(13) 1.) The coefficient of thermal expansion for liquid ethanol equals $1.12 \times 10^{-3}$ K$^{-1}$ at 20 $^\circ$C. Find the Molar volume of liquid ethanol at 15 $^\circ$C and 25 $^\circ$C. The density of liquid ethanol equals 0.7893 g/cm$^3$ at 20 $^\circ$C, and the Molecular weight equals 46.07 g/mol. Hint: Evaluate $(\frac{M}{M})_p$, then find $V$ by assuming that $V = (\frac{M}{M})_p @ T$, where $V$ is the volume change in going from 20 $^\circ$C to 15 $^\circ$C.

(15) 2.) Under normal breathing a man breathes at the rate of 14 respirations per minute, and takes in about 0.50 liters of air with each respiration. The air inhaled is 20.9% O$_2$ and 0.04% CO$_2$. The air exhaled is 16.3% O$_2$ and 4.38% CO$_2$. The remainder of the gases are N$_2$, Ar and water vapor. Assuming that the temperature is about 300 K, find the mass of O$_2$ consumed and CO$_2$ produced per day. You may take the atomic weights to be O = 16, C = 12.

(15) 3.) The molar heat capacity (in units of J/(mol K)) of steam is given by the equation $C_p = 36.8 - 7.9 \times 10^{-3} T + 9.2 \times 10^{-6} T^2$, while the molar heat capacity of H$_2$O$_(l)$ has a constant value 75.2 J/(mol K). The molar heat of vaporization of water at 373.15 K = 310.6 kJ. Find the molar heat of vaporization of water at 310.6 K.

(20) 4.) A certain gas follows the equation of state
Find the critical constants in terms of the parameters B and C.

\[ P = \frac{RT}{V} - \frac{B}{V^2} + \frac{C}{V^3} \]

Find the critical constants in terms of the parameters B and C.

(20) 5.) A tank contains 20 L of \( \text{N}_2 \) at 10 bar and 25 \(^\circ\)C. Calculate the maximum amount of work that may be obtained when the gas is allowed to expand reversibly to 1 bar pressure a.) isothermally,  b.) adiabatically. The molar heat capacity of \( \text{N}_2 \) may be taken to be 20.8 J/(mol K) and independent of the temperature.
A certain gas follows the equation of state \( P (V - b) = RT \), where \( V \) is the molar volume. Derive an expression for the Joule Thompson coefficient \( J_T \). When the pressure drops in a Joule Thompson expansion for such a gas, what is the sign of \( J_T \)?