Homework Solutions
10/22/2007

Conceptual

10. At high temperature and pressure the superheated steam inside exerts large forces on the lid. Even though it's latched down starting to open it would result in a HUGE release of pressure, so much that it would explode the pressure cooker apart. The pressure cooker needs to cool before it is opened.

12. The ruler's dimensions would be longer than they should be resulting in the object that is being measured being too short.

Problems

41. a.

$$KE = \frac{3}{2}k_B T = \frac{3}{2}\left(1.38 \bullet 10^{-23}\frac{J}{K}\right)(423K) = 8.76 \bullet 10^{-21} J$$

b. M is the molar mass and N_A is Avogadro's number.

$$v_{rms} = \sqrt{\frac{2KE_{molecule}}{m_{molecule}}}$$

$$m_{He,molecule} = \frac{M}{N_A} = \frac{4.00 \bullet 10^{-3}\frac{kg}{mole}}{6.02 \bullet 10^{23}\frac{molecules}{mole}} = 6.64 \bullet 10^{-27} kg$$

$$v_{He,rms} = \sqrt{\frac{2KE_{molecule}}{m_{molecule}}} = \sqrt{\frac{2\left(8.76 \bullet 10^{-21} J\right)}{6.64 \bullet 10^{-27} kg}} = 1620\frac{m}{s}$$

$$m_{Ar,molecule} = \frac{M}{N_A} = \frac{3.99 \bullet 10^{-2}\ \frac{kg}{mole}}{6.02 \bullet 10^{23}\ \frac{molecules}{mole}} = 6.63 \bullet 10^{-26} kg$$

$$v_{Ar,rms} = \sqrt{\frac{2KE_{molecule}}{m_{molecule}}} = \sqrt{\frac{2\left(8.76 \bullet 10^{-21} J\right)}{6.63 \bullet 10^{-26} kg}} = 514 \frac{m}{s}$$

50. In equilibrium, the gauge pressure of the gas inside exerts a force on the piston equal to the objects weight. The absolute pressure determines the volume and height.

$$P_{gauge} = \frac{F}{A} = \frac{mg}{A} = \frac{(5.0kg)\left(9.80\frac{m}{s^2}\right)}{0.050m^2} = 980Pa$$

$$P_{abs} = P_{atm} + P_{gauge} = 1.013 \bullet 10^5 Pa + 980Pa = 1.02280 \bullet 10^5 Pa$$

$$PV = nRT$$

$$V = \frac{nRT}{P}$$

$$h = \frac{V}{A} = \frac{nRT}{P \bullet A} = \frac{(3.0mol)\left(8.31\frac{J}{mol \bullet K}\right)(500K)}{\left(1.02280 \bullet 10^5 Pa\right)\left(0.050m^2\right)} = 2.4m$$

54. a. We do not know the number of moles of gas inside the tire so we need to set up a ratio of relationship between pressure and temperature because volume is constant.

$$P_{initial,abs} = P_0 + P_{gauge} = 1atm + 1.8atm = 2.8atm$$

$$P_{final,abs} = P_0 + P_{gauge} = 1atm + 2.2atm = 3.2atm$$

$$PV = nRT$$

$$V = \frac{nRT}{P}$$

$$V_{initial} = V_{final}$$

$$\frac{nRT_{initial}}{P_{initial}} = \frac{nRT_{final}}{P_{final}}$$

$$\frac{T_{initial}}{P_{initial}} = \frac{T_{final}}{P_{final}}$$

$$T_{final} = \left(\frac{P_{final}}{P_{initial}}\right)T_{initial} = \left(\frac{3.2atm}{2.8atm}\right)(300K) = 343K$$

b. With volume and temperature constant, the ideal gas law becomes:

$$\frac{V}{T} = \frac{nR}{P}$$

$$\frac{V_{initial}}{T_{initial}} = \frac{V_{final}}{T_{final}}$$

$$\frac{n_i R}{P_i} = \frac{n_f R}{P_f}$$

$$\frac{n_i}{P_i} = \frac{n_f}{P_f}$$

$$\frac{n_f}{n_i} = \frac{P_i}{P_f} = \frac{2.8atm}{3.2atm} = 0.875$$

The final mass of the air is 87.5% of the beginning mass so 12.5% was released into the atmosphere.

55.

$$\Delta L = \alpha L_0 \Delta T = \left(\frac{12 \bullet 10^{-6}}{°C}\right)(125m)(20.0°C) = 0.0300m$$

$$L_f = L_0 + \Delta L = 125m + 0.0300m = 125.03m$$

$$y = \sqrt{(125.03m)^2 - (125m)^2} = 2.74m$$