10. Gases

10.1 Pressure

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

barometer

$$P = (1.3547\times10^{4}\ kg\ m^{-3}) \times (\ 9.80665\ m\ s^{-2}) \times (0.7600\ m) = 1.013\times10^{5}\ kg\ m^{-1}\ s^{-2} = 1.013\times10^{5}\ Pa = 101.3\ kPa$$

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

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

10.2 The Gas Laws

10.2.1 BOYLE’S LAW

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

$$V = a\,T_C \;+\; b$$

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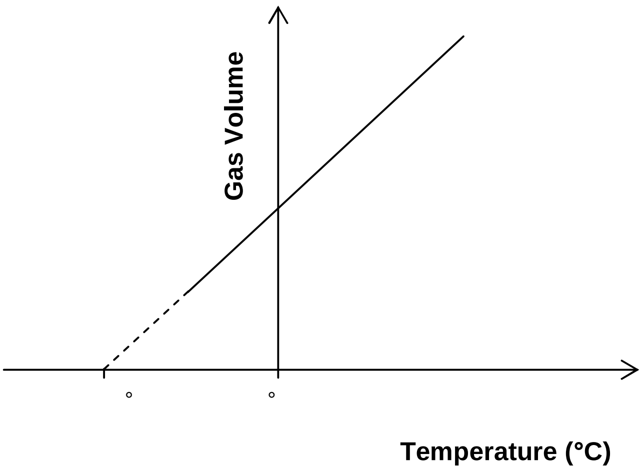

10.2.3 AVOGADRO’S LAW

$$V \quad n$$

$$n_1 \quad n_2$$

V_1 V_2

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

10.3 The Ideal Gas Law

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

$$V \quad T \qquad P \quad n$$

$$V \quad n \qquad P \quad T$$

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

$$\frac{P_1V_1}{n_1T_1} = \frac{P_2V_2}{n_2T_2}$$

PV nT

R

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

$$PV = nRT$$

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

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

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

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

(P_1, V_1, n_1, T_1) (P_2, V_2, n_2, T_2)

$P_1V_1 = n_1R\ T_1$ $P_2V_2 = n_2R\ T_2$

$n_1 = n_2$

$T_1 = T_2$

$P_1V_1 = P_2V_2$

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

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$PV = nRT$

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

$$T = 25.0°C + 273.15 = 298.2\ K$$

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

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

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

$$PV \quad nRT$$

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

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

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

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

$$n_{HCl} = 0.0869\ mol\ Cl_2 \quad \frac{1\ mol\ Cl_2}{4\ mol\ HCl} \quad = 0.0217\ mol$$

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$$542 \qquad \frac{\qquad}{760.0} \qquad 0.713$$

$$36.0 \quad 273.15 \quad 309.2$$

$$\frac{(0.0217 \qquad)(0.08206 \qquad {}^{1} \qquad {}^{1})(309.2 \quad)}{0.713} \quad 0.773$$

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CO_2 O_2

$$n_{tot} = n_{O_2} + n_{CO_2} = 0.532\ mol + 0.250\ mol = 0.782\ mol$$

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$$PV = nRT$$

$$V = \frac{nRT}{P} = \frac{(0.782\ mol)(0.08206\ L\ \ atm\ \ K^{1}\ \ mol^{1})(21.5 + 273.15)K}{1.002\ atm} = 18.9\ L$$

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