

Worksheet: Review of Significant Digits

1. All digits from 1 – 9 and zeroes in the middle of a measured value are significant digits.

1.667 cm	<u>4</u> sig digs	61 m/s	<u>2</u> sig digs	3.506 miles	<u>4</u> sig digs
307 mm	<u>3</u> sig digs	3.1428571	<u>8</u> sig digs	10006 km	<u>5</u> sig digs

2. “Leading zeroes” (zeroes at the beginning of a measured value) are not significant.

0.00667 cm	<u>3</u> sig digs	0.002004 m/s	<u>4</u> sig digs	0.506 miles	<u>3</u> sig digs
00307.2 cm	<u>4</u> sig digs	0.03 m	<u>1</u> sig digs	000005.2 s	<u>2</u> sig digs

3. “Trailing zeroes” (zeroes at the end of a measured value) are significant **ONLY IF** the number contains a decimal point.

16.00 ounces	<u>4</u> sig digs	42 000 km	<u>2</u> sig digs	0.6090 mm	<u>4</u> sig digs
100 g	<u>1</u> sig digs	0.0310 m	<u>3</u> sig digs	500.20 s	<u>5</u> sig digs

4. Counted values and conversion factors are considered to have an infinite number of sig. digs.

1000 m in a km	<u>∞</u> sig digs	12 eggs per dozen	<u>∞</u> sig digs	1 g = 1000 mg	<u>∞</u> sig digs
60 s per minute	<u>∞</u> sig digs	33 students	<u>∞</u> sig digs	1 marble	<u>∞</u> sig digs

5. When multiplying and/or dividing numbers, the answer must have the same number of significant digits as the measurement with the fewest number of significant digits.

1.5224 x 173 = 263	(3 sd)	100.0 ÷ 33 = 3.0	(2 sd)
1701 ÷ 288.76 = 5.891	(4 sd)	1200 ÷ 2974 = 0.40	(2 sd)
3.2 x 10.1 = 32	(2 sd)	30.75 x 000.822 = 25.3	(3 sd)

6. When adding and subtracting measured values, the answer must have the same number of decimal places as the measured number with the fewest number of decimal places.

15.224 + 173.6 = 188.8	(1 decimal place)	100 – 33 = 67	(no decimal place)
2500.2 – 389.753 = 2110.4	(1 decimal place)	200.5 + 29.498 = 230.0	(1 decimal place)
3.1428571 – 12 = - 9	(no decimal place)	10 – 62.344 = - 52	(no decimal place)

7. Complete the following calculations and round your answer to the correct number of sig.digs:

a) 22.4 h x 0.1 km/h = 2 km	(1 sd)	f) $\frac{465 \text{ km}}{5.21 \text{ h}} = 89.2514395 \text{ km/h}$ = 89.3 km/h (3 sd)
b) $18 \text{ cm}^3 \times 1.10 \text{ g/cm}^3 = 19.8 \text{ g}$		g) $72.5 \text{ m/s} \times 45.9 \text{ s} = 3327.75 \text{ m}$ = 3330 m (or $3.33 \times 10^3 \text{ m}$)
c) $17.5 \text{ mL} + 95 \text{ mL} + 8.25 \text{ mL} = 120.75 \text{ mL}$		h) $32.1 \text{ m} + 960 \text{ m} + 20.02 \text{ m} = 1012.12 \text{ m}$ = 1012 m
d) $0.2 \text{ cm} + 23.91 \text{ cm} + 0.62 \text{ cm} = 24.73 \text{ cm}$		i) $13.63 \text{ h} - 0.5 \text{ h} = 13.13 \text{ h}$ = 13.1 h (1 decimal place)
e) $\frac{567 \text{ m}}{86 \text{ s}} = 6.593023256 \text{ m/s}$		j) $15.9994 \mu + 1.00794 \mu + 65.39 \mu = 82.39734 \mu$ = 82.40 μ

Percentage Composition Problems

For all calculations, show a complete solution (equation, substitution and final answer). Include units for all numbers. Round your final answer to the appropriate number of significant digits.

1. Mercury (II) oxide decomposes when heated to produce pure mercury and oxygen gas.
a) Write the balanced chemical equation for this reaction, including the states of all reactants and products.

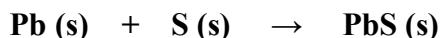


- b) Use the data given below to calculate the percentage by mass of mercury in the compound.

mass of empty test tube	12.25 g
mass of test tube and mercury (II) oxide	13.68 g
mass of test tube and mercury	13.57 g

2. A small amount of lead is heated strongly with sulfur to produce the compound lead (II) sulfide.

- a) Write the balanced chemical equation for this reaction, including the states of all reactants and products.



- b) Using the following data, calculate the percentage by mass of lead in lead (II) sulfide.

mass of crucible	23.1 g
mass of crucible and lead metal	25.1 g
mass of crucible and lead sulfide	25.4 g

3. A compound of nitrogen and oxygen is found to contain 4.20 g of nitrogen and 12.0 g of oxygen. What is the percentage composition by mass of each element in this compound?

4. When a compound of copper (II) oxide is heated, it is converted to pure copper. In an experiment 16.35 g of copper (II) oxide yielded 13.06 g of copper.

- a) Write the balanced chemical equation for this reaction, including the states of all reactants and products.



- b) Calculate the percentage by mass of oxygen in copper oxide.

5. Heating 2.43 g of magnesium in air produces 4.03 g of magnesium oxide.

- a) Write the balanced chemical equation for this reaction, including the states of all reactants and products.



- b) Calculate the percentage by mass of magnesium in magnesium oxide.

- c) Calculate the percentage by mass of oxygen in magnesium oxide.

6. A certain compound contains 30.1% oxygen by mass.

What mass of oxygen is there in 5.0 g of the compound?

Rearrange the equation:

$$\begin{aligned} \text{mass element} &= \text{mass compound} \times \% \text{ by mass of element} \\ &= 5.0 \text{ g} \times \frac{30.1}{100} \\ &= 1.5 \text{ g of oxygen in 5.0 g of the compound} \end{aligned}$$

Answers:

- 1b) 92.31% 4 sig digs
- 2b) 87.0 % 3 sig digs
3. 25.9% nitrogen and 74.1% oxygen, 3 sig digs
- 4b) 20.12% 4 sig digs
- 5b) 60.3 % 3 sig digs
- 5c) 39.7 % 3 sig digs
6. 1.5 g of oxygen, 2 sig digs

Introduction to the Mole: Answers to Practice Questions

1. Calculate the number of particles (atoms or molecules) in:

a) $4.55 \text{ moles} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}} = 2.74 \times 10^{24} \text{ atoms of sulfur}$

b) $0.772 \text{ moles} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} = 4.65 \times 10^{23} \text{ molecules of water}$

c) $364 \text{ moles} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} = 2.19 \times 10^{26} \text{ molecules of H}_2$

d) $5.00 \times 10^{-10} \text{ moles} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}} = 3.01 \times 10^{14} \text{ atoms of gold}$

2. Calculate the number of moles in:

a) $4.67 \times 10^{16} \text{ molecules} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} = 7.76 \times 10^{-8} \text{ moles of chlorine molecules}$

b) $3.90 \times 10^{33} \text{ atoms} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms}} = 6.48 \times 10^9 \text{ moles of gold atoms}$

c) $8.69 \times 10^9 \text{ crystals} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ crystals}} = 1.44 \times 10^{-14} \text{ moles of sand crystals}$

d) $7.44 \times 10^{55} \text{ molecules} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} = 1.24 \times 10^{32} \text{ moles of ammonia}$

3. Calculate the number of atoms in:

a) $100 \text{ molecules Fe}_2\text{S}_3 \times \frac{3 \text{ S atoms}}{1 \text{ Fe}_2\text{S}_3 \text{ molecule}} = 300 \text{ atoms of S}$

b) $100 \text{ molecules Fe}_2\text{S}_3 \times \frac{2 \text{ Fe atoms}}{1 \text{ Fe}_2\text{S}_3 \text{ molecule}} = 200 \text{ atoms of Fe}$

c) $100 \text{ molecules Fe}_2\text{S}_3 \times \frac{5 \text{ atoms in total}}{1 \text{ Fe}_2\text{S}_3 \text{ molecule}} = 500 \text{ atoms in total}$

d) $1.20 \times 10^6 \text{ molecules Al(ClO}_3)_3 \times \frac{9 (\text{O}) \text{ atoms}}{1 \text{ Al(ClO}_3)_3 \text{ molecule}} = 1.08 \times 10^7 \text{ atoms of (O)}$

e) $6.02 \times 10^{23} \text{ molecules Pb}_3(\text{PO}_4)_4 \times \frac{3 (\text{Pb}) \text{ atoms}}{1 \text{ Pb}_3(\text{PO}_4)_4 \text{ molecule}} = 1.81 \times 10^{24} \text{ atoms of Pb}$

f) $5 \text{ moles Pb}_3(\text{PO}_4)_4 \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{3 (\text{Pb}) \text{ atoms}}{1 \text{ Pb}_3(\text{PO}_4)_4 \text{ molecule}} = 9.03 \times 10^{24} \text{ atoms of Pb}$

What's so Special about the Mole: Answers to Practice Questions

1. Calculate the molar mass of the following:

- a) MM CO₂ = 1 (C) + 2 (O)
= 1 (12.01 g/mol) + 2 (16.00 /mol)
= 44.01 g/mol
- b) MM AlBr₃ = 1 (Al) + 3 (Br)
= 1 (26.98 g/mol) + 3 (79.90 g /mol)
= 266.68 g/mol
- c) MM Na₄Fe(CN)₆ = 4 (Na) + 1 (Fe) + 6 (C) + 6 (N)
= 4 (22.99 g/mol) + 1 (55.85 g /mol) + 6 (12.01 g/mol) + 6 (14.01 g /mol)
= 303.93 g/mol
- d) MM NH₄Cl = 1 (N) + 4 (H) + 1 (Cl)
= 1 (14.01 g/mol) + 4 (1.01 g /mol) + 1 (35.45 g/mol)
= 53.50 g/mol
- e) MM FeSO₄ = 1 (Fe) + 1 (S) + 4 (O)
= 1 (55.85 g /mol) + 1 (32.07 g/mol) + 4 (16.00 g /mol)
= 151.92 g/mol
- f) MM Co(CH₃COO)₃ = 1 (Co) + 6 (C) + 9 (H) + 6 (O)
= 1 (58.93 g/mol) + 6 (12.01 g /mol) + 9 (1.01 g/mol) + 6 (16.00 g /mol)
= 236.08 g/mol
- 2a) MM NH₃ = 1 (N) + 3 (H)
= 1 (14.01 g/mol) + 3 (1.01 g /mol)
= 17.04 g/mol
- b) 12.0 mol NH₃ x $\frac{17.04 \text{ g}}{1 \text{ mol NH}_3}$ = 204 g of NH₃
- c) MM C₄H₁₀ = 4 (C) + 10 (H)
= 4 (12.01 g/mol) + 10 (1.01 g /mol)
= 58.14 g/mol
- 0.26 mol C₄H₁₀ x $\frac{58.14 \text{ g}}{1 \text{ mol C}_4\text{H}_{10}}$ = 0.15 g of C₄H₁₀
- d) MM H₂ = 2 (H)
= 2 (1.01 g /mol)
= 2.02 g/mol
- 3.76 x 10⁵ mol H₂ x $\frac{2.02 \text{ g}}{1 \text{ mol H}_2}$ = 7.60 x 10⁵ g H₂

What's so Special about the Mole: Answers to Practice Questions (cont.)

4. Calculate the number of **moles** in:

a) MM NaF = 1 (Na) + 1 (F)
= 1 (22.99 g/mol) + 1 (19.00 g/mol)
= 41.99 g/mol

$$0.012 \text{ g NaF} \times \frac{1 \text{ mol}}{41.99 \text{ g}} = 0.000286 \text{ moles of NaF or } 2.9 \times 10^{-4} \text{ mol NaF (2 sig digs)}$$

b) MM C₆H₈O₆ = 6 (C) + 8 (H) + 6 (O)
= 6 (12.01 g/mol) + 8 (1.01 g/mol) + 6 (16.00 g/mol)
= 176.14 g/mol

$$60.0 \text{ mg C}_6\text{H}_8\text{O}_6 \times \frac{1 \text{ g}}{1000 \text{ mg}} \times \frac{1 \text{ mol}}{176.14 \text{ g}} = 0.000341 \text{ moles or } 3.41 \times 10^{-4} \text{ mol C}_6\text{H}_8\text{O}_6$$

c) MM NaCl = 1 (Na) + 1 (Cl)
= 1 (22.99 g/mol) + 1 (35.45 g/mol)
= 58.44 g/mol

$$0.500 \text{ kg NaCl} \times \frac{1000 \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ mol}}{58.44 \text{ g}} = 8.56 \text{ mol NaCl}$$

d) MM Au = 196.97 g/mol

$$62\,456 \text{ kg Au} \times \frac{1000 \text{ g}}{1 \text{ kg}} \times \frac{1 \text{ mol}}{196.97 \text{ g}} = 3.1708 \times 10^5 \text{ mol Au (5 sig digs)}$$

Using Avogadro's Number: Answers to Practice Questions

1. How many molecules are there in:

a) MM H₂O = 2 (H) + 1 (O)
= 2 (1.01 g/mol) + 1 (16.00 /mol)
= 18.02 g/mol

$$3.6 \text{ g H}_2\text{O} \times \frac{1 \text{ mol}}{18.02 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} = 1.2 \times 10^{23} \text{ molecules H}_2\text{O}$$

b) MM NaCl = 1 (Na) + 1 (Cl)
= 1 (22.99 g /mol) + 1 (35.45 g/mol)
= 58.44 g/mol

$$100.0 \text{ g NaCl} \times \frac{1 \text{ mol}}{58.44 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} = 1.030 \times 10^{24} \text{ molecules NaCl}$$

c) MM NaOH = 1 (Na) + 1 (O) + 1 (H)
= 1 (22.99 g /mol) + 1 (16.00 g/mol) + 1 (1.01 g/mol)
= 40.00 g/mol

$$50.0 \text{ g NaOH} \times \frac{1 \text{ mol}}{40.00 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} = 7.53 \times 10^{23} \text{ molecules NaOH}$$

2. Calculate the mass of:

a) MM Au = 196.97 g/mol

$$3.01 \times 10^{23} \text{ atoms Au} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms}} \times \frac{196.97 \text{ g}}{1 \text{ mol}} = 98.5 \text{ g Au}$$

b) MM C₁₂H₂₂O₁₁ = 12 (C) + 22 (H) + 11 (O)
= 12 (12.01 g /mol) + 22 (1.01 g/mol) + 11 (16.00 g/mol)
= 342.34 g/mol

$$9.03 \times 10^{25} \text{ molecules C}_{12}\text{H}_{22}\text{O}_{11} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} \times \frac{342.34 \text{ g}}{1 \text{ mol}} = 5.14 \times 10^4 \text{ g of C}_{12}\text{H}_{22}\text{O}_{11}$$

c) MM C₁₂H₂₂O₁₁ = 12 (C) + 22 (H) + 11 (O)
= 12 (12.01 g /mol) + 22 (1.01 g/mol) + 11 (16.00 g/mol)
= 342.34 g/mol

$$1 \text{ molecule C}_{12}\text{H}_{22}\text{O}_{11} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} \times \frac{342.34 \text{ g}}{1 \text{ mol}} = 5.69 \times 10^{-22} \text{ g C}_{12}\text{H}_{22}\text{O}_{11}$$

d) molecular mass C₁₂H₂₂O₁₁ = 12 (C) + 22 (H) + 11 (O)
= 12 (12.01 amu) + 22 (1.01 amu) + 11 (16.00 amu)
= 342.34 amu

NOTE: molar mass (MM) and molecular mass have the same numerical value, but the units are different.
Molar mass is measured in g/mol while molecular mass (the mass of a single molecule) is measured in amu.

Using Avogadro's Number: Answers to Practice Questions (cont.)

3. Given 180.2 g of water:

a) MM H₂O = 2 (H) + 1 (O)
= 2 (1.01 g/mol) + 1 (16.00 /mol)
= 18.02 g/mol

$$180.2 \text{ g H}_2\text{O} \times \frac{1 \text{ mol}}{18.02 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{2 \text{ atoms (H)}}{1 \text{ molecule H}_2\text{O}} = 1.204 \times 10^{25} \text{ atoms of H}$$

b) MM H₂O = 2 (H) + 1 (O)
= 2 (1.01 g/mol) + 1 (16.00 /mol)
= 18.02 g/mol

$$180.2 \text{ g H}_2\text{O} \times \frac{1 \text{ mol}}{18.02 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{1 \text{ atom (O)}}{1 \text{ molecule H}_2\text{O}} = 6.020 \times 10^{24} \text{ atoms of O}$$

c) MM H₂O = 2 (H) + 1 (O)
= 2 (1.01 g/mol) + 1 (16.00 /mol)
= 18.02 g/mol

$$180.2 \text{ g H}_2\text{O} \times \frac{1 \text{ mol}}{18.02 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{3 \text{ atoms in total}}{1 \text{ molecule H}_2\text{O}} = 1.806 \times 10^{25} \text{ total atoms}$$

Moles and the Volume of Gas at STP: Answers to Practice Questions

1. Calculate the volume, at STP, of:

a) 2.00 moles H₂ $\times \frac{22.4 \text{ L}}{1 \text{ mol}} = 44.8 \text{ L}$ of H₂ gas at STP

b) 0.075 moles H₂O $\times \frac{22.4 \text{ L}}{1 \text{ mol}} = 1.7 \text{ L}$ of H₂O vapour (gas) at STP

c) MM CO₂ = 1 (C) + 2 (O)
= 1 (12.01 g/mol) + 2 (16.00 /mol)
= 44.01 g/mol

$$5.00 \text{ g CO}_2 \times \frac{1 \text{ mol}}{44.01 \text{ g}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 2.54 \text{ L}$$
 of CO₂ gas at STP

d) MM SO₂ = 1 (S) + 2 (O)
= 1 (32.07 g/mol) + 2 (16.00 /mol)
= 64.07 g/mol

$$100.0 \text{ g SO}_2 \times \frac{1 \text{ mol}}{64.07 \text{ g}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 35.0 \text{ L}$$
 of SO₂ gas at STP

e) 6.02×10^{24} molecules N₂ $\times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 224 \text{ L}$ N₂ gas at STP

f) 1.20×10^{22} molecules CO $\times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 0.447 \text{ L}$ CO gas at STP

2. How many moles are there in the following volumes of gases at STP?

a) 1008 L CH₄ $\times \frac{1 \text{ mol}}{22.4 \text{ L}} = 45.0 \text{ mol}$ CH₄ at STP

b) 2000.0 mL N₂O₄ $\times \frac{1 \text{ L}}{1000 \text{ mL}} \times \frac{1 \text{ mol}}{22.4 \text{ L}} = 0.0893 \text{ mol}$ N₂O₄ at STP

c) $2.24 \times 10^6 \text{ L}$ benzene $\times \frac{1 \text{ mol}}{22.4 \text{ L}} = 1.00 \times 10^5 \text{ mol}$ benzene at STP

d) 14.56 L Freon $\times \frac{1 \text{ mol}}{22.4 \text{ L}} = 0.650 \text{ mol}$ Freon at STP

Moles Problems #1: Answers to Practice Questions

1. Calculate the volume at STP of:

a) 2.00 moles O₂ $\times \frac{22.4 \text{ L}}{1 \text{ mol}} = 44.8 \text{ L}$ of O₂ gas at STP

b) MM CO₂ = 1 (C) + 2 (O)
= 1 (12.01 g/mol) + 2 (16.00 /mol)
= 44.01 g/mol

$$5.0 \text{ g CO}_2 \times \frac{1 \text{ mol}}{44.01 \text{ g}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 0.25 \text{ L}$$
 of CO₂ gas at STP

c) 1.2 $\times 10^{22}$ molecules CO $\times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 0.45 \text{ L}$ CO gas at STP

2. MM SO₂ = 1 (S) + 2 (O)
= 1 (32.07 g/mol) + 2 (16.00 /mol)
= 64.07 g/mol

$$100.0 \text{ L SO}_2 \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{64.07 \text{ g}}{1 \text{ mol}} = 286 \text{ g}$$
 SO₂ gas at STP

3. 4.48 L NH₃ $\times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} = 1.20 \times 10^{23}$ molecules NH₃

4. 1000 L CH₄ $\times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{4 (\text{H}) \text{ atoms}}{1 \text{ CH}_4 \text{ molecule}} = 1.08 \times 10^{26}$ atoms of H

5. Calculate the number of moles in:

a) MM H₂O = 2 (H) + 1 (O)
= 2 (1.01 g/mol) + 1 (16.00 /mol)
= 18.02 g/mol

$$360.0 \text{ g H}_2\text{O} \times \frac{1 \text{ mol}}{18.02 \text{ g}} = 19.98 \text{ mol H}_2\text{O}$$

b) MM NaCl = 1 (Na) + 1 (Cl)
= 1 (22.99 g /mol) + 1 (35.45 g/mol)
= 58.44 g/mol

$$0.585 \text{ g NaCl} \times \frac{1 \text{ mol}}{58.44 \text{ g}} = 0.0100 \text{ mol NaCl}$$

c) 1.20 $\times 10^{25}$ atoms $\times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms}} = 19.9$ moles of uranium atoms

d) 1.00 $\times 10^9$ molecules CH₄ $\times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} = 1.66 \times 10^{-15}$ moles CH₄ molecules

Moles Problems #1: Answers to Practice Questions (cont.)

6. Calculate the mass, in grams, of:

a) MM $\text{Na}_2\text{CO}_3 = 2(\text{Na}) + 1(\text{C}) + 3(\text{O})$
 $= 2(22.99 \text{ g/mol}) + 1(12.01 \text{ g/mol}) + 3(16.00 \text{ g/mol})$
 $= 105.99 \text{ g/mol}$

$$25.0 \text{ mole } \text{Na}_2\text{CO}_3 \times \frac{105.99 \text{ g}}{1 \text{ mol}} = 2649.75 \text{ g or } 2.65 \times 10^3 \text{ g Na}_2\text{CO}_3$$

b) MM $\text{C}_{12}\text{H}_{22}\text{O}_{11} = 12(\text{C}) + 22(\text{H}) + 11(\text{O})$
 $= 12(12.01 \text{ g/mol}) + 22(1.01 \text{ g/mol}) + 11(16.00 \text{ g/mol})$
 $= 342.34 \text{ g/mol}$

$$1000.0 \text{ moles } \text{C}_{12}\text{H}_{22}\text{O}_{11} \times \frac{342.34 \text{ g}}{1 \text{ mol}} = 342,340 \text{ g C}_{12}\text{H}_{22}\text{O}_{11}$$

c) $2.4 \times 10^9 \text{ molecules CH}_4 \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} = 3.99 \times 10^{-15} \text{ moles CH}_4 \text{ molecules}$

d) MM C = 12.01 g/mol

$$1 \text{ atom C} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} \times \frac{12.01 \text{ g}}{1 \text{ mol}} = 1.995 \times 10^{-22} \text{ g C or } 2.00 \times 10^{-22} \text{ g C}$$

7. Calculate the number of **atoms** in:

a) $2.00 \text{ mol O}_2 \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{2 \text{ atoms (O)}}{1 \text{ molecule O}_2} = 2.41 \times 10^{24} \text{ atoms of O}$

b) MM Cu = 63.55 g/mol

$$0.635 \text{ g Cu} \times \frac{1 \text{ mol}}{63.55 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}} = 6.02 \times 10^{21} \text{ atoms of Cu}$$

c) MM K = 39.10 g/mol

$$3.91 \text{ g K} \times \frac{1 \text{ mol}}{39.10 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ atoms}}{1 \text{ mol}} = 6.02 \times 10^{22} \text{ atoms of Cu}$$

d) MM $\text{H}_2\text{O} = 2(\text{H}) + 1(\text{O})$
 $= 2(1.01 \text{ g/mol}) + 1(16.00 \text{ g/mol})$
 $= 18.02 \text{ g/mol}$

$$180.0 \text{ g H}_2\text{O} \times \frac{1 \text{ mol}}{18.02 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}} \times \frac{3 \text{ atoms in total}}{1 \text{ molecule H}_2\text{O}} = 1.80 \times 10^{25} \text{ total atoms}$$

Moles Problems #2: Answers to Practice Questions

1. What is the **mass**, in grams, of:

a) MM $\text{K}_2\text{CO}_3 = 2(\text{K}) + 1(\text{C}) + 3(\text{O})$
 $= 2(39.10 \text{ g/mol}) + 1(12.01 \text{ g/mol}) + 3(16.00 \text{ g/mol})$
 $= 138.21 \text{ g/mol}$

$$0.0100 \text{ mole } \text{K}_2\text{CO}_3 \times \frac{138.21 \text{ g}}{1 \text{ mol}} = 1.38 \text{ g } \text{K}_2\text{CO}_3$$

b) MM $\text{NaOH} = 1(\text{Na}) + 1(\text{O}) + 1(\text{H})$
 $= 1(22.99 \text{ g/mol}) + 1(16.00 \text{ g/mol}) + 1(1.01 \text{ g/mol})$
 $= 40.00 \text{ g/mol}$

$$6.0 \text{ mol NaOH} \times \frac{40.00 \text{ g}}{1 \text{ mol}} = 240 \text{ g NaOH}$$

c) MM $\text{H}_2\text{SO}_4 = 2(\text{H}) + 1(\text{S}) + 4(\text{O})$
 $= 2(1.01 \text{ g/mol}) + 1(32.07 \text{ g/mol}) + 4(16.00 \text{ g/mol})$
 $= 98.09 \text{ g/mol}$

$$0.50 \text{ mol H}_2\text{SO}_4 \times \frac{98.09 \text{ g}}{1 \text{ mol}} = 49 \text{ g H}_2\text{SO}_4$$

d) MM $\text{H}_2\text{O} = 2(\text{H}) + 1(\text{O})$
 $= 2(1.01 \text{ g/mol}) + 1(16.00 \text{ g/mol})$
 $= 18.02 \text{ g/mol}$

$$3.60 \times 10^{24} \text{ molecules} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} \times \frac{18.02 \text{ g}}{1 \text{ mol}} = 108 \text{ g H}_2\text{O}$$

e) MM $\text{C}_6\text{H}_{12}\text{O}_6 = 6(\text{C}) + 12(\text{H}) + 6(\text{O})$
 $= 6(12.01 \text{ g/mol}) + 12(1.01 \text{ g/mol}) + 6(16.00 \text{ g/mol})$
 $= 180.18 \text{ g/mol}$

$$1.00 \times 10^{23} \text{ molecules C}_6\text{H}_{12}\text{O}_6 \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} \times \frac{180.18 \text{ g}}{1 \text{ mol}} = 29.9 \text{ g C}_6\text{H}_{12}\text{O}_6$$

f) MM $\text{Cl} = 35.45 \text{ g/mol}$

$$1.0 \times 10^{20} \text{ atoms Cl} \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms}} \times \frac{35.45 \text{ g}}{1 \text{ mol}} = 5.9 \times 10^{-3} \text{ g or } 0.0059 \text{ g Cl}$$

g) MM $\text{Cl}_2 = 2(\text{Cl})$
 $= 2(35.45 \text{ g/mol})$
 $= 70.90 \text{ g/mol}$

$$44.8 \text{ L Cl}_2 \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{70.90 \text{ g}}{1 \text{ mol}} = 142 \text{ g Cl}_2 \text{ at STP}$$

Moles Problems #2: Answers to Practice Questions (cont.)

h) MM CO₂ = 1 (C) + 2 (O)
 = 1 (12.01 g/mol) + 2 (16.00 g/mol)
 = 44.01 g/mol

$$1.00 \text{ L CO}_2 \times \frac{1 \text{ mol}}{22.4 \text{ L}} \times \frac{44.01 \text{ g}}{1 \text{ mol}} = 1.96 \text{ g CO}_2 \text{ at STP}$$

2. What is the volume (assume at STP) in litres of:

a) 2.65 mol C₄H₁₀ × $\frac{22.4 \text{ L}}{1 \text{ mol}}$ = 59.4 L C₄H₁₀ at STP

b) MM C₄H₁₀ = 4 (C) + 10 (H)
 = 4 (12.01 g/mol) + 10 (1.01 g/mol)
 = 58.14 g/mol

$$2.65 \text{ g C}_4\text{H}_{10} \times \frac{1 \text{ mol}}{58.14 \text{ g}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 1.02 \text{ L of C}_4\text{H}_{10} \text{ at STP}$$

c) 2.65×10^{24} molecules C₄H₁₀ × $\frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}}$ × $\frac{22.4 \text{ L}}{1 \text{ mol}} = 98.6 \text{ L of C}_4\text{H}_{10} \text{ at STP}$

3. Calculate the following (assume all gases are at STP):

a) MM Pb(NO₃)₂ = 1 (Pb) + 2 (N) + 6 (O)
 = 1 (207.2 g/mol) + 2 (14.01 g/mol) + 6 (16.00 g/mol)
 = 331.22 g/mol

b) MM NaOH = 1 (Na) + 1 (O) + 1 (H)
 = 1 (22.99 g/mol) + 1 (16.00 g/mol) + 1 (1.01 g/mol)
 = 40.00 g/mol

$$0.250 \text{ mol NaOH} \times \frac{40.00 \text{ g}}{1 \text{ mol}} = 10.0 \text{ g NaOH}$$

c) K₄Fe(CN)₆ = 4 (K) + 1 (Fe) + 6 (C) + 6 (N)
 = 17 atoms/molecule or 17 atoms in total

d) 2 moles C₅H₁₁OH × $\frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mol}}$ = 1.20×10^{24} molecules of C₅H₁₁OH

e) MM CCl₄ = 1 (C) + 4 (Cl)
 = 1 (12.01 g/mol) + 4 (35.45 g/mol)
 = 153.81 g/mol

$$1 \text{ molecule CCl}_4 \times \frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}} \times \frac{153.81 \text{ g}}{1 \text{ mol}} = 2.55 \times 10^{-22} \text{ g CCl}_4$$

Moles Problems #2: Answers to Practice Questions (cont.)

f) MM CaCO₃ = 1 (Ca) + 1 (C) + 3 (O)
 = 1 (40.08 g/mol) + 1 (12.01 g/mol) + 3(16.00 g/mol)
 = 100.09 g/mol

20.0 g CaCO₃ x $\frac{1 \text{ mol}}{100.09 \text{ g}}$ = 0.19982 mol which rounds to 0.200 mole CaCO₃

g) 9.632 x 10²¹ molecules x $\frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}}$ = 0.0160 mol

h) 60.0 L NO₂ x $\frac{1 \text{ mol}}{22.4 \text{ L}}$ = 2.68 mole NO₂ at STP

i) This is a tricky one. The steps are: mass C₂H₆ → moles C₂H₆ → moles C

MM C₂H₆ = 2 (C) + 6 (H)
 = 2 (12.01 g/mol) + 6 (1.01 g/mol)
 = 30.08 g/mol

10.0 g C₂H₆ x $\frac{1 \text{ mol}}{30.08 \text{ g}}$ x $\frac{2 \text{ moles of atoms C}}{1 \text{ mole of C}_2\text{H}_6 \text{ molecules}}$ = 0.665 moles of C

j) MM NO₂ = 1 (N) + 2 (O)
 = 1 (14.01 g/mol) + 2 (16.00 /mol)
 = 46.01 g/mol

4.40 g NO₂ x $\frac{1 \text{ mol}}{46.01 \text{ g}}$ x $\frac{6.02 \times 10^{23} \text{ molecules NO}_2}{1 \text{ mole}}$ x $\frac{2 \text{ (O) atoms}}{1 \text{ NO}_2 \text{ molecule}}$ = 1.15 x 10²³ atoms (O)

k) 9.0 x 10²⁵ molecules H₂ x $\frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}}$ x $\frac{22.4 \text{ L}}{1 \text{ mol}}$ = 3349 L H₂ gas at STP
 rounds to 3300 L (2 sig digs)

l) This is a tricky one. The steps are: mass NaCl → moles NaCl → moles Na → mass Na

MM NaCl = 1 (Na) + 1 (Cl)
 = 1 (22.99 g/mol) + 1 (35.45 g /mol)
 = 58.44 g/mol

2.5 g NaCl x $\frac{1 \text{ mol}}{58.44 \text{ g}}$ x $\frac{1 \text{ moles of atoms Na}}{1 \text{ mole of NaCl molecules}}$ x $\frac{22.99 \text{ g}}{1 \text{ mol Na}}$ = 0.98 g of Na

m) 1.2 x 10²³ atoms Al x $\frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ molecules}}$ x $\frac{26.98 \text{ g}}{1 \text{ mol}}$ = 5.4 g of Al atoms

n) MM H = 1.01 g/ mol
 1 (H) atoms x $\frac{1 \text{ mol}}{6.02 \times 10^{23} \text{ atoms}}$ x $\frac{1.01 \text{ g}}{1 \text{ mol}}$ = 1.68 x 10⁻²⁴ g H

$$\begin{aligned} \text{o) MM C}_3\text{H}_8 &= 3 (\text{C}) + 8 (\text{H}) \\ &= 3 (12.01 \text{ g/mol}) + 8 (1.01 \text{ g /mol}) \\ &= 44.11 \text{ g/mol} \end{aligned}$$

$$8.0 \text{ g C}_3\text{H}_8 \times \frac{1 \text{ mol}}{44.11 \text{ g}} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 4.1 \text{ L of C}_4\text{H}_{10} \text{ at STP}$$

$$\begin{aligned} \text{p) MM CaBr}_2 &= 1 (\text{Ca}) + 2 (\text{Br}) \\ &= 1 (40.08 \text{ g/mol}) + 2 (79.90 \text{ g /mol}) \\ &= 199.88 \text{ g/mol} \end{aligned}$$

$$20.0 \text{ g CaBr}_2 \times \frac{1 \text{ mol}}{199.88 \text{ g}} \times \frac{6.02 \times 10^{23} \text{ molecules}}{1 \text{ mole}} \times \frac{2 \text{ atoms (Br)}}{1 \text{ CaBr}_2 \text{ molecule}} = \frac{1.20 \times 10^{23}}{\text{Br atoms}}$$