

$$22. \text{ (a) mass} = 2 \times 10^6 \text{ molecules} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} \times \frac{28.0 \text{ g}}{1 \text{ mol}} = 9 \times 10^{-17} \text{ g}$$

$$\text{(b) mass} = 1.25 \text{ L} \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{17.0 \text{ g}}{1 \text{ mol}} = \mathbf{0.949 \text{ g}}$$

$$\text{(c) mass} = 5 \times 10^{14} \text{ molecules} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} \times \frac{28.0 \text{ g}}{1 \text{ mol}} = 2 \times 10^{-8} \text{ g}$$

$$(d) \text{ mass} = 1 \text{ molecule} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} \times \frac{56.1 \text{ g}}{1 \text{ mol}} = 9.32 \times 10^{-23} \text{ g}$$

$$(e) \text{ mass} = 125 \text{ atoms} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms}} \times \frac{4.0 \text{ g}}{1 \text{ mol}} = 8.3 \times 10^{-22} \text{ g}$$

$$(f) \text{ mass} = 1 \text{ atom} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms}} \times \frac{107.9 \text{ g}}{1 \text{ mol}} = 1.79 \times 10^{-22} \text{ g}$$

$$(g) \text{ mass} = 4.15 \times 10^{15} \text{ molec} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} \times \frac{16.0 \text{ g}}{1 \text{ mol}} = 1.10 \times 10^{-7} \text{ g}$$

$$(h) \text{ mass} = 175 \text{ atoms} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms}} \times \frac{14.0 \text{ g}}{1 \text{ mol}} = 4.07 \times 10^{-21} \text{ g}$$

$$(i) \text{ mass} = 3.45 \text{ mL} \times \frac{10^{-3} \text{ L}}{1 \text{ mL}} \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{32.0 \text{ g}}{1 \text{ mol}} = 4.93 \times 10^{-3} \text{ g}$$

$$(j) \text{ mass} = 1.00 \times 10^8 \text{ L} \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{2.0 \text{ g}}{1 \text{ mol}} = 8.93 \times 10^6 \text{ g}$$

$$23. (a) \# \text{ of atoms} = 1.00 \text{ mol} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{6 \text{ atoms}}{1 \text{ molecule}} = 3.61 \times 10^{24} \text{ atoms}$$

$$(b) \# \text{ of atoms} = 2.5 \text{ mol} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{3 \text{ atoms}}{1 \text{ molecule}} = 4.5 \times 10^{24} \text{ atoms}$$

$$(c) \text{ \# of atoms} = 8.00 \text{ g} \times \frac{1 \text{ mol}}{55.8 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}} = 8.63 \times 10^{22} \text{ atoms}$$

$$(d) \text{ \# of atoms} = 15.0 \text{ L} \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}} = 4.03 \times 10^{23} \text{ atoms}$$

$$(e) \text{ \# of atoms} = 12 \text{ g} \times \frac{1 \text{ mol}}{34.0 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{4 \text{ atoms}}{1 \text{ molecule}} = 8.5 \times 10^{23} \text{ atoms}$$

$$(f) \text{ \# of atoms} = 55.0 \text{ mL} \times \frac{10^{-3} \text{ L}}{1 \text{ mL}} \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{3 \text{ atoms}}{1 \text{ molecule}} = 4.43 \times 10^{21} \text{ atoms}$$

$$(g) \text{ \# of atoms} = 40.0 \text{ g} \times \frac{1 \text{ mol}}{39.1 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}} = 6.16 \times 10^{23} \text{ atoms}$$

$$(h) \text{ \# of atoms} = 5.0 \text{ g} \times \frac{1 \text{ mol}}{58.5 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{2 \text{ atoms}}{1 \text{ molecule}} = 1.0 \times 10^{23} \text{ atoms}$$

$$(i) \text{ \# of atoms} = 125 \text{ g} \times \frac{1 \text{ mol}}{50.5 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{5 \text{ atoms}}{1 \text{ molecule}} = 7.45 \times 10^{24} \text{ atoms}$$

$$(j) \text{ \# of atoms} = 8.30 \times 10^{-4} \text{ mL} \times \frac{10^{-3} \text{ L}}{1 \text{ mL}} \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{4 \text{ atoms}}{1 \text{ molecule}} = 8.92 \times 10^{16} \text{ atoms}$$

$$(k) \text{ \# of atoms} = 6.5 \times 10^{-6} \text{ g} \times \frac{1 \text{ mol}}{83.8 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}} = 4.7 \times 10^{16} \text{ atoms}$$

$$(l) \text{ \# of atoms} = 9.5 \times 10^{-3} \text{ g} \times \frac{1 \text{ mol}}{17.0 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{4 \text{ atoms}}{1 \text{ molecule}} = 1.3 \times 10^{21} \text{ atoms}$$

$$24. \text{ (a) volume} = 16.5 \text{ g} \times \frac{1 \text{ mol}}{77.9 \text{ g}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = \mathbf{4.74 \text{ L}}$$

$$\text{(b) volume} = 5.65 \times 10^{22} \text{ molecules} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = \mathbf{2.10 \text{ L}}$$

$$\text{(c) volume} = 0.750 \text{ g} \times \frac{1 \text{ mol}}{48.0 \text{ g}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = \mathbf{0.350 \text{ L}}$$

$$\text{(d) volume} = 9.04 \times 10^{24} \text{ atoms} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = \mathbf{336 \text{ L}}$$

$$\text{(e) volume} = 8.65 \times 10^{21} \text{ molecules} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = \mathbf{0.322 \text{ L}}$$

$$\text{(f) volume} = 6.98 \times 10^{15} \text{ atoms} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = \mathbf{2.60 \times 10^{-7} \text{ L}}$$

$$\text{(g) volume} = 28.4 \text{ mg} \times \frac{10^{-3} \text{ g}}{1 \text{ mg}} \times \frac{1 \text{ mol}}{129.6 \text{ g}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = \mathbf{4.91 \times 10^{-3} \text{ L}}$$

$$\text{(h) volume} = 3.25 \text{ kg} \times \frac{10^3 \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ mol}}{30.0 \text{ g}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = \mathbf{2.43 \times 10^3 \text{ L}}$$