...gnment 1: Units of Measurement and Metric Conversions

1. Identify the quantity each measurement represents.

Density	a.	5.0 g/mL
Time	b.	37 s
Energy	c.	47 J
Mass	d.	39.56 g
Volume	e.	25.3 cm^3
Time	f.	325 ms
Area	g.	500 m^2
Volume	h.	30.23 mL
Mass	i.	2.7 mg
Volume	j.	0.005 L
Mass	k.	2000.5 kg
Speed	l.	63.5 km/h

2. Use appropriate metric prefixes to write the following measurements without the use of exponents.

4.5 mL	a.	4.5×10^6 L
1.25 km	b.	1.25×10^3 m
3.25 ms	c.	3.25×10^{-3} s
3.2 kg	d.	3.2×10^3 g
1.2 Mg	e.	1.2×10^{-6} g

3. Make the following metric conversions
   a. 1000 m = 1 km
   b. 1000 mm = 1 m
   c. 100 cm = 1 m
   d. 1m = 100 cm
   e. 1m = 1000 mm
   f. 1 kg = 1000 g

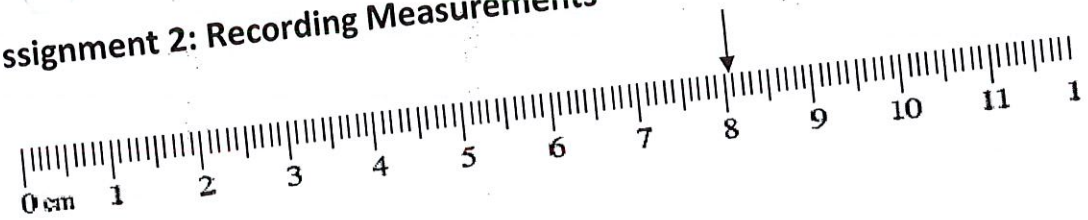
4. Which of the following is larger?

10 cm	a.	10 cm or 10 mm
1 km	b.	1m or 1 km
1 dg	c.	1 dg or 1 mg
1L	d.	1 L or 1 µL

5. Make the following metric conversions:
   a. 0.0225 g = 22.5 mg
   a. 15,000 µL = 15.0 mL
   c. 0.0105 kg = 10.5 g
   d. 1,570 m = 1.57 km
   e. ~~3,540~~ 0.00000354 g = 3.54 µg
   f. 3,500,000 µmol = 3.5 mol
   g. 1,200 mL = 1.2 L
   h. 358 mL = 358 cm^3
   i. 548.6 cm^3 = 548.6 mL

6. Make the following metric conversions Use scientific notation to replace the prefix. Example: 453 mg = 453×10^{-3} r
   a. 3.5 µmol = 3.5×10^{-6} mol
   b. 15 mm = 15×10^{-3} m
   c. 31 cg = 31×10^{-2} g
   d. 150 mg = 150×10^{-3} g
   e. 654 nm = 654×10^{-9} m
   f. 25 km = 25×10^{3} m
   g. 425 mL = 425×10^{-3} L

ssignment 2: Recording Measurements



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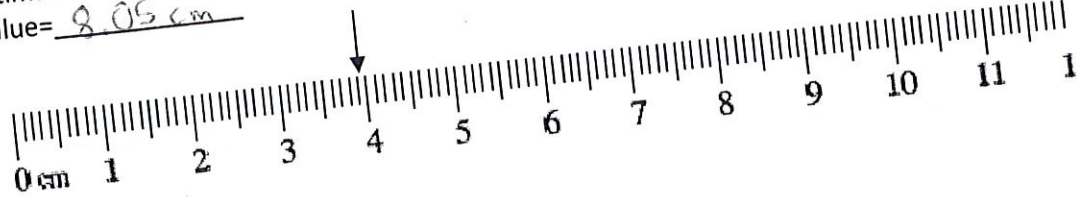
Estimated Place= hundredths
Value= 8.05 cm



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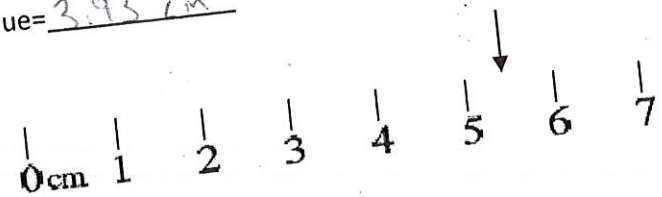

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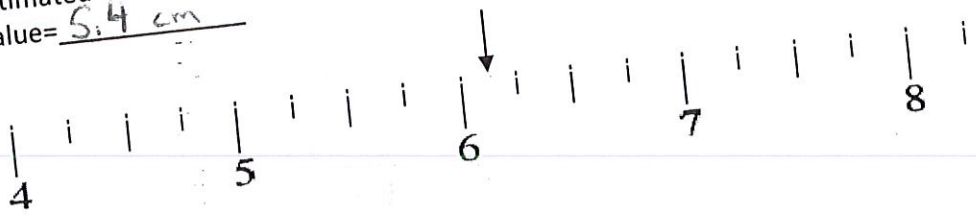

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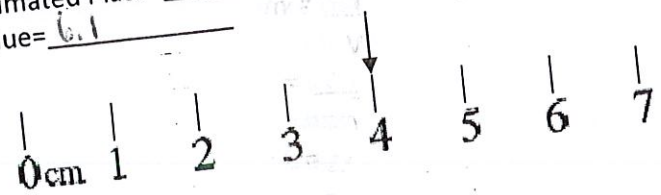
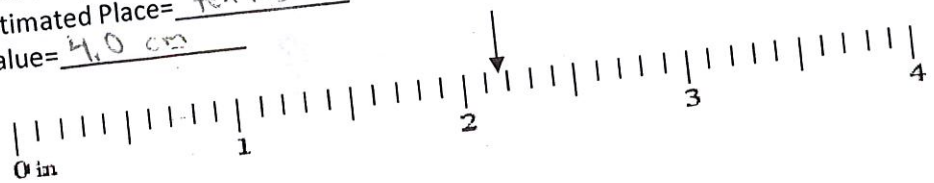


Interval= 1.0 cm
Estimated Place= tenths
Value= 4.0 cm



0.10 cm - interval
hundredths - Estimated place
2.17 cm - value

Assignment 3: Counting Significant Digits

How many significant digits are in each of the following?

3	1.	40.7 L	3	8.	28.6 g	4	15. 1002 m
5	2.	87009 km	4	9.	3440. cm	1	16. 400 mL
5	3.	0.0095897 m	2	10.	910 cm	3	17. 0.000625 kg
4	4.	85.00 g	4	11.	0.04604 L	1	18. 7000 cm
10	5.	9.000000000 g	5	12.	0.0067000 kg	4	19. 7000. cm
1	6.	2000 lbs	5	13.	804.05 g	6	20. 7000.00 cm
5	7.	20000. lbs	6	14.	0.0144030 km		

Assignment 4: Calculations Using Significant Figures

- When multiplying and dividing, limit and round tot the least number of significant figures in any of the factors.
    - **Example 1**
      23.0 cm * 432 cm * 19 cm = 188.784 cm^3
      The answer is expressed as 190,000 cm^3 since 19 cm has only two significant figures.
- When adding and subtracting, limit and round your answer to the least number of decimal places in any of the numbers that make up you answer.
    - **Example 2**
      123.25 mL + 46.0 mL + 86.267 mL = 255.507 mL
      The answer is expressed as 255.5 mL since 46.0 mL has only one decimal place.

Practice

Perform the following operations expressing the answer in the correct number of significant figures.

1. 1.35 m x 2.467 m = 3.33 m^2
2. 1,035 m^2 / 42 m = 25 m
3. 12.01 mL + 35.2 mL + 6 mL = 53 mL
4. 55.46 g – 28.9 g = 26.6 g
5. .021 cm x 3.2 cm x 100.1 cm = 6.7 cm^3
6. 0.15 cm + 1.15 cm + 2.051 cm = 3.35 cm
7. 150 m / 4 sec = 40 m/s
8. 505 kg – 450.25 kg = 55 kg
9. 1.252 mm x 0.115 mm x 0.012 mm = 0.0017 mm^3
10. 2.14267 * 10^2 m = 8.958 m

Assignment 5: Dimensional Analysis Practice

Item Number	Problem	Dimensional Analysis	Answer
1	500 inches = _____ ft	$500\ \text{in} \times \frac{1\ \text{ft}}{12\ \text{in}} = 40\ \text{ft}$	
2	25 ft = _____ yd	$25\ \text{ft} \times \frac{1\ \text{yd}}{3\ \text{ft}} = 8.3\ \text{yd}$	
3	6.4 km = _____ miles	$6.4\ \text{km} \times \frac{1\ \text{mi}}{1.6093\ \text{km}} = 4.0\ \text{mi}$	
4	30 in = _____ cm	$30\ \text{in} \times \frac{2.54\ \text{cm}}{1\ \text{in}} = 80\ \text{cm}$	
5	3.5 m^3 = _____ cm^3	$3.5\ \text{m}^3 \times \frac{10^6\ \text{cm}^3}{1\ \text{m}^3} = 3.5 \times 10^6\ \text{cm}^3$	
6	358 cm^3 = _____ mL	$358\ \text{cm}^3 \times \frac{1\ \text{mL}}{1\ \text{cm}^3} = 358\ \text{mL}$	
7	15 dm^3 = _____ mL	$15\ \text{dm}^3 \times \frac{1000\ \text{mL}}{1\ \text{dm}^3}$ = $15\ \text{dm}^3 \times \frac{1\ \text{L}}{1\ \text{dm}^3} \times \frac{10^3\ \text{mL}}{1\ \text{L}} = 15{,}000\ \text{mL}$	
8	0.35 in = _____ m	$0.35\ \text{in} \times \frac{2.54\ \text{cm}}{1\ \text{in}} \times \frac{1\ \text{m}}{10^2\ \text{cm}} = 0.0089\ \text{m}$	
9	0.75 L = _____ dm^3	$0.75\ \text{L} \times \frac{1\ \text{dm}^3}{1\ \text{L}} = 0.75\ \text{dm}^3$	

Assignment 3: Conversions

There are three mole conversions:

1 mol = 6.02×10^{23} particles

1 mol = molar mass (periodic table)

1 mol = 22.4 L for a gas at STP

Each conversion can be written as a set of two conversion factors:

$$\frac{1 \text{ mole}}{6.02 \times 10^{23} \text{ particles}} \qquad \frac{6.02 \times 10^{23} \text{ particles}}{1 \text{ mole}}$$

$$\frac{1 \text{ mole}}{\text{molar mass}} \qquad \frac{\text{molar mass}}{1 \text{ mole}}$$

$$\frac{1 \text{ mole}}{22.4 \text{ L}} \qquad \frac{22.4 \text{ L}}{1 \text{ mole}}$$

Mole – Particle Conversions

Examples:

1. How many moles of magnesium are 3.01×10^{22} atoms of magnesium?

2. How many molecules are there in 4.00 moles of glucose, $C_6H_{12}O_6$?

In class practice:

3. How many moles are in 1.20×10^{25} atoms of phosphorus?

$$1.20 \times 10^{25} \text{ atoms P} \times \frac{1 \text{ mol P}}{6.022 \times 10^{23} \text{ atoms P}} = 19.9 \text{ mol P}$$

4. How many atoms are in 0.750 moles of zinc?

$$0.750 \text{ mol Zn} \times \frac{6.022 \times 10^{23} \text{ atoms Zn}}{1 \text{ mol Zn}} = 4.52 \times 10^{23} \text{ atoms Zn}$$

5. How many molecules are in 0.400 moles of N_2O_5?

$$0.400 \text{ moles } N_2O_5 \times \frac{6.022 \times 10^{23} \text{ molec. } N_2O_5}{1 \text{ mol Zn}} = 2.41 \times 10^{23} \text{ molec. } N_2O_5$$

Assignment 4: The Mole and Avogadro's Number

One mole of a substance contains Avogadro's Number (6.02×10^{23}) of molecules

How many particles are in the quantities below?

1. 2.0 moles of NO_2

$$2.0 \text{ mol } NO_2 \times \frac{6.022 \times 10^{23} \text{ molec. } NO_2}{1 \text{ mol } NO_2} = 1.2 \times 10^{24} \text{ molec. } NO_2$$

2. 1.50 moles calcium

$$1.50 \text{ mol } NO_2 \times \frac{6.022 \times 10^{23} \text{ atoms Ca}}{1 \text{ mol Ca}} = 9.03 \times 10^{23} \text{ atoms Ca}$$

3. 0.75 moles water

$$0.75 \text{ mol } H_2O \times \frac{6.022 \times 10^{23} \text{ molec. } H_2O}{1 \text{ mol } H_2O} = 4.5 \times 10^{23} \text{ molec. } H_2O$$

4. 150 moles NH_3

$$150 \text{ mol } NH_3 \times \frac{6.022 \times 10^{23} \text{ molec. } NH_3}{1 \text{ mol } NH_3} = 9.0 \times 10^{25} \text{ molec. } NH_3$$

5. 0.35 moles H_2SO_4

$$0.35 \text{ mol } H_2SO_4 \times \frac{6.022 \times 10^{23} \text{ part. } H_2SO_4}{1 \text{ mol } H_2SO_4} = 2.1 \times 10^{23} \text{ part. } H_2SO_4$$

How many moles are in the number of particles below?

6. 6.02×10^{23} molecules of CO_2

$$6.02 \times 10^{23} \text{ molec. } CO_2 \times \frac{1 \text{ mol } CO_2}{6.022 \times 10^{23} \text{ molec. } CO_2} = 1.00 \text{ mol } CO_2$$

7. 1.204×10^{24} atoms of He

$$1.204 \times 10^{24} \text{ atoms He} \times \frac{1 \text{ mol He}}{6.022 \times 10^{23} \text{ atoms He}} = 2.000 \text{ mol He}$$

8. 1.5×10^{20} ions of Ag^+

$$1.5 \times 10^{20} \text{ } Ag^+ \text{ ions} \times \frac{1 \text{ mol } Ag^+}{6.022 \times 10^{23} \text{ } Ag^+ \text{ ions}} = 2.5 \times 10^{-4} \text{ mol } Ag^+$$

9. 3.4×10^{26} formula units of $CaBr_2$

$$3.4 \times 10^{26} \text{ f.u. } CaBr_2 \times \frac{1 \text{ mol } CaBr_2}{6.022 \times 10^{23} \text{ f.u. } CaBr_2} = 560 \text{ mol } CaBr_2$$

10. 7.5×10^{19} molecules of water

$$7.5 \times 10^{19} \text{ molec. } H_2O \times \frac{1 \text{ mol } H_2O}{6.022 \times 10^{23} \text{ molec. } H_2O} = 1.2 \times 10^{-4} \text{ mol } H_2O$$

Assignment 6: Molar Mass

Determine the molar mass of each compound below.

1. KMnO — 110.05 g/mol
2. KCl — 74.55 g/mol
3. Na_2SO_4 — 142.05 g/mol
4. $Ca(NO_3)_2$ — 164.10 g/mol
5. $Al_2(SO_4)_3$ — 342.17 g/mol
6. $(NH_4)_3PO_4$ — 149.10 g/mol
7. $CuSO_4 \cdot 5H_2O$ — 249.72 g/mol ~~No hydrate~~ anhydrous 159.62 g/mol
8. $Mg_3(PO_4)_2$ — 262.87 g/mol
9. $Zn(C_2H_3O_2)_2 \cdot 2H_2O$ — 219.52 g/mol ~~No hydrate~~ 183.48 g/mol
10. $Zn_3(PO_4)_2 \cdot 4H_2O$ — 458.19 g/mol ~~anhy No hydrate~~ 386.11 g/mol
11. H_2CO_3 — 62.03 g/mol
12. $Hg_2Cr_2O_7$ — ~~461.19 g/mol~~ ~~617.2 169 g/mol~~ 617.16 g/mol
13. $Ba(ClO_3)_2$ — 304.28 g/mol
14. $Fe_2(SO_3)_3$ — 351.91 g/mol
15. $NH_4C_2H_3O_2$ — ~~77.37 g/mol~~ 77.08 g/mol

Assignment 7: Conversions; Mole – Mass Conversions

Examples:

1. How many moles are in 28 grams of CO_2?

$$28\ g\ CO_2 \times \frac{1\ mol\ CO_2}{44.01\ g\ CO_2} = 0.64\ mol\ CO_2$$

2. What is the mass of 5.0 moles of Fe_2O_3?

$$5.0\ mol\ Fe_2O_3 \times \frac{159.7\ g\ Fe_2O_3}{1\ mol\ Fe_2O_3} = 800\ g\ Fe_2O_3$$

$$8.0 \times 10^2\ g\ Fe_2O_3$$

In class practice:

3. Find the number of moles of argon in 452 g of argon.

$$452\ g\ Ar \times \frac{1\ mol\ Ar}{39.95\ g\ Ar} = 11.3\ mol\ Ar$$

4. Find the grams in 1.26 X 10^{-4} mol of $HC_2H_3O_2$.

$$1.26 \times 10^{-4}\ mol\ HC_2H_3O_2 \times \frac{60.05\ g\ HC_2H_3O_2}{1\ mol\ HC_2H_3O_2} = 7.57 \times 10^{-3}\ g\ HC_2H_3O_2$$

5. Find the mass in 2.6 mol of lithium bromide.

$$2.6\ mol\ LiBr \times \frac{86.84\ g\ LiBr}{1\ mol\ LiBr} = 225.79\ g\ LiBr$$

$$230\ g\ LiBr$$

Assignment 8: Moles and Mass

Determine the number of moles in each of the quantities below.

1. 25 g of NaCl

$$25\text{ g NaCl} \times \frac{1\text{ mol NaCl}}{58.44\text{ g NaCl}} = 0.43\text{ mol NaCl}$$

2. 125 g of H_2SO_4

$$125\text{ g } H_2SO_4 \times \frac{1\text{ mol } H_2SO_4}{98.09\text{ g } H_2SO_4} = 1.27\text{ mol } H_2SO_4$$

3. 100. g of $KMnO_4$

$$100.\text{ g } KMnO_4 \times \frac{1\text{ mol } KMnO_4}{158.04\text{ g } KMnO_4} = 0.633\text{ mol } KMnO_4$$

4. 74 g of KCl

$$74\text{ g KCl} \times \frac{1\text{ mol KCl}}{74.55\text{ g KCl}} = 0.99\text{ mol KCl}$$

5. 35 g of $CuSO_4 \cdot 5H_2O$

$$35\text{ g } CuSO_4 \cdot 5H_2O \times \frac{1\text{ mol } CuSO_4 \cdot 5H_2O}{249.72\text{ g } CuSO_4 \cdot 5H_2O} = 0.14\text{ mol } CuSO_4 \cdot 5H_2O$$

Determine the number of grams in each of the quantities below.

6. 2.5 moles of NaCl

$$2.5\text{ mol NaCl} \times \frac{58.44\text{ g NaCl}}{1\text{ mol NaCl}} = 146.1\text{ g NaCl} \quad (150)$$

7. 0.50 moles H_2SO_4

$$0.50\text{ mol } H_2SO_4 \times \frac{98.09\text{ g } H_2SO_4}{1\text{ mol } H_2SO_4} = 49.05\text{ g } H_2SO_4 \quad (49)$$

8. 1.70 moles of $KMnO_4$

$$1.70\text{ mol } KMnO_4 \times \frac{158.04\text{ g } KMnO_4}{1\text{ mol } KMnO_4} = 269\text{ g } KMnO_4$$

9. 0.25 moles of KCl

$$0.25\text{ mol KCl} \times \frac{74.55\text{ g KCl}}{1\text{ mol KCl}} = 19\text{ g KCl}$$

10. 3.2 moles of $CuSO_4 \cdot 5H_2O$

$$3.2\text{ mol } CuSO_4 \cdot 5H_2O \times \frac{249.72\text{ g } CuSO_4 \cdot 5H_2O}{1\text{ mol } CuSO_4 \cdot 5H_2O} = 800\text{ g } CuSO_4 \cdot 5H_2O$$

$$8.0 \times 10^2\text{ g } CuSO_4 \cdot 5H_2O$$

Assignment 9: Conversions; Mole – Volume Conversions

Examples:

1. Determine the volume, in liters, occupied by 2.0 moles of a gas at STP.

$$2.0 \text{ mol} \times \frac{22.4 \text{ L}}{1 \text{ mol}} = 45 \text{ L}$$

2. How many moles of argon atoms are present in 11.2 L of argon gas at STP?

$$11.2 \text{ L Ar} \times \frac{1 \text{ mol Ar}}{22.4 \text{ L Ar}} = 0.500 \text{ mol Ar}$$

In Class Practice:

3. What is the volume of 0.05 mol of neon gas at STP?

~~1.12 L Ne~~

$$0.05 \text{ mol Ne} \times \frac{22.4 \text{ L Ne}}{1 \text{ mol Ne}} = 1 \text{ L Ne}$$

4. What is the volume of 1.2 moles of water vapor at STP?

$$1.2 \text{ mol } H_2O \times \frac{22.4 \text{ L } H_2O}{1 \text{ mol } H_2O} = 27 \text{ L } H_2O$$

~~26.9 L H_2O~~

5. How many moles of gas are there in a 400. L room at STP?

$$400. \text{ L} \times \frac{1 \text{ mol}}{22.4 \text{ L}} = 17.9 \text{ mol}$$

Assignment 10: Moles and Volume

Determine the number of moles in each of the quantities below.

1. 44.8 L of H_2

$44.8\,L\ H_2 \times \frac{1\ mol\ H_2}{22.4\,L\ H_2} = 2.00\ mol\ H_2$

2.00 mol H_2

2. 100. L of SO_3

4.46 mol SO_3

3. 28.0 L of N_2

1.25 mol N_2

4. 60. L of He

2.7

~~2.68~~ mol He

5. 11 L of NH_3

0.49 mol NH_3

Determine the number of liters in each of the quantities below.

6. 1.00 mole of H_2

$1.00\ mol\ H_2 \times \frac{22.4\,L\ H_2}{1\ mol\ H_2} =$

22.4 L H_2

7. 3.20 moles SO_3

71.7 L SO_3

8. 0.750 moles of N_2

16.8 L N_2

9. 1.75 moles of He

39.2 L He

10. 0.50 moles of NH_3

11 L NH_3

Assignment 11: Mixed Mole Problems 1

Given unit → Moles → Desired unit

1. How many oxygen molecules are in 3.36 L of oxygen gas at STP?

$$3.36\ L\ O_2 \times \frac{1\ mol\ O_2}{22.4\ L\ O_2} \times \frac{6.022\times10^{23}\ molec.\ O_2}{1\ mol\ O_2} = 9.03\times10^{22}\ molec.\ O_2$$

2. Find the mass in grams of 2.00×10^{23} molecules of F_2

$$2.00\times10^{23}\ molec.\ F_2 \times \frac{1\ mol\ F_2}{6.022\times10^{23}\ molec.\ F_2} \times \frac{37.96}{\cancel{32.00}\ g\ F_2} \frac{12.6\ g\ F}{\cancel{10.6}\ g\ F_2}$$

3. Determine the volume in liters occupied by 14 g of nitrogen gas at STP.

$$14\ g\ N_2 \times \frac{1\ mol\ N_2}{28.02\ g\ N_2} \times \frac{22.4\ L\ N_2}{1\ mol\ N_2} = 11\ L\ N_2$$

4. Find the mass, in grams, of 1.00×10^{23} molecules of N_2

$$1.00\times10^{23}\ molec.\ N_2 \times \frac{1\ mol\ N_2}{6.022\times10^{23}\ molec.\ N_2} \times \frac{28.02\ g\ N_2}{1\ mol\ N_2} = 4.65\ g\ N$$

5. How many particles are there in 1.43 g of a molecular compound with a molar mass of 233g?

$$1.43\ g \times \frac{1\ mol}{233\ g} \times \frac{6.022\times10^{23}\ molec.}{1\ mol} = 3.70\times10^{21}\ molec.$$

6. Aspartame is an artificial sweetener that is 160 times sweeter than sucrose (table sugar) when dissolved in water. It is marketed by G.D. Searle as Nutra Sweet. The molecular formular of aspartame is $C_{14}H_{18}N_2O_5$.

   a. Calculate the molar mass of aspartame.

   C $14 \times 12.01\ g/mol$
   H $18 \times 1.008\ g/mol$ = 294.30 g/mol
   N $2 \times 14.01\ g/mol$
   O $5 \times 16.00\ g/mol$

   b. How many moles of molecules are in 10.0 g of aspartame?

$$10.0\ g\ C_{14}H_{18}N_2O_5 \times \frac{1\ mol\ C_{14}H_{18}N_2O_5}{294.30\ g\ C_{14}H_{18}N_2O_5} \times$$

0.0340 mol $C_{14}H_{18}N_2O_5$

   c. What is the mass in grams of 1.56 moles of aspartame?

$$1.56\ mol\ C_{14}H_{18}N_2O_5 \times \frac{294.30\ g\ C_{14}H_{18}N_2O_5}{1\ mol\ C_{14}H_{18}N_2O_5} = 459\ g\ C_{14}H_{18}N_2O_5$$

   d. How many molecules are in 5.0 mg of aspartame?

$$5.0\ mg\ C_{14}H_{18}N_2O_5 \times \frac{1\ g}{1000\ mg} \times \frac{1\ mol}{294.30\ g} \times \frac{6.022 \times 10^{23}\ molec.}{1\ mol} = 1.0 \times 10^{19}\ molec.\ C_{14}H_{18}N_2O$$

   e. How many atoms of nitrogen are in 1.2 grams of aspartame?

$$1.2\ g\ C_{14}H_{18}N_2O_5 \times \frac{1\ mol\ C_{14}H_{18}N_2O_5}{294.30\ g\ C_{14}H_{18}N_2O_5} \times \frac{6.022 \times 10^{23}\ molec.\ C_{14}H_{18}N_2O_5}{1\ mol\ C_{14}H_{18}N_2O_5} \times \frac{2\ atoms\ N}{1\ molec.\ C_{14}H_{18}N_2}$$

4.9×10^{21} atoms N

Assignment 12: Mixed Mole Problems 2

*In **1.0** moles of H_2O there are **2.0** moles of Hydrogen atoms and **1.0** moles of oxygen atoms

1. Without doing any detailed calculations (but using a periodic table to give atomic weights), rank the following samples in order of increasing number of atoms: 0.50 mol H_2O; 23 g Na; 6.0×10^{23} N_2 molecules.

Na, H_2O, N_2

1.5 mol atoms H_2O (2) 1 mol atoms Na (1) 2 mol atoms N_2 (3)

2. Without doing any detailed calculations (but using a periodic table to give atomic weights), rank the following samples in order of increasing number of atoms: 3.0×10^{23} molecules of H_2O_2; 2.0 mol CH_4; 32 g O_2

2 mol atoms O_2 (1) 2 mol atoms H_2O_2 (1) 10 mol atoms CH_4 (2)

$H_2O_2 = O_2 < CH_4$

3. A sample of glucose, $C_6H_{12}O_6$, contains 5.77×10^{20} atoms of carbon.

   a. How many atoms of hydrogen does it contain?

$$5.77 \times 10^{20} \text{ C atoms} \times \frac{12 \text{ H atoms}}{6 \text{ C atoms}} = 1.15 \times 10^{21} \text{ H atoms}$$

   b. How many molecules of glucose does it contain?

$$5.77 \times 10^{20} \text{ C atoms} \times \frac{1 \text{ } C_6H_{12}O_6 \text{ molec.}}{6 \text{ C atoms}} = 9.62 \times 10^{19} \text{ molecules } C_6H_{12}O_6$$

   c. How many moles of glucose does it contain?

$$9.62 \times 10^{19} \text{ molec. } C_6H_{12}O_6 \times \frac{1 \text{ mol}}{6.022 \times 10^{23} \text{ molec.}} = 1.60 \times 10^{-4} \text{ mol } C_6H_{12}O_6$$

   d. What is the mass of this sample in grams?

$$1.60 \times 10^{-4} \text{ mol } C_6H_{12}O_6 \times \frac{180.16 \text{ g}}{1 \text{ mol}} = 0.0288 \text{ g } C_6H_{12}O_6$$

4. What is the molar mass of a substance that when there are 0.34 moles it weighs 26.2 grams?

$$\frac{26.7 \text{ g}}{0.34 \text{ mol}} = 77 \text{ g/mol}$$

5. How many moles of $CaBr_2$ are in 34.0 grams of $CaBr_2$

$$34.0\ g\ CaBr_2 \times \frac{1\ mol}{199.88\ g} = 0.170\ mol\ CaBr_2$$

6. How many grams are in 7.57×10^{23} molecules of N_2O_5?

$$7.57 \times 10^{23}\ molec.\ N_2O_5 \times \frac{1\ mol}{6.02 \times 10^{23}\ molec.} \times \frac{108.02\ g}{1\ mol} = 136\ g\ N_2O_5$$

7. Calculate the number of molecules in 0.245 mol CH_3OH.

$$0.245\ mol\ CH_3OH \times \frac{6.02 \times 10^{23}\ molec.}{1\ mol} = 1.47 \times 10^{23}\ molec.\ CH_3OH$$

8. What is the mass in grams of 1.73 mol CaH_2?

$$1.73\ mol\ CaH_2 \times \frac{42.10\ g}{1\ mol} = 72.83\ g\ CaH_2$$

9. Calculate the number of H atoms in 0.585 mol C_4H_{10}.

$$0.585\ mol\ C_4H_{10} \times \frac{10\ mol\ H}{1\ mol\ C_4H_{10}} \times \frac{6.02 \times 10^{23}\ H\ atoms}{1\ mol\ H} = 3.52 \times 10^{24}\ H\ atoms$$

10. How many liters are in 5.35×10^{24} molecules of hydrogen gas?

$$5.35 \times 10^{24}\ molec.\ H_2 \times \frac{1\ mol}{6.02 \times 10^{23}\ molec.} \times \frac{22.4\ L}{1\ mol} = 199\ L\ H_2$$

11. Calculate the moles of Chloride ions in 4.97 g of Aluminum Chloride.

$$4.97\ g\ AlCl_3 \times \frac{1\ mol\ AlCl_3}{133.33\ g\ AlCl_3} \times \frac{3\ mol\ Cl^-}{1\ mol\ AlCl_3} = 0.112\ mol\ Cl^-$$

Assignment 13: Percent Composition

1. The formula of a compound tells us the number of atoms or ions of each type in a unit of the compound.

2. The **Percent Composition by Mass** is the % by mass of each element in the compound.

3. Percent composition = $\frac{\text{subscript of element x molar mass of element}}{\text{molar mass of compound}}$

4. Percent Composition can also be experimentally determined.
   percent composition = $\frac{\text{mass of component in a sample}}{\text{total mass of the sample}}$

5. Calculate the percent composition by mass of each element in the following compounds:

   a. $KMnO_4$ K - 24.74%
   Mn - 34.76%
   O - 40.49%

   b. $Ca(C_2H_3O_2)_2$
   Ca $\frac{40.08}{158.17}$ = 25.34% | $\frac{48.04\ g}{158.17\ g}$ = 30.37% | H $\frac{6.048\ g}{158.17\ g}$ = 3.82% | O $\frac{64.00}{158.17\ g}$ = 40.46%

   c. $PtCl_2(NH_3)_2$
   Pt - $\frac{195.08}{300.05}$ = 65.02% | Cl = $\frac{70.90}{300.05}$ = 23.63% | N $\frac{28.02\ g}{300.05\ g}$ = 9.34% | H $\frac{6.048\ g}{300.05}$ = 2.02%

   d. $CuCl_2$
   Cu - 47.2%
   Cl - 52.8%

   e. SO_3
   S - 40.05%
   O - 59.95%

   f. CCl_4
   C - 7.81%
   Cl - 92.19%

   g. CH_3OH
   C - 37.48%
   H - 12.58%
   O - 49.93%

   h. $(NH_4)_2SO_4$
   N - 21.20%
   H - 6.10%
   S - 24.27%
   O - 48.43%

6. Calculate the percent composition by mass of the indicated element in each of the following:

   a. % Cr in $(NH_4)_2Cr_2O_7$

   41.26%

   b. % H in $Mg(C_2H_3O_2)_2$

   4.25%

   c. % Pt in $PtCl_3$

   64.72%

   d. % Cl in NH_4Cl

   66.28%

Assignment 14: Empirical Formulas

(Section 3.5 and 3.6, Chang), (Section 3.5, Brown and LeMay)

1. What is the difference between an empirical and molecular formula?

2. Give the empirical formula for each of the following compounds.
   a. C_2N_2 CN
   b. C_6H_6 CH
   c. C_9H_{20} C_9H_{20}
   d. P_4H_{10} P_2H_5
   e. B_2H_6 BH_3
   f. $AlBr_3$
   g. $Na_2S_2O_4$ $NaSO_2$
   h. N_2O_5
   i. $K_2Cr_2O_7$
   j. C_9H_{12} C_3H_4

The process of finding an empirical formula can be summarized as follows:

1. % to mass
2. mass to moles
3. divide by small
4. multiply until whole

Examples

1. Ascorbic acid is 40.92 % C, 4.58 % H, and 54.50 % O by mass. Find the empirical formula.

   $C_3H_4O_3$

2. A sample of a compound contains 3.758 g of Carbon, 0.316 g Hydrogen, and 1.251 g of Oxygen. Find the empirical formula.

   C_4H_4O

3. 6.21 g of a cerium (?) iodide contains 1.67 g Cerium (Ce). Assuming that the rest of the mass is due to iodine, find the empirical formula.

   CeI_3

Problems

Determine the empirical formula for each of the following.

1. 5.28 g Sn and 3.37 g F SnF_4

2. 0.104 mol Na, 0.052 mol S, and 0.156 mole O

   Na_2SO_3

3. 11.66 g Iron and 5.01 g Oxygen

   Fe_2O_3

4. 40.0 % C, 6.7 % H, and 53.3 % O

   CH_2O

5. 10.4 % C, 27.8 % S, and 61.7 % Cl

   $CSCl_2$

6. 21.7 % C, 9.6 % O, 68.7 % F

   C_3OF_6

Assignment 15: Hydrate Formulas

A hydrate is an ionic compound with water molecules loosely bonded to its crystal structure. The water is in a specific ratio to each formula unit of the salt. For example, the formula $CuSO_4 \bullet 5H_2O$ indicates that there are five water molecules for every one formula unit of Copper(II) Sulfate.

Examples

What is the formula for each of the following hydrates below?

1. 0.391 g Li_2SiF_6 and 0.0903 g H_2O

$Li_2SiF_6 \cdot 2H_2O$

2. 0.737 g $MgSO_3$ and 0.763 g H_2O

$MgSO_3 \cdot 6H_2O$

Problems

1. 95.3 g $LiNO_3$ and 74.7 g H_2O

$LiNO_3 \cdot 3H_2O$

2. 76.9 % $CaSO_3$ and 23.1 % H_2O

$CaSO_3 \cdot 2H_2O$

3. 89.2 % $BaBr_2$ and 10.8 % H_2O

$BaBr_2 \cdot 2H_2O$

4. Epsom salts, a strong laxative used in veterinary medicine, is a hydrate, which means that a certain number of water molecules care included in the solid structure. The formula for Epsom salts can be written as $MgSO_4 \times H_2O$, where x indicates the number of moles of water per mole of $MgSO_4$. When 5.061 g of this hydrate is heated to 250 °C, all of the water of hydration is lost, leaving 2.472 g of $MgSO_4$. Determine the formula for the hydrate.

5. Washing soda, a compound used to prepare hard water for washing laundry, is a hydrate, Its formula can be written as $Na_2CO_3 \times H_2O$, where x is the number of moles of water per mole of Na_2CO_3. When a 2.558 g sample of washing soda is heated at 125 °C, all the water of hydration is lost, leaving 0.948 g of Na_2CO_3. What is the formula for the hydrate?

Assignment 16: Molecular Formulas

(p. 83-84 Chang) (p. 93, Brown and LeMay)

.e process of finding a molecular formula:

1. Find the empirical formula.
2. Calculate the FW of the empirical formula.
3. Find the Molecular Weight given in the problem.
4. Divide the MW by the FW. Round to a whole number.
5. Multiply all subscripts in the empirical formula by the whole number.

Examples

1. Mesitylene has an empirical formula of C_3H_4. The molecular weight is 121 amu. Find the molecular formula. C_9H_{12}

2. Ethanol is 52.2 % C, 13.0 % H, and 34.8 % O. It has a molar mass of 46.0 g. Find the molecular formula. C_2H_6O

Problems

3. Benzene has a molecular weight of 78 amu and the empirical formula CH. Find the molecular formula. C_6H_6

4. What is the molecular formula of a substance with a molar mass of 184.5 g/mol and the empirical formula CClN? $C_3Cl_3N_3$

5. Find the molecular formula for epinephrine (adrenaline) a hormone secreted into the bloodstream in times of danger or stress. It is found to be 59.0 % C, 7.1 % H, 26.2 % O, and 7.7 % N by mass. The molecular weight is about 180 amu. $C_9H_{13}O_3N$

6. Find the molecular formula for nicotine, a component of tobacco.
   74.1 % C, 8.6 % H, 17.3 % N
   Molar mass = 160 +/- 5 g $C_{10}H_{14}N_2$

7. Find the molecular formula for ethylene glycol, the substance used as the primary coolant in antifreeze solutions.
   38.7 % C, 9.7 % H, 51.6 % O
   MW = 62.1 amu $C_2H_6O_2$

8. Find the molecular formula for caffeine, a stimulant found in coffee.
   49.5 % C, 5.15 % H, 28.9 % N, 16.5 % O
   Molar mass is about 195 g $C_8H_{10}N_4O_2$