

CHEMISTRY 11 AP – MOLES MULTIPLE CONVERSIONS WORKSHEET

1) What is the mass of 1.25 L of $\text{NH}_3(\text{g})$ at STP?

$$\begin{aligned} \text{g} &= 1.25 \text{ L} \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{17.03 \text{ g}}{1 \text{ mol}} \\ &= 0.951 \text{ g} \end{aligned}$$

2) How many atoms are contained in 8.00 g of Fe? ^{atom}

$$\begin{aligned} \text{atoms} &= 8.00 \text{ g} \times \frac{1 \text{ mol}}{55.85 \text{ g}} \times \frac{6.022 \times 10^{23} \text{ atoms}}{1 \text{ mol}} \\ &= 8.63 \times 10^{22} \text{ atoms} \end{aligned}$$

3) What is the volume of 9.04×10^{24} atoms of $\text{He}(\text{g})$ at STP?

$$\begin{aligned} \text{L} &= 9.04 \times 10^{24} \text{ atoms} \times \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ atoms}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} \\ &= 336 \text{ L} \end{aligned}$$

4) What is the mass of 2.3×10^{19} Ag atoms?

$$\begin{aligned} \text{g} &= 2.3 \times 10^{19} \text{ atoms} \times \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ atoms}} \times \frac{107.87 \text{ g}}{1 \text{ mol}} \\ &= 0.0041 \text{ g} \end{aligned}$$

5) How many O atoms are contained in 1.40 L of $\text{N}_2\text{O}(\text{g})$ at STP? ^{molecule}

$$\begin{aligned} \text{O atoms} &= 1.40 \text{ L} \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{1 \text{ O atom}}{1 \text{ molecule}} \\ &= 3.76 \times 10^{22} \text{ O atoms} \end{aligned}$$

6) What is the volume of 0.750 g of $\text{O}_3(\text{g})$ at STP?

$$\begin{aligned} \text{L} &= 0.750 \text{ g} \times \frac{1 \text{ mol}}{48.00 \text{ g}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} \\ &= 0.350 \text{ L} \end{aligned}$$

7) How many atoms are contained in 5.0 g of NaCl? ^{molecule}

$$\begin{aligned} \text{atoms} &= 5.0 \text{ g} \times \frac{1 \text{ mol}}{58.44 \text{ g}} \times \frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{2 \text{ atoms}}{1 \text{ molecule}} \\ &= 1.0 \times 10^{23} \text{ atoms} \end{aligned}$$

8) What is the mass of 4.15×10^{15} CH₄ molecules?

$$g = 4.15 \times 10^{15} \text{ molecules} \times \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ molecules}} \times \frac{16.04 \text{ g}}{1 \text{ mol}} \\ = 1.11 \times 10^{-7} \text{ g}$$

9) What is the volume of 16.5 g of AsH_{3(g)} at STP?

$$L = 16.5 \text{ g} \times \frac{1 \text{ mol}}{77.94 \text{ g}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} \\ = 4.74 \text{ L}$$

10) How many atoms are contained in 15.0 L of Ar^{atom}(g) at STP?

$$\text{atoms} = 15.0 \text{ L} \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{6.022 \times 10^{23} \text{ atoms}}{1 \text{ mol}} \\ = 4.03 \times 10^{23} \text{ atoms}$$

11) What is the mass of 3.45 mL of O_{2(g)} at STP?

$$g = 3.45 \text{ mL} \times \frac{10^{-3} \text{ L}}{1 \text{ mL}} \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{32.00 \text{ g}}{1 \text{ mol}} \\ = 0.00493 \text{ g}$$

12) How many F atoms are contained in 8.30×10^{-4} mL of BF₃^{molecule}(g) at STP?

$$\text{F atoms} = 8.30 \times 10^{-4} \text{ mL} \times \frac{10^{-3} \text{ L}}{1 \text{ mL}} \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{3 \text{ F atoms}}{1 \text{ molecule}} \\ = 6.69 \times 10^{16} \text{ atoms}$$

13) What is the volume of 8.65×10^{21} molecules of SO_{2(g)} at STP?

$$L = 8.65 \times 10^{21} \text{ molecules} \times \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ molecules}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} \\ = 0.322 \text{ L}$$

14) What is the mass of 9.05×10^{26} N₂ molecules?

$$g = 9.05 \times 10^{26} \text{ molecules} \times \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ molecules}} \times \frac{28.02 \text{ g}}{1 \text{ mol}} \\ = 4.21 \times 10^4 \text{ g}$$

The following questions can be solved using density. The density conversion factor allows you to convert directly from mass to volume and vice versa. Using density is extremely convenient for solids and liquids since you cannot use the STP 22.4 L/mol conversion factor.

15) How many moles are contained in 1.25 mL of CS₂ (l)? (Density = 1.26 g/mL)

$$\begin{aligned} \text{mol} &= 1.25 \text{ mL} \times \frac{1.26 \text{ g}}{1 \text{ mL}} \times \frac{1 \text{ mol}}{76.13 \text{ g}} \\ &= 0.0207 \text{ mol} \end{aligned}$$

16) What volume of C₆H₆ (l) contains 8.50 × 10²⁴ atoms of C? Density of C₆H₆ (l) = 0.877 g/mL

$$\begin{aligned} \text{mL} &= 8.50 \times 10^{24} \text{ atoms} \times \frac{1 \text{ molecule}}{6 \text{ C atoms}} \times \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ molecules}} \times \frac{78.11 \text{ g}}{1 \text{ mol}} \times \frac{1 \text{ mL}}{0.877 \text{ g}} \\ &= 2.10 \times 10^2 \text{ mL} \end{aligned}$$

17) What is the volume occupied by 0.0155 mol of NaCl? (Density of NaCl = 2.17 g/mL)

$$\begin{aligned} \text{mL} &= 0.0155 \text{ mol} \times \frac{58.44 \text{ g}}{1 \text{ mol}} \times \frac{1 \text{ mL}}{2.17 \text{ g}} \\ &= 0.417 \text{ mL} \end{aligned}$$

18) If 250.0 mL of silane gas at STP has a mass of 0.358 g, what is the molar mass of silane? If silane is made of silicon and hydrogen atoms, suggest a molecular formula for silane?

$$\frac{\text{g}}{\text{mol}} = \frac{0.358 \text{ g}}{250.0 \text{ mL}} \times \frac{1 \text{ mL}}{10^{-3} \text{ L}} \times \frac{22.4 \text{ L}}{1 \text{ mol}}$$

$$= 32.1 \text{ g/mol} \quad \therefore \text{silane would be SiH}_4$$

19) What is the mass of 2.50 L of $\text{PF}_5(\text{g})$ at STP?

$$g = 2.50\text{L} \times \frac{1\text{mol}}{22.4\text{L}} \times \frac{125.97\text{g}}{1\text{mol}}$$
$$= 14.1\text{g}$$

20) What is the volume of 10.0 g of $\text{H}_2\text{S}(\text{g})$ at STP?

$$L = 10.0\text{g} \times \frac{1\text{mol}}{34.08\text{g}} \times \frac{22.4\text{L}}{1\text{mol}}$$
$$= 6.57\text{L}$$

21) What is the mass of 1.5×10^{15} molecules of AgCl ?

$$g = 1.5 \times 10^{15} \text{ molecules} \times \frac{1\text{mol}}{6.022 \times 10^{23} \text{ molecules}} \times \frac{143.32\text{g}}{1\text{mol}}$$
$$= 3.6 \times 10^{-7} \text{g}$$

22) How many molecules are there in 75.0 L of $\text{O}_3(\text{g})$ at STP?

$$\text{molecules} = 75.0\text{L} \times \frac{1\text{mol}}{22.4\text{L}} \times \frac{6.022 \times 10^{23} \text{ molecules}}{1\text{mol}}$$
$$= 2.02 \times 10^{24} \text{ molecules}$$

23) What volume at STP is occupied by 5.75×10^{10} molecules of $\text{SbH}_3(\text{g})$?

$$L = 5.75 \times 10^{10} \text{ molecules} \times \frac{1\text{mol}}{6.022 \times 10^{23} \text{ molecules}} \times \frac{22.4\text{L}}{1\text{mol}}$$
$$= 2.14 \times 10^{-12} \text{L}$$

24) What is the mass of 2.00 L of $\text{SF}_6(\text{g})$ at STP?

$$g = 2.00\text{L} \times \frac{1\text{mol}}{22.4\text{L}} \times \frac{146.06\text{g}}{1\text{mol}}$$
$$= 13.0\text{g}$$

25) How many B atoms are contained in 1.75 L of $\text{B}_2\text{H}_6(\text{g})$ at STP?

$$\text{B atoms} = 1.75\text{L} \times \frac{1\text{mol}}{22.4\text{L}} \times \frac{6.022 \times 10^{23} \text{ molecules}}{1\text{mol}} \times \frac{2 \text{ B atoms}}{1 \text{ molecule}}$$
$$= 9.41 \times 10^{22} \text{ atoms}$$

26) What is the mass of 25.0 mL of Kr_(g) at STP?

$$g = 25.0 \text{ mL} \times \frac{10^{-3} \text{ L}}{1 \text{ mL}} \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{83.80 \text{ g}}{1 \text{ mol}}$$
$$= 0.0935 \text{ g}$$

27) How many molecules are contained in 50.0 mL of NH_{3(g)} at STP?

$$\text{molecules} = 50.0 \text{ mL} \times \frac{10^{-3} \text{ L}}{1 \text{ mL}} \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mol}}$$
$$= 1.34 \times 10^{21} \text{ molecules}$$

28) How many atoms are contained in 75.0 g of ^{molecule}C₁₂H₂₂O₁₁?

$$\text{atoms} = 75.0 \text{ g} \times \frac{1 \text{ mol}}{342.30 \text{ g}} \times \frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{45 \text{ atoms}}{1 \text{ molecule}}$$
$$= 5.94 \times 10^{24} \text{ atoms}$$

29) What is the volume of 15.0 mg of SbH_{3(g)} at STP?

$$L = 15.0 \text{ mg} \times \frac{10^{-3} \text{ g}}{1 \text{ mg}} \times \frac{1 \text{ mol}}{124.77 \text{ g}} \times \frac{22.4 \text{ L}}{1 \text{ mol}}$$
$$= 0.00269 \text{ L}$$

30) How many atoms are contained in 5.20 g of ^{atom}Cu?

$$\text{atoms} = 5.20 \text{ g} \times \frac{1 \text{ mol}}{63.55 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}}$$
$$= 4.93 \times 10^{22} \text{ atoms}$$

31) What is the mass of 7.10×10^{18} Au atoms?

$$g = 7.10 \times 10^{18} \text{ atoms} \times \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ atoms}} \times \frac{196.97 \text{ g}}{1 \text{ mol}}$$
$$= 0.00232 \text{ g}$$

32) What is the volume of 5.0×10^{20} atoms of Kr_(g) at STP?

$$L = 5.0 \times 10^{20} \text{ atoms} \times \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ atoms}} \times \frac{22.4 \text{ L}}{1 \text{ mol}}$$
$$= 0.019 \text{ L}$$

33) How many H atoms are in 15.0 L NH_3 (g) at STP?

$$\begin{aligned} \text{H atoms} &= 15.0 \text{ L} \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{6.022 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{3 \text{ H atoms}}{1 \text{ molecule}} \\ &= 1.21 \times 10^{24} \text{ atoms} \end{aligned}$$

34) What is the mass of 1.85×10^{24} molecules of CsI?

$$\begin{aligned} \text{g} &= 1.85 \times 10^{24} \text{ molecules} \times \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ molecules}} \times \frac{259.82 \text{ g}}{1 \text{ mol}} \\ &= 798 \text{ g} \end{aligned}$$

35) If 135 L of cyanogen gas has a mass of 313 g at STP, what is the molar mass of cyanogen?

$$\begin{aligned} \frac{\text{g}}{\text{mol}} &= \frac{313 \text{ g}}{135 \text{ L}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} \\ &= 51.9 \text{ g/mol} \end{aligned}$$

36) What is the volume of 0.0694 mol of molybdenite, MoS_2 , having a density of 4.80 g/mL?

$$\begin{aligned} \text{mL} &= 0.0694 \text{ mol} \times \frac{160.06 \text{ g}}{1 \text{ mol}} \times \frac{1 \text{ mL}}{4.80 \text{ g}} \\ &= 2.31 \text{ mL} \end{aligned}$$