

47.76 An expansion tank consists of an air bladder which is filled to a pressure of 10psig which sits atop a column of water 4ft high. The tank has a single opening at the bottom of the tank. What is the pressure at the opening?

- A. 12psia
- B. 26psia
- C. 29psia
- D. 34psia

Consider the static pressure due to the air bladder and the height of the water column which exerts additional hydrostatic pressure on the point of interest. Neglect velocity pressure.

$$P = P_s + \gamma z$$

Since the answer choices are in *absolute* pressure, convert the bladder pressure from *psig* to *psia*.

$$P_s = 10\text{psig} + 14.7\text{psi} = 24.7\text{psia}$$

For the water column, divide by the conversion factor rule of thumb for water, $2.31\frac{\text{ft}}{\text{psi}}$.

$$\frac{4\text{ft}}{2.31\frac{\text{ft}}{\text{psi}}} = 1.73\text{psi}$$

Solve for the total pressure.

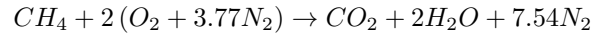
$$P = 24.7\text{psia} + 1.73\text{psi} = 26.43\text{psia}$$

Answer B

47.77 How much air is required to burn 25lb of methane with 30% excess air?

- A. 260lb
- B. 340lb
- C. 430lb
- D. 560lb

Use the [Combustion Reactions of Common Fuel Constituents](#) table and consider the reaction and [Stoichiometric Oxygen and Air Requirements](#) for methane. Optionally, re-write the reaction including nitrogen on both sides to validate the stoichiometric air requirements provided in the table. Calculate the air-to-fuel ratio on a molar/volume basis as well as on a mass basis. Use the [Periodic Table](#) for atomic weights as needed. Alternatively, use the values provided directly in the table.



$$\frac{N_{air}}{N_{fuel}} = \frac{2 + 2(3.77)}{1} = 9.54 \frac{moles_{air}}{moles_{fuel}} = 9.54 \frac{ft^3_{air}}{ft^3_{fuel}}$$

$$\frac{m_{air}}{m_{fuel}} = \frac{9.54(29)}{1(16)} = 17.29 \frac{lb_{air}}{lb_{fuel}}$$

Calculate the mass of air based on the mass of fuel given, the air-to-fuel ratio, and the amount of excess air.

$$m_{air} = (25lb_{fuel}) \left(17.29 \frac{lb_{air}}{lb_{fuel}} \right) (1.3) = 562lb_{air}$$

Answer D

47.78 During the process of condensing in a counterflow heat exchanger, the enthalpy of R-410A is reduced from $125 \frac{Btu}{lb}$ to $42 \frac{Btu}{lb}$. The cooling medium is water which enters at $50^\circ F$ and exits at $75^\circ F$. The surface area of the heat exchanger is $40ft^2$ and the overall coefficient of heat transfer is $10 \frac{Btu}{hr \cdot ft^2 \cdot ^\circ F}$. What is the mass flow rate of refrigerant being condensed?

- A. $36 \frac{lb}{hr}$
- B. $41 \frac{lb}{hr}$
- C. $46 \frac{lb}{hr}$
- D. $51 \frac{lb}{hr}$

Search for **Heat Exchangers** and use the formula for the rate of heat transfer in the condenser. Assume $F = 1$. The overall coefficient of heat transfer, U , is given. The area, A , is given.

$$\dot{Q} = UAF\Delta T_{lm}$$

To determine the **Log Mean Temperature Difference**, ΔT_{lm} , sketch the water cooled condenser and label the entering and exiting refrigerant and water temperatures. Use the **Refrigerant 410A** table and observe that for the condenser exit condition corresponding to State 3 of the refrigeration cycle, $h_3 = 42 \frac{Btu}{lb}$, therefore $P_3 \approx 240psia$ and $T_3 \approx 77^\circ F$. The temperature of the refrigerant throughout the condenser is approximately constant as it is undergoing a phase change at constant pressure.

$$77^\circ F \longleftarrow 77^\circ F$$

$$50^\circ F \longrightarrow 75^\circ F$$