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MET 330
HW1.2

Ch 3

State whether statements 6-10 are (or can be) true or false. For those that are false, explain why.

6) The value for the absolute pressure will always be greater than that for the gage pressure.

Answer: True, $P_{abs} = P_{gage} + P_{atm}$

7) As long as you stay on the surface of Earth, the atmospheric pressure will be 14.7 psia.

Answer: False, That is atmospheric pressure at sea level. The surface has different elevations.

*In this book, assume $P_{atm} = 14.7$ psia

$\Delta p = \gamma h$

8) The pressure in a certain tank is -55.8 Pa (abs)

Answer: False, A perfect vacuum is the lowest possible pressure. Therefore, an absolute pressure will always be positive.

9) The pressure in a certain tank is -4.65 psig.

Answer: True, The tank and gage are below atmospheric pressure to create a negative gage pressure

$$10.05\,psia_{abs} = -4.65\,psig + 14.7\,psia$$

10) The pressure in a certain tank is -150 kPa(gage).

Answer: True, The tank and gage are below atmospheric pressure to create a negative gage pressure.

$$52\,kPa_{(abs)} = -150\,kPa_{(gage)} + 98\,kPa_{(abs)}$$

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11) If you were to ride in an open-cockpit airplane to an elevation of 4000 ft above sea level, what would the atmospheric pressure be if it conforms to the standard atmosphere?

Answer: The standard atmosphere is taken at sea level (14.7 psia) and at temperature of 15°C.

$P = \gamma h$

Table E.3 properties of air at various altitudes

Temp at 4000 ft = 45°F

specific weight γ at 45°F $\approx 0.0788\ lb/ft^3$

$$\cancel{P = \left(0.0788\ \frac{lb}{ft^3}\right) 4000\ ft}$$

$$\cancel{315\ psi = P}$$

Figure E.1 shows $P = 12.7\ psia$ at Elevation 4000 ft.

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13) Expressed as a gage pressure, what is the pressure at the surface of a glass of milk?

Answer: A glass of milk is less than 1000ft tall, so we can assume the surface of the milk is at atmospheric pressure of 14.7 psia.

$$P_{gage} = P_{abs} - P_{atm}$$
$$0_{psia} = 14.7_{psia} - 14.7_{psia}$$

$P_{atm} = 14.7$ psia
$P_{abs} = 14.7$ psia

$$\boxed{P_{gage} = 0_{psia}}$$

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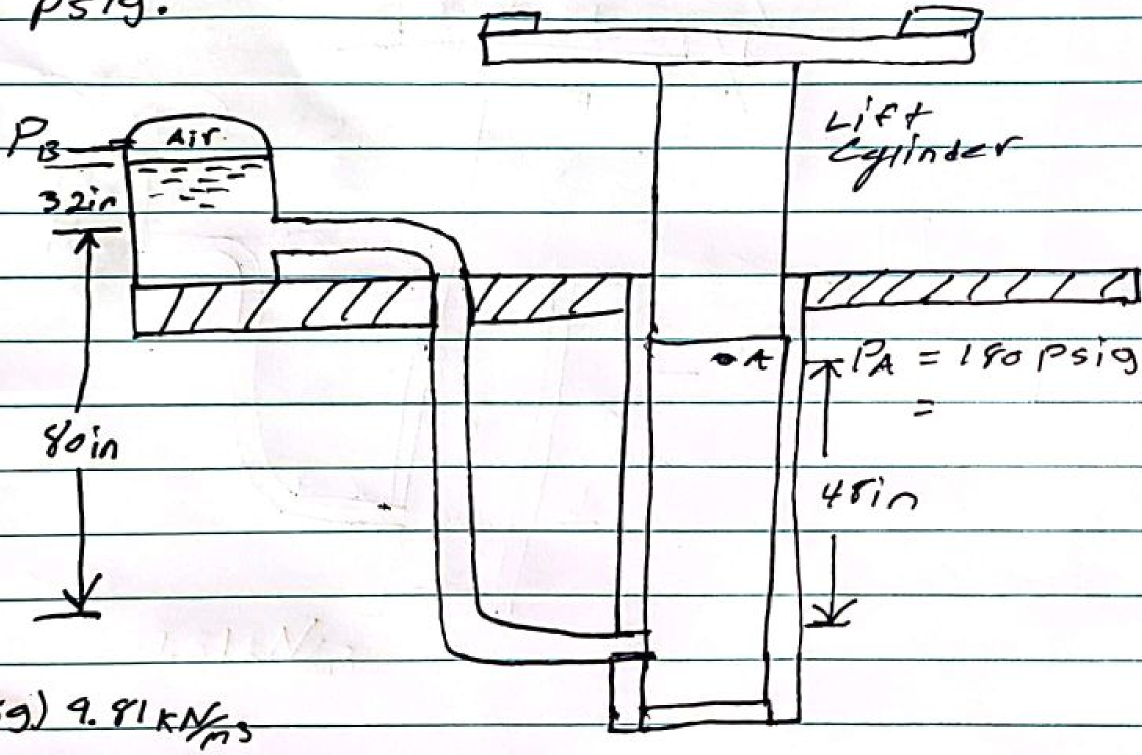
41) Figure 3.19 shows a diagram of the hydraulic system for a vehicle lift. An air compressor maintains pressure above the oil in in the reservoir. What must the air pressure be if the pressure at point A must be at least 180 psig?



$\gamma_{oil} = (sg)\, 9.81\, kN/m^3$

$\gamma_{oil} = (0.90)\, 9.81\, kN/m^3 = 8.82\, kN/m^3$

$P_B = P_A - \gamma h + \gamma h + \gamma h$

$P_B = P_A - (8.82\, kN/m^3)(\overset{1.219}{\cancel{0.813m}}) + (8.82\, kN/m^3)(2.03m) +$

$(8.82\, kN/m^3)(0.813m)$

$P_B = P_A - 10.75\, kN/m^2 + 17.90\, kN/m^2 + 7.17\, kN/m^2$

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$$P_B = P_A - 14.32\ kN/m^2$$

$P_A = 180\ psig$

$P_A = 1,241.06\ kpa$

$$P_B = 1,241.06\ kpa - 14.32\ kpa$$

$$P_B = 1,226.74\ kpa$$

$$\boxed{P_B = 177.9\ psig}$$

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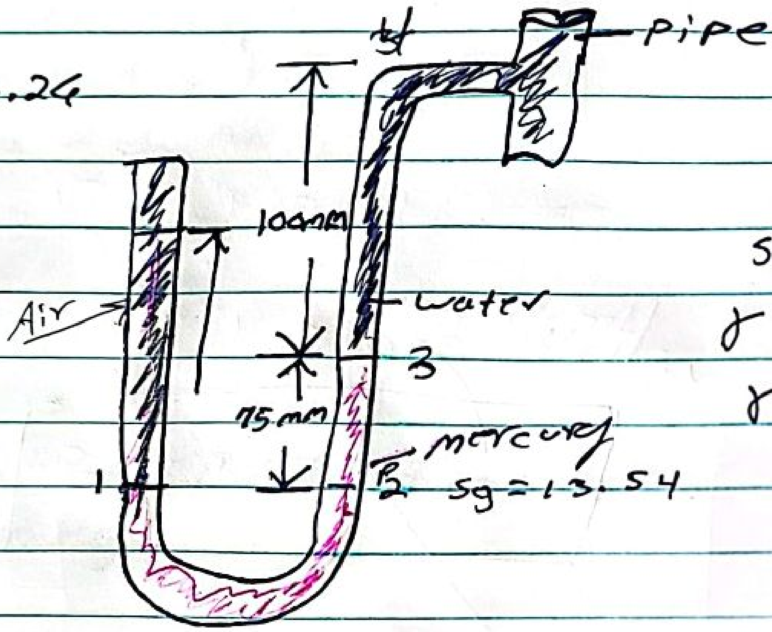
62) Water is in the pipe shown in Fig 3.26. Calculate the pressure at point A in kPa (gage).

Fig 3.26



sg = 13.54

$\gamma = 13.54 \times 9.8 \frac{kN}{m^3}$

$\gamma = 132.83 \frac{kN}{m^3}$

$P_1 = P_2$

$$P_A = P_1 - \gamma h - \gamma h$$

75mm → 0.075m

100mm → 0.100m

$$P_A = P_1 - \left(132.83 \frac{kN}{m^3}\right)(0.075m) - \left(132.83 \frac{kN}{m^3}\right) .100m$$

$$P_A = P_1 - 9.96 \frac{kN}{m^2} - 13.28 \frac{kN}{m^2}$$

$$P_A = 101.3 kPA - 9.96 kPA - 13.28 kPA$$

$$\boxed{P_A = 78.06 \text{ kPA}}$$

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83) A barometer indicates the atmospheric pressure to be 30.65 in Hg. Calculate the atmospheric pressure in psia.

$\gamma_{mercury} = 133.\ KN/m^3$

1.0 inHg = 0.491psi

30.65 inHg × 0.491 psi = 15 psi

90) The pressure in a vacuum chamber is −68.2 Kpa. Express this pressure in mmHg.

1.0mm Hg = 133.3 Pa = 0.133 kpa

−68.2 kpa

$$\frac{1.0\text{mm Hg}}{-512.78\text{mmHg}} = \frac{0.133\text{ kpa}}{-68.2\text{ kpa}}$$

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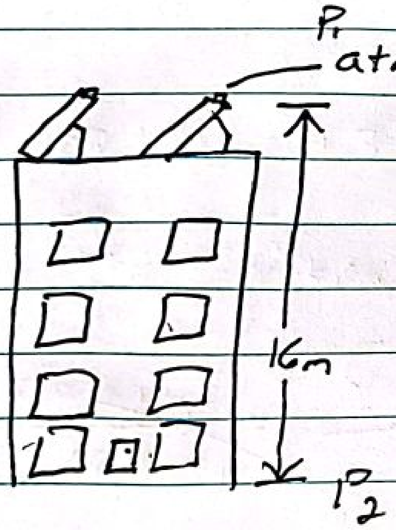
94) A passive solar water heater is to be installed on the roof of a multi-story building. The heater tank is open to atmospheric pressure and is mounted 16 m above ground level. In the static (non-flowing) state, what gage pressure, in kPa, must the plumbing line be designed to withstand if it is connected all the way down to ground level?



$sg\ water =$

$\gamma_{water} = (sg\ water)\ 9.81\ kN/m^3$
$\quad\quad (sg\ water = 1)$

$P_2 = P_1 + \gamma h$

$= P_1 + \left(9.81 \frac{kN}{m^3}\right)(16m)$

$P_2 = P_1 + 156.96 \frac{kN}{m^2}$

$= 101.3\ kPa + 156.96\ kPa$

$\boxed{P_2 = 258.26\ kPa}$