Chemistry

Answers to Gas Laws Practice Problems

1. molar mass of Cl_2 = 2(35.45) = 70.90 g/mole

$$d = \frac{mm}{mV} = \frac{70.9\ g}{22.4\ L} = 3.17\ \text{g/L}$$

2. Molar volume is the volume when *n* = 1.00 mole.

V = ?; *n* = 1.00 mol; T = 78°C + 273 = 351 K; P = 1.20 atm

$$V = \frac{nRT}{P} = \frac{(1.00\ mol)(0.08206)(351\ K)}{1.20\ atm} = 24.0\ \text{L}$$

3. V_1 = 6.66 L; STP: T_1 = 0°C = 273 K; P_1 = 1.00 atm = 760 torr;

T_2 = 546 °C + 273 = 819 K; P_2 = 684 torr; V_2 = ?

$$\frac{P_1V_1}{T_1} = \frac{P_2V_2}{T_2} \quad V_2 = V_1 \times \frac{P_1}{P_2} \times \frac{T_2}{T_1} = 6.66\ L \times \frac{760\ torr}{684\ torr} \times \frac{819\ K}{273\ K} = 22.2\ \text{L}$$

4. mass of CO_2 = ?; V = 5.60 L; T = 273K; P = 2.00 atm

$$n = \frac{PV}{RT} = \frac{(2.00\ atm)(5.60\ L)}{(0.08206)(273\ K)} = 0.500 \text{ moles; } 0.500 \text{ moles} \times \frac{44.0\ g\ CO_2}{1\ mole\ CO_2} = 22.0\ \text{g } CO_2$$

5. From the Table, P_{H2O} at 21°C = 19 mm Hg; You can subtract in atm or torr.

For torr: P_T = 1.02 atm $\times \frac{760\ torr}{1\ atm}$ = 775 torr; $P_{N2} = P_T - P_{H2O}$ = 775 – 19 = 756 torr

For atm: P_{H2O} = 19 torr $\times \frac{1\ atm}{760\ torr}$ = 0.025 atm; $P_{N2} = P_T - P_{H2O}$ = 1.02 – 0.025 = 0.99 atm

6. P_{N2} = 0.50 atm; P_{O2} = 0.30 atm; 28.0 g N_2; n_T = ?

$P_T = P_{N2} + P_{O2}$ = 0.50 atm + 0.30 atm = 0.80 atm;

moles N_2 = 28.0 g $N_2 \times \frac{1\ mole\ N_2}{28.0\ g\ N_2}$ = 1.00 mol N_2

$$P_{N_2} = \left(\frac{n_{N_2}}{n_T}\right)P_T \quad n_T = \left(\frac{P_T}{P_{N_2}}\right)n_{N_2} = \left(\frac{0.80}{0.50}\right)1.00\ mol = 1.6\ \text{moles}$$

7. a) 2.80 L $\times \frac{1\,mole\,O_2}{22.4\,L\,O_2} \times \frac{4\,mole\,Na}{1\,mole\,O_2} \times \frac{23.0\,g\,Na}{1\,mole\,Na}$ = 11.5 g Na

b) First find molar volume at 25°C and 2.00 atm:

$$V = \frac{nRT}{P} = \frac{(1.00\,mol)(0.08206)(298\,K)}{2.00\,atm} = 12.2\text{ L}$$

4.60 g Na $\times \frac{1\,mole\,Na}{23.0\,g\,Na} \times \frac{1\,mole\,O_2}{4\,mole\,Na} \times \frac{12.2\,L\,O_2}{1\,mole\,O_2}$ = 0.610 L O_2

8. First find molar volume at 78°C and 1.20 atm. See problem 2: at 78°C and 1.20 atm, molar volume is 24.0 L/mole.
molar mass of ethane (C_2H_6) = 2(12.0) + 6(1.0) = 30.0 g/mole

$$d = \frac{mm}{mV} = \frac{30.0\,g}{24.0\,L} = 1.25\text{ g/L}$$