

The Ideal Gas Law and Gas Density Problems Answer Key

1. Initial

$$P_1V_1 = nRT_1$$

$$n = \frac{P_1V_1}{RT_1}$$

$$n = \frac{(113.30 \text{ kPa})(0.50 \text{ L})}{\left(8.314 \frac{\text{kPa} \cdot \text{L}}{\text{mol} \cdot \text{K}}\right)(295 \text{ K})}$$

$$n = 0.0231 \text{ mol}$$

Final

$$P_2V_2 = nRT_2$$

$$V_2 = \frac{nRT_2}{P_2}$$

$$V_2 = \frac{(0.0231 \text{ mol})\left(8.314 \frac{\text{kPa} \cdot \text{L}}{\text{mol} \cdot \text{K}}\right)(273 \text{ K})}{113.30 \text{ kPa}}$$

$$V_2 = 0.463 \text{ L}$$

$$D = \frac{m}{V}$$

$$D = \frac{20.0 \text{ g}}{0.463 \text{ L}}$$

$$D = 43 \frac{\text{g}}{\text{L}}$$

2. $PV = nRT$

Substitute in $n = \frac{m}{M}$

$$PV = \frac{m}{M}RT$$

Rearrange $PV = \frac{m}{M}RT$ to solve for M .

$$PV \cdot M = \frac{m}{M}RT \cdot M$$

$$\frac{\cancel{PV}M}{\cancel{PV}} = \frac{mRT}{PV}$$

$$M = \frac{mRT}{PV}$$

$$D = \frac{m}{V}$$

Substitute D into $M = \frac{mRT}{PV}$ in place of $\frac{m}{V}$.

$$M = D \cdot \frac{RT}{P}$$

$$M = \left(1.61 \frac{\text{g}}{\text{L}}\right) \frac{\left(8.314 \frac{\text{kPa} \cdot \text{L}}{\text{mol} \cdot \text{K}}\right)(303.15 \text{ K})}{110 \text{ kPa}}$$

$$M = 37 \frac{\text{g}}{\text{mol}}$$

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| CHAPTER 4 | The Ideal Gas Law and Gas Density Problems Answer Key (continued) | BLM 4.2.2A |
| ANSWER KEY | | |
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3. $PV = nRT$

Substitute in $n = \frac{m}{M}$.

$$PV = \frac{m}{M} \cdot RT$$

Rearrange $PV = \frac{mRT}{M}$ to solve for $\frac{m}{V}$.

$$\frac{PV}{V} = \frac{mRT}{M} \cdot \frac{1}{V}$$

$$P \cdot \frac{M}{RT} = \frac{m \cancel{RT}}{\cancel{M}V} \cdot \frac{\cancel{M}}{\cancel{RT}}$$

$$\frac{m}{V} = \frac{PM}{RT}$$

$$D = \frac{m}{V}$$

$$D = \frac{PM}{RT}$$

$$D = \frac{(100.0 \text{ kPa}) \left(20.18 \frac{\text{g}}{\text{mol}} \right)}{\left(8.314 \frac{\text{kPa} \cdot \text{L}}{\text{mol} \cdot \text{K}} \right) (298.15 \text{ K})}$$

$$D = 0.8141 \frac{\text{g}}{\text{L}}$$