

## 10. Gases

### 10.1 Pressure

$$P = \frac{\text{Force}}{\text{Area}} \quad \frac{\text{N}}{\text{m}^2} \quad \text{Pascal, Pa}$$

**barometer**

$$P = (1.3547 \times 10^4 \text{ kg m}^{-3}) \times (9.80665 \text{ m s}^{-2}) \times (0.7600 \text{ m}) = 1.013 \times 10^5 \text{ kg m}^{-1} \text{ s}^{-2} = 1.013 \times 10^5 \text{ Pa} = 101.3 \text{ kPa}$$

$$P = 753.3 \text{ mmHg} \frac{\text{atm}}{760.0 \text{ mmHg}} = 0.9912 \text{ atm}$$

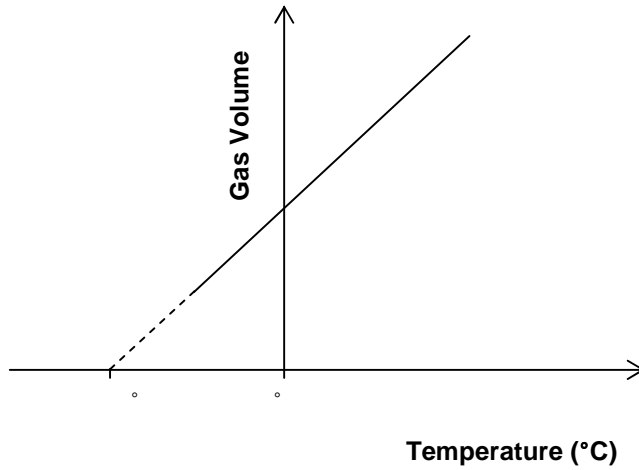
$$P = 753.3 \text{ mmHg} \frac{101.3 \text{ kPa}}{760.0 \text{ mmHg}} = 100.4 \text{ kPa}$$

## 10.2 The Gas Laws

### 10.2.1 BOYLE'S LAW

$$\frac{V_1}{T_1} = \frac{V_2}{T_2}$$

$$V = a T_C + b$$



### 10.2.3 AVOGADRO'S LAW

$$V_1 \quad V_2$$

$$\frac{V}{n_1} = \frac{V}{n_2}$$

$$\frac{V_1}{n_1} = \frac{V_2}{n_2}$$

### 10.3 The Ideal Gas Law

$$V \propto \frac{1}{P} \quad T \quad n$$

$$V \propto T \quad P \quad n$$

$$V \propto n \quad P \quad T$$

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

$$\frac{P_1 V_1}{n_1 T_1} = \frac{P_2 V_2}{n_2 T_2}$$

$$\frac{PV}{nT} = R$$

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$$PV = nRT$$

$$R = 8.3143 \text{ kPa L K}^{-1} \text{ mol}^{-1}$$

$$0.08206 \text{ L atm K}^{-1} \text{ mol}^{-1}$$

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$$(P_1, V_1, n_1, T_1)$$

$$(P_2, V_2, n_2, T_2)$$

$$P_1 V_1 = n_1 R T_1$$

$$P_2 V_2 = n_2 R T_2$$

$$n_1 = n_2$$

$$T_1 = T_2$$

$$P_1 V_1 = P_2 V_2$$

$$V_2 = V_1 \frac{P_1}{P_2} = 10.0 \text{ L} \frac{1.5 \text{ atm}}{2.0 \text{ atm}} = 7.50 \text{ L}$$

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$$PV = nRT$$

$$P = 753.3 \text{ torr} \frac{101.3 \text{ kPa}}{760.0 \text{ atm}} = 100.4 \text{ kPa}$$

$$T = 25.0^\circ\text{C} + 273.15 = 298.2 \text{ K}$$

$$n = \frac{PV}{RT} = \frac{(100.4 \text{ kPa})(4.84 \text{ L})}{(8.3142 \text{ kPa L K}^{-1} \text{ mol}^{-1})(298.2 \text{ K})} = 0.196 \text{ mol}$$

$$MM = \frac{14.275 \text{ g}}{0.196 \text{ mol}} = 72.8 \text{ g mol}^{-1}$$

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

$$PV = nRT$$

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

$$P = m \frac{RT}{MM V}$$

$$P = \frac{m}{V} \frac{RT}{MM} \quad \frac{RT}{MM}$$

$$MM = \frac{RT}{P} \frac{(1.95 \text{ g mL}^{-1})(0.08206 \text{ L atm K}^{-1} \text{ mol}^{-1})(273.15 \text{ K})}{1.000 \text{ atm}} \quad 43.7 \text{ g mol}^{-1}$$



$$\begin{array}{c}
 \circ \\
 \text{CO}_2 \quad \text{O}_2 \\
 n_{\text{tot}} = n_{\text{O}_2} + n_{\text{CO}_2} = 0.532 \text{ mol} + 0.250 \text{ mol} = 0.782 \text{ mol}
 \end{array}$$

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$$\begin{array}{c}
 PV = nRT \\
 V = \frac{nRT}{P} = \frac{(0.782 \text{ mol})(0.08206 \text{ L atm K}^{-1} \text{ mol}^{-1})(21.5 + 273.15)\text{K}}{1.002 \text{ atm}} = 18.9 \text{ L}
 \end{array}$$

$$V = \frac{nRT}{P} = \frac{(0.782 \text{ mol})(0.08206 \text{ L atm K}^{-1} \text{ mol}^{-1})(273.15 \text{ K})}{1.000 \text{ atm}} = 17.5 \text{ L}$$