

Ch. 13.1 & 14 Review Game Problems Answer Key

Pressure

What is the atmospheric pressure, in kPa, when the pressure is sufficient to support 731.2 mm Hg?

Note that this is essentially asking to convert the pressure would be in mmHg (on a barometer) to kPa:

$$? \text{ kPa} = 731.2 \text{ mm Hg} \times \frac{101.3 \text{ kPa}}{760 \text{ mm Hg}} = 97.46 \text{ kPa}$$

1) Partial Pressure

What is the total pressure of a mixture of gases with $P_{\text{He}} = 128 \text{ mm Hg}$, $P_{\text{Ar}} = 421 \text{ mm Hg}$ and $P_{\text{Ne}} = 389 \text{ mm Hg}$?

$$\begin{aligned} P_{\text{Total}} &= 128 \text{ mm Hg} + 421 \text{ mm Hg} + 389 \text{ mm Hg} \\ &= 938 \text{ mm Hg} \end{aligned}$$

2) Boyle's Law

A sample of CO_2 gas occupies a volume of 345 mL at 94.8 kPa. At what pressure will its volume be 142 mL?

$$P_1 V_1 = P_2 V_2; P_2 = \frac{P_1 V_1}{V_2}; P_2 = \frac{(345 \text{ mL})(94.8 \text{ kPa})}{142 \text{ mL}} = 230. \text{ kPa}$$

3) Charles's Law

A balloon full of air has a volume of 8.39 L at 38.0°C . At what T in $^\circ\text{C}$ is its volume 3.78 L?

$$T_1 = 38^\circ\text{C} + 273 = 311 \text{ K}$$

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}; T_2 = \frac{V_2 T_1}{V_1} = \frac{(3.78 \text{ L})(311 \text{ K})}{8.39 \text{ L}} = 140. \text{ K}; T_2 = 140. \text{ K} - 273 = -133^\circ\text{C}$$

4) Gay-Lussac's Law

A lab vessel of Kr gas has a pressure of 83.4 kPa at -45°C . What will its pressure be at 43°C ?

$$T_1 = -45^\circ\text{C} + 273 = 228 \text{ K}; T_2 = 43^\circ\text{C} + 273 = 316 \text{ K}$$

$$\frac{P_1}{T_1} = \frac{P_2}{T_2}; P_2 = \frac{P_1 T_2}{T_1} = \frac{(83.4 \text{ kPa})(316 \text{ K})}{228 \text{ K}} = 115 \text{ kPa}$$

5) Combined Gas Law

A piston of N_2 gas has a volume of 3.50 L at 1.15 atm and 29.0°C . What is its pressure when compressed to 1.29 L at 56.0°C ?

$$T_1 = 29.0^\circ\text{C} + 273 = 302 \text{ K}; T_2 = 56.0^\circ\text{C} + 273 = 329 \text{ K}$$

$$\frac{P_1 V_1}{T_1} = \frac{P_2 V_2}{T_2}; P_2 = \frac{P_1 V_1 T_2}{V_2 T_1} = \frac{(1.15 \text{ atm})(3.50 \text{ L})(329 \text{ K})}{(1.29 \text{ L})(302 \text{ K})} = 3.40 \text{ atm}$$

6) Avogadro's Principle

What is the mass of 32.8 L of Xe at STP?

$$? \text{ g Xe} = 32.8 \text{ L Xe} \times \frac{1 \text{ mol Xe}}{22.4 \text{ L Kr}} \times \frac{131.3 \text{ g Xe}}{1 \text{ mol Xe}} = 192 \text{ g Xe}$$

$\underbrace{\hspace{10em}}_{=1.46 \text{ mol Xe}}$

7) Ideal Gas Law

What is the volume of 66.8 g NO₂ at 855 torr and 15°C?

$$n = 66.8 \text{ g NO}_2 \times \frac{1 \text{ mol NO}_2}{46.01 \text{ g NO}_2} = 1.45 \text{ mol}; P = 855 \text{ torr} \times \frac{1 \text{ atm}}{760 \text{ torr}} = 1.13 \text{ atm}; T = 15^\circ\text{C} + 273 = 288 \text{ K}$$

$$V = \frac{nRT}{P} = \frac{(1.45 \text{ mol})(0.0821 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}})(288 \text{ K})}{1.13 \text{ atm}} = 30.3 \text{ L}$$

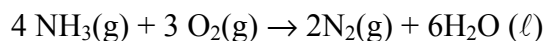
8) Molar Mass Calculations

What is the molar mass of a gas with density = 1.91 g/L at a pressure of 0.572 atm and -14°C?

T = -14°C + 273 = 259 K; Assume V = 1 L

$$n = \frac{PV}{RT} = \frac{(0.572 \text{ atm})(1 \text{ L})}{(0.0821 \frac{\text{L} \cdot \text{atm}}{\text{mol} \cdot \text{K}})(259 \text{ K})} = 0.0269 \text{ mol}; \text{MM} = \frac{1.91 \text{ g}}{0.0269 \text{ mol}} = 71.0 \text{ g/mol}$$

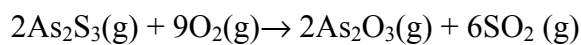
9) Volume-Volume Calculations



How many L of NH₃ are needed to produce 18.6 L N₂ at the same T & P?

$$? \text{ L NH}_3 = 18.6 \text{ L of N}_2 \times \frac{4 \text{ L NH}_3}{2 \text{ L N}_2} = 37.2 \text{ L NH}_3$$

10) Mass-Volume Calculations



What is the theoretical yield of As₂O₃ for 29.3 L O₂, at STP, reacting with excess As₂S₃?

$$\text{MM As}_2\text{O}_3 = 2(74.92 \text{ g}) + 3(16.00 \text{ g}) = 197.8 \text{ g/mol}$$

$$? \text{ g As}_2\text{O}_3 = 29.3 \text{ L O}_2 \times \underbrace{\frac{1 \text{ mol O}_2}{22.4 \text{ L O}_2}}_{=1.31 \text{ mol O}_2} \times \underbrace{\frac{2 \text{ mol As}_2\text{O}_3}{9 \text{ mol O}_2}}_{=0.291 \text{ mol As}_2\text{O}_3} \times \frac{197.8 \text{ g As}_2\text{O}_3}{1 \text{ mol As}_2\text{O}_3} = 57.5 \text{ g As}_2\text{O}_3$$