$$\Rightarrow v_f = 43.4\left[\frac{m}{s}\right]$$ (same as if it fell 96 meters, starting at $v = 1\left[\frac{m}{s}\right]$)

(15) Again, Bernoulli's Equation:

$$\cancel{P_i} + \underbrace{\rho}_{10^3}\underbrace{g}_{9.8}\underbrace{y_i}_{259} + \cancel{\frac{1}{2}\rho v_i^2}^{\,0} = \cancel{P_f} + \underbrace{\rho}_{10^3}\underbrace{g}_{9.8}\underbrace{y_f}_{96} + \frac{1}{2}\underbrace{\rho}_{10^3}\underbrace{v_f^2}_{5} + \frac{energy}{m^3}$$

$$\Rightarrow \frac{energy}{m^3} = 1.58\times10^6\,\frac{J}{m^3} \Rightarrow 1.58\times10^6\,\frac{J}{m^3}\cdot\underbrace{3.93\,\frac{m^3}{s}}_{(10000\cdot\pi\cdot0.005^2)\cdot5} = 6.21\times10^6\,[W]$$