Homework 1 Solutions

1.7

$$P_{abs} = \rho \cdot g \cdot h + P_{atm}$$

$\rho = 13.535 \frac{gm}{cm^3}$ $\quad g = 9.832 \frac{m}{s^2}$ $\quad h = 56.38\ cm$

$P_{atm} = 101.78\ kPa$ $\quad P_{abs} = \rho g \cdot h + P_{atm}$

$$\boxed{P_{abs} = 176.808\ kPa}$$

1.12

Given : $\frac{d}{dz} P = -\rho \cdot g$ and $\rho = \frac{M \cdot P}{R \cdot T}$

Substituting : $\frac{d}{dz} P = -\frac{M \cdot P}{R \cdot T} g$

Separating Variables and integrating : $\int_{P_{sea}}^{P_{denver}} \frac{1}{P} dP = \int_0^{Z_{denver}} -\left(\frac{M \cdot g}{R \cdot T}\right) dz$

After Integrating : $\ln\left(\frac{P_{denver}}{P_{sea}}\right) = -\frac{M \cdot g}{R \cdot T} \cdot Z_{denver}$

Taking the exponential of both side and rearranging : $P_{denver} = P_{sea} \cdot e^{\left(-\frac{Mg}{R \cdot T} \cdot Z_{denver}\right)}$

$P_{sea} = 1\ atm$ $\quad M = 29 \frac{gm}{mol}$ $\quad g = 9.8 \frac{m}{s^2}$

$R = 82.06 \frac{cm^3 atm}{mol \cdot K}$ $\quad T = (10 + 273.15)\ K$

$Z_{denver} = 1\ mi$ $\quad \frac{Mg}{RT} \cdot Z_{denver} = 0.194$

1.12 cont.

$$P_{denver} = P_{sea} \cdot e^{\left(\frac{-Mg}{RT} \cdot z_{denver}\right)}$$

$\boxed{P_{denver} = 0.823 \text{ atm}}$

$\boxed{P_{denver} = 0.834 \text{ bar}}$

1.16

$D = 0.47 \text{ m}$ $\quad mass = 150 \text{ kg}$ $\quad g = 9.813 \frac{m}{s^2}$

$P_{atm} = 101.57 \text{ kPa}$ $\quad A = \frac{\pi}{4} \cdot D^2 = 0.173 m^2$

a) $F = P_{atm} \cdot A + mass \cdot g$ $\quad \boxed{F = 1.989 \times 10^4 \text{ N}}$

b) $P_{abs} = \frac{F}{A}$ $\quad \boxed{P_{abs} = 110.054 \text{ kPa}}$

c) $\Delta l = 0.83$

$Work = F \cdot \Delta l$ $\quad \boxed{W = 15.848 \text{ kJ}}$

$\Delta E_p = mass \cdot g \cdot \Delta l$ $\quad \boxed{\Delta E_p = 1.222 \text{ kJ}}$

Answer :

2.32)

$$W = -\int p \, dV$$

given :

$$V = \frac{RT}{p} + b$$

$$V - b = \frac{RT}{p}$$

$$p = \frac{RT}{V-b}$$

$$W = -\int_{V_1}^{V_2} \frac{RT}{V-b} \, dV$$

$$\boxed{W = -RT \ln\left(\frac{V_2 - b}{V_1 - b}\right)}$$