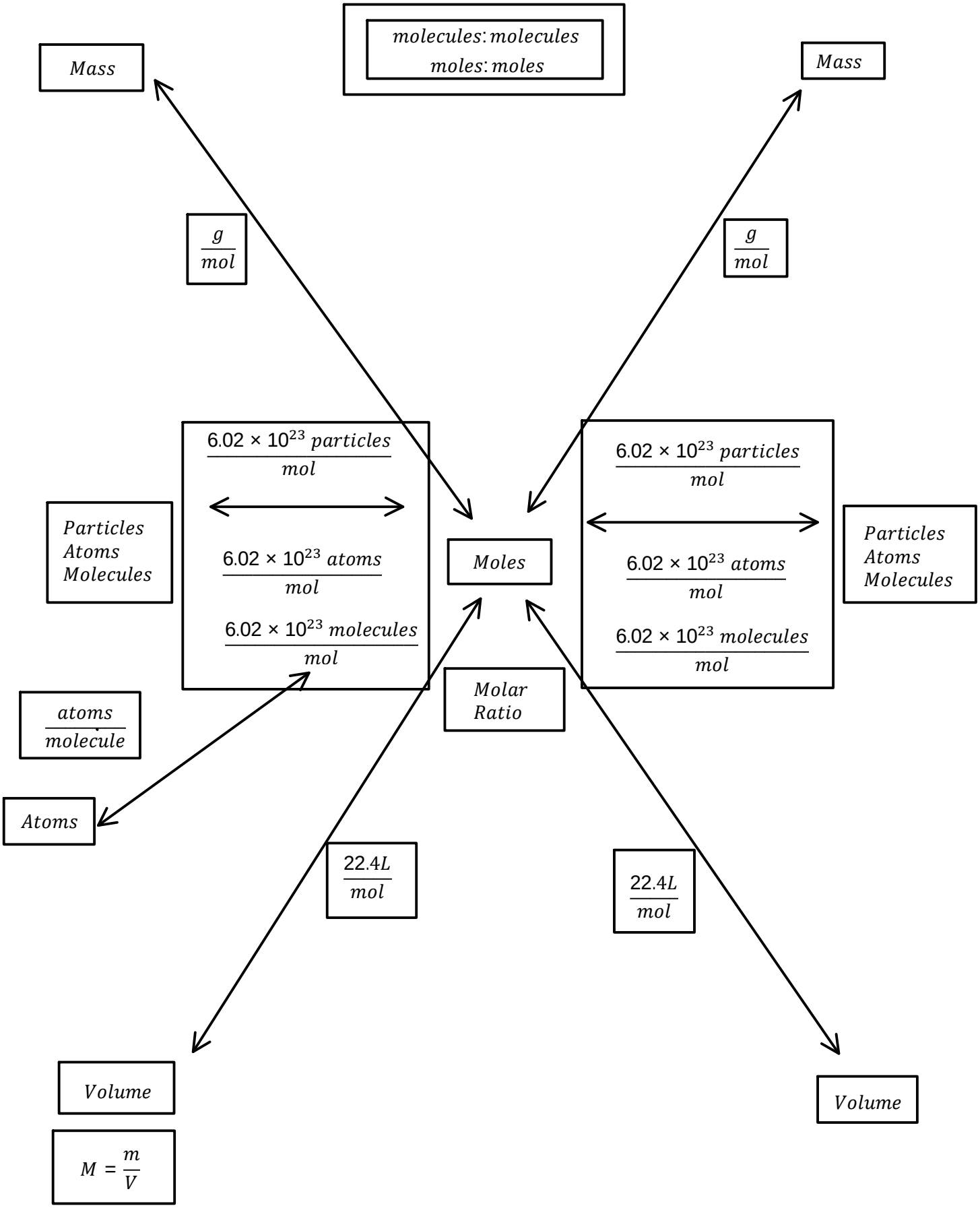
C11 - 1.0 - Mole Hill Review



Notes

C11 - 1.1 - Density Notes

Density: Mass per unit Volume

What is the density of an object with a mass of 100 *g and a volume of* 20 *mL*?

$$D = \frac{m}{V}$$

$$D = \frac{100}{20}$$

$$D = 5\frac{g}{mL}$$

$$D = \frac{m}{V}$$

What is the mass of an object with a density of $12\frac{kg}{L}$ *occupying* 48 *L*?

$$D = \frac{m}{V}$$

$$12 = \frac{m}{48}$$

$$48 \times 12 = m$$

$$m = 576\ kg$$

$$D = \frac{m}{V}$$
$$m = DV$$
$$m = 12 \times 48$$
$$m = 576\ kg$$

What is the volume of a 20 *kg object with a density of* $8\frac{g}{L}$?

$$D = \frac{m}{V}$$

$$8 = \frac{20}{V}$$

$$8V = 20$$

$$V = \frac{20}{8}$$

$$V = 2.5\ L$$

$$D = \frac{m}{V}$$
$$V = \frac{m}{D}$$
$$V = \frac{20}{8}$$
$$v = 2.5\ L$$

C11 - 1.2 - Molar Mass Element/Molecule Notes

Molar mass: the mass of one mole of particles

The mass of a single atom is too small to measure on a conventional scale.

Chemists decided to measure the mass of 6.02×10^{23} *particles of Carbon to be* 12 *grams and to call that one mol of Carbon.*

Just like how it would be silly to ask your weight in milligrams. So similarly we decided to call $1000mg$ $1kg$ *and measure people in* kg.

Calculate the molar mass of the following, assume 1 mol?

Cl $\quad mass\ Cl = 35.5g$ $\quad mass\ Cl = \frac{35.5g}{mol}$

N_2 $\quad mass\ N_2 = 2N = 2 \times 14g = 28g$ $\quad mass\ N_2 = \frac{28\ g}{mol}$

H_2O $\quad mass\ H_2 = 2H = 2 \times 1g = 2g$

$mass\ O = 1O = 1 \times 16g = 16g$

$= 18g$ $\quad mass\ H_2O = \frac{18\ g}{mol}$

$2FeO$ $\quad mass\ 2Fe = 2Fe = 2 \times 55.8g = 111.6g$

$mass\ 2O = 2O = 2 \times 16g = 32g$

$= 143.6g$ $\quad mass\ 2FeO = \frac{143.6\ g}{mol}$

What is the molar mass of a 4.3 *gram sample of* 0.125 *mol* CO_2?

$$molar\ mass = \frac{4.3\ g}{0.15\ mol}$$

C11 - 1.3 - Mass <-> Moles Notes

Mole: The number of Carbon atoms in 12g of Carbon

Conversion Factors $\boxed{\frac{g}{mol}}$ *Molar Mass: Periodic Table*

How many eggs in 2 dozen?

$$2\ dozen\ eggs \times \frac{12}{dozen} = 24\ eggs$$

$\frac{12}{dozen}$

How many moles in 12g of Carbon? By Definition

$$Moles\ Carbon = 12g\ Carbon \times \frac{1\ mol}{12g} = 1\ mol\ C$$

How many moles in 24g of Carbon?

$$Moles\ Carbon = 24g\ Carbon \times \frac{1\ mol}{12g} = 2\ mol\ C$$

How many moles in 12g of Helium?

$$Moles\ Helium = 12g\ Helium \times \frac{1\ mol}{4g} = 3\ mol\ He$$

How many moles in 25g of Sodium?

$$Moles\ Sodium = 25g\ Sodium \times \frac{1\ mol}{23g} = 1.09\ mol\ Na$$

How many moles in 50g of H_2O?

$$Moles\ H_2O = 50g\ Helium \times \frac{1\ mol}{18g} = 2.78\ mol\ He$$

How many grams of Carbon in 3 moles of Carbon?

$$g\ Carbon = 3\ moles\ Carbon \times \frac{12\ g}{1\ mol} = 36\ g\ C$$

What is the mass of 3.5 moles of CO_2?

$$g\ CO_2 = 3.5\ moles\ CO_2 \times \frac{44\ g}{1\ mol} = 154\ g\ C$$

C11 - 1.4 - Moles <-> Atoms/Particles Notes

Equal moles of different elements contains the same number of particles.

Conversion Factors

Avogadro's # $\frac{6.02 \times 10^{23}\ molecules}{mol}$ $\frac{6.02 \times 10^{23}\ atoms}{mol}$ $\frac{6.02 \times 10^{23}\ particles}{mol}$

How many atoms in 1 *mol of Carbon*?

$$Atoms\ Carbon = 1\ mol\ Carbon \times \frac{6.02 \times 10^{23}\ atoms}{mol} = 6.02 \times 10^{23}\ atoms\ Carbon$$ *By Definition*

How many particles in 1 *mol of Carbon*?

$$Particles\ Carbon = 1\ mol\ Carbon \times \frac{6.02 \times 10^{23}\ particles}{mol} = 6.02 \times 10^{23}\ particles\ Carbon$$ *By Definition*

How many atoms in 3 *mol of Helium*?

$$Atoms\ Helium = 3\ mol\ Helium \times \frac{6.02 \times 10^{23}\ atoms}{mol} = 18.06 \times 10^{23}\ atoms\ Helium$$

Because carbon is three times the mass of helium, the number of atoms in 12 g of helium is three times the number of atoms in 12 g of carbon.

How many moles in 2.18×10^{28} *particles of Helium*?

$$moles\ Helium = 2.18 \times 10^{24}\ particles\ Helium \times \frac{mol}{6.02 \times 10^{23}\ particles} = 3.62\ moles\ He$$

How many moles in 8.38×10^{12} *atoms of Al*?

$$moles\ Al = 8.38 \times 10^{12} atoms\ Al \times \frac{mol}{6.02 \times 10^{23}\ atoms} =$$

C11 - 1.4 - Moles <-> Molecules Notes

Equal moles of different elements contains the same number of particles.

Conversion Factors

Avogadro's #

$$\frac{6.02 \times 10^{23}\ molecules}{mol} \qquad \frac{6.02 \times 10^{23}\ atoms}{mol} \qquad \frac{6.02 \times 10^{23}\ particles}{mol}$$

How many moles in 5 *molecules of Carbon Dioxide*?

$$moles\ CO_2 = 5\ molecules\ CO_2 \times \frac{mol}{6.02 \times 10^{23}\ molecule} = 8.31 \times 10^{-24}\ moles\ CO_2$$

How many molecules of FeO in 2 *moles of FeO*?

$$molecules\ FeO = 2\ moles\ FeO \times \frac{6.02 \times 10^{23}\ molecule}{mol} =$$

C11 - 1.5 -Moles <-> Volume STP Notes

Avagadros Hypothesis: Equal volumes of different gases, at the same temperature and pressure contain the same number of particles.

Conversion Factors $\boxed{\frac{22.4L}{mol}}$ *@ STP; Standard Temperature and Pressure*

What is the volume occupied by 1 *mol of* $N_{2(g)}$ *at STP?*

$$\#\ Litres = 1\ mol \times \frac{22.4\ L}{mol} = 22.4\ L\ N_{2(g)}$$ *By Definition*

What is the volume occupied by 0.5 *mol of* $O\_(2(g))$ *at STP?*

$$\#\ Litres = 0.5\ mol \times \frac{22.4\ L}{mol} = 11.2\ L\ O_{2(g)}$$

How many moles of CO_2 *gas in a balloon with a volume of* 50 L *at STP?*

$$\#\ of\ Moles\ CO_2 = 50\ L \times \frac{1\ mol}{22.4\ L} = 2.23\ mol\ CO_{2(g)}$$

C11 - 1.6 - Mass <-> Moles <-> Volume STP Notes

What is the volume occupied by 12 g of carbon gas at STP?

$$Volume\ Carbon = 12\ g\ Carbon \times \frac{1mol}{12g} \times \frac{22.4L}{mol} = 22.4\ L\ Carbon \qquad By\ definition$$

What is the volume occupied by 32 g of oxygen gas at STP?

$$Volume\ Oxygen = 32\ g\ Oxygen \times \frac{1mol}{16g} \times \frac{22.4L}{mol} = 44.8\ L\ Oxygen$$

What is the volume occupied by 100 g of boron gas at STP?

$$Volume\ Boron = 100\ g\ Oxygen \times \frac{1mol}{10.8g} \times \frac{22.4L}{mol} = 207.4\ L\ Oxygen$$

What is that mass of 22.4 L of nitrogen gas at STP?

$$mass\ Nitrogen = 22.4L\ Nitrogen \times \frac{1mol}{22.4L} \times \frac{14g}{mol} = 14\ g\ Nitrogen \qquad By\ definition$$

What is the mass of two litres of helium gas at STP?

$$mass\ Helium = 2\ L\ Helium \times \frac{1mol}{22.4L} \times \frac{4g}{mol} = 0.357\ g\ Helium$$

C11 - 1.6 - Mass <-> Moles <-> Atoms/Particles Notes

How many atoms in 12 g of carbon?

$$atoms\ Carbon = 12\ g\ Carbon \times \frac{1mol}{12g} \times \frac{6.02 \times 10^{23}\ atoms}{mol} = 6.02 \times 10^{23} atoms \qquad By\ definition$$

How many atoms in 4 g of helium?

$$atoms\ Helium = 4\ g\ Helium \times \frac{1mol}{4g} \times \frac{6.02 \times 10^{23}\ atoms}{mol} = 6.02 \times 10^{23} atoms$$

How many particles in 24 g of carbon?

$$particles\ Carbon = 24g\ Carbon \times \frac{1mol}{12g} \times \frac{6.02 \times 10^{23}\ particles}{mol} = 12.04 \times 10^{23} particles$$

How many atoms in 50 g of oxygen?

$$atoms\ Oxygen = 50g\ Oxygen \times \frac{1mol}{16g} \times \frac{6.02 \times 10^{23}\ atoms}{mol} = 1.88 \times 10^{24} atoms$$

$What\ is\ the\ mass\ of\ 6.02 \times 10^{23}\ atoms\ of\ carbon?$

$$mass\ Carbon = 6.02 \times 10^{23} atoms\ Carbon \times \frac{1mol}{6.02 \times 10^{23} atoms} \times \frac{12g}{mol} = 12\ g\ Carbon \qquad By\ definition$$

$What\ is\ the\ mass\ of\ 3.18 \times 10^{24}\ atoms\ of\ Sodium?$

$$mass\ Sodium = 3.18 \times 10^{24} atoms\ Sodium \times \frac{1mol}{6.02 \times 10^{23} atoms} \times \frac{23g}{mol} = 121.49\ g\ Sodium$$

$What\ is\ the\ mass\ of\ 100\ atoms\ of\ Lithium?$

$$mass\ Lithium = 100\ atoms\ Sodium \times \frac{1mol}{6.02 \times 10^{23} atoms} \times \frac{6.9g}{mol} = 1.15 \times 10^{-21}\ g\ Lithium$$

C11 - 1.7 - Molecules/Moles <-> Atoms Notes

How many atoms in one molecule of Iron (III) oxide?

$Fe^{+3}O^{-2}$
Fe_2O_3

$$atoms\ Fe_2O_3 = molecule\ Fe_2O_3 \times \frac{5\ atoms}{molecule} = 5\ atoms$$

How many oxygen atoms in one molecule of iron (III) oxide?

$$atoms\ Oxygen = 1\ molecule\ Fe_2O_3 \times \frac{3\ Oxygen\ atoms}{1\ molecule\ Fe_2O} = 3\ Oxygen\ atoms$$

How many hydrogen atoms in two molecules of water?

$H^{-1}O^2$
H_2O
$2H_2O$

$$atoms\ Hydrogen = 2\ molecule\ H_2O \times \frac{2\ H\ atoms}{1\ molecule\ H_2O} = 4\ H\ atoms$$

How many atoms in one mole of calcium nitrate?

$Ca^{-2}(NO_3)^{-1}$
$Ca(NO_3)_2$

$$atoms\ N = 1\ mol\ Ca(NO_3)_2 \times \frac{6.02 \times 10^{23} molecules}{1\ mol\ Ca(NO_3)_2} \times \frac{9\ N\ atoms}{1 Ca(NO_3)_2\ molecule} = 9999\ atoms\ N$$

How many Nitrogen atoms in one mole of calcium nitrate?

$$atoms\ N = 1\ mol\ Ca(NO_3)_2 \times \frac{6.02 \times 10^{23} molecules}{1\ mol\ Ca(NO_3)_2} \times \frac{2\ N\ atoms}{1 Ca(NO_3)_2\ molecule} = 12.04 \times 10^{23}\ atoms\ N$$

How many Oxygen atoms in one mole of calcium nitrate?

$$atoms\ O = 1\ mol\ Ca(NO_3)_2 \times \frac{6.02 \times 10^{23} molecules}{1\ mol\ Ca(NO_3)_2} \times \frac{6\ Oxygen\ atoms}{1 Ca(NO_3)_2\ molecule} = 3.61 \times 10^{24} atoms\ oxygen$$

C11 - 1.7 - Molecules <-> Mass Notes

$Find\ the\ mass\ of\ 2\ molecules\ of\ water\ H_2O.$

$$mass\ H_2O\ =\ 2\ molecules\ H_2O\ \times \frac{1mol}{6.02\times10^{23}\ molecules} \times \frac{18\ g}{mol} =$$

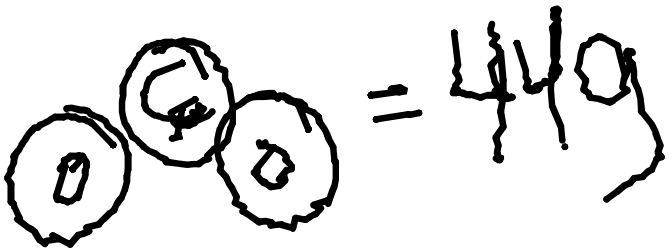
$Find\ the\ number\ of\ molecules\ in\ 48\ g\ of\ CH_4.$

$$molecules\ CH_4\ =\ 48\ g\ CH_4\ \times \frac{mol}{16g} = \frac{6.02\times10^{23} molecules}{mol} =$$

C11 - 1.7 - Mass <-> Mol <-> Molecules <-> Atoms

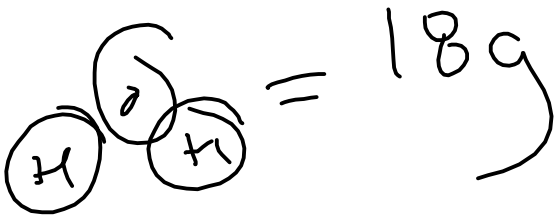
How many atoms in 80 $g\ CO_2$?

$$atoms\ CO_2 = 80\ g\ CO_2 \times \frac{1\ mol}{44\ g} \times \frac{6.02 \times 10^{23} molecules}{mol} \times \frac{3\ atoms}{molecule} = 3.28 \times 10^{24}$$



What is the mass of 3.24 × 10^{24} *atoms* H_2O?

$$mass\ H_2O = 3.24 \times 10^{24}\ atoms\ H_2O \times \frac{1\ molecule}{3\ atoms} \times \frac{1\ mol}{6.02 \times 10^{23}\ molecules} \times \frac{18g}{mol} = 32.29\ g\ H_2O$$



C11 - 1.8 - Percent Composition Notes

Find the Percent Compsotion?

Percent Composition: Percent by mass of the animal in the compound.

2 *red balls*
3 *black balls*
5 *total balls*

$$\% \, red = \frac{2}{5} \times 100\%$$
$$\% \, red = 40\%$$

$$\% \, black = \frac{3}{5} \times 100\%$$
$$\% \, black = 60\%$$

4 kg *air*
1 kg *pollution*
5 kg *total*

$$\% \, air = \frac{4}{5} \times 100\%$$
$$\% \, air = 80\%$$

$$\% \, air = \frac{1}{5} \times 100\%$$
$$\% \, air = 20\%$$

CH_4

$$mass \, H_4 = 4H = 4 \times 1g = 4g$$
$$mass \, C = 1C = 1 \times 12g = 12g$$
$$= 16g$$

$$\%C = \frac{12}{16} \times 100\%$$
$$\%C = 75\%$$

$$\%H = \frac{4}{16} \times 100\%$$
$$\%H = 25\%$$

H_2O

$$mass \, H_2 = 2H = 2 \times 1g = 2g$$
$$mass \, O = 1O = 1 \times 16g = 16g$$
$$= 18g$$

$$\%H = \frac{2}{18} \times 100\%$$
$$\%H = 999\%$$

$$\%C = \frac{16}{18} \times 100\%$$
$$\%C = 999\%$$

FeO

$$mass \, Fe = Fe = 55.8g$$
$$mass \, O = O = 16g$$
$$= 71.8g$$

$$\%Fe = \frac{55.8}{71.8} \times 100\%$$
$$\%H = 999\%$$

$$\%H = \frac{16}{71.8} \times 100\%$$
$$\%H = 999\%$$

C11 - 1.8 - Empirical/Molecular Formula Notes

Empirical Formula: aka The simplest formula of the compound.

Assume $100g$

What is the Empirical Formula of a compound with 80% *Carbon and* 20% *Hydrogen*?

$$moles\ Carbon = 80\ g\ Carbon \times \frac{1mol}{12g} = 6.67\ moles\ C$$

$$moles\ Hydrogen = 20\ g\ Hydrogen \times \frac{1mol}{1g} = 20\ moles\ H$$

Molar Ratio

$moles\ C : moles\ H$
$6.67\ C : 20\ H$
$1\ C : 3\ H$

CH_3

Molecular Formula: formula of the compound

Empirical Mass: Molar Mass of the Empirical Formula

A molecule has an Empirical Formula of NO *and a Molar Mass of* 90 g. *What is the Molecular Formula*?

$$Empirical\ Mass\ NO = \frac{30g}{mol} \qquad 14\ g + 16\ g = 30g$$

$$N = \frac{Molar\ Mass}{Empirical\ Mass}$$
$$N = \frac{90}{30}$$
$$N = 3$$

$$molecular\ Formula = N \times Empirical\ Formula$$
$$molecular\ Formula = 3 \times (NO)$$
$$molecular\ Formula = N_3O_3$$

Molecular Formula N_3O_3

C11 - 1.9 - Molar Concentration/Molarity (c) Notes

$Conentration$: $Amount\ of\ Substance\ in\ a\ given\ Volume\ of\ Solution$

$Molarity$: $\#\ of\ Moles\ in\ 1\ Litre\ of\ Solution.$

$What\ is\ the\ Molarity\ of\ 2\ moles\ of\ LiBr\ contained\ in\ 5\ L\ of\ solution?$

$$c = \frac{n}{V}$$

$$c = \frac{2\ mol}{5\ L}$$

$$c = \frac{0.4\ mol}{L}$$

$$c = 0.4\ M$$

$[LiBr]\ 0.4\ M$

$c = Molarity$

$n = number\ of\ moles$

$V = Volume\ in\ Litres$

$$M = \frac{mol}{L}$$

$$c = \frac{n}{V}$$

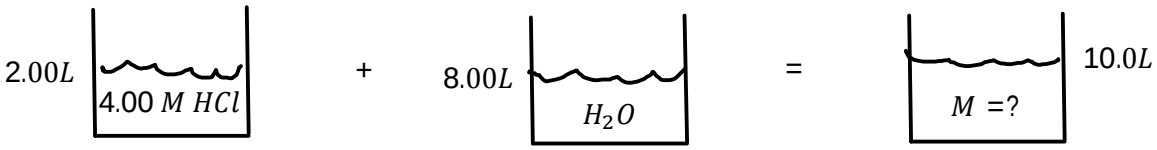
C11 - 1.9 - Dilution Moles-->Molarity Notes

$$Molarity\ of\ Mixture = \frac{total\ Moles\ of\ Chemicals}{total\ Volume\ of\ Mixture} \qquad Molarity = \frac{moles}{Volume} \qquad \boxed{c = \frac{n}{V}}$$

What is the Molarity Concentration of 2 *moles of HCl in* 4 *Litres of water*?

$$c = \frac{n}{V}$$
$$c = \frac{2moles}{4Litres}$$
$$c = 0.5\ M\ HCl$$

If 2.00 *L of* 4.00 *M HCl is added to* 8.00*L of Water what is the Molarity of the Mixture*?

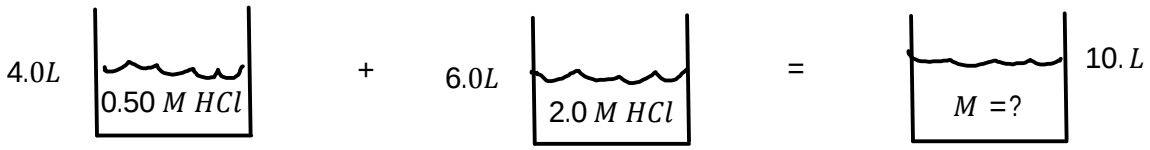


$c = \frac{n}{V}$
$c = MV$
$c = 4.00\ M\ HCl \times 2.00\ L$
$c = 8.00\ moles\ HCl$

Find # of moles, Find Molarity

$c = \frac{n}{V}$
$c = \frac{8.00\ moles}{10.0L}$
$c = 0.800\ M\ HCl$

If 4.0 *L of* 0.50 *M HCl is added to* 6.0*L of* 2.0 *M HCl what is the Molarity of the Mixture*?



$c = \frac{n}{V}$
$c = MV$
$c = 0.50\ M\ HCl \times 4.0\ L$
$c = 2.0\ moles\ HCl$

$c = \frac{n}{V}$
$c = MV$
$c = 2.0\ M\ HCl \times 6.0\ L$
$c = 12.0\ moles\ HCl$

$c = \frac{n}{V}$
$c = \frac{12.\ moles}{10.0L}$
$c = 1.2\ M\ HCl$

Find # of moles, Twice, Find Molarity