3.49

GIVEN: MASS RATE OF AIR DURING BREATHING IS CONST.
16 BREATHS PER MINUTE AT SEA LEVEL,
WHERE $T = 15\,^{\circ}C$ AND $p = 101\ kPa$.

FIND: BREATHING RATE AT 5486 m.
ASSUME A STANDARD ATMOSPHERE.

SOLUTION:

I WILL ASSUME THE <u>VOLUME</u> INHALED AND EXHALED IS CONSTANT. THE MASS INHALED & EXHALED IS <u>VOLUME</u> × <u>DENSITY</u>.

$$m = \forall \rho \qquad \forall_o = \forall_A \leftarrow \text{AT ALTITUDE}$$
$$\text{AT SEA LEVEL}$$

THE MASS RATE IS $\frac{m}{\Delta t}$.

WE ARE GIVEN THAT: $\frac{m_o}{\Delta t_o} = \frac{m_A}{\Delta t_A}$

$$\frac{\cancel{\forall_o}\ \rho_o}{\Delta t_o} = \frac{\cancel{\forall_A}\ \rho_A}{\Delta t_A}$$

$$\frac{\Delta t_A}{\Delta t_o} = \frac{\rho_A}{\rho_o} \qquad \rho_o = \frac{p_o}{R T_o}$$

DENSITY FOR IDEAL GAS.

$$\rho_A = \frac{p_A}{R T_A}$$

USE TROPOSPHERE EQUATIONS ON PAGE 40 OF TEXT TO FIND T_A & p_A.

$$T_A = T_o - \alpha(z - z_o)$$

$$= 15^\circ C - \left(6.5 \times 10^{-3} \frac{K}{m}\right)(5486\,m)$$

$$T_A = -20.7^\circ C = 252.4\ K$$

$$p_A = p_o \left(\frac{T_A}{T_o}\right)^{\frac{g}{\alpha R}} = 101\,kPa \left(\frac{252.4}{288.1}\right)^{5.259}$$

$g = 9.8 \frac{m}{s^2}$ AND $R = 287 \frac{J}{kg \cdot K}$

$$p_A = 50.4\ kPa$$

$$\frac{\Delta t_a}{\Delta t_o} = \frac{\frac{p_A}{R T_A}}{\frac{p_o}{R T_o}} = \left(\frac{p_A}{p_o}\right)\left(\frac{T_o}{T_A}\right)$$

$$= \left(\frac{50.4}{101}\right)\left(\frac{288.1}{252.4}\right)$$

$$\frac{\Delta t_a}{\Delta t_o} = 0.57 \qquad \frac{\Delta t_o}{\Delta t_a} = 1.76$$

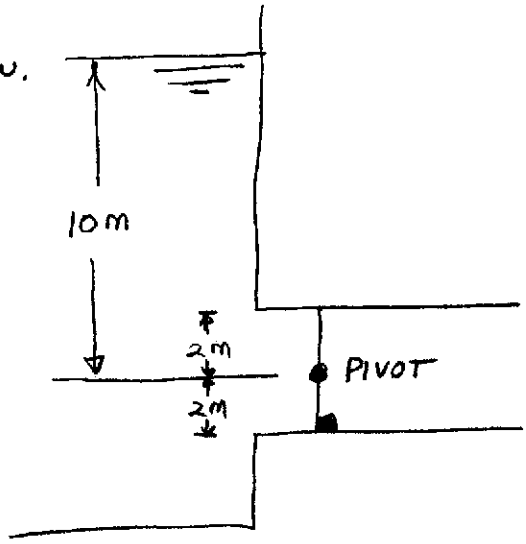
BREATHING RATE AT ALTITUDE IS 1.76×16.

28 BREATHS PER MINUTE

3.59

GIVEN: SQUARE GATE AS SHOWN.

FIND: FORCE ON BLOCK



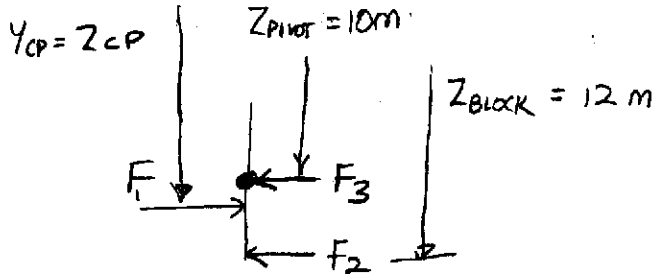
SOLUTION:

$$F_1 = \bar{p} A = \gamma \bar{z} A = \left(9800 \frac{N}{m^3}\right)(10\,m)(16\,m^2)$$

$$F_1 = 1.57\ MN$$

THIS IS THE RESULTANT FORCE ON THE GATE.

DRAW F.B.D.



SUM MOMENTS ABOUT PIVOT.

$$F_2 (z_{BLOCK} - z_{PIVOT}) - F_1 (z_{CP} - z_{PIVOT}) = 0$$

NEED y_{CP}. $\quad y_{CP} = \bar{y} + \dfrac{\bar{I}}{\bar{y} A}$

$$\bar{I} = \frac{s^4}{12} \qquad y_{CP} = \bar{y} + \frac{s^4}{12 \bar{y} s^2} = \bar{y} + \frac{1}{12}\frac{s^2}{\bar{y}}$$

$$y_{CP} = 10\,m + \frac{1}{12}\frac{16\,m^2}{10\,m} = 10.133\,m$$

$$F_2 (2m) = 1.57\ MN\ (10.133m - 10\,m)$$

$$\boxed{F_2 = 0.105\ MN = 105\ kN}$$

3.65 WORKED IN CLASS

3.86

GIVEN: A ROCK WEIGHS 913 N IN AIR AND 609 N IN WATER

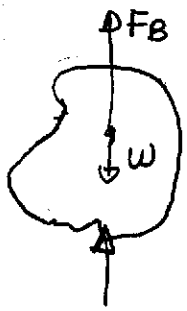
FIND: THE VOLUME OF THE ROCK

SOLUTION: DRAW FREE BODY DIAGRAMS

AIR

$W = mg$

WATER



$W = R_1$

$F_B + R_2 = W$

COMBINE THESE EQUATIONS TO GET: $F_B = R_1 - R_2$

ALSO: $F_B = \forall \gamma_w$

$$\forall = \frac{R_1 - R_2}{\gamma} = \frac{913 - 609}{9800}$$

$$\forall = 0.031\ m^3$$