Physics 10154 - Exam #10A

Answer the following two questions. Be sure to clearly indicate your answer with a circle or box. Show all work. If I cannot see how you arrived at an answer, I will deduct points!

1. The density of Argon gas at a pressure of 1.00 atm and a temperature of 20.0° C is 2540 grams/cm^3. The temperature of the gas is raised to 225°C, and the pressure is raised to 1.40 atm with the amount of gas remaining constant.

What is the new density of the gas in mks units (kg/m^3)?

$P_1 = 1.00\ atm \qquad P_2 = 1.40\ atm$

$T_1 = 293\ K \qquad T_2 = 498\ K$

$n_1 = n_2$

$$\frac{V_2}{V_1} = \frac{\left(\frac{n_2}{n_1}\right)\left(\frac{R}{R}\right)\left(\frac{T_2}{T_1}\right)}{\left(\frac{P_2}{P_1}\right)} = \frac{(1)(1)\left(\frac{498}{293}\right)}{\left(\frac{1.4}{1.0}\right)} = 1.21$$

$$\frac{\rho_2}{\rho_1} = \frac{\left(\frac{m_2}{m_1}\right)}{\left(\frac{V_2}{V_1}\right)} = \frac{1}{1.21}$$

$$\rho_2 = \frac{\rho_1}{1.21} = \frac{2.540}{1.21} = 2.090\ gm/cm^3$$

$$2.090\ \frac{gm}{cm^3} \cdot \frac{1\ cm^3}{10^{-6}\ m^3} \cdot \frac{1\ kg}{1000\ g} = \boxed{2090\ kg/m^3}$$

2. A 2.5 kg aluminum pot is sitting on a hot burner. It has an initial temperature of 330° C. 150 grams of water is poured into the pot with a temperature of 25° C.

Determine the final temperature of the system. If the final temperature is 100° C, then determine how many grams of water are converted into steam. All numbers below given in mks units.

The specific heat of aluminum is 900.
The specific heat of water is 4186.
The specific heat of steam is 2010.
The latent heat of vaporization for water is 2.26×10^6.

To cool Al: $(2.5)(900)(-230) = -517500$

To heat water to 100°C: $(.150)(4186)(75) = 47092.5$

To boil water: $(.150)(2.26 \times 10^6) = 339000$

All water boils, $T_F > 100\,^\circ C$

$$\Delta Q_{Al} + \Delta Q_w = 0$$

$$(2.5)(900)(T_F - 330) + 47092.5 + 339000 + (.150)(2010)(T_F - 100) = 0$$

$$2250 T_F - 742500 + 47092.5 + 339000 + 301.5 T_F - 30150 = 0$$

$$2251.5 T_F - 386557.5 = 0$$

$$T_F = \frac{386557.5}{2251.5} = \boxed{172\,K}$$